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Vol. 1

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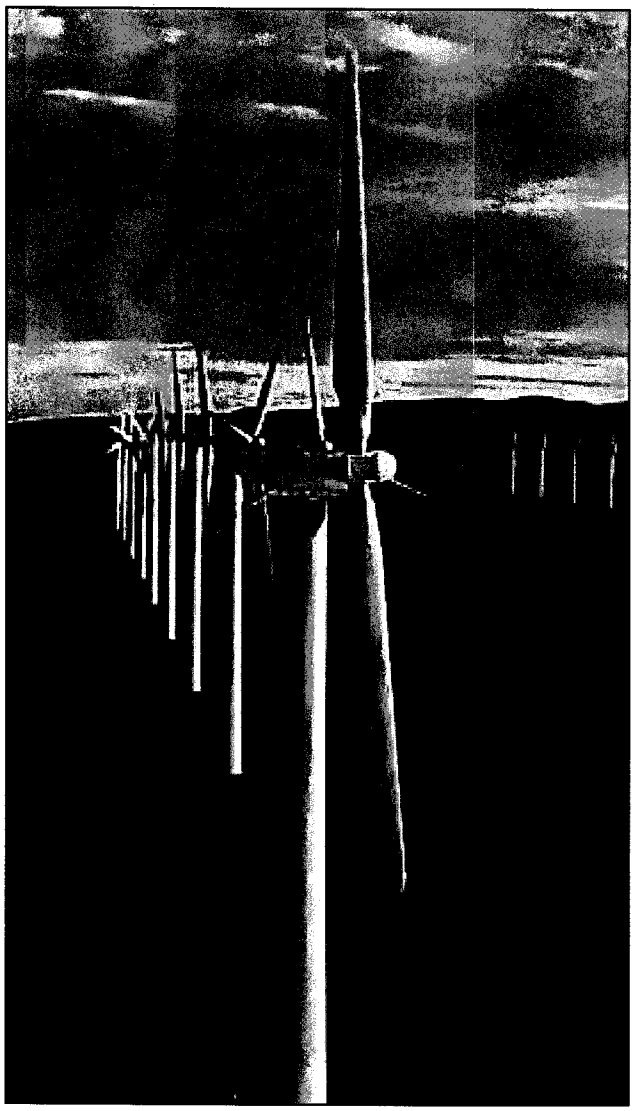

FEASIBILITY STUDY CALAMA WIND FARM

FINAL REPORT

PUBLIC VERSION VERSION – FULL REPORT

Report Prepared by:
SeaWest WindPower, Inc.
4542 Ruffner Street, Suite 200
San Diego, CA 92111-2239

This report was funded by the U.S. Trade and Development Agency (USTDA), a foreign assistance agency of the U.S. Government. **The opinions, findings, conclusions, or recommendations expressed in this document are those of the author(s) and do not necessarily represent the official position or policies of USTDA.**

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Pat Daughetee
Grants Administrator
USTDA
1000 Wilson Blvd., Suite 1600
Arlington, VA 22209

RE: Copyright Language in Public Versions of Feasibility Study of Calama Wind Farm, Final Report

Dear Ms. Daughetee:

This letter serves as notification from AES SeaWest, Inc (formerly know as SeaWest WindPower, Inc.) that the information contained in the below listed exhibits may be disseminated in the Public Versions of the Feasibility Study of Calama Wind Farm - Final Report, prepared by AES SeaWest, Inc., and they are not otherwise subject to a copyright limitation for this purpose.

1. Appendix G - Fluor Daniel's Analysis of Wind Plant interconnection in the SING
2. Appendix I – Fluor Daniel's Wind Turbine and Tower Layout and Installation of Calama Wind Farm
3. Appendix J – Trexler and Associates, Inc Baseline Study of CO_2 Credits for Calama Wind Farm

Thank you,

AES SEAWEST, INC.

Michael Azeka
Vice President

AES SeaWest, Inc.
4542 Ruffner Street, Suite 200
San Diego, California 92111-2239

www.aes.com
Telephone: 858.268.7909
Facsimile: 858.277.5721

DRAFT TERMS OF REFERENCE (TOR)
and CRITICAL PATH for ENVIRONMENTAL IMPACT STATEMENT ("DIA")
CALAMA WIND FARM

Deuman Engineering and Rescan analyzed the process and requirements of performing an environmental analysis and impact assessment for a potential wind farm on the Calama sites. Based on the conditions and impacts of a potential wind project at these sites, it was determined that an Environmental Impact Statement ("DIA") would be more appropriate and would meet the regulatory requirements, rather than an Environmental Impact Assessment ("EIA"). The reasons for this are contained in Section 8, pages 119 through 124 of the Final Report.

The following information describes the Scope of the DIA, the Critical Path schedule that would be needed to prepare the DIA, and an estimated budget.

1. Preparation of DIA:
   a. Prepare Project Description, including drawing showing project layout, wind turbine elevation, foundation schematic design, road sections and layout, electrical system layout, and a written description of all the proposed facilities. Description shall include project name, project sponsor, investment kind and amount, justification of the project, technology used, and proposed phasing.

   b. Determine baseline environmental conditions, gather data and perform studies. Studies shall be of sufficient detail to evaluate the existing biological, cultural, geographic, political-administrative location, and historic conditions of the site(s).

   c. Evaluate and describe the environmental characteristics of the Project site(s) and the expected environmental impacts of the Project relative to the criteria contained in Statutory Decree DS 95/01 issued in 2001. Meet with Regional Environmental Commission (COREMA) and/or the National Environmental Commission (CONAMA) to discuss the preliminary findings and secure concurrence on the scope of the DIA.

   d. Forecast and assess the environmental impacts of the Project relative to the criteria contained in Statutory Decree DS 95/01 issued in 2001.

   e. Prepare the DIA report and submit it for review by COREMA and/or CONAMA.

   f. Respond to questions or comments, and finalize the DIA.

2. Critical Path Schedule
   a. Preparation of Project Description (prepare preliminary project design, drawings, interconnection plan and write up description): 2 months
   b. Prepare baseline environmental conditions: 2 months

c. Prepare and submit preliminary environmental findings to COREMA and CONAMA for concurrence on scope of the DIA: 2 months
d. COREMA and CONAMA review of preliminary findings and scope: 1 month
e. Potential new studies required as a result of COREMA and CONAMA review and comments: 0 to 13 months, depending on scope, comments from COREMA and CONAMA and specific topics to be addressed
f. Prepare and submit DIA to COREMA and/or CONAMA: 1 month
g. COREMA/CONAMA review (3 months)
h. Completion of DIA review and issuance of decision: 1 month

Total Time for preparation of project design, studies, documents and approval by COREMA/CONAMA: 12 to 25 months

3. Estimated Budget

a. Prepare Project Description, including drawing showing project layout, wind turbine elevation, foundation schematic design, road sections and layout, electrical system layout, and a written description of all the proposed facilities.
$US 50,000 to $US 95,000

b. Determine baseline environmental conditions, gather data and perform studies.
$US 35,000 to $US 50,000

c. Evaluate and describe the environmental characteristics of the Project site(s) and the expected environmental impacts of the Project relative to the criteria contained in Statutory Decree DS 95/01 issued in 2001.
$US 15,000 to $US 25,000

d. Forecast and assess the environmental impacts of the Project relative to the criteria contained in Statutory Decree DS 95/01 issued in 2001.
$US 18,000 to $US 35,000

e. Prepare the DIA report and submit it for review by COREMA and/or CONAMA.
$US 5,000 to $US 10,000

f. Respond to questions or comments, and finalize the DIA.
$US 1,000 to $US 20,000

SUMMARY OF BUDGET ESTIMATE: $US 124,000 TO $US 235,000

List of Subcontractors Who Have Worked On
Feasibility Study, Calama Wind Farm

1. Wireless Energy Chile Ltda.
Parcela 6; Km 6.5, Route 5,
Puerto Montt, Chile
Contact: **Nelson Stevens**
(Company that installed and mounted the meteorological towers for the monitoring of winds and performed a preliminary soil investigation in October 2002.)

2. Ron Nierenberg- Consulting Meteorologist-
Address: 850 NW View Ridge Court, Camas, WA 98607 U.S.A.

3. NRG Systems Inc. Met Tower Supplier
110 Commerce Street, Hinesburg,
Vermont 05461 U.S.A.

4. Bill Sefton
Data analyst U.S.A.
6191 Rancho Mission Rd., # 310
San Diego, CA 92108
PH: (619) 885-8097
Fax: (775) 249-8270
Bill@seftek.com

5. Deuman Engineers Ltda. –
Jaime Parada, Executive Director
Pablo Cayunao H., Mechanical Engineer
Address: Av Vitacura 2909 Suite 617 Las Condes, Santiago, Chile

6. Interplex Solar Inc. (Lighting)
1003 W. Thomas St.
Arlington Heights, Illinois 60004-4547

7. Trexler & Associates, Inc.
516 SE Morrison St., Suite 1100
Portland, Oregon
website: www.climate services.com

Annex T
United States Sources of Supply for the Project

Equipment Suppliers:

GE Wind Energy (wind turbines)
13000 Jameson Rd.
Tehachapi, CA 93561 USA
Contact: Jeff Ghilardi (760) 294-2482

Vestas - American Wind Technology Inc. (wind turbines)
111 SW Columbia, Suite 480
Portland, OR 97201
Contact: Soren Christensen (760) 329-8226

Second Wind (Wind SCADA systems)
366 Summer Street
Somerville, MA 02144
Contact: Jamie Schwartz (617) 776-8520

NRG Systems (wind measurement towers & equipment)
110 Riggs Road
Hinesburg, Vermont 05461
Contact: David Simkins (802) 482-2255

IsoTruss, Inc. (wind measurement towers)
1080 North Main Street
Suite One
Brigham City, Utah 84302
Contact: Christine Mikell 801-565-9096

Radian Communication Services (wind measurement towers)
740 E. Campbell Road, Suite 100
Richardson, TX 75081
Contact: Mark Triplett (972)669-5175

Valmont Industries (wind measurement towers)
1545 Pidco Drive
Plymouth, IN 46563-4005 USA
Contact: John R. Erichsen 574-936-4221

Honeywell Airport Systems (aircraft lights)
2162 Union Place
Simi Valley, CA 93065
Contact: Sales (805) 581-5591

Flash Technologies
213 Barrington Court West
Franklin, TN 37067
Contact: Guy Bowker (615) 591-4609

Meteorology

Garrard Hassan Americas (meteorology, due diligence)
11770 Bernardo Plaza Ct., Suite 209
San Diego CA 92128
Contact: Bernie Holst (858) 451-7013

Windots (consulting meteorologist)
80 Alta Vista Avenue
Mill Valley, CA 94941
Contact: Richard Simon (415) 381-2245

AWS Truewind, LLC (wind forecasting & mapping)
255 Fuller Road
Suite 274
Albany, New York 12203
Contact: Sales 1-518-437-8660

Specialized Wind Services

Patrick & Henderson (wind turbine foundations)
1965 Airport Drive
Bakersfield, CA 93308
Contact: Allan Henderson (661) 391-9854

Barr Engineering (wind turbine foundations)
4700 West 77th Street
Minneapolis, MN 55435-4803
Contact: Christopher Kopchynski (800)832-2277

Minner, Stinnett, Koo & Agbayani (turbine tower engineering)
1716 Oak St. #21
Bakersfield, CA 93301
Contact: Nestor Agbayani (661) 324-9724

3-Tier Environmental Group (wind energy forecasting)
2825 Eastlake Ave East, Suite 330
Seattle WA 98102
Contact: Pasquel Storck (206) 325-1573

General Power Engineering/Design/Construction

Fluor Daniel Inc. (Full EPC, development)
1 Fluor Daniel Drive
Aliso Viejo, CA 92656
Contact: David Eppinger (949)349-2000

GE Power Systems (Substation & UG Electrical Design)
3633 E. Inland Empire Blvd, Ste. 800
Ontario, CA 91765
Contact: Michelle Lesh (760) 294-4830

Other:
Pure Power Technologies (power firming technology)
183 Little Lease Road
Holliday, TX 76366
Contact: David Kleis (940)586-0911

Trexler & Associates (Climate and Energy Services)
516 SE Morrison St, Suite 1100
Portland, OR 972
Contact: Sheldon Zakreski (503) 231-2727

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ANNEX B: Technical Report of Topographical Inspection by SeaWest Meteorologist

ANNEX C: Technical Specifications of Wind Registering Equipment

ANNEX D: Wind Data Processing of El Loa Airport and of Met Towers of Codelco

ANNEX E: Results of the Forecast Study of Electricity Demand and Electricity Prices in the SING

ANNEX F: Formal Request to CDEC-SING of Firm Capacity of the Wind Farm and Response

ANNEX G: Study of the Interconnection of the Wind Farm to the SING by Fluor Daniel

ANNEX H: Transmission Line Diagram

ANNEX I: Wind Turbine and Tower Layout and Installations of Wind Farm

ANNEX J: Base Line Study of the CO_2 Emissions by Trexler & Associates

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ANNEX L: Price Quotations from Turbine Manufacturers Vestas and NEG Micon

ANNEX M: Study of Construction Costs Estimates by Fluor Daniel Chile

ANNEX N: Templates of the Financial Model

ANNEX O: Financial Model

ANNEX P: Sample of Power Purchase Agreement and Carbon Credit Agreement

ANNEX Q: Development and Construction Plan for the Wind Farm

ANNEX R: Operation and Maintenance Plan for the Wind Farm

ANNEX S: Information Memorandum for the Promotion of the Project to Investors and Financial Institutions

INTRODUCTION

This document is the Final Report of the "Feasibility Study for Calama Wind Farm", commissioned by the Corporación Nacional del Cobre ("Codelco") and prepared by SeaWest WindPower, Inc. ("SeaWest")

This Report includes the technical, financial and economical evaluation of the project - analysis that has been developed with multiple project definitions and scenarios. In the Final Draft Report of April 2003, evaluations of 24 scenarios were performed, considering the following assumptions and principal variables: i) different sizes of the project (12 MW, 21 MW, 30 MW, 40 MW); ii) evaluations for the project with and without financing; iii) sensitivity analysis to the interest rate of the financing (7.5% and 9.5%); iv) sensitivity analysis to the price of the carbon credits. The cost of the wind turbine generators and towers used in the Draft Final Report corresponded to referential prices provided by some of the turbine suppliers to SeaWest.

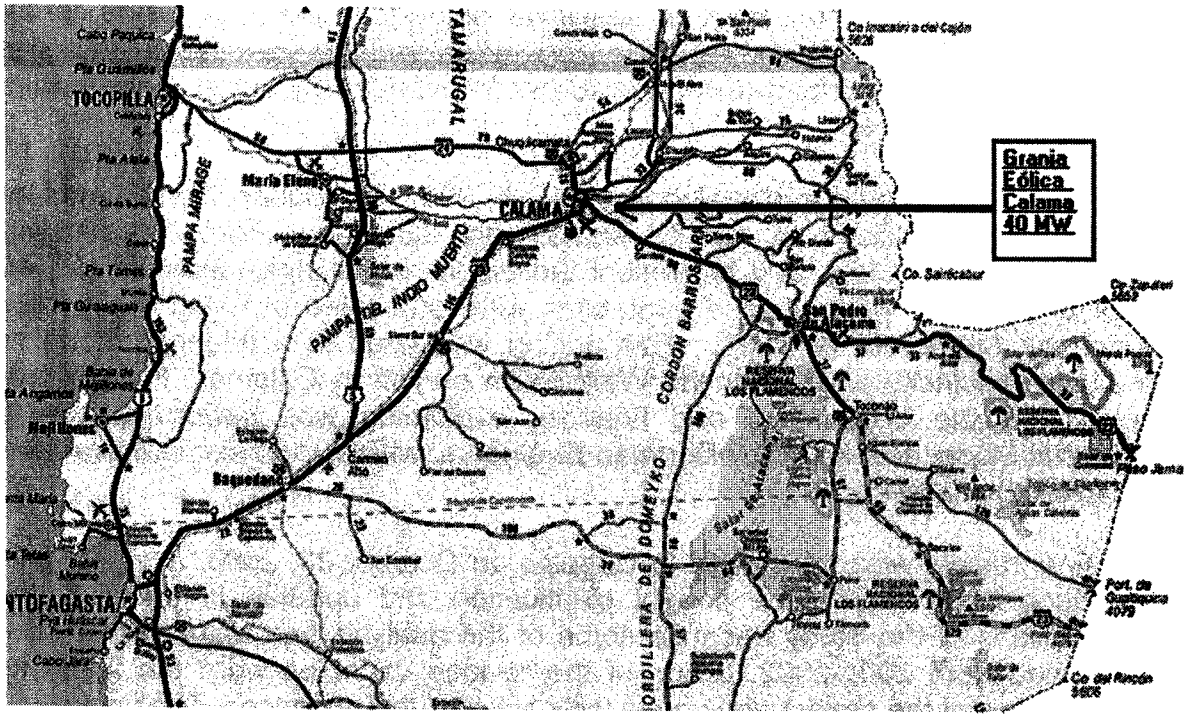
After the meeting held at Codelco on May 15, 2003, the Supervision Committee of the project decided to ask for formal price quotations from vendors with representation in Chile, and to present the results of the evaluations for a wind farm of 40 MW. Formal price quotations were submitted by Vestas and NEG Micon by August 18 of 2003. This pricing was used in a financial model to evaluate electricity pricing for the Wind Farm project in Calama. It should be noted that the economical and financial evaluation was performed with a Financial Model developed by Deuman Engineers, which had been reviewed and approved by Codelco.

The final results were presented to Codelco on October 23, 2003, at which time the Supervision Committee sought clarification and updates of some of the assumptions of the Study because some of the analysis had been done during the period from 2001-2002. Some of the revised variables were the financing assumptions of the project and a new forecast of electricity prices. The final result of this analysis is presented below.

1 EXECUTIVE SUMMARY

Location of the Project:

The proposed Calama Wind Farm is a 40MW project to be constructed in the north of Chile, 1,630 kilometers from Santiago. It is located in the Second Region of Antofagasta, 10 km south-east of Calama, and 20 km from the Chuquicamata copper mine of CODELCO. The site is 220 km from the port of Antofagasta and at an elevation of 2,400 meters above sea level.



Wind Regime:

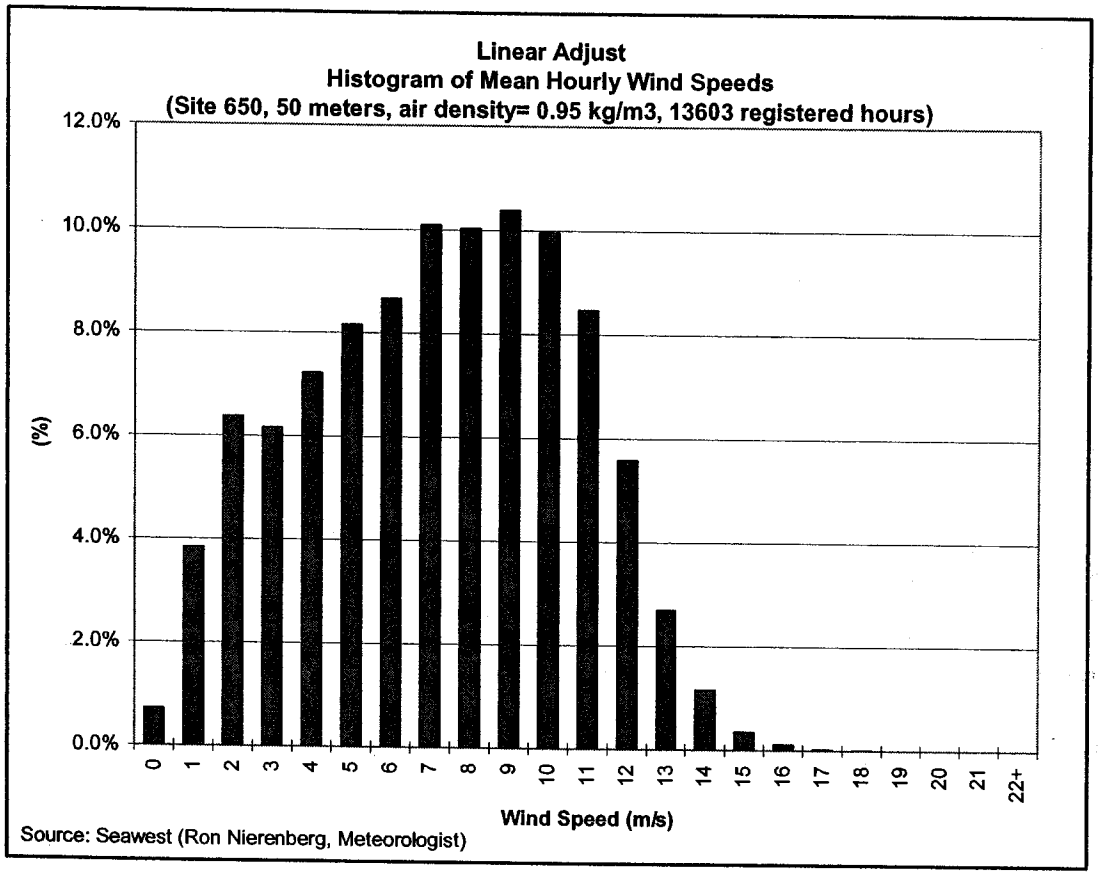
The Meteorological Direction of Chile considers the Calama zone to be the second windiest place in Chile. Zond Wind Energy, on behalf of Codelco, monitored the wind speeds during the period September 1994 to November 1995 in 12 different locations at a height of 10 meters.

Subsequent to that, in February of 2002, SeaWest installed 3 meteorological towers (denominated towers 650, 651, and 652), with a height of 50 meters and a weight of 785 kilograms. Wind speeds and directions were measured at 30 and 50 meters.

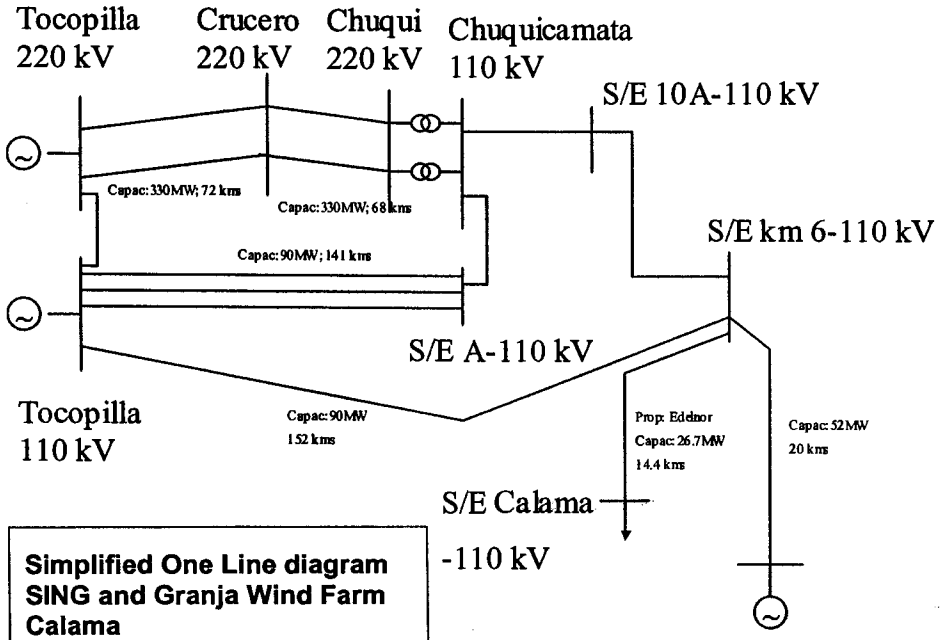
Wind data spanning a period of 16 years was also obtained from the Loa Airport of Calama and was analyzed and contrasted with the data collected by SeaWest.

The average wind speed in site was estimated to be around 7.5 meters per second (27 km/hour). Air density was estimated to be 0.95 kg/m^3.

The histogram of mean hourly wind speeds for the measurement period from February 2002 to September 2003 at tower 650 is presented in the following chart:



Electrical Interconnection of the Wind Farm to the Northern grid:
A 110 kV transmission line 20 km long was assumed, connecting the substation of the Wind Farm with the substation km6-100 kV of Chuquicamata.



Simplified One Line diagram SING and Granja Wind Farm Calama

Granja Wind Farm Calama 40 MW

Estimated Generation of the Wind Farm:

With the wind regime histogram, and the power curves of the different wind turbine suppliers adapted to the air density of Calama, estimates were made for the average annual production, ranging between 100,000 and 128,000 MWh. The different generation values respond to the different technical performance of the wind turbine models in this particular wind regime. Three turbine models for which formal quotations were received were used for the final economic evaluation. Those models included the Vestas V52-850kW, Neg Micon NM54-950 kW and Neg Micon NM82-1650 kW.

	MHI MWT-600	**Enercon** E40-600	**Vestas** V47-660 kW	**Gamesa** G52-850	**Vestas** V52-850
# of Turbines:	67	67	61	47	47
Total MW:	40.2	40.2	40.26	39.95	39.95
Capacity (kW):	600	600	660	850	850
Generation (MWh-year)	117,671	119,811	117,317	114,940	112,688
Gross Capacity Factor (without losses) (%)	33.4	34.0	33.3	32.8	32.2

	NEG Micon NM54-950 kW	**MHI** MWT 1000A	**Nordex** N62-1.3 MW	**General Electric** GE 1.5 MW S	**NEG Micon** NM82-1650 kW
# of Turbines:	42	40	31	27	25
Total MW:	39.9	40	40.3	40.5	41.25
Capacity (kW):	950	1000	1300	1500	1650
Generation (MWh-year)	99,614	116,525	99,166	116,427	128,279

Gross Capacity Factor (without losses) (%)	28.5	33.3	28.1	32.8	35.5

Estimation of CO_2 emission reductions:

Wind generation has important local and global benefits for the environment. The Wind Farm of Calama will allow the reduction of CO_2 emissions due to the displacement of generation in the Northern Grid, which uses thermal plants that burn coal-pet coke and natural gas. The 40MW will reduce emissions in a volume of approximately 100,000 tons of CO_2 annually. This amount of CO_2 emission reductions is very attractive to investors in the international market of Green House Gases Emissions Trading. The figures provided for CO_2 emission reduction was based on the current methodologies of the International Panel on Climate Change (IPCC), utilizing the fuel specific consumption rates of the thermal plants in the Northern Interconnected Grid (SING) and the future expansions of the generation units (with and without the Wind Farm of Calama).

The methodology to calculate the CO_2 emission reductions produced by the operation of the Wind Farm is based on determining the difference between CO_2 emissions of SING in the base line scenario (without the Calama project or business as usual scenario), and the CO_2 emissions in the scenario with the Calama project.

Based on the recent experience of trading of Certified Emission Reductions (CERs) in wind generation projects in Colombia, Jamaica and India, these consultants used a target price of 4 US$ per ton of CO_2. With this, annual revenues above US$400,000 would be received, representing revenues of around US$8.4 million in a crediting period of 21 years (nearly 17% of the total cost of the project).

Cost of Investments in Infrastructure and Equipment:

Price quotations for Wind Turbine Generators and their corresponding towers were received from Vestas and NEG Micon, who both have representation in Chile.

Fluor Daniel Chile developed the capital cost estimate for the construction of the wind farm project using a case of 67-600kW turbines including civil works, foundations for the towers, and electrical work. Since quotations from vendors corresponded to 47 units of 850kW, 42 units of 950kW and 25 units of 1650kW, the costs from Fluor Daniel were modified for these configurations.

In summary, the Investment Costs of the Project for the scenarios, with and without import duties, are presented as follows. In the scenario without import duties, the total costs range from 1,262 to 1,510 US$ per installed kW:

	Without Import Duties			With Import Duties (6%)		
	39.9MW 47X850kW US$ 1000	39.9MW 42X950kW US$ 1000	41.25MW 25X1650kW US$ 1000	39.9MW 47X850kW US$ 1000	39.9MW 42X950kW US$ 1000	41.25MW 25X1650kW US$ 1000
Cost of Turbines and Towers	31,209	32,071	46,734	33,041	33,995	49,538
Construction Costs	19,206	18,345	15,557	19,355	18,494	15,706
Total Costs	50,416	50,416	62,291	52,396	52,489	65,243
Costs of Turbines and Towers (US$/kW)	781	804	1,133	827	852	1,201
Construction Costs (US$/kW)	481	460	377	484	463	381
Total Cost (US$/kW)	1,262	1,264	1,510	1,312	1,316	1,582

Note: For the 850kW Turbine, the cost of the Pad Mounted Transformers has been included

Source: Equipment Costs from Price Quotations of vendors, Construction Costs from Study by Fluor Daniel

Economical and Financial Evaluation of the Project:

One of the scenarios evaluated assumed the operation of the Wind Farm as a merchant plant in the spot market of the Northern Interconnected Power System (SING). In this condition of operation, and consultation with CDEC-SING (Economical Dispatch Center of the SING), it was determined that the Wind Farm would only receive remuneration for a portion of its installed capacity. This event produces a scenario of low cash flow if compared to the income of a similar sized thermal plant that burns natural gas. The Net Present Value of this scenario is negative and the Internal Rate of Return has very reduced values.

The other scenarios that were modeled were those in which the Wind Farm sells its energy to Chuquicamata Mine of Codelco by means of a PPA (Power Purchase Agreement). In these cases, the selling price of the energy was modeled as being very similar to the prices that Chuquicamata pays its sole generator Electroandina, by virtue of a Contract that runs until year 2009. After year 2009, prices were modeled ranging from 33 to 35 US$/MWh. Under this scenario, the profitability of the project increases, but it is still not able to satisfy the profitability standards that Codelco imposes on its investment projects. The Internal Rate of Return without VAT varies in a range from 5.38 % to 10.99% (in the scenario without import duties, with financing at interest rates of 5.5%, with a debt/equity ratio of 60/40 and contemplating carbon credits at 4 US$/ton CO_2). In the case of recovery of VAT, IRR ranges from 10.80% to 13.69%. The effect of the carbon credits is to elevate the IRR in a range of 1 to 3%.

2 ANALYSIS OF THE LOCATION OF THE WIND FARM AND OF THE WIND REGIME

2.1 GENERAL ASPECTS

The analysis of location for the farm and wind regime contemplated the following fundamental tasks.

- Revision of Maps and Topographical Planes of the Location of the Project
- Analysis of the previous meteorological studies in the zone
- Analysis of the historical records of winds in the zone of Calama´s El Loa Airport
- Soil Analysis
- Installation of Meteorological Towers
- Analysis of the wind data by using adequate software tools and modeling
- Installation of additional meteorological towers in alternative sites
- Calculation of the future generation of the Wind Farm based on the wind resources of the zone

The development of these activities and its results are discussed in the next section.

2.2 REVISION OF TOPOGRAPHICAL MAPS AND PLANES

During the Study, Codelco provided SeaWest with a satellite map of the zone of Calama and a map with information about the owners of the sites.

Additionally, SeaWest developed a topographic map in the scale 1:10.000 of the area that corresponds to 8.000 hectares of the eastern zone of the city of Calama, which corresponds to the potential site fot the Wind Farm. For reference, the area depicted is traversed in its central section by the Loa river, which crosses the city of Calama. The ground coordinates of this quadrant are as follows:

Table 1. Coordinates of the Site of the Wind Farm

Point 1.	Point 2.
Coordinates UTM N 7.523.000 m. E 511.000 m Geographical Coordinates: Longitude 68° 53′ 35′′ W Latitude 22° 24′ 4′′ S	Coordenadas UTM N 7.523.000 m. E 519.000 m Geographical Coordinates: Longitude 68° 48′ 55′′ W Latitude 22° 24′ 4′′ S
Point 3.	**Point 4.**
Coordinates UTM N 7.513.000 m. E 511.000 m Geographical Coordinates: Longitude 68° 53′ 35′′ W Latitude 22° 29′ 21′′ S	Coordinates UTM N 7.513.000 m. E 519.000 m Geographical Coordinates: Longitude 68° 48′ 55′′ W Latitude 22° 29′ 21′′ S

2.3 SOIL STUDIES

A preliminary soil investigation was conducted in October 2002 by Wireless – Energy, the company that installed and mounted the meteorological towers for the monitoring of winds. This study, identified as "Study of Soil Mechanics and Recommendations for the Design of Foundations" served as support to the construction of the foundations for the meteorological tower #652, which was installed in December of 2002.

The results of the explorations and soil tests, established the bases for the analysis of the characteristics of the terrain, which is presented in ANNEX A.

The principal results of the study are the following:

Type of Soil

- **Results of Soil Mechanics:**
  - **A stratum of soil and a bed of limestone rock below**
  - **Type of soil : limestone sands of low energy deposits**
  - **Type of rock: sedimentary rock formed by limestone of fine grain with small content of silica**
  - **Bed of rock at a depth of 0.65 meters**

2.4 REVISION OF THE PREVIOUS METEOROLOGICAL STUDY BY ZOND

SeaWest reviewed and analyzed a great quantity of wind data registered by Zond (and its affiliate Zond – Chile), at an elevation of 10 meters, between the months of September 1994 and November 1995. This data were analyzed according to its quality and registering horizon.

In the majority of the sites analyzed by Zond, wind data was registered for more than a year. In some sites there was a gap or discontinuity of information for periods between one to two months. The following table shows a listing of the metering program followed by Zond for each site. Wind data was registered in 12 different sites, during variable periods of time, some of which were 2 weeks periods.

Table 2. Wind Data Registered by Zond

(September 1994 to November 1995)

Ayqui1 A 16/09/94 to 23/12/94 13/01/95 to 8/7/95 8/09/95 to 25/11/95	Ayqui 2 16/09/94 to 1/10/94 2/11/94 to 23/12/94 13/01/95 to 2/07/95 8/09/95 to 2/11/95	Ayqui3 A 16/09/94 to 30/09/94
Chiu1 A 16/09/94 to 5/11/94 23/12/94 to 1/01/95 13/01/95 to 8/07/95 8/09/95 to 25/11/95	Chu2 A 16/09/94 to 5/11/94 23/12/94 to 1/01/95 13/01/95 to 5/08/95	Chiu3 A 16/09/94 to 5/11/94 23/12/94 to 1/01/95 13/01/95 to 8/07/95 8/09/95 to 25/99/95
Limonve A 13/08/94 to 1/09/94 2/11/94 to 1/12/94 23/12/94 to 1/01/95 13/01/95 to 8/07/95 8/09/95 to 25/11/95		

Notes: i) During the period 5/1/95 to 6/1/95 the name of the site changed to Limonv 1A.
ii) During the period 6/1/95 to 7/8/95 the name of the site changed again to Limonv 2A.

Milagro A 16/09/94 to 5/11/94 23/12/94 to 1/01/95 13/01/95 to 8/07/95 8/09/95 to 25/11/95 7/06/97 to 31/07/97	Milagro B 6/06/97 to 31/07/97	Mtecrit A 27/08/94 to 1/09/94 1/10/94 to 22/01/95

Notes: i) The name of the site changed to Mtcrit A during the next period 23/2/95 to 7/4/95
ii) The name of the site changed to Mtcrist A during the period 20/5/95 to 8/7/95

Mtzuma A 16/09/94 to 1/12/94 23/12/94 to 1/01/95 13/01/95 to 8/07/95 8/09/95 to 25/11/95	Talabre A 16/09/94 to 30/09/94 5/11/94 to 25/01/95 2/02/95 to 8/07/95	

The sites called Ayqui1, Ayqui2 y Ayqui3 are located to the east of El Loa airport and between the southern border of the Loa River and the road that drives to San Pedro de Atacama. The sites Mtzuma and Limonve (situated bin the Pampa Moctezuma and Pampa Limón Verde) are located to the south of El Loa airport. The sites Chiu 1, 2 and 3 are located in the northern border of Loa River. Finally, the sites Milagro (Cerro Milagro), Talabre and Montecrit are located to the north of the Chiu group.

The data was registered in meteorological stations mounted by Zond, called Windrunner. There is no information of the type of sensors used, or about its calibration or the mounting configuration. However, due to the broad participation of Zond in the wind industry, it is presumed that the appropriate practices were adopted, in relation to the metering procedures and with the equipment and instruments that were used.

The type of information that was registered by Zond was the following:

- Average wind speed: Average of the data registered during a one hour interval (in meters per second).
- Standard Deviation of the wind speed: Average of the data of each one second data, during a one hour interval.
- Speed of the most rapid wind gust: Maximum speed of each one second data, during a one hour interval.
- Direction of the most rapid wind gust: Predominant direction of each one second data wind gust, during a one hour interval.

These four parameters are very important for the identification and characterization of the wind resources, being the average wind speed and the direction of the wind, the most important ones.

After an exhaustive technical revision of the wind data registered by Zond, it was concluded that the data had a great quality, with a small amount of erroneous or lost data. However, it is important to mention that there is uncertainty about the exact configuration of the meteorological equipment, especially regarding to the measuring height.

The summary of the wind data presented by Zond in its reports indicate that wind speeds were forecasted for a height of 40 meters, equivalent to the height of the center of the rotor of the wind turbine generators. However, the assumptions made by Zond to make its forecasts are not clear.

According to this Consultant, the majority of the sites used to register wind data by Zond are not adequate for the construction of a Wind Farm. Therefore, the program established by this Study to register the winds, modified the wind registering program of Zond, and defined new sites for the installation of the meteorological towers.

2.5 INSPECTIONS TO THE INSTALLATION SITES

Several visits to the sites were done, and revisions of the topographical maps from Codelco were performed, to determine the characteristics of the terrain and to identify the potential installation sites of the Wind Farm.

The topographical revision was complemented with the analysis of the wind data, to obtain an initial technical approximation of the characteristic wind regime in the zone. Afterwards, a more detailed analysis of the topographical characteristics of every potential site was performed to determine their individual wind flux in relation to the regional wind flux.

Additionally, during April 26 and 27, 2001, personnel from SeaWest visited the sites where Zond had installed wind registering towers. The objective of this visit was to collect information that would be used to analyze the relationship between wind data registered and the local and regional topographical characteristics.

One of the alternative sites that were visited was Cerro Calama, in which strong winds were perceived. This site had not been considered in the metering by Zond. Although it was perceived as a site with an important wind potential, it was considered that this site had a limitation because of its small area, which would limit the size of the wind farm to be in the range of 0-15 MW; this aspect discarded the site for wind registering.

A site known as Cerro Negro was considered as an alternative site for wind registers, during the visit. However, it was later discarded because the transportation of heavy equipment to the area would face great difficulties.

One of the conclusions of the visit to the Calama area, was the selection of two sites to start wind metering: Cerro Milagro 2 and Ayqui 3; a cost-effect analysis of the different visited sites guided the consultants in the selection of the sites for the Wind Farm.

The technical visit also concluded that sites Milagro and Talabre were not adequate for the installation of the wind turbine generators because of the rugged nature of the sites, which would difficult the construction of foundations and the erection of towers and turbines. On the other hand, it was verified that both sites had higher wind speeds than surrounding areas, due to their elevation, but they had a limited area because of the ruggedness of the terrain. The installation of metering towers at this site would have produced additional costs associated to the adjusting and leveling of the terrain.

The objective of the metering plan was to complement the original data collected by Zond, to have a more solid basis for the feasibility analysis of the project.

Later, Mr. Brian Armstrong, the meteorologist from SeaWest, visited the zone of Calama during the week of October 28, 2002 to inspect the selected site for the

project , to review the proposed layout, to select the site for the additional tower, and to make a visual inspection of the feasibility of the construction of the Project.

The results of the inspection indicated that the two meteorological (#650 y 652) would capture adequately the variability of the wind resource in the selected site for the project. The form of the terrain is relatively plain, with some ridges of dry creeks, which have not more than 5 meters of depth. The surface is relatively uniform. The site has a good access from the road that heads from Calama to San Pedro de Atacam, which suggests that there will not be greater technical difficulties to construct the wind farm. The technical report of Mr. Armstrong is included in ANNEX B.

2.6 EQUIPMENT IMPORTS AND METEOROLOGICAL TOWER´S ASSEMBLY

As previously mentioned, the first step of this work stage was the visit paid by the SeaWest meteorologist Brian Armstrong meteorologist to the zone of Calama in April 2001, with the purpose of selecting sites for the installation of meteorological towers. As a result of such a visit, a proposal was made to set up one tower in the area known as Ayqui 3 (site #650), and a second tower in the area known as Milagro (site #651), leaving the definition of a third site conditioned to the results of measurements taken from sites #650 and #651. The third tower was later set up in site #652 following due analysis of the first 5,400 wind data hours from the area. This is described in detail throughout the following paragraphs.

On May 15 2001, wind measurement equipment made up by 4 50-meter high meteorological towers as well as the related instruments (the technical data related thereto is enclosed to ANNEX C) arrived in Chile. Then on May 30, 2001, those pieces of equipment were transferred to the warehouse located on gate #4, kilometer 6, Chuquicamata Division. It is important to mention that such equipment was initially imported under a tax exemption scheme for 180 days commencing on May 22, 2001. Such a grace period expired on November 18 2001. On that date, all import duties - i.e. VAT and custom rights- had to be paid for each of the four units imported.

In accordance with the requirements of the General Directorate of Civil Aeronautics, tower setting-up over 10 meters in height must comply with the safety standards applicable to air traffic. Therefore aeronautics certificates were duly requested for each tower to be installed. Such certificates were received in June 2001. They stated that each tower had to be painted in segments of approximately 7-meter in length, using reflective colors (red & white) for daytime protection purposes, and that they should also be equipped with 2 flashing lightening systems of 300-candela in luminance for night time aeronautic protection purposes.

Requirements contained in the certificates and those requirements provided for by the Trade Development Agency -TDA led to the import of 4 flashing lightening solar systems. The solar units were imported considering the absence of an electricity network in the tower setting-up area, which could provide power for the operation of such equipment. On the other hand, the idea of setting up generation motors was disregarded in the light of the high maintenance and fuel requirements, which is almost null for solar units. Solar equipment import process was one factor with an impact in the delay of meteorological towers setting-up in accordance with the original schedule of the Study.

It is worth mentioning that based on the characteristics of the soil in the area of Calama, foundations were required for each tower base as well as their respective guyed wires. This was not originally planned, since based on technical specifications applicable to the meteorological towers purchased from NRG Systems Inc. in the USA, the setting-up does not require concrete foundations. However, installing such foundations provided the ongoing measurements with additional safety in the event of possible natural occurrences, such as earthquakes and hurricanes.

Foundations for measurement towers #650 and # 651 were constructed from January 4 through 15, 2002, letting them set for ten days. Such concrete setting time was determined and certified by PREMIX, which was timely reported to Codelco.

Wireless Energy conducted the tower setting-up and assembly processes from January 31 through February 3, 2002. This company met each and every standard defined by Codelco in terms of safe operations.

The original wind measurement plan was developed hoping that approximately six months would be needed to establish a relationship between sites #650 and #651. After reviewing data out of the first three months, such relationship was verified to occur in a very brief period of time. A possible reason is the consistency of wind in Calama. Data shows the wind speed pattern for each day is very well defined, with no significant changes from one day to another or from one month to another. Historic data also shows such daily wind speed patterns remains constant all through the year. Therefore it was decided that data collection from two distant locations would not be necessary.

On the other hand, measurements during the first quarter showed more wind availability in the site #650 area. The next stage of the monitoring schedule was created having that in mind, with the purpose of recording the wind variability in the project area that surrounds site #650. The initial proposal was to move the tower located at site #651 to site #650, in order to be a complement to the information recorded at site #650. However, after studying the idea, Codelco decided to keep the monitoring plan over the two sites and install the additional meteorological tower #652 in the vicinity of site #650.

Given the delay in towers installation as already described and, in order to have a longer range of wind measurements for a more thorough analysis, Codelco and SeaWest agreed to extend the analysis performance period until June 2003. Finally, in order to have enough time to reply to Codelco's comments about the Final Documents of the Study, as it is explained in detail in the following sections, such period was extended until December 2003.

The features of wind measurements equipment used for this study are summarized below:

Wind Registering

- Characteristics of Metering Equipments:
  - 3 met towers named 650, 651 and 652
  - Height: 50 meters; individual weight: 785 kilograms
  - 2 Anemometers @ 50 mts; 1 anemometer @ 30 mts
  - Wind vanes @ 30 and 50 mts
  - Temperature Sensor @ 3 mts
  - 9200-Plus NRG Wind Energy Data Logger
  - Night lights and photoelectric cells
- Location: 2 towers in the terrains of Ministery of National Property and one in the terrains of Codelco

The location of measurement towers #650, #651 and #652, as well as installation dates and a reference to the owner of the land where they are located is presented below. Towers #650 and #652 are located south from Loa River and tower #651 is located north of Loa River.

Table 3. Location of Meteorological Towers Installed by SeaWest

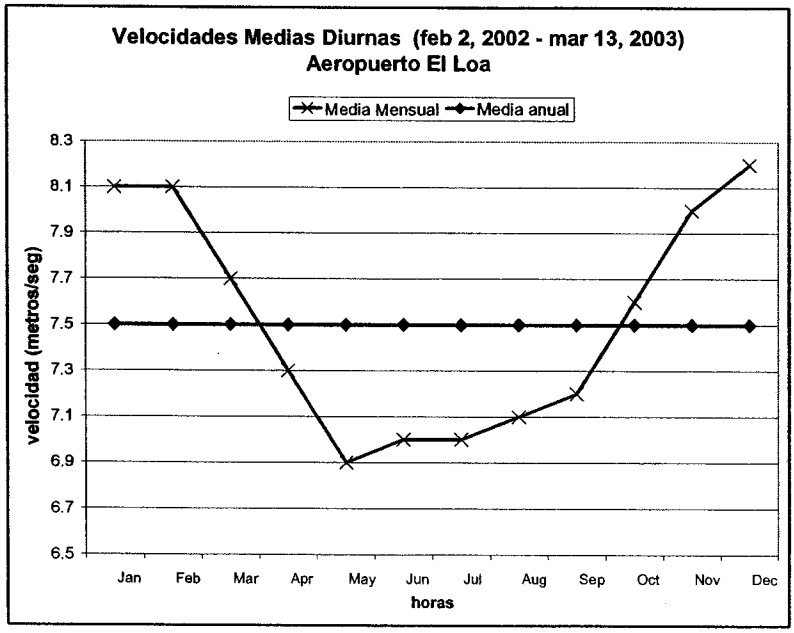
Tower	Site	Coordinates		Setting-up	Land Owner
Tower #650	Calama Hill (Ayqui 3)	22° 28' 00" S	68° 51' 06" W	Feb. 3, 2002	Ministry of National Property
Tower #651	Milagro Hill	22° 25' 40" S	68° 50' 53" W	Feb. 3, 2002	Codelco
Tower #652	Calama Hill	N 7.514.100	E 515.675	Dec. 2002	Ministry of National Property

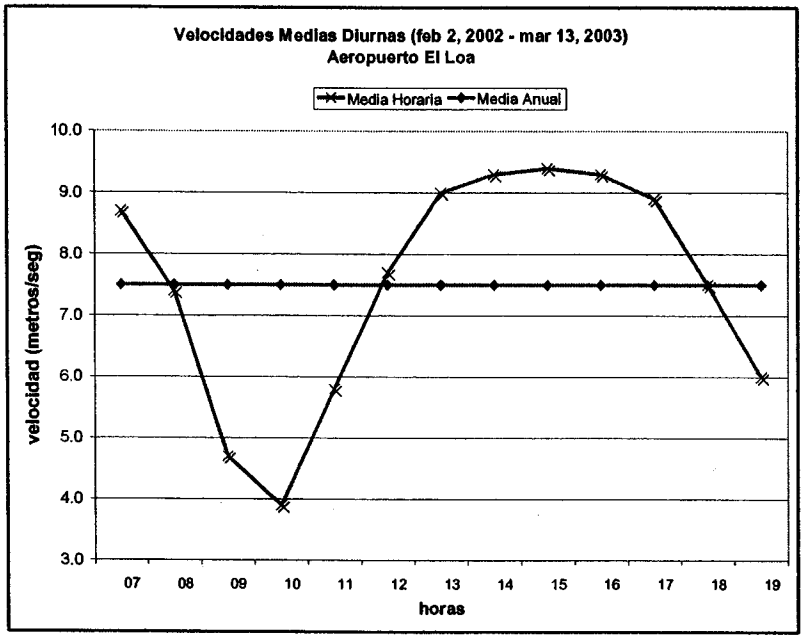
2.7 ANALYSIS OF WIND RECORDS FROM THE CALAMA AIRPORT

Historic wind database for the El Loa airport in Calama was requested to the Bureau of Meteorology. Such information includes hourly wind speed and direction in the airdrome control tower from 8:00 AM to 8:00 PM at 25 meters above ground level approximately. Such data was recorded from October 1, 1999 to January 31, 2003. It is worth pointing out that prior October 1999, wind data was recorded at the old control tower of the El Loa airport at only 10 meters above ground level. That is why there is a coincidence between the requested data time span and the moment when instruments measure from the new control tower at a higher height that is October 1999.

The analysis of daytime wind speed data from El Loa Airport for the period February 2002 - March 2003 conducted by SeaWest concludes that the average wind speed at the airport was 7.5 meters/second (the mean for monthly averages.) It also shows that months with the lowest wind speed levels are those in the May-September period, with an average speed of 7.0 meters/second. On the other hand, the average wind speed increased to 7.9 meters/second over the October-April period. The highest speed levels throughout the day can be observed from noon to 6 PM, exceeding the average of 7.5 meters/second. This is shown by the following illustration and enclosed information in ANNEX D.

Illustration 1. Wind Speed Diurnal Monthly Average (1988 -2003)





Source: Report of Meteorologist Ron Nierenberg for SeaWest.

The information collected from the El Loa Airport was also analyzed over the January 1988 - January 2003 period, concluding that the average speed for the past 15 years was 7.5 meters/second. With this in mind, it is possible to state that the period of time measured by SeaWest at stations #650 and #652 is a normal period containing reliable data. We should bear in mind that the estimated average speed for such stations was 7.5 meters/second, as shown below in the next section.

2.8 PREPARING THE GENERATION MATRIX FOR THE WIND FARM

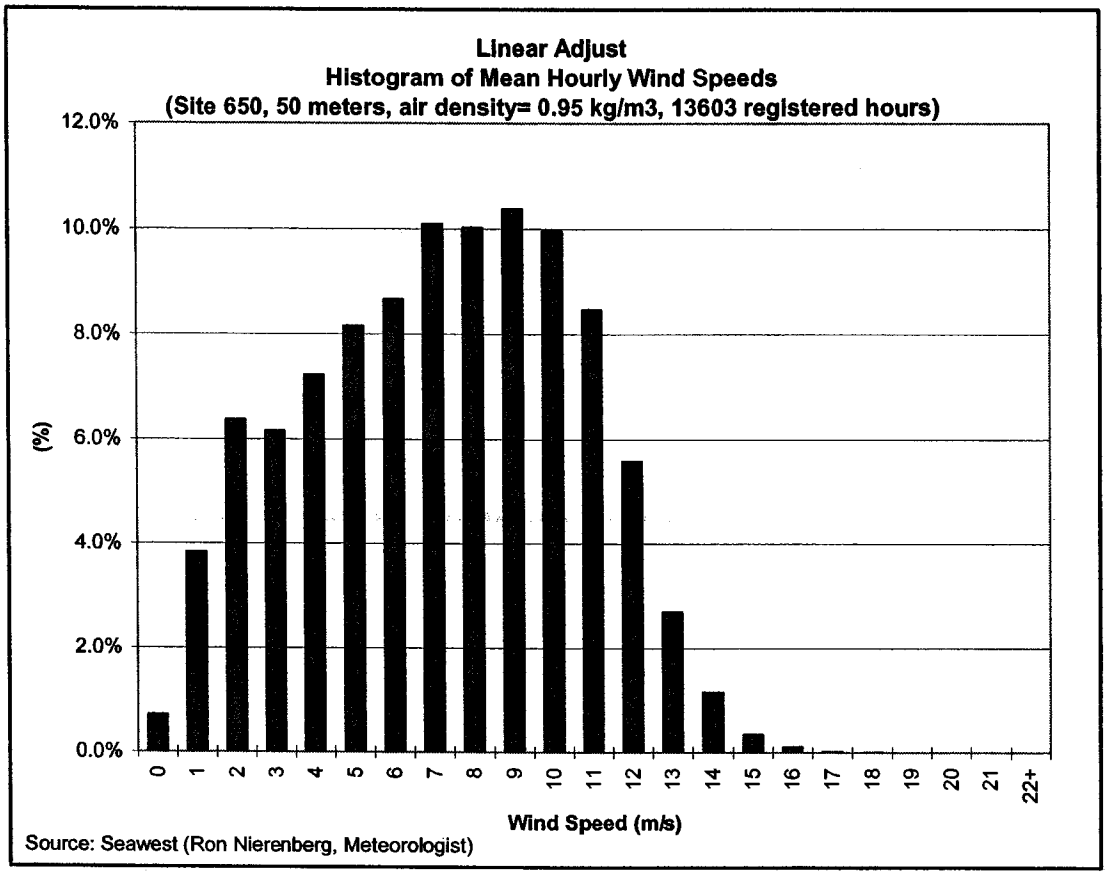
Measurements were analyzed over 20 months from February 2, 2002 to September 16, 2003. Below is the general information recorded from towers #650, #651 and #652 set up by SeaWest. Information from tower #650 is presented solely for illustrative purposes, but information from the three towers is enclosed in ANNEX D. There are 13,603 hours recorded from tower #650, which were used for long-term calculations.

Table 4. Registered Information at Tower 650

	sena1	sens1	sena2	sens2	sena3	sens3	sena4
Tower # 650	Speed @ 30 mts (meters/sec)	Stand. Dev @ 30 mts	Speed @ 50 mts (meters/sec)	Stand. Dev @ 50 mts	Speed @ 50 mts (meters/sec)	Stand. Dev @ 50 mts	Direction @ 30 mts (degrees)
Feb-02	7.10	1.07	7.18	1.04	7.10	1.03	212.42
Mar-02	6.63	1.01	6.70	0.99	6.57	0.98	207.06
Apr-02	7.43	1.02	7.52	1.02	7.42	1.02	190.22
May-02	7.19	1.06	7.26	1.04	7.21	1.04	188.53
Jun-02	8.01	1.00	8.02	0.97	7.95	0.98	175.33
Jul-02	7.52	1.11	7.43	1.09	7.44	1.08	195.76
Aug-02	7.94	1.10	7.96	1.09	7.94	1.08	187.30
Sep-02	7.84	1.10	7.79	1.10	7.71	1.11	191.43
Oct-02	7.53	1.13	7.52	1.11	7.39	1.12	196.32
Nov-02	7.79	1.15	7.88	1.11	7.71	1.13	200.52
Dec-02	7.82	1.22	7.96	1.18	7.91	1.19	206.68
Jan-03	7.45	1.12	7.53	1.10	7.30	1.10	205.47
Feb-03	7.13	1.07	7.27	1.03	7.02	1.03	207.10
Mar-03	7.22	1.04	7.47	1.02	7.14	1.02	196.99
Apr-03	7.84	1.01	7.97	0.99	7.65	1.00	184.15
May-03	7.83	1.00	7.97	0.97	7.75	0.99	171.94
Jun-03	8.50	0.96	8.62	0.95	8.46	0.96	172.36
Jul-03	7.48	1.10	7.50	1.08	7.26	1.09	180.60
Aug-03	8.13	1.06	8.21	1.05	7.97	1.06	183.24
Sep-03	8.36	1.13	8.43	1.12	8.20	1.13	190.13
Feb02-Sep03	7.64	1.07	7.71	1.05	7.55	1.06	192.18

Source: Deuman based on data processing by SeaWest

Below there is a histogram of average hourly speeds related to tower #650 measurements period.



The table below shows the main characteristics of meteorological conditions and wind regime at the sites selected for carrying out measurements in Calama. Some of the main characteristics are a low air density (0.95 kg/m^3) in the area, which affects the electricity production of the Wind Farm, as generation provided by wind turbines depends directly on density and speed (raised to the power of three.) Turbine manufacturers can provide power curves for any air densitity upon request, however the most readily available power curves are those based on density at the sea level, that is, at 1.225 kg/m^3.

Another significant factor relates to the average speed of 7.5 meters/second and the fact that speed does not appear to exceed 19 meters/second throughout the year.

Calama is also characterized by the presence of a wind shear exponent ranging from –0.10 to +0.10. That means that there are certain hours during the year where wind speed near the ground can exceed the wind speed detected at 50 meters in height. Wind speed is usually lower at ground level (due to friction-caused inertia) and increases with height. The presence of negative wind shear exponents over some hours may cause blades to be pushed against the tower base at their lowest trajectory point.

Table 5. Principal Characteristics of Calama Site

Average Density of the Air:	0.95 (kg/m^3)
Elevation :	2.400 meters above sea level
Annual Average Temperature:	23° Celsius
Annual average wind speed:	7.5 meters / second @ 50 meters
Wind shear exponent :	-0.10 a + 0.10
Turbulence Intensity (for wind speed > 15.0 m/s):	12%
Maximum in-flow angle (for extreme load):	0 degrees
Maximum in-flow angle	0 degrees
Seismic Classification Zone 1 (Z Factor)	3 UBC

Source: SeaWest

The SeaWest meteorology consultant found a correlation between the statistical wind data from towers #650 and #652, and the information from the El Loa airport (enclosed to section 2.4)) Long-term estimates for wind regime were generated based on the above.

First of all an analysis was conducted over a 13-month measurements period from sites #650 and #652 in order to determine whether it represented a normal wind season in the zone. That was confirmed by the wind behavior analyses for the past year and the past 15 years taken from the Calama airport, where the wind speed reached 7.5 meters/second.

Information from site #650 was finally used to create long-term forecasts without losses, for such data was collected at 50 meters in height, which is also the height proposed for wind generator towers.

The table below shows wind distribution in Calama, which was used to estimate the resulting average speed of 7.5 meters/second. It also includes power curves reported for the Vestas V47 660-kW turbine, for the air densities in the order of 1.225 kg/m^3 (standard sea level) and 0.95 kg/m^3 (density in Calama.) As gathered from the table, given such air density levels, a wind turbine in Calama can generate 84% of the power it would generate at sea level (assuming the same wind regime).

Annual generation was calculated for the Vestas VE-47 660-kW turbine using a density equal to 0.95 kg/m^3, resulting in 1.923 MWh-year, which is equivalent to a capacity factor of 33.3%.

Table 6. Distribution of Wind Speeds, Power Curves and Electricity Generation (Site #650)

		Vestas Data V47-660		Vestas Data V47-660		NEG Micon Data NM54-950kW		NEG Micon Data NM82-1650kW		NEG Micon Data V52-850kW	
		dens=0.95 kg/m3		dens=1.225 kg/m3		dens=0.95 kg/m3		dens=0.95 kg/m3		dens=0.95 kg/m3	
Wind Speed m/ seg	Hours	Power V47-660 kW [kW]	Energy [MWh]	Power V47-660 kW [kW]	Energy [MWh]	Power NM54-950kW [kW]	Energy [MWh]	Power NM82-1650kW [kW]	Energy [MWh]	Power V52-850 [kW]	Energy [MWh]
0	24		0		0		0		0		0
1	177		0		0		0		0		0
2	545		0		0		0		0		0
3	662		0		0		0		0		0
4	575	0	0	3	2	19	11	14	8	14	8
5	812	23	19	44	36	54	44	102	83	46	37
6	769	64	49	97	75	97	75	230	177	89	68
7	790	118	93	166	131	159	126	386	305	147	116
8	967	187	181	252	244	246	238	570	551	226	219
9	799	271	217	350	280	344	275	770	615	326	260
10	894	367	328	450	402	444	397	965	863	445	398
11	941	465	438	538	506	538	506	1154	1,086	572	538
12	599	549	329	600	359	632	379	1327	795	685	410
13	366	606	222	635	232	713	261	1471	538	766	280
14	143	637	91	651	93	786	112	1603	229	814	116
15	38	652	25	657	25	846	32	1650	63	837	32
16	13	657	9	659	9	882	11	1650	21	846	11
17	3	659	2	660	2	913	3	1650	5	849	3
18	1	660	1	660	1	934	1	1650	2	850	1
19	0	660	0	660	0	952	0	1650	0	850	0
20	0	660	0	660	0	957	0	1650	0	850	0
21	0	660	0	660	0	948	0	1650	0	850	0
22+	0	660	0	660	0	941	0	1650	0	850	0
Totals:	9118		2,002		2,396		2,470		5,341		2,498
Adjusted Generation (MWh)			1,923		2,302		2,373		5,131		2,400
Capacity Factor			33.3%		39.8%		28.5%		35.5%		32.2%

Source: SeaWest and Vestas.

Having the wind distribution data for Calama, air density equal to 0.95 kg/m^3, power curves provided by manufacturers (for Vestas and NEG Micon) and power curves estimated by SeaWest in all the other cases, the capacity factor was found to range from 33% to 28% for the different models and manufacturers. The turbines with the best capacity factors were MHI 600kW, Enercon E40-600kW, Vestas V47-660kW and MHI 1000kW, with values on the order of 33% (see the table below.)

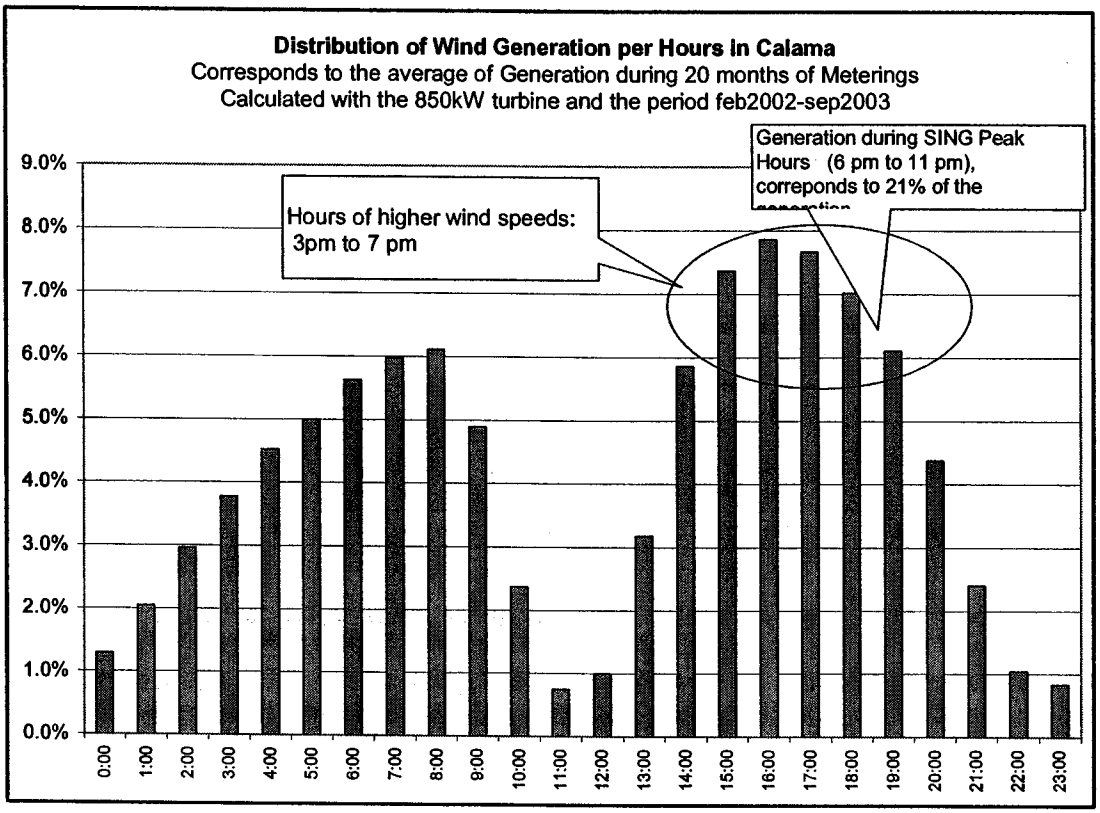
Table 7. Generation Data from different Turbines

	MHI MWT-600	Enercon E40-600	Gamesa G52-850	MHI MWT 1000-A	General Electric GE 1.5 MW S
Rotor Height (m):	38	46	44/55/65/74/86	60	65
# Turbines:	67	67	47	40	27
Total MW:	40.2	40.2	39.95	40	40.5
Power of each turbine (kW):	600	600	850	1000	1500
Rotor Diameter (m)	47	44	52	61.4	70.5
Swept Area (m^2)	1,735	1,521	2,124	2,961	3,904
Kwh/ m2	1,012	1,176	1,152	984	1,105
Generation per turbine (MWh-year)	1,756	1,788	2,446	2,913	4,312
Generation of Wind Farm (MWh-year)	117,671	119,811	114,940	116,525	116,427
Capacity Factor (without losses) (%)	33.4	34.0	32.8	33.3	32.8

	Vestas V47-660 kW	Vestas V52-850	NEG Micon NM54-950 kW	Nordex N62-1.3 MW	NEG Micon NM82-1650 kW
Rotor Height (m):	50	60	34	69	34
# Turbines:	61	47	42	31	25
Total MW:	40.26	39.95	39.9	40.3	41.25
Power of each turbine (kW):	660	850	950	1300	1650
Rotor Diameter (m)	47	52	55	62	78
Swept Area (m^2)	1,735	2,124	2,290	3,019	2,290
Kwh/ m2	1,109	1,130	1,072	1,060	1,072
Generation per turbine (MWh-year)	1,923	2,398	2,372	3,199	5,131
Generation of Wind Farm (MWh-year)	117,317	112,688	99,614	99,166	128,279
Capacity Factor (without losses) (%)	33.3	32.2	28.5	28.1	35.5

Source: SeaWest and manufacturers.

The chart below was built based on hourly data for 20 months of measurements, and it shows electricity generation of the Wind Farm at different times of the day, including peak hours in the system.



The analyses of wind records taken from three meteorological towers over 20 months lead to the conclusion that, as an average, highest and lowest wind speed times occur at 11:00 AM and 4:00 PM, respectively.

The major part of the generation of the Wind Farm occurs over a nine-hour period (from 2:00 PM to 10:59 PM.) Therefore, the highest production hours of the Wind Farm are ahead of the so-called SING peak hour period (from 6:00 PM to 11:00 PM.) This would strongly affect the firm capacity of the plant if its production was sold in the spot market. However, if the project sells its production to Chuquicamata, such production profile should be coordinated with the production processes performed by the mining company during evening and night operations.

3 ANALYSIS OF WIND GENERATION TECHNOLOGY

3.1 IDENTIFICATION OF TURBINE MANUFACTURERS

This section presents a comparative analysis of the different technologies present in the wind market of the principal turbine vendors. It is important to note that the analyzed manufacturers are located in the top 10 ranking prepared annually by BTM Consult ApS. The top five vendors in 2002 included: Vestas (with a 22.2% share of the market), Enercon (with 18.5%), NEG Micon, Gamesa and GE Wind.

3.1.1 VESTAS

Vestas, a Danish manufacturer, offers pitch-regulated turbines which optimize the energy output of the turbines by constantly adjusting the angle of the blades in relation to the characteristics of the wind. This feature is called OptiTip by Vestas. OptiSlip, another Vestas feature, is used when a wind gust hits the rotor. The controller allows the speed of the generator to increase slightly to respond to the gust. At the same time, the pitch system turns the blades to a less aggressive angle to decrease the rotor revolutions-per-minute which decreases the loads on the turbine. Vestas machines are also variable speed, a feature which is called OptiSpeed by Vestas. This feature allows the rotor and the generator to rotate at variable speeds, ensuring higher energy production and low noise levels. The V47-660kW has OptiTip and OptiSlip technology. The V52-850kW has OptiSpeed and OptiTip technology.

A normally configured V47 turbine is not a good match for the Calama site because the V47 experiences blade tower strikes at sites with negative wind shear. This site appears to have zero mean shears, i.e., equal amounts of time with positive and negative wind shear. Vestas does have a fix for this problem that they term PS2 or PS3. When the project goes to bid, Vestas should be informed of the site specific conditions. If the turbines are installed without the PS2 or PS3 fix, there could be serious problems with blade tower strikes.

Vestas turbines are the "gold standard" in the industry. Their extremely long operating history and reputation for reliability make them a good choice for a fairly remote project where service and availability could become an issue. This reliability and reputation allows Vestas to charge a small premium in the market for their products. Their typical warranty period is two (2) years.

One advantage of Vestas in comparison to the rest of the manufacturers is its presence in Chile, since the end of 2001, year in which Edelaysen (a PSEG-Sempra company) installed three turbines V47-660kW in the south of Chile, in Alto Baguales.

3.1.2 NORDEX

NORDEX is a small-to-mid sized Danish/German manufacturer. According to data until March 2003, Nordex had installed 2294 turbines around the world, with an installed capacity of 2000 MW.

Although information is available about their 600kW and 800kW machines, they are no longer in standard production and will only be produced for substantial orders. For the Calama project, their only appropriate offering is the N60/62 1.3MW machine. Nordex now has around 560 of the N60/62 installed worldwide. Because Nordex is a smaller manufacturer, they tend to provide very good sales support and personal attention as they are trying to gain market share.

Nordex was not recommended in Progress Report No. 4 because of their relatively small installed market share and lack of South American experience, although they do have a sales support office in Brazil. The primary concern for a manufacturer like Nordex is that they may not be able to adequately provide operations and maintenance support to the Calama project because the project size may not warrant a full-time Nordex support person, and it would be cost prohibitive for Nordex to service the facility adequately.

SeaWest has also found that their technology tends to be not as cost-competitive as other manufacturers on a kWh per dollar basis; however, in meetings with Nordex, they have indicated that they will optimize their machine for the site, and can improve on the rated power curve for the particular wind regime. They provided a site conditions sheet which could be filled out and sent back to Nordex to help optimize the machine for the site. This could be worth exploring as Nordex is also becoming more aggressive in their pricing. Their typical warranty period is two years.

The most recent experience of Nordex in South America, is the selling of 15 turbines of 1300 kW to the Colombian company Empresas Públicas de Medellín, for the Jepirachi Wind Farm, which will start operations in 2004.

3.1.3 NEG MICON

NEG Micon, the Danish manufacturer, has been manufacturing turbines for about 20 years. NEG Micon enjoys a long and solid operating history and reputation in the industry. Their 900 series technology incorporates lessons learned in operating their 750 series technology, and the reliability of the equipment is quite high. Currently the NM54/950 is their top performing machine. The NM54/950 turbine incorporates a passive stall technology and something they term Power-Trim to optimize production. Power-Trim technology basically uses three hydraulic actuators to alter the angle of the turbine blades by +/- 4 degrees. If the actual power production at a given wind speed is lower than the calculated power production, the blade pitch angle is automatically changed to maximize production.

NEG Micon has several thousand of their 750 series technology installed, but relatively few of their 900 series and so this could be a concern as it has not logged the extensive operating hours of some of the other manufactures. To their benefit, NEG Micon provides excellent sales and service support. They also have sales materials available in Spanish, and Codelco would find it relatively easy to work with NEG Micon.

NEG Micon is active within the project development area via its project development company Global Renewable Energy Partners (GREP), and also works in close cooperation with local project development companies and customers in selected markets. If Codelco determines it would be interested in using NEG Micon's technology, GREP could provide Codelco with turn-key project development services for any size project including project financing and assistance in locating a project purchaser, effectively cutting out the need for Codelco to work with a third party developer such as SeaWest or FPL. NEG Micon's standard warranty period is two (2) years.

3.1.4 GAMESA EÓLICA

Gamesa is a large Spanish industrial company specializing in aircraft and renewable energy products and one of the top five (5) wind turbine manufacturers in the world.

According to data until March 2003, Gamesa Eólica, the division of Gamesa that manufactures wind turbines, had installed 4146 turbines for a total of 3000 MW. The large majority of these turbines are in Spain where it has approximately 56% of the market share. Additionally Gamesa has installations in France, Mexico, China, Argentina, and Italy. Gamesa's G52-850 kW is a variable pitch, variable speed machine, very similar in technology to the Vestas machine. Gamesa has thousands of operating hours on their machines, especially their 47-660kW turbine, and has achieved a very good reliability and industry reputation. The

Gamesa G52-850kW machine is a work-horse and would be an ideal choice for the Calama project because of its long operating history and excellent reliability.

With a service office in Brazil, Gamesa could provide the Calama wind farm with a reasonably prompt service response. Another benefit of Gamesa is that like NEG Micon, Gamesa has a development division. This development arm, called Gamesa Energia, could provide Codelco with a turn-key wind farm including financing, operations and maintenance, effectively eliminating the need for another developer. If Codelco determines it favors the Gamesa technology they would be a good choice as a development partner.

Furthermore, interfacing with Gamesa would be quite easy for Codelco as Gamesa operates primarily in Spanish and can provide operational support to a project in Chile. Similar to the other manufacturers, Gamesa's typical warranty period is two (2) years.

3.1.5 MHI

MITSUBISHI HEAVY INDUSTRIES (MHI), the Japanese manufacturer, has a wind turbine manufacturing division. Although MHI has been very active in the wind industry in Japan since 1980, they have been working very hard over the last five (5) years or so to make a significant play into markets outside of Japan.

According to data until March 2003, MHI had installed 1382 turbines, totaling 587 MW, which is a small capacity if compared to European manufacturers.

MHI was offering the best warranties in the business, with a standard five (5) year warranty, extremely competitive turbine and construction financing, along with competitive turbine pricing. The combination of these factors caused SeaWest to install 344 MHI turbines in the last several years as MHI offered the greatest value on a dollar-per-kilowatt hour of investment.

As MHI is now solidly established in the US market, they have cut their standard warranty period to two (2) years, although they are still offering aggressive pricing and equipment financing. Their ability to provide construction financing is also a benefit which SeaWest has not found with any other turbine manufacturer. MHI seems to spend their resources impacting the bottom line of projects and consequently does not put as much effort into marketing and sales as their competitors. The result is that their marketing materials and proposals tend to be not as impressive as other manufacturers. Because of this, Codelco may find MHI not as easy to work with as other manufacturers, however MHI is difficult to beat when it comes to kilo-watt hours generated for each dollar of investment.

MHI does not have as long of an operating history of some of the other turbine manufacturers, and therefore, their technology has not been as reliable. They compensate by being extremely responsive to service issues and furthermore

have the financial capabilities to back up their warranties. MHI does have one 450kW turbine installed in Pombamba, Peru, but they may have difficulty effectively servicing a project in Calama, especially one smaller than about 40 MW, where it would then be economical to have a full-time person at the facility.

3.1.6 GENERAL ELECTRIC

GENERAL ELECTRIC recently purchased Enron Wind's manufacturing capabilities and has since expanded Enron's offerings. GE offers both a new 950kW and a 1.5 MW turbine. The 950kW turbine is based on the 1.5 MW technology, but offers a smaller and more versatile solution with no requirement for a large-scale crane for erection. It is more easily transported and erected than the 1.5 MW and therefore, more economical for construction.

The 950kW machine is both active yaw and pitch regulated with power/torque control capabilities. Both turbines have variable speed control to attain the maximum annual energy production as compared to fixed speed machines.

The GE turbines were not recommended in Report No. 4 on the basis of their lack of installations in South America, and a concern for their ability to adequately service a project near Calama. GE however is an aggressive player in the market and may easily overcome this issue. Furthermore, SeaWest has found that the 1.5 MW machine is the top performing machine on a couple of sites, beating out even the MHI machines on a kWh of production per dollar of investment. GE provides good sales support and Codelco may find that GE would be quite easy to work with as they have targeted an international cliental and have sufficient marketing materials and technical support available in Spanish. Like the other manufacturers, their standard warranty period is two (2) years.

3.1.7 BONUS

BONUS ENERGY is a Danish mid-to-large turbine manufacturer. According to data until March 2003, Bonus had installed 4.453 turbines around the world, totaling 2284 MW.

The company has been in business since 1979. Bonus offers CombiStall Technology which is a combination of two (2) traditional methods of power regulation. The turbine combines stall regulation and pitch regulation. The Bonus turbines have blades mounted to bearings on the rotor hub. The blades can be turned around their axis for pitch setting adjustment. The benefit of this is that the maximum power output can be kept constant at high wind speeds, regardless of the conditions and variations in air density are automatically compensated for. The Calama site, however, has virtually no hours per year when the turbine would reach its maximum, or rated, capacity. This feature

therefore, is not as important to the Calama wind regime as a feature that would optimize the power output at lower wind speeds.

Bonus does have five (5) of their 600kW machines installed in Argentina. Based on the availability of parts and service, the 600kW machine would probably be the best choice for the Calama project, although Bonus does make a 1 MW and a 1.3 MW turbine which may be worth exploring further. The 1 MW has relatively few machines installed. The sales support for Bonus is out of Denmark, and it would make the turbine negotiation process somewhat difficult. SeaWest has found that Bonus's support is not a robust as some of the other vendors as they did not respond to repeated messages for quotations, and so SeaWest was not able to make a recommendation of the Bonus machine. As with the other manufacturers, their standard warranty period is two (2) years.

In June of 2003 Bonus informed SeaWest that the company currently has no interest in wind projects in South America, since their strategy is focused to other markets.

3.1.8 ENERCON

ENERCON, the German wind turbine vendor, is currently manufacturing the E-40/600kW, E-58/1000kW and the E66-1800kW. Like many of the other manufacturers, their turbines are variable speed. Enercon's special offering on the E-40, E58 and E66 are gearless converters. Gearless converters mean that generators and rotors run as a single unit with no gears between the two, shortening energetic paths. Enercon's claim is that this results in a converter significantly more productive in terms of yield and technical life span than other wind turbine generators.

With 19 years in the manufacturing business, Enercon has a lengthy operating history. They have many turbines installed globally and are also the dominant manufacturer in Germany with about 34% of the market share. Enercon has 42 installed machines in South America, all of which are the E-40/600kW. Like Gamesa, Enercon has a development division, which could provide Codelco with a turn-key wind farm including financing, operations and maintenance, if Codelco determines it would like to use the Enercon technology. Their typical warranty period is two (2) years. Although SeaWest has not worked with Enercon recently they are a top-notch organization and may also be a good fit for Codelco in terms of working together to achieve a successful project.

3.2 WIND SPEED OPERATION RANGE FOR WIND TURBINES

CODELCO asked to include the following section about wind speed operation ranges, since severe wind gusts have affected Chuquicamata mining installations and operations in the past.

The maximum wind speeds that are resisted by wind turbines are indicated in the technical specifications of each model and supplier. In fact, technical specifications and design facts for each model are provided by manufacturers as part of their reference manuals for each turbine model.

All the turbines that were analyzed in this Study have been designed according to the international standards of IE 61400-1, which assure security requirements for the design and usage of the different turbines. This standard establishes that each wind turbine model must meet different types of maximum loads.

The wind speed operation range of turbines varies from the starting speed (cut-in wind speed) or minimum wind speed at which a turbine will start generating electricity, through a normal operating range, up to a maximum speed (cut-out wind speed). At the cut-out wind speed, the turbine stops generation to avoid damage to the equipment. For additional information, a summary for the models analyzed is presented in the following Table.

Table 8. Wind Speed Operational Ranges of Wind Turbines

Turbine Model	Manufacturer	Cut-in wind speed [m/s]	Cut-out wind speed [m/s]
N43-600kW y N60-1300kW	Nordex	3-4	25
G47-660kW, G52-850kW	Gamesa	4	25
600kW, 1MW, 1.3MW	Bonus	3	25
V 52 - 850 kW, V47-660kW, V80-2MW	Vestas	4	25
E40/6.44 - 600 kW , E66-1.8MW, E66-2MW	Enercon	2,5	28 - 34
MWT-600kW	Mitsubishi Heavy Industries	3	24
MWT-1000kW	Mitsubishi Heavy Industries	4	25
900kW	General Electric	3	25
1500kW	General Electric	4	25
NM54-950kW	NEG Micon	3.5	25
NM82-1650kW	NEG Micon	3.5	20

Source: Reference Technical Manuals of the Manufacturers

It is important to mention that because wind turbines are designed to stop their operation after a critical level of wind speed, they should be protected against an over-speed of the machine. This design considerations besides other more specific design and security standards described in IEC 61400, guarantee an optimal operation of wind turbines in the zone of Calama.

3.3 TECHNOLOGY SELECTION FOR THE CALAMA PROJECT

The turbine that Codelco selects should be dependant on a number of factors including: i) price; ii) the power curve that best fits the air density of Calama; iii) ease of working with the manufacturer; iv) reliability of the equipment; v) reputation of the technology; vi) ability to service the turbines and back up the warranties; vii) service that the turbine manufacturer offers, among others. It will also depend on the project size selected by Codelco.

Each of the turbine manufacturers analyzed offers a variety of turbines, although not all of the turbines would be appropriate for a variety of reasons including availability, transportation or erection, and performance. The following table presents a list of the prospective turbines for the project whose features were analyzed thoroughly. From that list, SeaWest worked with each of the turbine manufactures to have the manufacturer recommend their most appropriate technology for this particular site. The recommended turbines appear in the table below.

Manufacturer	Evaluated Model
Vestas	V47-660 kW
Vestas	V52-850kW
Nordex	N62-1.3 MW
NEG Micon	NM54-950 kW
NEG Micon	NM87-1650 kW
Gamesa	G52-850 kW
MHI	MWT-600kW
MHI	MWT-1000A kW
GE	900kW
GE	1.5 MW
Bonus	Not interested in projects in South America
Enercon	E40-600kW

The Calama site has a fairly unique wind pattern with three important features: i) it has negative wind shear during some hours of the day; ii) a very low air density (0.95 kg/m^3); iii) no hours during the year where the wind speed is above 19 m/s. Due to this pattern, many turbines will never reach their rated capacity and so the most productive turbine will accommodate this particular wind profile. The power curves at the Calama site air density of 0.95 kg/m^3 were requested from all the manufacturers for the listed turbine models, with which final energy projections for each of the models were estimated.

3.4 CONSIDERATIONS ABOUT THE SIZE OF THE WIND FARM

In the different scenarios that will be described in the following section, and in the different stages of the project, SeaWest recommends CODELCO utilize an experienced wind consulting or development firm, for the bidding, negotiation, permitting and construction processes. Whether a consultant or developer is selected will depend on if Codelco seeks ownership in the facility.

The following should be considered when determining the size of the project, especially in the scenarios in which CODELCO participates in the ownership of the Wind Farm. If CODELCO decides to do a bid a power purchase agreement for the supply of electricity (with a component that comes from renewable energies), the bidders will decide the size of the turbines and the equipment supplier, although Codelco would specify the amount of generation requested in its bid.

3.4.1 LARGER SIZE PROJECT

If Codelco wants to move forward with a larger project, for example 25-40MW, the best strategy for moving the project forward would be to work with one of the turbine manufacturers who have a development division.

The choices include NEG Micon, Gamesa, or Enercon. All three of those manufacturers have top-notch technology and all could assist with development services. The turbines that SeaWest feels suitable are the NM54-950 by NEG Micon, the Gamesa G52-850 and Enercon'sE40-600kW. Gamesa and Enercon would both probably have a small edge over NEG Micon in accessing financing for a Chilean project because of their relative strength in South America. Furthermore, both have an existing operational presence in South American and could most effectively service a project near Calama. NEG Micon, however, has a sales agents in Brazil and Argentina and might be extremely motivated to get their first installed project in South America so they could potentially offer very competitive pricing.

Utilizing this strategy of working with the development arm of one of the three manufacturers would allow Codelco the freedom from working with a third-party developer who would require a development fee or a success fee for the project. The negative part of this strategy is that Codelco would be required to utilize the technology of the developer. Codelco could pursue negotiations for both turbine supply and development services with the manufacturer who has the most economic turbine for Calama's specific wind regime.

In this development scenario, Codelco would need to offer a long term power purchase agreement to the manufacturer and would need to provide all the results gathered over the course of the feasibility study. This scenario should

offer the most competitive power purchase price for Codelco. It is also a development scenario that does offer the possibility of becoming a real project because the project size is large enough to be attractive and profitable to one of the three developers.

3.4.2 SMALL SIZE PROJECT

If Codelco determines that it would like to move forward with a very small project, such as 5-6 MW in order to limit its risk and investment, then the best strategy to pursue would be to go for a competitive bid on the selected machines, but require the turbine manufacturer to provide erection of the turbines. Although Codelco should send the bid documents to all the named manufacturers for the selected equipment, Codelco would probably find that the larger manufacturers would not have very competitive pricing for their products and Codelco would have more success with some of the smaller vendors including MHI or Nordex. It is also possible that some of the larger vendors with either no or a small South American presence might have an interest in getting their products deployed in South America and so Codelco could also see interest from GE or NEG Micon. Vestas could also be interested in a small size project, since it installed in the south of Chile three V47-660kW turbines in 2002. The ideal manufacturer would be one who was anxious to "demonstrate" their technology in South America to break into the South American market and would offer very competitive pricing on turbines.

Furthermore, this scenario assumes that Codelco self-finances the project and purchases all the power. This development scenario would result in the highest power purchase price but would have the least amount of investment risk. This scenario also has the highest probability of becoming a real project as Codelco would make the investment and retain total control over the course of the project.

3.4.3 MEDIUM SIZE PROJECT

In the event that CODELCO determines it wishes to move forward with a 5-25 MW project, the development scenario is a bit more complex. CODELCO may find that the three manufacturers, NEG Micon, Enercon, and Gamesa don't have much interest in such a small project and will have a lot of difficulty in financing the project. The first choice for CODELCO would probably be to work with one of those manufacturers in a similar arrangement as the large project development scenario. If CODELCO is not able to successfully negotiate an arrangement with one of those developers because the project size does not sufficiently motivate the developer, the best course of action would be to competitively bid the project to independent developers by offering a fixed term Power Purchase Agreement of perhaps 20-25 years for the power. Codelco could then be provided with different power rates by the independent developers. In this scenario, Codelco would have to let the developer select the technology that they felt would provide

the developer with the most profitability for the winning power price. For the bid, CODELCO would need to provide the different developers with extensive details about the project and wind regime.

This development scenario probably has the least likelihood of providing Codelco with a real project for several reasons. The project would require third party financing and the transaction fees for a smaller size project would have to be spread over fewer megawatt hours produced, resulting in a high power purchase price which would likely be unattractive for CODELCO. It also requires about the same amount of a developer's time to develop a 15 MW project as a 40MW project, yet the margins would be much lower. Also, the turbines are not being purchased in a large enough quantity to provide a volume discount, yet the number of turbines is too large to provide a demonstration project for a manufacturer. Furthermore, CODELCO would turn over development control of the project to the independent developer and so the project would be developed on another party's schedule.

4 ANALYSIS OF THE ASPECTS OF THE POWER MARKET THAT AFFECT THE WIND FARM

The following sections present an analysis of the context in which the Calama wind farm will be located. The electric market in which the farm will operate and its different agents, the aspects of electricity prices in the SING, as well as the different aspects of the system's operation that directly affect the farm will also be described. The present analysis is focused principally on Codelco's Chuquicamata Division.

4.1 DESCRIPTION OF THE POWER MARKET IN THE SING

The Northern Interconnected Power System (SING) is the second size electrical system of the country, after the Central Interconnected Power System (SIC). It extends between the first and second regions of Chile (Region of Tarapacá and Antofagasta, respectively), covering a surface of about 185,148 Km2, equivalent to 24.5% of the Chilean continental territory. The main economic activity in the SING's territory is copper mining.

The population served by the SING reaches 900,000 inhabitants (6,1% of the national total) and is located principally in the coast, specially in the cities of Arica (200,000 inhabitants), Iquique (210,000 inhabitants) and Antofagasta (270,000 inhabitants). Another important population pole is the city of Calama (with about 150,00 inhabitants), located 20 km toward the south of Codelco's Chuquicamata mine. The Wind Farm of the present study is projected to be constructed near Calama.

Historically, the power supplying the energy needs of the populated centers and copper mines in the north of Chile was made through several separated electric subsystems, based principally on thermoelectric plants operating with fuel oil and diesel. By the end of 1987, some of those subsystems were interconnected, giving birth to the SING. A simplified one-line diagram of the SING is presented below.

Diagrama Unilineal Simplificado del SING - 2003

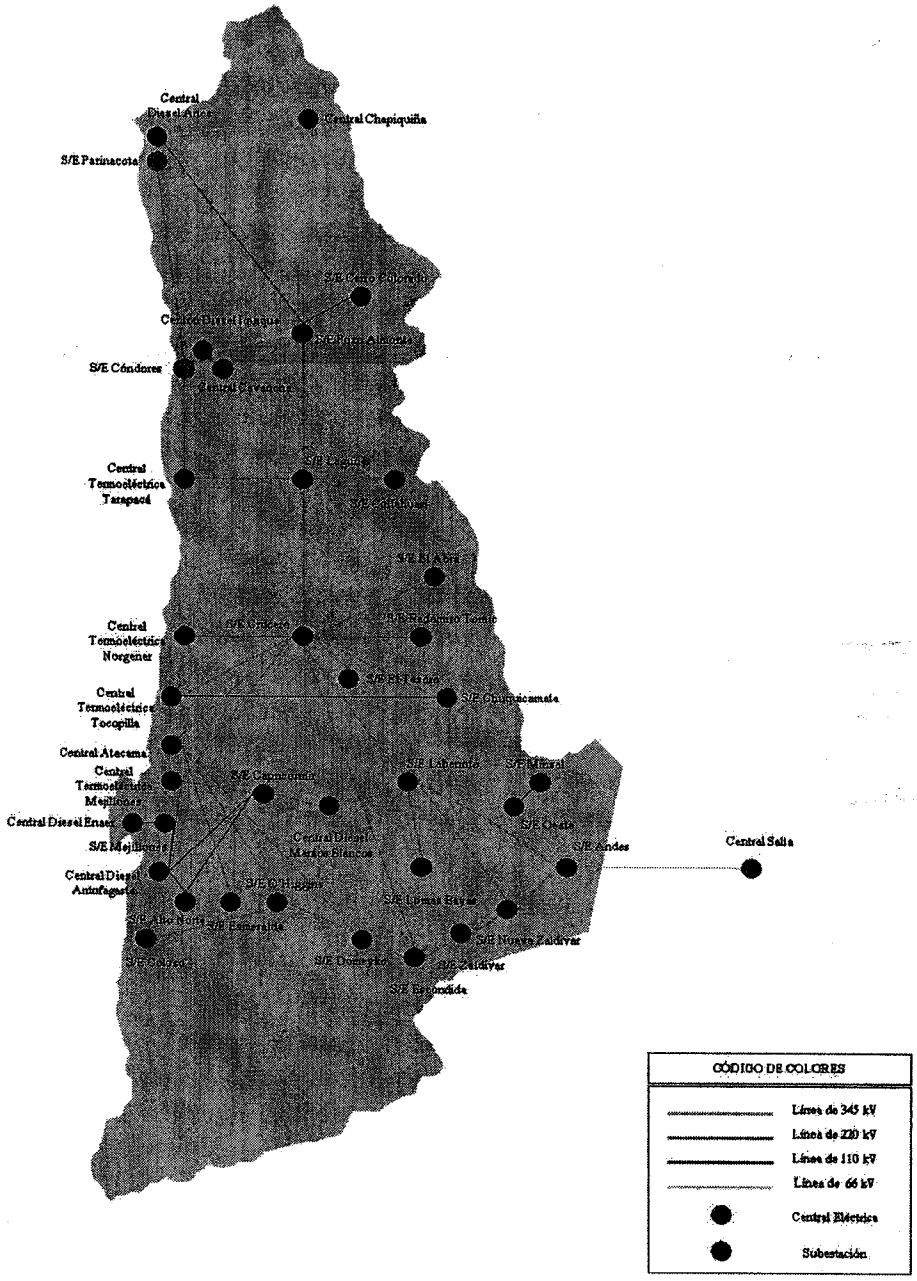


Illustration 2. One-line Diagram of the SING

Source: Web CDEC-SING

4.1.1 GENERATION IN THE SING

During the period of 1994-96 the introduction of new generators to the SING began. The main generator, ELECTROANDINA, was losing its participation in the market, and EDELNOR and NORGENER started to gain market share.

In the period 1997-98, coal fired generation was consolidated as the most relevant fuel within the system, with the entrance of three additional coal units of NORGENER, EDELNOR and Patache of CELTA.

With the arrival of the Argentinean natural gas to the SING in 1999 through the operation of Gasatacama and Norandino natural gas pipelines, the installation of natural gas combined cycle technology by ELECTROANDINA, EDELNOR and GAS ATACAMA began. On the other hand, AES GENER constructed a combined cycle gas plant in Argentina, whose energy is injected to the SING through a transmission line.

By the end of 2002, the SING reached an installed capacity of 3,634 MW, which supplied a maximum gross demand of about 1,360 MW. The maximum demand in the SING is generally between November and December (because the greatest consumption level comes from mining copper companies, whose demand growths throughout the year and doesn't depend on winter or summer cycles).

SING's gross generation reached 10,400 GWh (which meant an increase of 5,6% compared to 2001) and the energy consumption was 9.482 GWh in the same year. Generation by company and type of fuel is presented in the following table.

Table 9. Generation in the SING (2002)

BY COMPANY

	GWh	(%)
EDELNOR	1,870	18.0
ELECTROANDINA	3,115	30.0
NORGENER	315	3.0
AES GENER	1,813	17.4
CELTA	640	6.2
GASATACAMA	2,647	25.5
TOTAL	**10,400**	**100.0**

BY FUEL

	GWh	(%)
HIDRO	67	0.6
CARBON	3,818	36.7
DIESEL	18	0.2
FUEL OIL N°6	12	0.1
GAS NATURAL	6,485	62.4
TOTAL	**10,400**	**100.0**

Source: CDEC-SING Annual Report 2002

The property of the six generating companies in the SING is concentrated in a reduced number of controlling entities, principally European and North American multinational companies. Four controlling entities operated until 2001, which currently were reduced to 3 in 2002, affecting the competition between electric companies developing projects like the Calama Wind Project.

ENDESA ESPAÑA directly or indirectly controls CELTA and GASATACAMA[1]. TRACTEBEL entered as shareholder controller of ELECTROANDINA in 1996. SOUTHERN ENERGY (later called Myriant Energy) obtained the control of EDELNOR between 1993-1998, but sold its participation to Del Sol Inversiones at the end of 2001. Finally ELECTROANDINA through an operation of debt purchase has majority interest in EDELNOR. AES obtained the control of GENER and NORGENER at the beginning of 2001 and additionally is the owner of Salta, the natural gas plant in Argentina.

[1] Endesa controls Gas Atacama in conjuntion with the american company CMS.

4.1.2 TRANSMISSION IN THE SING

SING's transmission system includes 4,342 km of lines owned by companies integrating the CDEC-SING and 1,422 km of lines owned by mining companies. Six generation companies (EDELNOR, ELECTROANDINA, NORGENER, AES GENER, CELTA and GAS ATACAMA) have about 75% of the transmission infrastructure. The rest of the infrastructure is shared by non–regulated clients, which are basically mining companies (Escondida, Zaldívar, Quebrada Blanca, Fundición Alto Norte, Michilla, Cerro Colorado, Meridian and Cascada).

In the following Table, a comparison of the SING's transmission facilities is shown.

Table 10. Transmission Lines in the SING [2002]

Voltage (kV)	Length (km)	Capacity (MVA)
66 kV	207.6	285
110 kV	1,042.0	1,428
220 kV	2,684.9	8,730
345 kV	408.0	777
Subtotal	**4,342.4**	**11,220**

2. TRANSMISSION LINES OF MINING COMPANIES

Voltage (kV)	Length (km)	Capacity (MVA)
66 kV	118.0	65
110 kV	163.0	128
220 kV	1,141.0	2,618
Subtotal	**1,422.0**	**2,811**
Total SING	**5,764.4**	**14,031**

Source: CDEC-SING Annual Report 2002

CODELCO's current supplier of electricity is ELECTROANDINA, a company with approximately 1,038 km of transmission lines, which are used almost exclusively for supplying the mines of Radomiro Tomic, Chuquicamata and El Abra (see following Table). Furthermore, the city of Calama is also supplied through the lines of Electroandina and a 100 kV line of Edelnor (between substation km6 of Chuquicamata and substation Calama).

Table 11. Transmission lines of Electroandina [2002]

Owner	Transmission line	Voltage (kV)	No. Circuits	Length (km)	Capacity (MVA)	Year Start Of operation
Electroandina	Central Tocopilla - Crucero	220	2	72x2	330x2	1986
	Crucero - Chuquicamata	220	2	68x2	330x2	1986
	Crucero - El Abra	220	1	101.0	330	1995
	Crucero - Radomiro Tomic	220	1	82.0	450	1996
	Central Tocopilla - Chuquicamata 1	110	1	141.0	90	1910
	Central Tocopilla - Chuquicamata 2	110	1	141.0	90	1910
	Central Tocopilla - Chuquicamata 3	110	1	141.0	90	1915
	Central Tocopilla - Chuquicamata 4	110	1	152.0	90	1982
	Total			**1,038.0**	**2,460**	

Source: CDEC-SING Annual Report 2002.

Transmission is an important issue for the Calama wind farm, because of transmission tolls and back-up power systems. If the Project is developed by Codelco for self generation and to provide electricity to Chuquicamata, then the transmission issue would not be relevant, because the wind farm would transport its electricity from the site of production through a new 20 km transmission line, injecting its electricity directly into Chuquicamata's KM6 substation.

However, if the project is developed by a third party (through a bid, and by means of a Purchase Power Agreement - PPA) to sell its energy to Chuquicamata, this agent must necessarily offer back-up power to the mining company and this implies that it might have to consider the payment of transmission tolls to the actual owners of the transmission lines that feed Chuquicamata. This is important to note, since the copper production requires a good quality service and does not admit interruptions or failures in the electric supply.

Therefore, the agent must offer a non interruptible contract, which because of the variability and intermitting of the wind resource, forces this agent to have back-up power systems (own or contracted). If this back-up system corresponds to thermoelectric plants located at the coast, this agent must anticipate, whether necessary, to use Electroandina lines for providing Chuquicamata with back-up power. And this use of lines of Electroandina will have to be paid through a transmission toll, aspect that can be considered as an entrance barrier for the project. This agent could have another back–up alternative, to avoid the payment of transmission tolls to existing agents; this alternative is the construction of a transmission line between the generation units in the western coast and the mining company facilities. However, this alternative would represent an additional cost for the project (the project has a low profitability, even without involving in the assessments the payments of transmission tolls).

In this sense, and considering the transmission and back-up power issues, if Codelco decides to make a request for proposals offering a PPA, there would be two entities that would have an advantageous position over others: Electroandina and Edelnor. Its important to remember that Tractebel, the controller of Electroandina also now has a stake in Edelnor (after the exit of Myriant from its property and the purchase of Edelnor's debt by Electroandina)

4.1.3 DISTRIBUTION IN THE SING

Regulated clients in the SING are served by three distribution companies that belong to the multinational PP&L. ELECDA, which serves the zone of Antofagasta, EMELARI which serves the zone of Arica and ELIQSA which serves the zone of Iquique. Jointly, these distributors serve about 237,000 clients, whose energy consumption is approximately 1,020 GWh per year, as shown in the following Table.

Table 12. Distribution Market in the SING

Distributors in SING	Controller Group	Clients (2002)		Sales (2002)	
		Thousands	Increase v/s 2001	GWh	%
ELECDA	PP&L	120.2	2.1%	533.4	5.6%
ELIQSA	PP&L	62.5	4.2%	298.5	2.6%
EMELARI	PP&L	54.6	1.1%	187.9	3.8%
TOTAL		237.3	2.3%	1019.8	4.5%

Source: Annual Reports of the companies of the Emel Group.

The electric supply for the city of Calama, which is 20km from the Wind Farm, is provided by ELECDA, a distribution company. It is necessary to remember that the consumption of the city of Calama will grow in the next few years due to the relocation plan of the workers at Chuquicamata.

4.1.4 PRINCIPAL ELECTRICITY CLIENTS IN THE SING

The Electricity Law classifies clients into regulated and non-regulated. Regulated clients have demands which are less than or equal to 2 MW, and consume about 10% of the electricity in the SING. Non-regulated clients are mining and industrial companies, which consume the remaining 90% of the electricity generated in the SING. The following Table presents the main clients and suppliers in the SING.

Table 13. Non-regulated clients in the SING

Generator	Client	Type	Supplying Node	Convened Power (MW)	Final year of Contract
AES Gener	Lomas Bayas	Mining	Laberinto 220 kV	30	2008
AES Gener	Zaldívar	Mining	Laberinto 220 kV	65	2008
Celta	ACF Minera	Mining	Lagunas 220 kV	na	Na
Celta	Collahuasi	Mining	Lagunas 220 kV	110	2016
Celta	DSM Minera	Mining	Lagunas 220 kV	na	Na
Edelnor	Altonorte	Industry	Antofagasta 110 kV	40	2014
Edelnor	Inacesa	Industry	Antofagasta 110 kV	6	2005
Edelnor	Polpaico	Industry	Mejillones 23 kV	na	Na
Edelnor	Cosayach	Mining	Pozo Almonte 66 kV	nd	Na
Edelnor	La Cascada	Mining	Pozo Almonte 66 kV	nd	Na
Edelnor	Mantos Blancos	Mining	Mantos Blancos 220 kV	36	2005
Edelnor	Michilla	Mining	Mejillones 110 kV	22	2006
Edelnor	Quiborax	Mining	Arica 66 kV	0.8	2006
Edelnor	Rayrock	Mining	Antofagasta 110 kV	6	Indef
Edelnor-Celta (*)	Cerro Colorado	Mining	Pozo Almonte 220 kV	23	2008
Electroandina	Chuquicamata	Mining	Crucero220 kV - C.Tocopilla110 kV	310	2009
Electroandina	El Abra	Mining	Crucero 220 kV	150	2008
Electroandina	Radomiro Tomic	Mining	Crucero 220 kV	80	2017
Electroandina	SQM El Loa	Mining	Crucero 220 kV	40	2010
Electroandina	SQM Nva.Victoria	Mining	Lagunas 220 kV	35	2010
Electroandina	Lipesed	Mining	Tocopilla 5 kV	na	na
Gasatacama	Emel	distrib.	(***)	229	2012
Gasatacama	Enaex	Industry	Mejillones 110 kV	10	2005
Gasatacama	El Peñón	Mining	C. Atacama 220 kV	10	2009
Gasatacama	El Tesoro	Mining	Encuentro 220 kV	30	na
Gasatacama	Quebrada Blanca	Mining	Collahuasi 220 kV	nd	Nd
Gasatacama	Escondida	Mining	Crucero 220 kV - C. Atacama 220 kV	150	2008
Norgener	SQM Nitratos	Mining	Crucero 220 kV	nd	Nd
Norgener	SQM Salar	Mining	Laberinto 220 kV	10	2007
Norgener	Escondida	Mining	Crucero 220 kV	172	2007

(*) With Edelnor 22MW until 2004 and with Celta 23 MW until 2008

(***) Cóndores 110 kV - Esmeralda 110 kV - Parinacota 66 kV

Source: Deuman based on CDEC-SING Annual Report 2002; Electricidad Interamericana Magazine.

Regarding the duration of Contracts in the SING, it is important to indicate that before year 2008, 11 of the main contracts with non-regulated clients will be ended. Convened Demands in these contracts add up to 525 MW, which represents about a third part of the total convened demands currently in the SING. If these new contracts started in 2008, it would be very possible that they would have lower prices than current prices for non-regulated clients (about 44 mils/kWh), since they shall incorporate benefits associated to reduced generation costs using natural gas.

The contract of Codelco (Chuquicamata) with Electroandina ends in 2009. It is important to consider this aspect for the analysis of power prices for non-regulated clients, which will be analyzed below in this report. On the one hand, if Codelco decides to participate in the Wind Farm project as a self-generator, it does not have impediment in doing so, under the current Contract. But if Codelco decides that the way to develop the project is through a public bid, in which it offers a long term Power Purchase Agreement, it must consider that the current contract for a convened capacity of 310 MW lasts until 2009. Codelco expects to obtain lower prices, regarding current contract prices, when Chuquicamata initiates its new contract in 2010.

Considering the power demand in the SING, Chuquicamata occupies the first place (about 25% of the consumption of all the mining companies), followed by Escondida, Collahuasi, El Abra and Radomiro Tomic. If the consumption of distributing companies of the SING is added, then distributors reach the third place in the consumption ranking (approx. 1,000 GWh).

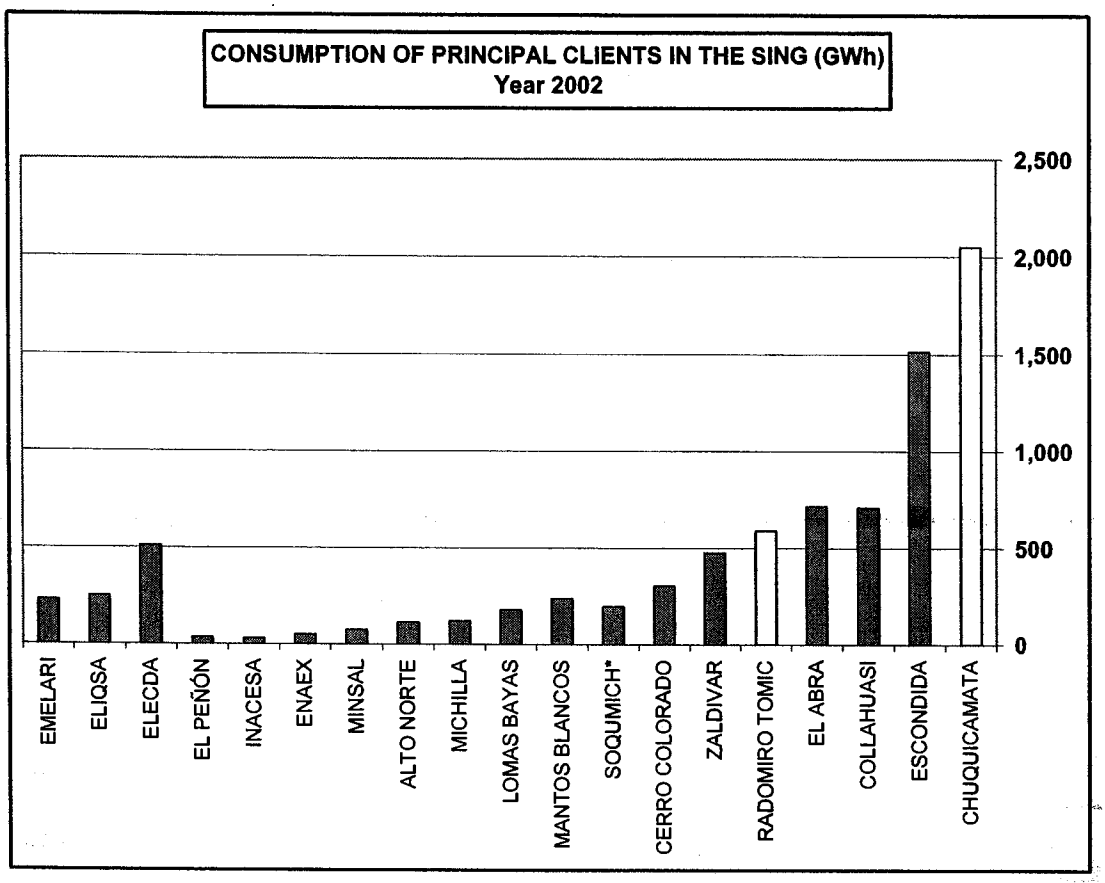


Illustration 3. Consumption of the principal clients in the SING

Source: Deuman calculations based on data of CDEC-SING

4.2 ELECTRICITY PRICE FORECAST FOR THE SING

This section presents the calculations and results of the electricity price forecast for the SING, for the period 2003-2013, including in the analysis the operation of the Calama Wind Farm.

4.2.1 ELECTRICITY DEMAND FORECAST

For projecting SING's electricity demand, both the historical behavior of generation and the electrical demand was analyzed. It was observed that for the last 9 years, the net generation experienced an annual growth of about 13.7%. This is a high rate as compared with the growth rate for the same period in the Central Interconnected System-SIC (6.8%). The high growth responds to a strong increase during period 1993-1998 (approx. 17%) driven by mining projects and a smaller rate during the most recent period 1998-2002 (equivalent to an annual rate of 9%).

The SING has the peculiarity that around 90% of its demand corresponds to the mining sector and the remaining 10% to the distributors serving the cities of Arica, Iquique, Antofagasta and the other townships of the first and second regions. Therefore, the main influence in future behavior of the demand comes from the consumption of mining companies. For that reason, the demand projection was based on Codelco's information as a specialist of this sector.

Table 14: Historical Performance SING (1993-2002)

SING	Growth Annual average 2002/1993	Growth Annual average 1998/1993	Growth Annual average 2002/1998
Gross Generation (GWh)	13.4%	17.0%	9.0%
Net Generation (GWh)	13.7%	17.0%	9.6%
Total Sales (GWh)	13.5%	16.8%	9.4%
Sales to mining clients (GWh)	14.4%	18.4%	9.6%
Sales to distributors (GWh)	7.7%	7.7%	7.8%
Installed Capacity (MW)	18.3%	13.1%	25.3%
Max Gross Generation (MW)	13.1%	19.7%	6.9%
Max Gross Demand (MW)	13.4%	19.7%	7.4%

Source: Deuman based on CDEC-SING.

For projecting SING's demand for periods 2003-2013 and 2013-2023, annualized growth rates of 5,3% and 3,6% were assumed respectively. Variations year to year are presented in the following table. For the first part of the period, growth rates provided by Codelco were used. The growth rate of 3,6% per year considers one of the conservative growth scenarios of demand that Codelco uses.

Table 15: Demand Forecast (2003-2013)

Scenario without SIC-SING Interconnection

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Net Generation (GWh)	10,839	11,127	12,023	12,784	13,545	14,306	15,068	15,829	16,590	17,351	18,112
Annual var (%)	9.7%	2.7%	8.1%	6.3%	6.0%	5.6%	5.3%	5.1%	4.8%	4.6%	4.4%
Max Demand (MW)	1,422	1,460	1,578	1,677	1,777	1,877	1,977	2,077	2,177	2,277	2,377
Annual var (%)	4.6%	2.7%	8.1%	6.3%	6.0%	5.6%	5.3%	5.1%	4.8%	4.6%	4.4%
Installed Capac (MW)	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,634	3,874	4,007	4,007
New MW									240	133	0
Max Demand / Inst Capac (%)	39%	40%	43%	46%	49%	52%	54%	57%	56%	57%	59%

Source: Deuman calculations.

In the following figure, the behavior of projected net generation is shown, compared with the historical profile and various reference scenarios. The projection that uses the historical growth rate of the last 9 years, is included, a scenario that has a low probability of occurrence. Additionally, a scenario with an annual growth rate of 5%, and the scenario used by the CDEC-SING in Transmission Tolls Report for 2003-2007 are included.

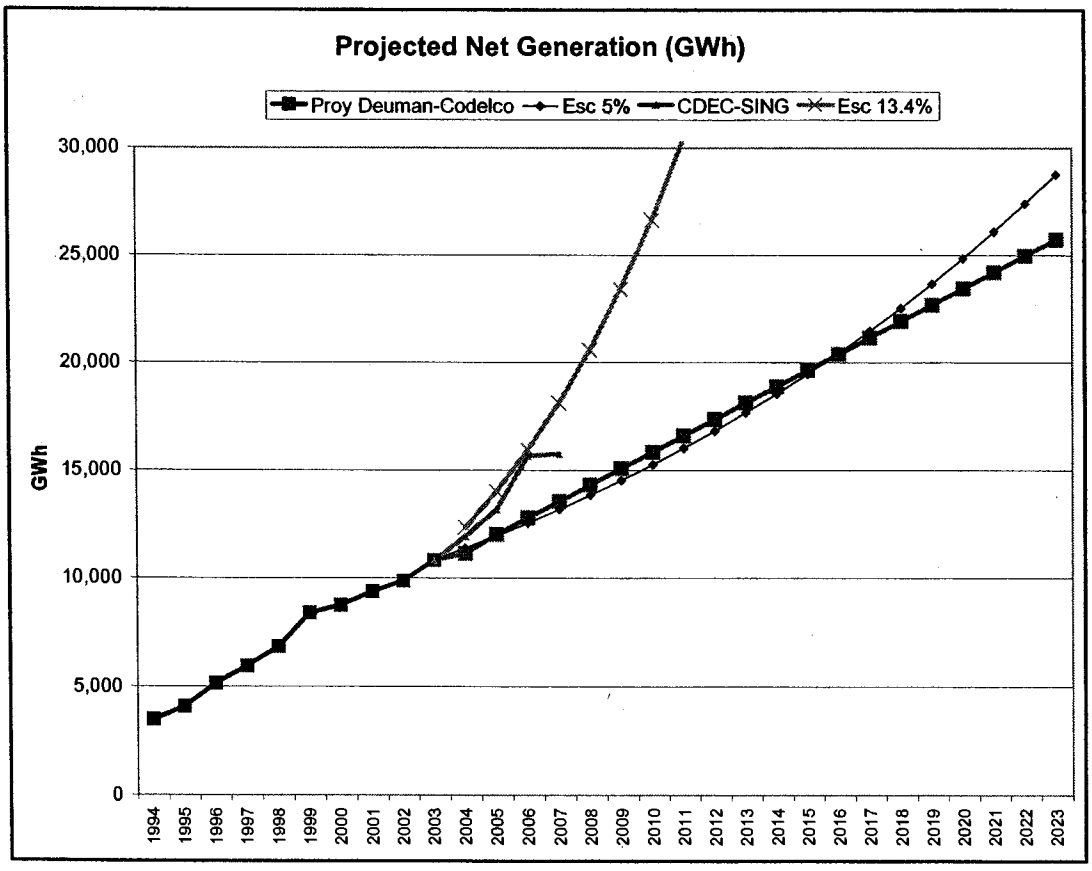


Illustration 4. Forecast of Net Generation in the SING

Source: Deuman

According to the estimates made, the demand until 2011 is covered totally by existing plants in 2003. The entrance of a new 240 MW in 2011 and 133 MW in 2012 was added to the model. That is due to surplus installed capacity in the SING since the arrival of natural gas, which is demonstrated in the numbers of year 2002: a maximum gross demand of 1360 MW (presented in December 23, 2003) with respect to an installed capacity of 3,634 MW. For modeling the entrance of new MW to the system, a safety range from 35% to 45%, between maximum demand and installed capacity, was considered.

Additionally, marginal costs of energy of the system, associated with growth scenarios of the installed capacity demand, were observed as a way of checking those years in which the operation cost of the power generation is increased and therefore capacity additions are required. The evolution of maximum demand and installed capacity are presented as follows.

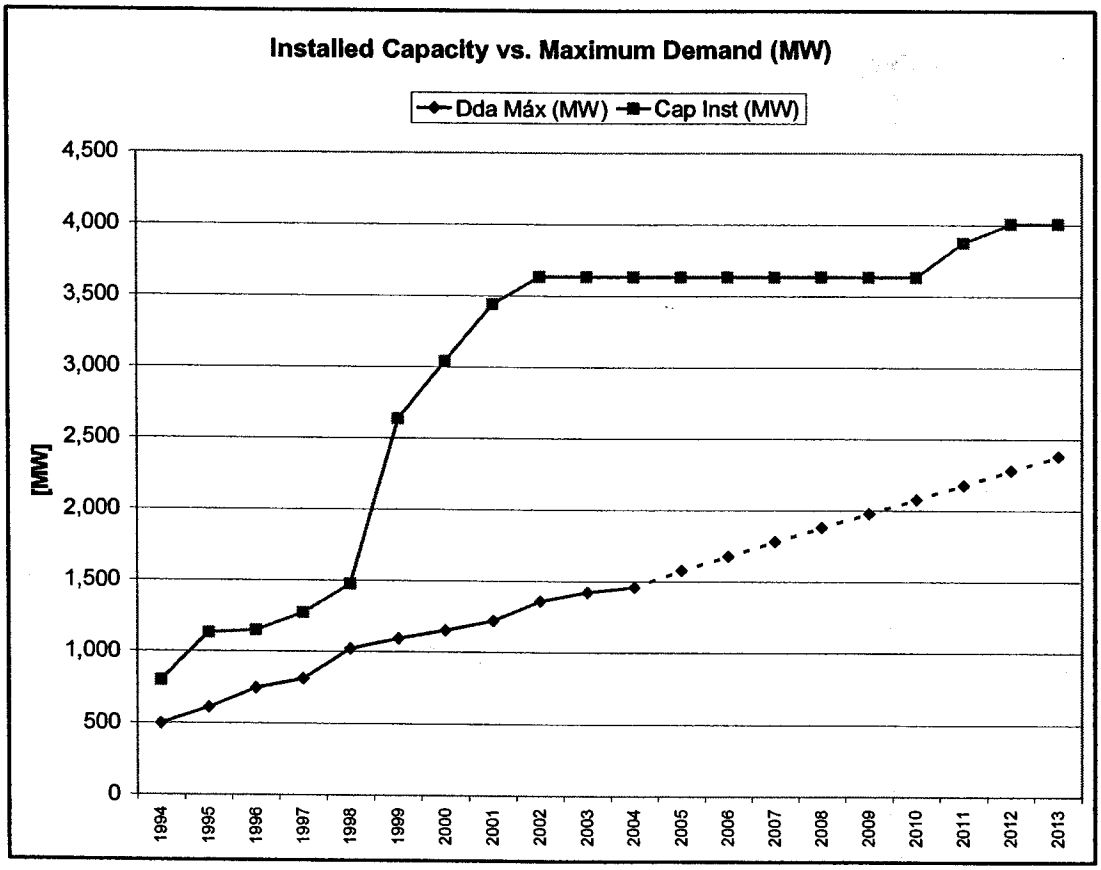


Illustration 5. Evolution of Installed Capacity and Maximum Demand in the SING

Source: Deuman

4.2.2 *FORECAST OF FUEL PRICES*

For projecting fuel prices, the prices reported by generating companies to the CDEC-SING for the last week of June 2003 were taken as basis values. Prices projections of each fuel are described in the next section.

Fuels Derived from Crude Oil

For projecting fuel prices of each one of the power plants operating with fuel or diesel, the price reported by generating companies to the CDEC-SING in June 2003 was taken as a basis and projected yearly with the same variation experienced by Brent oil prices.

As a projection of Oil Brent prices, the same projection used by the National Energy Commission (CNE) for determining Node Prices of October 2003 were used, i.e., the estimation of CERA (Cambridge Energy Research Associates). After the year 2012, constant prices around 20,5 US$ per barrel were assumed. The profile of prices is as follows:

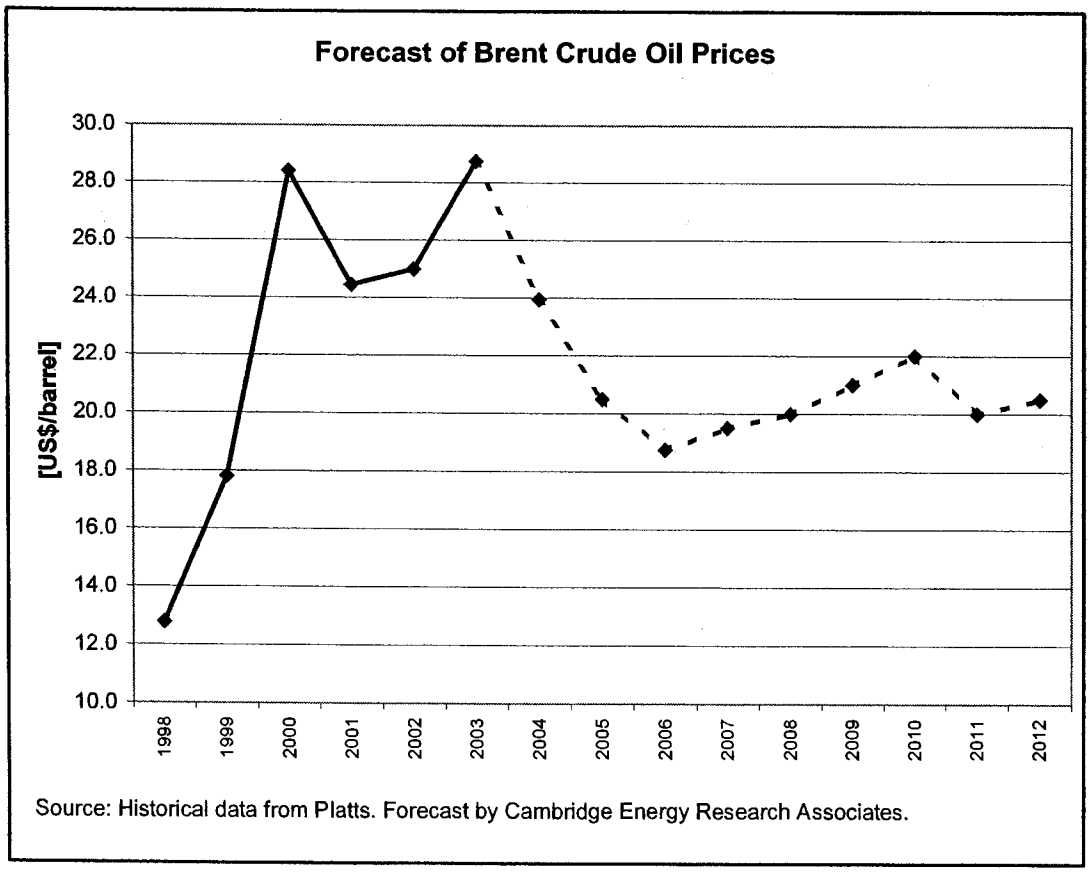


Illustration 6. Forecast of the Brent crude oil prices

Natural Gas:

For projecting fuel prices of power plants operating with natural gas, the price reported by generating companies to the CDEC-SING in June 2003 was taken as a basis. The annual projections were determined by supposing that the future behavior of the natural gas depends 50% on the Brent oil profile and 50% on the behavior of wholesale prices in the United States (Producer Price Index – PPI Finished Goods). A future behavior of PPI with an annual growth of 1,56% was assumed, which corresponds to the average growth of that variable from January 1990 to October 2003.

Coal and Pet Coke:

In order to project fuel prices of power plants operating with coal and a coal-pet coke mixture, the price reported by Edelnor to the CDEC-SING in June 2003 was taken as basis. It was assumed that this level of price stays constant in the horizon of projection and that Edelnor, and its unit CTM2, is the only unit that generates from this mixture of fuels.

4.2.3 VARIABLE OPERATION COSTS

Variable operating costs were obtained according to what is established in DFL N°1 of 1982, article 99°, using fuel prices described in the previous numeral and taking the specific consumptions reported by companies to the National Energy Commission (CNE) for determining node prices for October 2003. Non – fuel variable costs used are the same than those used by the National Energy Commission for the same regulatory process. Variable costs of each plant have been calculated as referred to Crucero node (the center of gravity of SING), by using the adequate penalty factors in consideration that the model Coste4 is an uninode model.

With the previous considerations, following variable costs for each power plant in the SING were obtained.

Table 16. Variable Operation Costs (2004-2007)

Costs4 Code	Machine Type	Net Power MW	Specific Consumption (g/kWh)	Forced Unavailability Rate	Non Fuel Var. Costs US$/MWh	2004 Fuel Var. Costs US$/MWh	2005 Fuel Var. Costs US$/MWh	2006 Fuel Var. Costs US$/MWh	2007 Fuel Var. Costs US$/MWh
CAVAC	Hidro runoff river	3.2	0	2.5%		0.00	0.00	0.00	0.00
CHAP	Hidro runoff river	10.1	0	2.5%		0.00	0.00	0.00	0.00
MIR1	Motor Diesel	2.9	268	2.8%	9.42	48.15	41.24	37.71	39.22
MIR2	Motor Diesel	2.8	268	10.8%	9.42	48.15	41.24	37.71	39.22
GMA1	Motor Diesel	8.4	251	4.2%	9.42	47.21	40.44	36.97	38.45
NAEX	Motor Diesel	1.9	245	5.0%	9.76	86.41	73.99	67.67	70.35
SULZ	Motor Diesel	4.1	277	3.0%	9.41	47.34	40.53	37.06	38.56
MIR3	Motor Diesel	2.9	268	2.1%	9.41	43.75	37.46	34.25	35.64
MANI	Motor Fuel	5.6	257	7.1%	7.51	32.30	27.65	25.29	26.29
TG-I	Turbogas Diesel	23.6	324	4.0%	1.62	55.34	47.40	43.35	45.10
MITS	Motor Fuel	5.9	228	7.8%	4.47	28.64	24.53	22.44	23.32
MAN1	Motor Fuel	11.3	275	2.9%	9.73	38.61	33.06	30.22	31.43
GAN1	Motor Diesel	16.7	245	7.3%	10.90	48.63	41.65	38.10	39.62
TGB3	Turbogas Diesel	23.7	334	5.0%	1.00	55.61	47.63	43.55	45.29
VC14	Coal	117	406	6.0%	0.97	13.56	13.56	13.56	13.56
VC15	Coal	117	406	6.0%	0.97	13.56	13.56	13.56	13.56
VC12	Coal	76.5	445	6.0%	1.10	14.86	14.86	14.86	14.86
VC13	Coal	76.5	445	6.0%	1.10	14.86	14.86	14.86	14.86
VP10	Fo No6	36.0	301	6.0%	1.21	41.06	35.16	32.15	33.44
VP11	Fo No6	36.0	301	6.0%	1.21	41.06	35.16	32.15	33.44
VP09	Fo No6	43.0	264	7.0%	0.82	36.01	30.84	28.20	29.33
TGT1	Turbogas Diesel	20.9	398	2.0%	1.02	73.07	62.57	57.23	59.54
TGT2	Turbogas Diesel	20.9	398	2.0%	1.02	73.07	62.57	57.23	59.54
TGT3	Turbogas Gas	37.2	345	3.0%	0.92	16.77	15.70	15.15	15.56
MEJ1	Coal	155	392	5.0%	0.89	12.78	12.78	12.78	12.78
NT01	Coal	128	355	5.0%	0.81	17.36	17.36	17.36	17.36
MBL1	Motor Fuel	28	237	7.0%	9.45	33.94	29.06	26.57	27.63
NT02	Coal	128	355	5.0%	0.81	17.36	17.36	17.36	17.36
MEJ2	Coal-Pet coke	164	374	5.0%	0.42	12.87	12.87	12.87	12.87
PAT1	Coal	149	421	4.1%	1.31	13.68	13.68	13.68	13.68
GA11	Comb Cycle Gas	370	206	2.3%	1.18	8.57	8.01	7.73	7.93
GA21	Comb Cycle Gas	370	206	2.3%	1.18	8.57	8.01	7.73	7.93
GA22	Comb Cycle Gas	200	206	2.3%	1.18	0.00	0.00	0.00	0.00
INCC	Comb Cycle Gas	582.4	200	2.5%	0.86	9.10	8.52	8.22	8.44
CCEL	Comb Cycle Gas	380.0	180	3.0%	0.82	8.96	8.39	8.10	8.33
CTM3	Comb Cycle Gas	243	193	2.3%	0.87	9.96	9.32	8.99	9.24
CAL1	Wind Farm	40				0.00	0.00	0.00	0.00

Table 17. Variable Operation Costs (2008-2014)

	2008	2009	2010	2011	2012	2013	2014
Cost 4 Code	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh	Fuel Var Cost US$/MWh
CAVAC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MIR1	40.22	42.24	44.26	40.24	41.24	41.24	41.24
MIR2	40.22	42.24	44.26	40.24	41.24	41.24	41.24
GMA1	39.43	41.42	43.40	39.48	40.44	40.44	40.44
NAEX	72.18	75.78	79.38	72.15	73.97	73.97	73.97
SULZ	39.66	41.52	43.49	39.53	40.53	40.53	40.53
MIR3	36.56	38.37	40.19	36.53	37.45	37.45	37.45
MANI	26.96	28.30	29.63	28.93	27.60	27.60	27.60
TG-1	46.27	48.57	50.87	46.23	47.40	47.40	47.40
MITS	23.92	25.10	26.29	23.89	24.49	24.49	24.49
MAN1	32.23	33.85	35.48	32.26	33.06	33.06	33.06
GAN1	40.82	42.85	44.89	40.62	41.63	41.63	41.63
TGE3	46.46	48.80	51.14	46.49	47.66	47.66	47.66
VC14	13.56	13.56	13.56	13.56	13.56	13.56	13.56
VC15	13.56	13.56	13.56	13.56	13.56	13.56	13.56
VC12	14.86	14.86	14.86	14.86	14.86	14.86	14.86
VC13	14.86	14.86	14.86	14.86	14.86	14.86	14.86
VP10	34.28	36.00	37.72	34.28	35.13	35.13	35.13
VP11	34.28	36.00	37.72	34.28	35.13	35.13	35.13
VP09	30.07	31.57	33.08	30.07	30.81	30.81	30.81
TGT1	61.05	64.12	67.18	61.09	62.61	62.61	62.61
TGT2	61.05	64.12	67.18	61.09	62.61	62.61	62.61
TGT3	15.87	16.39	16.91	16.28	16.63	16.77	16.91
MEJ1	12.78	12.78	12.78	12.78	12.78	12.78	12.78
NT01	17.36	17.36	17.36	17.36	17.36	17.36	17.36
MBL1	28.35	29.77	31.19	28.35	29.06	29.06	29.06
NT02	17.36	17.36	17.36	17.36	17.36	17.36	17.36
MEJ2	12.87	12.87	12.87	12.87	12.87	12.87	12.87
PAT1	13.68	13.68	13.68	13.68	13.68	13.68	13.68
GA11	8.10	8.36	8.63	8.30	8.47	8.53	8.59
GA21	8.10	8.36	8.63	8.30	8.47	8.53	8.59
GA22	0.00	0.00	0.00	0.00	0.00	0.00	8.59
INCC	8.62	8.90	9.18	8.84	9.02	9.10	9.18
CCEL	8.51	8.80	9.07	8.73	8.91	8.98	9.05
CTM3	9.44	9.75	10.06	9.67	9.86	9.94	10.02
CAL1	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.2.4 RATIONING COST

The rationing cost corresponds to " the incurred average cost per kWh, by the clients, when they don't have energy and have to generate it with emergency generators if were convenient" (DFL N°1 of 1982, Art. 9°). The value used in calculations was 335 US$ /MWh, which corresponds to the value used by the CNE in the setting of regulated node prices of October 2003.

4.2.5 DISCOUNT RATE

The discount rate used in calculating marginal costs is 10% real annual, according to what has been established by Law (DFL N°1 of 1982, Art. 100).

4.2.6 SING-SIC INTERCONNECTION

Two general scenarios were prepared, both including the operation of the wind farm starting in year 2004. The first scenario is without interconnection of the two electric systems SIC and SING, currently not electrically interconnected.

The second scenario considers a SIC-SING interconnection with the following characteristics, which are related to the interconnection projected by the CNE in the setting of node regulated prices for the SIC in October 2003.

- Direct Current Line at 500kV, bipolar.
- Transmission capacity of 600 MW.
- Operation entrance in January 2009.
- Transmission Line connects La Negra substation in SING to Polpaico substation in SIC

The scenario with SING-SIC interconnection was simulated as an increase of demand in 600 MW since year 2009. It was taken into account that the demand of 600 MW of the SIC has the characteristic capacity factor of this system (74,4%[2], caused by greater commercial and residential consumptions and the particularities of the consumption in the SIC) which is different than the capacity factor of the SING (87%).

4.2.7 OPERATION RESTRICTIONS OF THE SING

In the SING there are operational restrictions limiting the maximum dispatch power per unit, within the framework of a Safety Plan of Supply which has been agreed by its members (this Plan[3] was implemented as an answer to black-outs occurred in 2000-2001).

A current limitation of 200MW of maximum power for all the units of the system until year 2006 was considered in the scenario without interconnection. The current restriction level established by the CDEC tries to avoid that a plant which faces a failure or

[2] Corresponds to the value used by CNE in its SIC Node Price Setting Report of octuber 2003.
[3] This Security Plan includes mining clients, who have accepted the installation of low frequency relays which disconnect part of the loads when unstability occurs in the system.

interruption, represents more than 15% of the maximum demand. After 2007, a maximum dispatch limit per unit of 250 MW until year 2013 is assumed, and no dispatch restrictions are assumed after year 2014.

In the SIC – SING interconnection scenario, it was assumed that the restriction limit for the dispatch does not exist after the year of the interconnection (year 2009).

4.2.8 MARGINAL COSTS CALCULATIONS

4.2.8.1 Marginal Costs of Energy:

In order to determine Marginal Costs of Energy, the Uninodal Dispatch Model for Forecasting Electricity Prices (COSTE4) was used. This model fills the load monotonic curve considering situations in which all the units operate, and situations in which one or more units are out of service, affected by the corresponding probabilities and unavailability factors. This is the same model used by CNE to set the node regulated prices every six months.

Monthly resultant marginal costs of energy were weighted by the energies of the corresponding monotonic curve, to find annual marginal energy costs. Marginal costs are calculated in Crucero Node, which is considered to be the basic node of energy in the SING. The profile of marginal costs of energy obtained from calculations was the following:

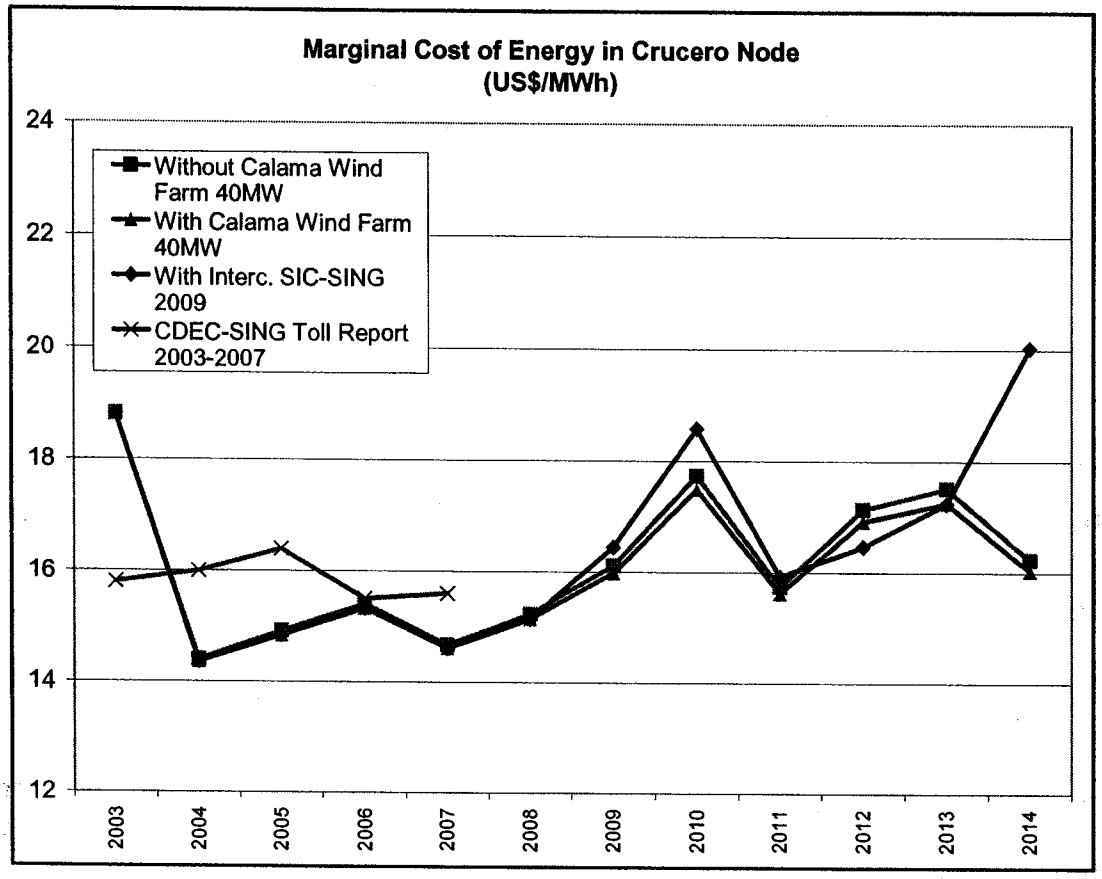


Illustration 7. Marginal Costs of Energy (Annual Averages) in the SING

In the analyzed scenarios (with and without SING-SIC interconnection) it is observed that the annual marginal costs of energy profile ranges from 14 to 20 US$ /MWh.

The effect of additional MW incoming in 2011 is observed. In the "without interconnection" scenario, the effect of not considering the restriction about maximum dispatch level of units in 2014, is observed; it causes the reduction of the marginal costs profile. As a reference, the marginal energy costs profile calculated by the CDEC-SING in December 2002 for the Transmission Tolls Report 2003 –2007 is also presented, with an average level of 16 US$/MWh.

For the financial modeling that will be described in other sections, it was assumed that the Long Term Marginal Energy Cost, since the year 2014, will be located around 18 to 19 mills/kWh.

The profile of the marginal monthly costs of energy is presented as follows:

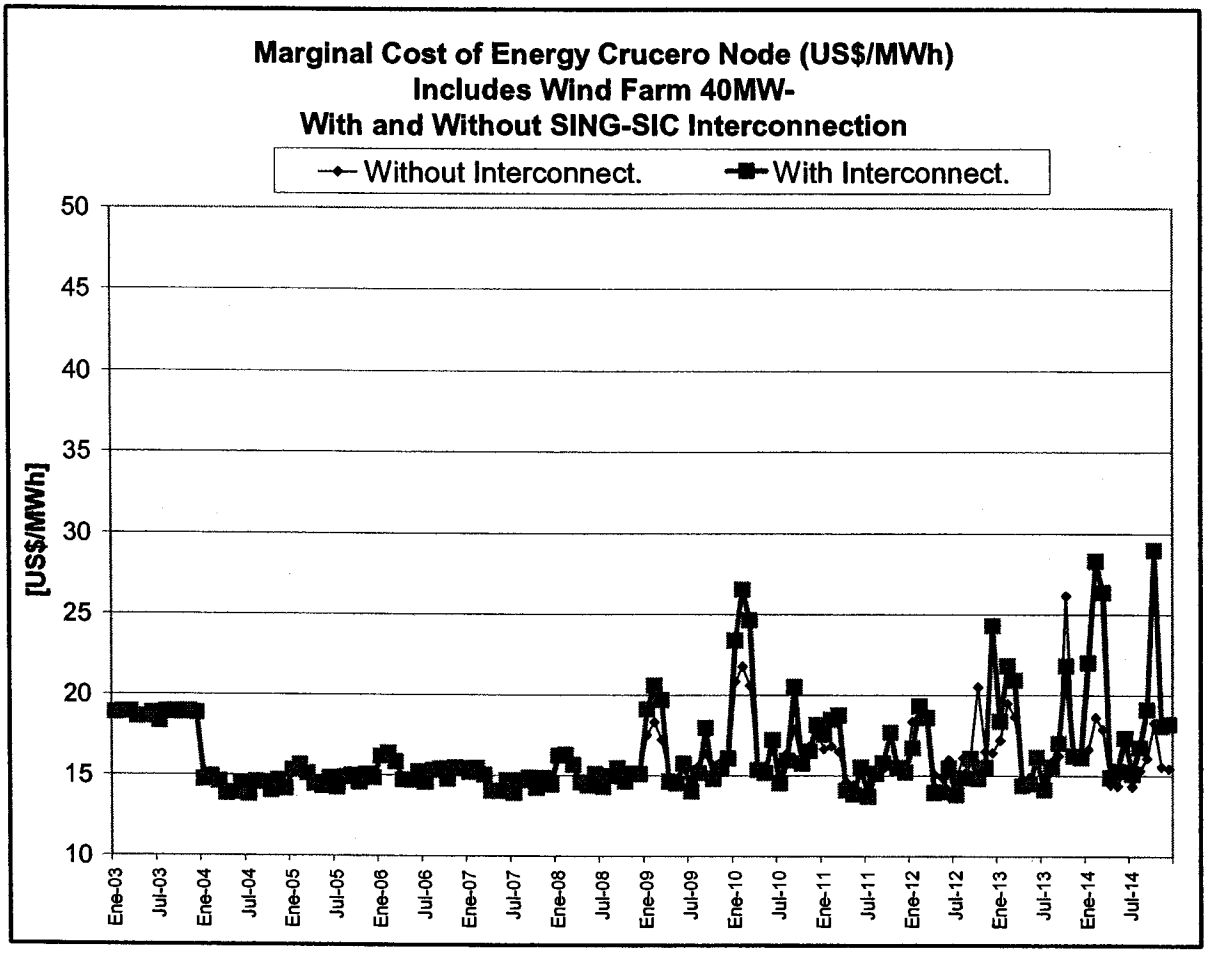


Illustration 8. Marginal Energy Costs in monthly basis for the SING

4.2.8.2 Marginal Costs of Power:

The Marginal Cost of Power was obtained from the cost of increasing the installed capacity of the SING through gas turbines of 50MW, in the node Parinacota-220kV, with the same methodology used by the CNE in the node price regulation process for October 2003. This occurs because the transactions of power in the SING are valued with the marginal cost of the theoretical power, calculated by the CNE in each node regulatory process.

The investment unit cost per additional kW is 471,3 US$/kW (which includes the financial cost associated with the anticipation in 6 months between the installation and the occurrence of the annual peak demand). Additionally, an operational cost of 0,99 US$/kW-month for that plant is assumed, and finally the monthly payment is calculated assuming an useful life of 15 years and a legal discount rate of 10%. Finally, the value is increased by a factor of 11,76% (which corresponds to the SING's margin of reserve and is equivalent to an average availability of 89,48% of the most economic generating units for supplying additional capacity in peak hours.

The basic price of peak power in the Crucero substation is calculated affecting the value of Parinacota by the penalty factor calculated by the CNE in the last node-price fixation (0,8695), which takes into account marginal losses in the system. Therefore, the marginal cost of power in Crucero–220kV has a value of 7,29 US$/kW-month. This value was assumed to remain constant in the projection horizon.

4.2.9 PROJECTED GENERATIONS

Summary results for the dispatch in the scenarios without SING-SIC interconnection (with Wind Farm operation and without Wind Farm operation), are presented in the following table. The details of these Scenarios are presented in ANNEX E.

Table 18. Annual Generation by Fuel (Scenario without Interconnection)

Caso1: Without Interconnection SIC-SING, Without Calama Wind Farm

	2002 GWh	2003 GWh	2004 GWh	2005 GWh	2006 GWh	2007 GWh	2008 GWh	2009 GWh	2010 GWh
HIDRO	62	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8
DIESEL	18	-	-	0.0	0.2	0.1	0.3	1.5	5.0
FUEL	12	0.0	0.1	0.7	3.0	1.1	4.0	11.5	29.7
CARBON	2881	1,284.5	1,821.2	2,713.2	3,462.0	2,248.4	2,997.4	3,740.2	4,459.8
COAL-PET	936	1,202.7	1,242.9	1,247.5	1,247.6	1,242.9	1,247.1	1,247.6	1,247.6
GAS	6490	8,244.8	7,956.0	7,955.4	7,965.4	9,947.1	9,952.1	9,962.4	9,981.7
EOLICA	-	-	-	-	-	-	-	-	-
TOTAL	10,399	10,845.8	11,134.0	12,030.5	12,791.9	13,553.3	14,314.7	15,076.9	15,837.5

Caso2: Without Interconnection SIC-SING, With Calama Wind Farm

	2002 real GWh	2003 GWh	2004 GWh	2005 GWh	2006 GWh	2007 GWh	2008 GWh	2009 GWh	2010 GWh
HIDRO	62	113.8	113.8	113.8	113.8	113.8	113.8	113.8	113.8
DIESEL	18	-	-	0.0	0.1	0.0	0.3	1.3	4.4
FUEL	12	0.0	0.1	0.5	2.5	0.9	3.4	10.2	26.6
CARBON	2,881	1,284.5	1,714.1	2,600.8	3,350.9	2,140.2	2,886.3	3,630.7	4,354.2
COAL-PET	936	1,202.7	1,237.5	1,247.3	1,247.6	1,239.0	1,246.9	1,247.6	1,247.6
GAS	6,490	8,244.8	7,955.9	7,955.4	7,964.3	9,946.8	9,951.4	9,960.8	9,978.5
EOLICA	-	-	112.6	112.6	112.6	112.6	112.6	112.6	112.6
TOTAL	10,399	10,845.8	11,134.0	12,030.5	12,791.9	13,553.3	14,314.7	15,077.0	15,837.7

Source: Deuman based on Coste4 results

4.2.10 FORECAST OF ELECTRICITY PRICES OF NON-REGULATED CLIENTS

In the following illustration, the evolution of average monomic prices for non-regulated clients of the SING referred to node Crucero –220 KV, in current dollars, are showed. These have been calculated using as basis the Technical Reports elaborated by the CNE for setting node prices each semester.

In the last 10 years there has been a reduction of non-regulated prices (also called free prices or market prices) from levels around 70 US$ /MWh to an average near 44 US$/MWh. From October 1992 until October 1995, prices for non-regulated clients were ranging from 73 to 65 US$ /MWh. Afterwards, in the period April 1996 – October 1998, prices reduced to a range from 60 to 50 US$ /MWh. Since 1999, prices have moved in a range from 50 to 42 US$/MWh, in a relatively stable tendency, with oscillations around 44 US$/MWh. The CNE calculated (in the node price fixation for October 2003) that the prices for non-regulated clients during the period March-September 2003, had been around 44.12 US$/MWh.

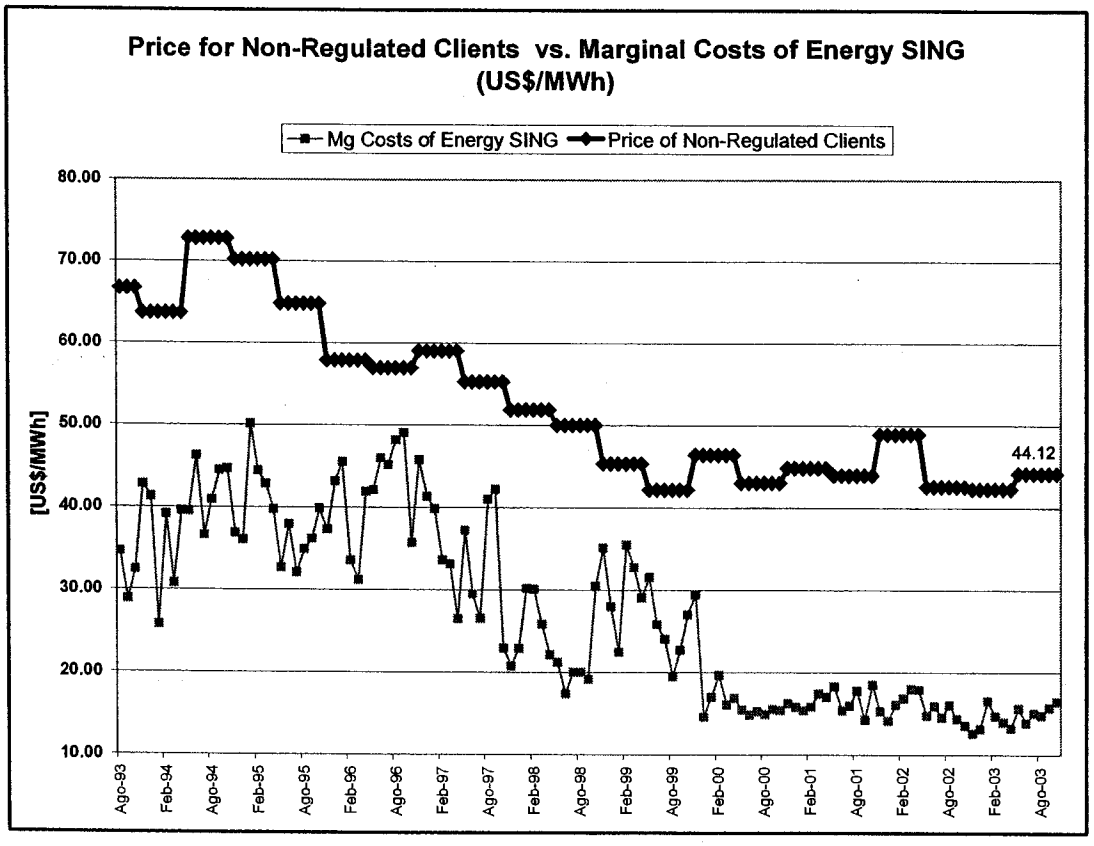


Illustration 9. Electricity Prices for Non-regulated clients vs. Real Marginal Costs in Crucero

Source: Deuman based on data of CNE and CDEC-SING.

In the same illustration, besides the prices for non-regulated clients, the monthly behavior of the Real Marginal Costs of Energy in the node Crucero, at 220kV, is presented. These are the prices at which transactions of energy between agents are valued in the SING spot market. The effect of the entrance of more efficient coal thermoelectric plants is also observed in the period 1995-1998 (effect that reduced marginal energy costs from 50 to 30 US$/MWh). Later entrance of natural gas fired plants, produced an additional decrease in marginal energy costs bellow 20 US$/MWh, with an average near 16 USD$/MWh in the period January 2000 – October 2003.

It has been estimated that until 2008, the price for non-regulated clients will be between 42 and 40 US$/MWh. As mentioned in section 4.1.4, from 2004 to year 2008, existing contracts for an convened capacity near 520 MW will be ended (almost a third part of the system's maximum demand). Therefore, until that year the prices of existing contracts will continue with the last 3 years tendency, subject to the current indexing. In general, the main contracts of non-regulated clients of the SING index their energy prices with polynomials including prices of the fuels that conform the energy matrix of the system, and index their power prices with indexes that reflect the movements of international wholesales prices of factor of productions (Consumer Price Index-CPI or Producer Price Index-PPI, both from the United States of America)

However, since 2008, with the signature of new contracts to serve these 520 MW referred, better prices for those clients who reflect more directly the effect of natural gas-based generation (and its greater weight on the fuel matrix) shall be incorporated. In the year 2009 the 10 year contract between Codelco Chuquicamata and Electroandina, whose convened capacity is 310MW, ends, and it's expected the mining company will benefit from lower market prices that would occur because of new contracts starting in the next 5 years.

It was assumed that the new level of prices for non-regulated clients since the year 2009 will be about 35.6 US$/MWh, which represents a strong assumption because it means a reduction around 15% with respect to the price of 42 US$/MWh for a non-regulated client, which is estimated for 2008 (it was assumed a reduction from the current average level of 44 US$/MWh to 42 USD$/MWh in 2008). Higher reductions in electricity prices are not considered feasible because the technological change has already been made. Additionally, the level of monomical prices between 33 and 36 US$/MWh reflects the total generating costs of a natural gas project in the SING (considering the fuel cost, fuel transportation, and Operating & Maintenance costs of the plant).

Additionally, electricity prices could experience greater reductions in a scenario with high competition between generators, reality that doesn't correspond to the SING. Until 2001 there were 4 controller groups in the SING: ENDESA España (through its participation in Celta and Gas Atacama), Tractebel (through its control of Electroandina), Myrant Energy (by its property in Edelnor) and AES Gener (by its participation in Norgener and Salta). However, at the end of 2001

the property of Edelnor was modified through transfer and buy operations of its debt in which Electroandina was involved. Therefore, the number of generating controller agents was reduced to 3, which limits the competition.

4.3 METHODOLOGY FOR OBTAINING THE REMUNERATION OF FIRM CAPACITY FOR THE WIND FARM

Since the Calama wind farm revenues will be directly influenced by firm capacity remunerations, a section elaborating on this regard has been prepared in case the production is sold in the spot market The current methodology for firm capacity remuneration will be analyzed and the treatment that a wind plant would receive will be addressed.

The current relevant regulations were consulted upon preparing this section (Statutory Decree DFL 1 issued in 1982, Decree 327 issued in 1997, CDEC-SING By-Laws, Resolution 163 by the Ministry of Economy), and a meeting was held on June 26, 2003 with the responsible officer from CDEC-SING[4] (José Miguel Arévalo, Head of Transfers Office for CDEC-SING.)

Additionally, a formal request was done to CDEC-SING, asking for an estimation or a guideline that might illustrate the firm capacity payment that the Calama Wind Farm would receive. A twenty-month (February 2002-September 2003) generation forecast was prepared for the 40-MW wind farm, considering wind records and power curves for an 850-KW turbine. That request is enclosed to Annex F. The related reply from CDEC-SING is also enclosed to Annex F, laying stress on the fact that CDEC-SING abstained from defining a firm capacity payment value for the wind plant, and requested Codelco to conduct computations based on current regulations. Apparently CDEC-SING argues that no preliminary judgments will be pronounced before the plant is installed.

Therefore, three different scenarios for firm capacity remuneration or acknowledgement were considered when running financial model simulations: i) 50% firm capacity, i.e. 20 MW; ii) 40% firm capacity, i.e. 16 MW; and iii) 30% firm capacity, i.e. 12 MW. Wind plants are acknowledged to contribute no firm capacity, for their variable intermittent nature is unable to instantly respond to changes in the system demand. Consequently plants are dispatched as base generation by Economic Load Dispatch Centers, in the countries in which they operate. As shown below in the economic results section, business profitability in the scenario of sales to the spot market is anticipated to be very low for simulated scenarios (1.5% for the IRR in scenario in which firm capacity is 30% of the installed capacity).

[4] Preliminary meetings were previously held with the CDEC-SING's Director of Operations in early 2001, and the Director of Transmission Tolls expressed his interest in discussing the issue.

4.3.1 THE CDEC-SING ROLE AND OPERATION

The operation of the SING´s Economic Dispatch Load Center and its related responsibilities are briefly described below as an introduction to firm capacity, according to the applicable law requirements.

Each CDEC is responsible for coordinating the operation of its related electric system as per the applicable regulations. The coordination instructions issued by every CDEC are mandatory for every power plant and transportation line interconnected with its related system.

For operation purposes each CDEC has its own internal rules, which must comply with every applicable regulation.

The main roles legally required from each CDEC include but are not limited to:

a) Planning the electric system operation in the short term, in consideration of its current and expected statuses for the medium and short term, and reporting it to those interconnected with the system that must operate their respective facilities in accordance with the resulting programs;
b) Computing the instant marginal costs for electricity in every bar that belongs to the respective electric system node;
c) Coordinating major preventative maintenance for generation units;
d) Checking for compliance with operation and major preventative maintenance programs, and taking any remedial actions needed while checking.
e) Determining and appraising electricity transfers among generation companies;
f) Developing the procedures needed to meet service quality requirements according to the law;
g) Establishing, coordinating and verifying the system backup generation supply;
h) Coordinating load disconnection in consumption bars as well as any other measures needed by members of the electric system subject to coordination, in order to preserve the service overall safety in the electric system, as per the procedures defined by internal bylaws.
i) Assuring the right of way for established transmission systems via a concession as per the rights and duties provided for by the law;
j) Assembling the transmission system and making it available to generation and production companies, as well as to any other interested party willing to use it even if not a part of CDEC;
k) Giving the National Commission of Energy (CNE) and the Electricity and Fuel Superintendent (SEC) due notice of all failures and any other situations that affect or may affect the normal operation of power plants and transmission lines in the system, as well as of any other respects that

may have an impact on the service safety or installed capacity of the system.

l) Organizationally speaking each CDEC is composed of a Board of Directors, the Direction of Operations and the Direction of Transmission Tolls.

The Board of Directors is composed of one representative from each organization that is a CDEC member. Notwithstanding the above, smaller generation companies may generally be represented by member companies if deemed useful and so agreed.

The Board role includes but is not limited to:

a) Watching for compliance with the duties assigned to CDEC by the law and internal bylaws;
b) Releasing the special reports on CDEC operations upon the request of CNE and the Superintendent within the required timeframes notwithstanding the regular reporting defined by this bylaws.
c) Approving and amending DEC internal bylaws.
d) Resolving conflicts submitted to it by the Direction of Operations or the Direction of Transmission Tolls.
e) Giving CNE notice of the disconnection, removal and reintroduction of new generation plants or units and transportation lines;

The Direction of Operations and the Direction of Transmission Tolls play clearly technical and executive roles and follow the general work criteria determined by the Board.

The role of the Direction of Operations includes but it is not limited to:

a) Proposing the Board the decisions and procedures that lead to compliance with the law and internal bylaws;
b) Making decisions needed to apply methodologies, mathematical models, parameter values, measurement schemes and other technical matters related to the system operations;
c) Establishing, coordinating and verifying backup generation supply in the system in order to instantly regulate frequency within limits set forth by the law, and arranging load disconnection in consumption bars, as well as any other steps needed from the system generators and transmitters in order to preserve its overall service safety;
d) Planning the operation and coordination of major maintenance events for generation units and transportation lines of the electric system in the short, medium and long term;
e) Checking for compliance with planned operation programs, recording any deviations and their related causes, and defining the measures needed to remedy them;
f) Estimating firm generation for each power plant and checking for the related balances for each generation company;

g) Computing the instant marginal costs for electricity in every bar that belongs to the respective electric system node;
h) Performing any other tasks needed to deliver CDEC duties, except for those the Direction of Transmission Tolls is responsible for; and
i) Proposing the Board internal bylaws related to the role of this Direction and any related amendments.

The role of the Direction of Transmission Tolls includes but it is not limited to:

a) Proposing the Board the decisions and procedures that lead to compliance with the law and internal bylaws;
b) Determining and forecasting annually the capacity and maximum additional usage of each transportation system with operations arranged by CDEC, for a five-year term and with illustrative purposes, and using the service quality criteria applicable under the law.
c) Making decisions needed to apply methodologies, mathematical models, parameter values, measurement schemes and other technical matters required to comply with its role;
d) Defining and proposing the Board the facilities involved in the influence area of each plant with its operations coordinated by CDEC;
e) Requesting and receiving information on new replacement values and operation and maintenance costs applicable to toll calculations in each section from the organizations subject to the coordination of each respective CDEC that either own or operate a transmission facility.
f) Forecasting early each year the toll revenues from each transportation facility subject to CDEC coordination.
g) Collecting information on new replacement values, operation and maintenance costs, transferred generation and toll revenue forecasts applicable to toll calculations; calculated actual revenues per section; and capacities available in lines and substations for additional tolls in the different system sections, and their related calculations
h) Calculating the basic toll expressed as a unit per unit of firm generation added to the system, with the related adjustment formulae, for each substation included in section 274 of the electrical regulations;
i) Requesting from substation operators referred to in section 274 a report that elaborates on the facilities needed to receive the additional generation injections mentioned in the request, and defining those that are vital to achieve the legally required service quality.
j) Developing the regular reports provided for by this regulation and the internal bylaws and the especial reports requested by the Board.
k) Proposing the Board internal bylaws related to the role of this Management and any related amendments.

The Antofagasta-based Dispatch and Control Center is finally responsible for coordinating the real time operation of the electrical system as a whole, i.e., in every generation unit and transportation line.

As of July 2003 there are seven CDEC-SING member companies, i.e., six generation (AES Gener, Celta, Edelnor, Electroandina, Gas Atacama y Norgener) and one transmission company (Transelec Norte.) The Calama wind farm could become a CDEC-SING member either directly or requesting to be represented by other member companies.

As gathered from the above, and assuming the wind farm operation belongs to CDEC-SING, that organization holds every legal power required to define operational conditions, particularly firm capacity remuneration.

4.3.2 GENERAL ASPECTS OF FIRM CAPACITY

Section 259 of Decree 327 from 1998 defines firm capacity: "*The firm capacity of a generator shall be understood as the maximum power it might be able to inject and transfer to transmission systems during peak time hours in the system, considering its probable unavailability. Such probable unavailability shall result from the sum of firm capacities in each of its own units and firm capacity contracted with third party services operating in synchronicity with the system.*"

On the other hand, the Law provides that transfer calculations for annual firm capacity will be preliminarily prepared by CDEC-SING in December of the previous year, considering maximum demand forecasts for each generator interconnected with the respective system. Later through the year numbers will be recalculated and payments among generation companies will be adjusted consequently.

Although these definitions are fully in force, now the different market agents hold different views of how to interpret them. As a result, the firm capacity calculation methodology is not accepted by all the agents, which causes that the methodology is discussed and analyzed by the Ministry of Economy, with the involvement of the National Commission on Energy in its capacity as the technical advisory organization. The current process or status for this calculation methodology is referred to as "divergence."

This situation affects both current and new plants and should be settled by the authorities by the end of this year. The sector in the meantime is and will continue to operate the system transactions waiting for a final determination. Then any applicable recalculations will be processed.

4.3.3 METHODOLOGY FOR FIRM CAPACITY CALCULATION IN THE SING

The calculation methodology for firm capacity in the Northern Interconnected Power System (SING) is composed of three independent calculations in order to quantify sufficiency and security of service. The first calculation estimates the

input from each plant to the system sufficiency. It is known as the *Sufficiency Case Calculation.*

The second and third calculations quantify the input from each power plant to the system's security. These calculations are known as the *Startup Time Case Calculation* and *Load Increase Time Case Calculation*, respectively.

The three calculations consider an *Initial Capacity* for each plant, which is determined from the so-called plant power histogram.

For all calculations under this methodology, the Peak period of the system corresponds to all the hours in a year. Peak hours correspond to the hours between 6:00 PM through 11:00 PM for every day in the winter season, and from 7:00 PM through 12:00 AM or midnight for every day in the summer season, except Sundays and holidays.

4.3.3.1 Calculating Procedure for firm capacity in the SING

The firm capacity of a plant is determined by the following sequence of calculations:

a) Preliminary Firm Capacity is determined for each generation unit over each sub period.
b) Firm Capacity per sub period in a unit is equal to the Preliminary Firm Capacity for the respective sub period, prorated with the rest of the generation units, as a proportion of the Maximum Demand in the SING.
c) Firm Capacity of a generation unit is equal to the sum of Firm Capacities per Sub period, weighted by the number of peak time hours in the respective sub period, and divided by the total number of peak time hours.
d) The unit is checked to verify that it is able to inject and transfer its firm capacity through the transmission system. Should the unit fail to inject and transfer its firm capacity through the transmission system, it shall reduce its firm capacity proportionally, in case there are other units facing the same issue. Therefore, the units that are able to inject and transfer their firm capacity through the transmission system, will increase their own firm capacity proportionally, so that the combined firm capacity of all the generation units may adjust to the Maximum Demand of the SING.

Below is a brief description of the principal steps that the final firm capacity calculation consists of.

Determination of preliminary firm capacity:

The preliminary firm capacity is calculated as:

$$PFP = 0.50PF_S + 0.25PF_{TP} + 0.25\ PF_{IC}$$

With:

PF_S: Firm Capacity for the Sufficiency Case
PF_{TP}: Firm Capacity for Star-up Time Case
PF_{IC}: Firm Capacity for the Load Increase Time Case

Each plant's PFP is later adjusted using a unique factor defined as the quotient resulting from maximum demand during peak time hours (of each month in the year) and the sum of preliminary firm generations in each plant, thus producing the firm capacity for each plant. Then:

$$PF_i = PFP_i * [Dmáx / \sum PFP_i]$$

The above process applies to each corresponding sub period. Then the unique PFP value for each plant is obtained, adjusted to the Maximum Demand considering the number and length of sub periods defined.

Finally, it must be verified that the Firm Capacity of each plant may can be injected and transferred to the transmission system. In other words, with the adjusted PFP to the equivalent Maximum Demand of the system, the adjustment of transmission restrictions is done.

Should the plant fail to inject or transfer PFP through the transmission system, it shall reduce its firm capacity proportionally, in case there are other plants facing the same issue. Thus the plants able to inject and transfer PFP through the transmission system will increase their own Firm Capacity proportionally, so that firm capacity in the system may adjust to the maximum demand.

Initial Capacity

Initial Capacity (PI) of a generation unit is equal to the average value of the Histogram of Maximum Powers. Such value is defined considering historical operation of the plant.

In the case of runoff river hydraulic units -such as Cavancha (3.2 MW) and Chapiquiña (10.2 MW)- initial capacity is calculated from the average of hourly mean generations, which is equivalent to acknowledging the maximum power equivalent to the generable runoff the river.

The methodology states that to determine initial power of a plant, and in order to collect information on the generation limitations found for each power plant or generation unit, a "power histogram" of each plant in the system must be constructed.

Each power plant in the system will be solely represented by a Capacity or Initial Capacity status, equal to the equivalent capacity status resulting from the weighted addition of the different statuses found in the respective power histogram.

With regards to the possible treatment of the firm capacity applicable to a wind plant, in its condition of a new plant and new technology, the Economic Dispatch Load Center (CDEC-SING) informed this consultants that a wind plant could receive a treatment similar to that applicable to runoff river hydroelectric power plants. In this case, the Initial Capacity would correspond to the average power of the plant during the past operating year.

In addition and considering that it would be a brand new plant without historical generation, such average capacity for the first year should be pronounced as part of the preliminary firm capacity calculation.

Firm Capacity Sufficiency Case (PF_S)

Considering Initial Capacity (discounting plant's own consumption) and associated mechanical unavailability, the Sufficiency Case Firm Capacity Generation must be calculated for each power plant and each sub period of the year as the case may be. The following equation is used for that purpose.

$$PF_S = PI*(1 - cp) * (1 - I_e) * \frac{Pr*(P'_S > D_{máx} - PI(1- cp))}{Pr*(P_S > D_{máx})}$$

With:

PF_S : Firm Capacity Sufficiency Case of a generation unit .
Pr: Function that shows excess probability
P'_S Random Variable that represents the capacities of all the units in the system, excluding the unit that is being evaluated.
P_S : Random Variable that represents the capacities of all the units in the system, including the unit that is being evaluated.

Firm Capacity Start-up Time Case (PF_{TP})

In this case the startup time attribute is assessed for each power plant under the same test, calculating the "Ftp" area factor, which weights the Initial Capacity of the power plant after discounting own consumption.

The power plant is specifically tested for its startup capacity, considering the so-called power plant's minimum technical level expressed in MWs and its cold startup time until such minimum technical level (fp) is achieved.

The power plant startup capacity is measured for a five-hour time window, considering the above in terms of the quotient resulting from the area where the power plant contributes with capacity and the total area defined by the minimum technical level and five hours. Such quotient defines the Ftp area factor.

The Startup Time Case results from weighting the unit Initial Capacity, discounting own consumption, by the Ftp factor. Then:

$$PF_{TP} = PI*(1 - cp)*F_{tp}$$

Where:

$$F_{tp} = \begin{cases} 1 - \frac{Tp}{10} & ; \quad Tp \leq 5 \text{ hours} \\ \frac{5}{2*Tp} & ; \quad Tp > 5 \text{ hours} \end{cases}$$

Therefore the respective Ftp factor weights the Initial Capacity (minus own consumption) for each power plant included in the calculation, thus obtaining the Firm Capacity for the Startup Time case in each sub period.

In the particular case of the wind plant, the operator and/or manufacturer should state the PF_{TP} for the first year of operation.

Firm Capacity Load Increase Case (PF_{IC})

In this case the load increase time attribute is assessed for each power plant under the same test, calculating the "Ftc" area factor, which weights the Initial Capacity of the power plant after discounting own consumption.

The power plant is specifically tested for its capacity to take load starting from an initial operating condition equal to the minimum technical level, considering the so-called power plant minimum technical level expressed in MW's and its load increase rate (MW/min).

The power plant load intake capacity is measured for a five-hour time window, considering the above in terms of the quotient resulting from the area where the power plant takes the load and the total area defined by the Maximum Capacity minus the Minimum technical level and five hours. Such quotient defines the Ftc area factor. Then:

$PF_{IC} = PI^{*}(1 - cp)^{*}F_{tc}$

Donde:

$$F_{tp} = \begin{cases} 1 - \frac{Tc}{10} & ; \quad Tc \leq 5 \text{ hours} \\ \frac{5}{2^{*}Tc} & ; \quad Tc > 5 \text{ hours} \end{cases}$$

Therefore, the respective Ftp factor weights the Initial Capacity (minus own consumption) for each power plant included in the calculation, thus obtaining the Firm Capacity for the Load Increase case in each sub period.

In the particular case of the wind plant, the operator and/or manufacturer should state the PF_{IC} for the first year of operation.

4.3.4 APLICATION OF THE FIRM CAPACITY METHODOLOGY TO THE CASE OF A WIND FARM

Considering the above it is possible to state that:

- If the decision is made to sell energy and power from the Calama Wind power plant to the SING´s spot market, operational regulations provided for by the CDEC-SING Direction of Operations shall be followed.
- Regardless of the above, it would be feasible for the wind farm to acknowledge and receive remuneration from its firm capacity as per the applicable regulations.
- However, considering the wind plant's nature with variable intermittent generation, and international experience with these power plants, firm capacity delivery is not one its main attributes. It fails to maintain the system's firmness in the light of demand requirements, unless wind resources are immediately available.
- Therefore a number of scenarios were assumed, acknowledging firm capacity for 50%, 40% and 30% of its installed capacity.
- From the second year onwards, the firm generation value may gradually increase year by year since the operational statistics of the plant will be available, thus possibly raising the firm capacity remuneration. A conservative approach has been adopted, however, maintaining a fixed remuneration in each scenario.

4.3.5 POSSIBLE AMENDMENTS TO THE FIRM CAPACITY REMUNERATION IN THE SHORT ELECTRICITY LAW

The Short Electricity Law drafted by the Ministry of Economy, Development and Reconstruction (Minecon) amends the Electricity Law applicable since 1982 (Statutory Decree DFL 1 issued in 1982.) Both the National Commission of Energy (CNE) and the Minecon introduced changes to this Bill in the course of discussions. It is currently being discussed in Congress, but its date of passing and applicability remains uncertain.

This Short Electricity Law introduces changes to firm capacity remuneration, but its main focus is aimed at modifying transmission pricing, complementary service remuneration and pricing applicable to isolated systems (Aysén and Magallanes.)

In terms of firm capacity, this CNE Bill proposes[5]:

1. Providing the concept of firm capacity with legal hierarchy in association with the sufficiency or capacity concepts. The firm capacity remuneration is currently under divergence. Should the law at least define the concept of firm capacity, such definition would have a higher hierarchy, than the current definition which appears in one of the Minecon´s Resolutions.

2. Establish guidelines to define regulatory methodologies for appraisal of the corresponding revenues and transfers.

3. Establishing the Price for Firm Capacity Transfer Among Generators as equal to the Final Power Node Price.

Therefore the Short Electricity Law amendments would not initially impact the currently acknowledged MW quantities, though they would impact the price of their transactions. This transaction price amendment might have a positive impact on the Calama wind project, for the firm capacity transaction price would increase. Firm Capacity transfers are currently priced at a value equal to the basic theoretical power node price calculated by CNE, before the price band adjustment in the SING takes place, using the market prices of the free non-regulated clients[6]. Actually the theoretical power node price is lower than the final power node price.

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[5] {0>Fuente:<}0{>Source:<0} {0>Página web de la CNE en la versión de junio de 2003 (www.cne.cl)<}0{>CNE website as of June 2003 (www.cne.cl)<0}

[6] {0>La CNE en cada fijación semestral tarifaria calcula el precio teórico básico de energía y el precio teórico básico de potencia.<}0{>CNE sets twice a year, the basic theoretical node prices for both energy and power.<0} This theoretical node prices are modified after checking them against the market prices that are charged to free non-regulate clients. {0>Posteriormente, compara el precio promedio monómico resultante de estos dos precios anteriores, con el precio medio de los clientes libres.<}0{> <0}{0>Si el precio teórico medio supera en más de 10% o es inferior más de 10% del precio medio de clientes libres, entonces se corrigen los precios teóricos de energía y

potencia para ajustarse a la banda de +-10%, obteniéndose los precios de nudo básicos definitivos.<}0{>Should the theoretical average monomical price (or price that summarizes the energy and power theoretical node prices) differ from the free client average price by more than or less than 10%, theoretical power and energy prices shall be adjusted to remain within the +-10% price band, thus obtaining the final basic node price.<0} {0>Si el precio medio teórico se encuentra dentro de la banda de precios libres, entonces no se corrige el cálculo teórico, transformándose éste en definitivo.<}0{>Should the theoretical average price be within the free price band, no adjustments apply to the theoretical calculation, which becomes final.<0} {0>Con esto el regulador ha buscado que los precios regulados (precios de nudo) se acerquen a lo que son los precios de mercado (precios de los clientes libres).<}0{>The regulation aims at approaching regulated prices (node prices) to market prices (free client's or non-regulated prices.)<0}

5 ELECTRICAL DESIGN AND REQUIREMENTS FOR THE INTERCONNECTION OF THE WIND FARM

5.1 ANALYSIS DE LA INTERCONNECTION DE LA CENTRAL WITH EL SING

The Analysis of the Interconnection of the Wind Farm with the Northern Interconnected Grid (SING) was developed by Fluor Daniel-Chile, for SeaWest WindPower. The complete analysis is presented in ANNEX G.

The simplified system that was considered consisted of an equivalent load of 435 MW (300 MW corresponding to the consumption of Chuquicamata and 135 MW corresponding to consumption concentrated in Crucero substation). The simplified electrical system consists of the following nodes (with their corresponding voltages) and loads: Tocopilla-220kV, Tocopilla-110kV, Crucero-220 kV, Chuquicamata-220kV and substation A-110kV (230 MW), substation km 6-110 kV (50 MW) and substation Calama-110 kV (20 MW). Two scenarios were simulated for the size of the Wind Farm: 37.5 MW and 50 MW.

The principal conclusion of the analysis is that the incorporation of the Wind Farm will not produce perturbations that will affect normal operation of the SING. The principal effects of the interconnection of the Wind Farm to the SING are summarized as follows:

1. The operation of the Wind Farm allows loss reductions in the system:

   Without wind power generation, transformation and transmission losses in the portion of the SING that was modeled are estimated to be around 14MW (which represent 3.2% of the total considered load of 435 MW). The losses in the system, under the operation of a 37.5MW Wind Farm, are estimated to be 12.3 MW. And for the case of a 50MW Wind Farm, losses are estimated in 12 MW, which represent a 2 MW earning (equivalent to 17,520 MWh per year).

2. The operation of the Wind Farm improves voltage regulation:

   An improvement in the voltage regulation in the nodes at 100kV of Chuquicamata is observed, due to a lesser drop in voltage level in the de transmission lines of 220 kV and 110 kV.

3. Fuel source diversification and less dependence of the generation from the coast:

   SING is benefited by the diversification of energy sources, which reduces the dependence on the generation based on fossil and imported fuels. At present, almost all the demand of Chuquicamata (95%) is supplied by thermal power

plant CT Tocopilla. SING and Codelco will benefit from clean energy production.

4. Effects over the quality of service in the SING:

Quality of service in SING is very particular. In the portion of the system that was modeled, the capacity of the transmission lines that add up to 172 km and 590 km in 110 kV, is equivalent to a condenser bank of 17 and 40 MVAR, respectively. This capacitance improves the power, but also produces resonance at different frequencies to the grid, thus making the system vulnerable to harmonic distortion. On the other hand, the 90% of the SING demand comes from large mining companies with high non-linear load (electro-winning and electro-refining rectifiers), with a significant production of harmonics not completely filtered by the plants.

Even though SING has become stronger in the past few years as a result of additional generators and the interconnection of the system to the Argentine Salta substation, its short circuit capacity is not very high and it remains to be a weak system, vulnerable to transient and stationary distortions. Notwithstanding the high load factor from SING large mining clients, it allows for enough damping to minimize such distortions.

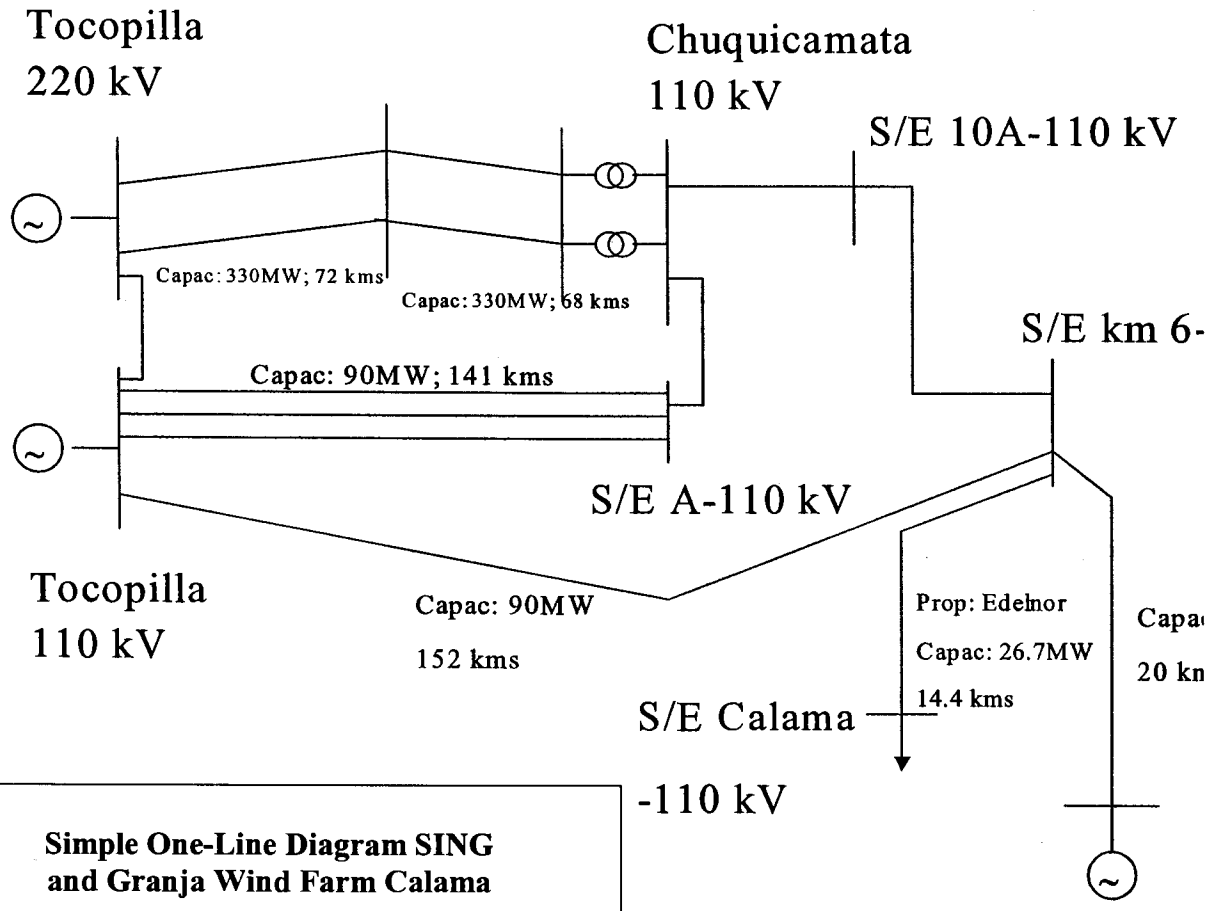
The entrance of generator units of the synchronous type, such as wind turbines, is a clean alternative because it will not cause harmonic injections and will help to strengthen the grid.

5. Rapid recovery of the system after a failure of the Wind Farm:

An interruption in the wind farm generation was simulated as a failure in the transmission line. This will cause the SING a sudden increase in the demand, which is equivalent the connection of a 50MW load block in the rest of the system, in the worst case. The increase of the load will produce a sudden voltage drop < 3% in the 100 kV bus bars of Chuquicamata, which soon may be reset back to normal values given the LTC action of autotransformers located in the Chuquicamata substation. The highest load may be absorbed by the spinning reserve of generators operating in the SING. This load increase is shared among the two lines operating at 220 kV and in the four lines operating at 110kV, in a proportion that will depend on the generation plants that are operating in the Tocopilla Thermal Power Plant.

5.2 STUDY OF ALTERNATIVES FOR THE INTERCONNECTION OF THE WIND FARM TO THE SING

The location of the Wind Farm in the SING and its interconnection to Codelco´s electrical system is presented in the following simplified one-line chart.



Simple One-Line Diagram SING and Granja Wind Farm Calama

The transmission lines at 220 kV between Thermal Plant Tocopilla and the Chuquicamata substation at 220kV are owned by Electroandina, the actual and only power supplier of Codelco. Electroandina also owns the 3 transmission lines at 110kV between Thermal Plant Tocopilla bus bar at 110kV and the substation A-110kV, and the fourth transmission line at 110kV between the Thermal Plant Tocopilla bus bar at 110kV and substation Km6. Edelnor is a generator that owns the transmission line between the substation Km6 and the substation Calama (transmission line with a nominal capacity of 26.7MW which serves the city of Calama). The rest of the installations showed in the diagram, corresponding to substations A, 10A, km6 and Chuquicamata-110kV, are property of Codelco.

In a joint analysis with personnel from Codelco and Fluor Daniel, different alternatives were studied for the interconnection of the Wind Farm to the Northern Interconnected Power System-SING:

Alternative 1:
Interconnection to the closest high voltage substation to the site of the project. Consists of a 9 km transmission line that connects to the Calama substation at 110kV (substation that allows the electrical supply to the city of Calama). This alternative has the difficulty that Calama substation is property of the local distributor ELECDA and the line to Chuquicamata is property of Edelnor.

Alternative 2:
Interconnection to substation Km6-100kV that serves Chuquicamata mine. This is a construction of a new line that heads north from the substation of the Wind Farm, in a distance of approximately 20 km.

Alternative 3:
Construction of a new substation located in a sector of the 110kV transmission line of Edelnor (the line that joins substation Calama with substation Km6). The distance of the new substation to the Wind Farm is around 7 km.

Finally, Alternative 2 was adopted. The proposed transmission line starts in the substation of Wind Farm and heads north, borders an existing Salar and later runs parallel to a railway, turning westward until it connects to substation Km6. This was the route for the transmission line that was used by Fluor Daniel to prepare the Analysis of the Interconnection of the Wind Farm to SING (in previous section) and to prepare the Study of Construction Costs (which is presented in ANNEX M). The diagram of the Transmission Line is presented in ANNEX H.

5.3 ANALYSIS DE LOS REQUISITOS TÉCNICOS Y REGULATORIOS DE LA INTERCONNECTION OF THE WIND FARM WITH EL SING

The implementation of an electricity generation project in Chile must comply with the national regulatory framework. This section will focus on regulatory requirements to be met by the project if implemented. Understanding this section should deal exclusively with the SING interconnection, it was considered appropriate to describe the regulatory requirements to be met by this project during construction.

5.3.1 GENERALITIES

In accordance with the economic policy prevailing in Chile, the electricity generation, transportation and distribution activities are led by the private sector, while the State keeps the regulatory, enforcement and subsidiary role.

This means that companies are free to decide how to invest their resources, market their services and run their facilities. They are consequently responsible for the service provided to each segment, in compliance with the duties and requirements provided for by the law, regulations and standards that collectively make the regulatory framework applicable to this sector.

Generation and transmission companies in particular have to coordinate the operation of their power plants and transmission lines for them to work in interconnection, in order to keep the system safety and assure its operation for the lowest possible cost. On the other hand, electricity line owners in use of public national assets ought to allow their facilities to be used for electricity transmission purposes, being in exchange entitled to receive a payment from those agents that use of such facilities.

The operation of power plants is coordinated in each electric system by an Economic Load Dispatch Center (CDEC), an organization composed of the most important generation and transmission companies. CDEC is responsible for planning the optimum operation of the system and economically appraising the power transferred among generators.

In relation to this project, the composition of the Norte Grande Interconnected System (SING) is important, chiefly in terms of its generation and transmission system, for the Calama wind farm will finally connect with it.

5.3.2 INSTITUTIONS OF THE POWER SECTOR

The institutional character of the electricity sector basically rests on the following legal bodies:

Legal Statute	Document	Ministry	Official Gazette Publication
Establishment of the National Commission on Energy.	Statutory Decree 2224	Ministry of Mining	June 8, 1978
Establishment of the Electricity and Fuel Superintendent.	Law # 18,410 Amended by Law # 19,613 (Official Decree D.O. 08 June 1999)		May 22, 1985

Regardless of the above, the main public organizations that participate in the electricity sector regulation in Chile are: the National Commission of Energy (CNE), the Ministry of Economy, Development and Reconstruction (Minecon), the Electricity and Fuel Superintendent (SEC), the National Commission for the Environment (CONAMA), the Stock and Exchange Commission (SVS), city halls and competition advocacy organizations.

SEC, SVS and competition advocacy organizations are also responsible for enforcement.

National Commission of Energy (CNE)

A decentralized autonomous public corporation that reports directly to the President of the Republic. Its role is to develop and coordinate plans, policies and regulations needed for the domestic energy sector to properly operate and develop, watch for compliance with them and advise government organizations in all energy-related areas.

Particularly in electricity, CNE is responsible for designing standards for the sector and calculating the regulated prices defined by the law (technical reports.) It acts as a technical body notifying the Ministry of Economy of any divergences among members of the Economic Dispatch Load Centers (CDEC) for the Ministry to resolve.

Ministry of Economy, Development and Reconstruction.

Ministry responsible for promoting the modernization of the domestic productive structure, strengthening and expanding Chilean economy and actively positioning it in the international markets. With those goals in mind it implements mechanisms to adjust market distortions and increase transparency.

The Ministry defines electricity distribution tariffs and node prices and solves the conflicts arising among the CDEC members, based on a technical paper prepared by CNE in all the cases. It also grants final concessions with following report issuance by SEC.

Electricity and Fuel Superintendent (SEC.)

Organization responsible for enforcing and overseeing compliance with the law, regulations and technical standards regarding the generation, production, storage, transportation and distribution of liquid and gaseous fuel and electricity.

SEC is the technical organization responsible for granting temporary concessions and giving the Ministry of Economy, Development and Reconstruction due notice of any final concession petitions related to electricity distribution and installation of hydraulic power plants, electric substations and transmission lines -application for a final concession is not mandatory in the last three examples. SEC is similarly responsible for checking the quality of service rendering.

SEC is a decentralized organization governed by Law # 18,410 enacted in 1985 that reports to Government through the Ministry of Economy, Development and Reconstruction.

(DGTE) Electricity Generation and Transportation Department of SEC.

This department enforces applicable legal provisions, regulations and standards related to electricity generation and transmission companies, Centers for Load Economic Dispatch (CDEC), and generation company clients.

Some its duties are: Developing the technical reports of provisional and final concession petitions for hydraulic power plants, lines and substations with voltage over 23 KV, that are submitted by the sector companies; Analyzing

This department is also responsible for proposing the Superintendent how to interpret general standards and instructions applicable to energy generation and transportation companies; proposing amendments and revisions to the laws, regulations and standards in the light of experience and technological progress; And proposing sectorial policies to be implemented nationwide through the Regional SEC Offices.

Given the importance of information available to it for its enforcement activities, this department is responsible for creating and keeping permanently up-to-date the SEC databases that contain significant information on the generation and transportation sector and the operation of the Chilean electric system in those levels.

National Commission for the Environment (CONAMA.)

Organization responsible for acting as the advisory, analysis, communication and coordination body for all environment-related matters. It is also responsible for managing the environmental impact assessment system nationwide, coordinating the generation process for environmental quality standards, and determining environmental quality compliance programs.

The National Commission on Environment is an organization that reports to the Ministry General Secretariat of the Presidency and is governed by Law # 19,300 enacted in 1994.

Conama is in addition the (DNA) Designated National Authority appointed by the Chilean Government to manage the Climate Change issues. Therefore if the Calama wind project is to be funded using the Clean Development Mechanism, it must be first approved by Conama in its capacity as the DNA, to assure that it meets every environmental regulation and all the Kyoto Protocol requirements.

Stock and Exchange Commission (SVS.)

Organization responsible for enforcing the law, regulations and standards applicable to individuals who issue or manage bonds for public offering, stock exchanges, mutual funds, private corporations and insurance companies.

SVS is an autonomous organization governed by Statutory Decree 3,538 issued in 1980, which reports to the Government through the Ministry of Finance.

Competition Advocacy Organizations.

Organizations responsible for preventing, investigating and remedying any possible attacks against free competition and other abuses made by monopoly holders. These organizations are: a) Regional Prevention Commissions; b) the Central Prevention Commission; c) the Resolutory Commission; and the National Economic Commission. Law # 211 -enacted in 1973, and revised by Decree 511 issued in 1980- governs all those organizations.

City Halls.

City halls participate in the electricity sector regulation by granting permits for electricity transportation lines not subject to a concession may cross the streets, other public national assets and other electricity lines.

In the case of electric systems with installed capacity below 1.5 MW, city halls additionally negotiate with distribution concessionaires the respective fares and supply quality.

Economic Dispatch Load Centers (CDEC.)

Organizations not legally incorporated and composed of the main generation companies in each electric system, which regulate the coordinated operation of power plants and transmission lines that are interconnected in the corresponding electric system. Statutory Decree 327 issued in 1998 by the Ministry of Mining governs them.

5.3.3 REGULATION OF THE POWER SECTOR

Global Legal Framework

The global legal framework applicable the Chilean electricity sector is composed of the following legal regulations.

Legal Statute	# and Ministry	Official Gazette Publication
Approval of amendments to Statutory Decree DFL 4 issued in 1959 of the Electric Service Law in the field of Electricity.	Statutory Decree DFL 1 issued by the Ministry of Mining.	Official Gazette Publication on September 13, 1982
Establishment of the General Electricity Service Law.	Statutory Decree 327 issued by the Ministry of Mining.	Official Gazette Publication on September 10, 1998
Setting pricing formulae for electricity companies.	Decree 632 issued by the Ministry of Economy, Development and Reconstruction.	Official Gazette Publication on November 13, 2000
Setting knot prices for electricity supplies.	Decree issued by the Ministry of Economy, Development and Reconstruction.	Official Gazette Publication on October 31, 2003
Enactment of the Additional Protocol to the 16th Bilateral Trade Agreement with Argentina for Regulatory Standards on Electric Interconnection and Electricity Supply.	Statutory Decree 4 issued by the Ministry of Foreign Affairs.	Official Gazette Publication on February 24, 1998
Amendment of Statutory Decree 327	Statutory Decree 158 issued in 2003	Official Gazette Publication on October 09, 2003

Specific Regulatory and Technical Framework.

All electric projects will be governed the previously described legal texts. Regardless of the above, each segment -distribution, generation and transmission- has its own regulations and standards. The Calama project not only is subject to the general legal framework, but also to construction standards and regulations during construction.

Below is a list with the principal regulations and standards regulating the project.

- Decree 119: Approval of a set of regulations applicable to electricity and fuels.
- Decree 399: Approval of a regulation applicable to electric product certification.
- Statutory Decree 92: Regulation applicable to electricity fitters and electricians in public show facilities.

- Resolution exempted from the Controller Office approval # 78 issued in 2000:
- Enactment of a technical standard approved by the National Commission on Energy on the "public information system" of Centers for load economic dispatch in the Central and Norte Grande Interconnected Systems.
- Resolution exempted from the Controller Office approval # 78 issued in 2000:
- Enactment of a technical standard approved by the National Commission on Energy on the "public information system" of Centers for load economic dispatch in the Central and Norte Grande Interconnected Systems.
- Standard 5: Standard on strong current facilities.
- Official form letter # 2273 dated 1986: provides instructions for electricity generation, transportation and distribution.
- Official form letter # 03487 dated 1998: provides extra fare instructions based on the monthly average generation factor.
- Official form letter # 4886 dated 2000: directs how to submit and update information on Medium Voltage Feeders.

6 ESTIMATION OF THE CO_2 EMISSIONS REDUCTIONS AND MARKET VALUE OF THE CARBON CREDITS

Unlike the previous study by Zond, this study included the analysis of the revenues from the sale of CO2 emissions reductions in addition to electricity sales of the Calama Wind Farm project. For this reason, it was very important to determine several scenarios for the baseline emissions of the project as a way to quantify the potential revenues due to the trading of the offsets in the international GHG emissions market.

The determination of the baselines of emissions for this project considered several potential scenarios, to present a broad evaluation. Several baseline methodologies have been used internationally by the developers and buyers of carbon credits, under the framework of the Kyoto Protocol. The baselines are described in the next sections.

Additionally, it must be mentioned that since this study was developed during an extended period, new methodologies were incorporated in this recent years by CDM renewable generation projects. That is why besides the analysis by Trexler of year 2001, a new methodology was developed, taking in account: i) the methodologies presented to UNFCCC by wind projects in Jepirachi (Colombia), Wigton Farm (Jamaica) and Tamil Nadu (India); ii) the revised generation dispatch that was done to update the forecast of electricity prices for the Calama project.

The results of the Study by Trexler are included in ANNEX J1. This study was based on the electricity price forecast and generation dispatch performed in 2001. The results of the new methodology are included in ANNEX J2, which takes in account the situation of SING in year 2003.

6.1 CO_2 BASELINE STUDY BY TREXLER

Dispatch Model Developed for the Project

A dispatch model was developed by Deuman for the project, which allowed the estimation of spot prices of electricity that the project might face in a 10 year period in the SING. Besides the marginal costs of electricity, the model identifies the marginal plants that would be dispatched if the Calama project was not implemented. The model considered four dispatch scenarios for projecting prices and the order in which units would dispatch electricity to the grid. The power sector scenarios under which the Calama Project might operate are:

Base Case: This scenario assumes the SING would be interconnected with the SADI in 2002 with a maximum transmission capacity of 230 MW, and with the SIC in 2004 with a maximum transmission capacity of 250MW. The dispatch model under this scenario predicts that coal would be displaced each month

throughout the project's first 10 years. The baseline emissions for this scenario is 1.00 ton CO_2 per MWh.

SING-SIC Interconnection: This scenario analyzes the effect of increasing the maximum transmission capacity of the transmission line from 250MW to 500MW. The baseline emissions estimate for this scenario is 1.00 ton CO_2 per MWh.

SING-SADI Interconnection: This scenario explores gradually increasing maximum transmission capacity to 230 MW in 2002; 350 MW in 2004; and 400 MW in 2006. The baseline emissions estimate for this scenario is 1,04 ton CO_2 per MWh.

Coal- pet coke fuel mix: This scenario evaluates the option in which coal plants reduce operating costs by utilizing a 70/30 mix of coal and pet coke. The baseline emissions estimate for this scenario is 1,03 ton CO_2 per MWh.

Recent Capacity Additions Baseline Scenario

This approach is intended to proxy for predictable future additions to the SING grid. The intent behind this approach is to use it as an alternative to the existing capacity approach. The problem with existing capacity baselines is that they incorporate the full spectrum of plants in a system, regardless of recent trends. The result is that such baselines tend to be a poor approximation of what the mitigation project displaces. The recent capacity additions approach seeks to add accuracy by focusing on what recently has occurred in an electricity system as an approximation of what would mostly likely happen "but for" the proposed offset project.

Much of the new capacity has come in the form of combined-cycle gas turbine plants that began operating as recently as 1999. However, nearly 700 MW of coal-fired capacity have also come online since 1995. Additionally, two new diesel plants and one fuel-oil plant came online since 1995. However, given their small capacity (less than 25 MW) these units would likely act as backup sources and serve peak demand periods in the grid.

The baseline approximation for measuring CO2 emissions displaced by the Calama project would be the weighted average of these sources, which is 0,548 tCO_2 per MWh.

Dynamic Marginal Source Baseline Scenario

This baseline utilizes the current marginal source as a baseline for the first 10 years of a proposed project and then switch to a proxy "best available technology" gas plant as the baseline for the remainder of the project life. This split was chosen because the SING is rapidly evolving and there is a definite shift towards gas-fired generation.

The emissions factor for the current marginal source (which is the weighted average of coal-fired units in the grid) is 1.00 tCO_2 per MWh, while recent gas plants have a factor of 0.387 tCO_2 per MWh. The switch to a natural gas –based benchmark indicates that this is the source that the proposed project would most likely displace in the future.

Natural Gas Combined-Cycle Technology Benchmark

This approach divorces itself slightly from current operating conditions in the SING. A strong case can be made, though, that a natural gas emissions rate benchmark would be a suitable baseline for this project. This is because it is evident that natural gas would be the fuel of choice for new capacity additions to the SING. Under this scenario, the Calama project would generate offsets at the rate of 0.38 tCO_2 per MWh, which corresponds to the emissions rate for current combined-cycle gas turbine plants.

Baseline Summary

A summary of the different baseline scenario approaches and their corresponding CO_2 reductions per MWh are presented in the following table. The selection of a baseline approach will have a significant effect on the potential magnitude of the project's $CO_{2\ emissions}$ reductions. The more conservative the baseline, the higher the likely price a purchaser will pay.

Baseline Scenario	Baseline (tCO_2 per MWh)
Dispatch Model Base Case	1.00
Dispatch Model SING-SIC Interconnection	1.00
Dispatch Model SING-SADI Interconnection	1.04
Dispatch Model Coal-Pet coke	1.03
Recent Capacity Additions	0.548
Dynamic Marginal Source	1.00 for years 1-10; 0.387 for years 11-20
Natural Gas Benchmark	0.387

Source: Trexler and Associates, Inc., 2001.

Each of the presented scenarios was calculated by using guidelines in the IPCC's revised 1996 methodology for calculating national emission inventories. ANNEX J describes the steps taken by Trexler & Associates Inc. for the calculations and lists tables illustrating how the reductions associated with the different baselines were calculated, expressed in terms of tCO_2 per MWh.

6.2 GHG OFFSET MARKET AND ELEMENTS FOR CALAMA'S VALUATION OF ITS CARBON CREDITS

This section provides a brief overview of the dynamics of the current greenhouse gas (GHG) offset market, and the characteristics of the different buyer segments currently participating in the market. It then describes the different transaction types taking place in the market and what they reveal concerning offset prices.

6.2.1 GHG EMISSIONS GLOBAL MARKET OVERVIEW

The market in GHG emissions reduction projects began more than a decade ago, when independent power producer AES Corp. decided, as a way of demonstrating corporate responsibility, to voluntarily offset the emissions of several of its coal-fired power plants being built in the United States. AES's initial projects involved forecast conservation in Latin America, and all of them cost pennies per ton of CO2 offset. These projects set the stage for corporate thinking about climate change mitigation. Since then, the mitigation market has come a long way, as has corporate thinking about how to pursue climate change mitigation objectives. Over the last decade, many more companies and even countries have decided to participate in the GHG market for many reasons:

- To benefit form the public relations benefits of "doing something" about climate change;
- To come up the "learning curve" on GHG projects, contracting, and implementation;
- To take advantage of low-cost mitigation projects for long-term risk management;
- To fulfill voluntary GHG commitments;
- To establish competitive advantage for their company or product; and
- To comply with contractual and regulatory mitigation mandates.

The effect of these different buyer motivations is that today's GHG market is continually evolving with some uncertainties, partially due to the existence of these different buyer motivations, and due to the fact that there is a learning process that involves the personnel of UNFCCC, the operational entities, the Designated National Authorities, the buyers, the brokers, the consulting firms and the project developers. This situation is made abundantly clear by offset prices ranging from less that US$1 to more than US$50 per ton. Clearly, a range of "GHG commodities" is finding their way into today's market. The offset buyer segments that are contributing to the broad range in offset prices includes:

- Compliance Market Buyers. These buyers believe that GHG emissions reduction mandates will come into force in the relatively near term and that purchasing credits now is a way to hedge the risk of future mandates.

Thus, these buyers are driven by their perception of the likelihood and timing of future GHG emissions reduction mandates. Because they face potentially significant CO2 liabilities, compliance buyers tend to be very price sensitive. To that end, such buyers tend to pursue project and credit transactions whereby they can accumulate relatively low cost offsets that can be used under a future compliance system.

- Pre-Compliance Market Buyers. Pre-Compliance Market Buyers include companies that have made voluntary commitments; companies with strong sustainable development ethics; and companies seeking to create competitive advantage by capitalizing on public and policy concern over climate change. Thus, pre-compliance buyers are not driven primarily by a fear of future mandates. Instead, pre-compliance buyers are driven by their desire to do the right thing, or to gain a marketing advantage over their competitors. As a market driven segment that does not face significant compliance costs, pre-compliance buyers are less price sensitive and tend to pursue high quality offsets. The pre-compliance market will never get as large as the potential future compliance market; however, it is an important market force, particularly given the remaining uncertainties over the timing and structure of a future compliance system.

- Institutional Buyers. The GHG market is also evolving through the growing number of governmental and institutional efforts being pursued with long-term GHG emissions reduction mandates in mind. These include organized government efforts to purchase offsets; and potential monetization of GHG emissions reductions into investment fund decision making. The two more prominent institutional buyers- the Dutch government Emissions Reduction Unit Purchasing Tender Program (ERUPT) and the World Bank Prototype Carbon Fund (PCF), with offset purchase budgets of more than US$100 million fundamentally changes the character of the market from just a couple of years ago. Their recent entrance signals a major expansion in the scope and size of the market. It is worth noting that the PCF and the Dutch are willing to may far more for offsets (US$6-8 per ton) than is being paid by many conventional buyers in the risk-management market. They are willing to do so largely because the standards being set for such projects, which can be thought of as adding up to a "quality hurdle" at the project level, are significantly higher than for many transactions being pursued by individual companies or through brokers.

The impact of these distinct buyer segments is that the GHG mitigation market is characterized by a number of different demand and supply functions that are a reflection of the divergent motivations of the offset buyers that are currently participating in the market. While the effect of multiple demand and supply functions is a broad range of prices, the underlying cause is the absence of policy standards defining what is a CO2 offset commodity. Perhaps, the most significant of these is additionally, which will define the extent to which a project exceeds

business as usual practices to the likely benefit of the climate. Although the lack of standards complicates the pricing process, it underscores the importance of being conservative to enhance the certainty that the associated level of offsets will be creditable.

6.2.2 *TRANSACTION ANALYSIS*

This transaction analysis draws on the results of Trexler & Associates (TAA) review of credit-based and project-based transactions listed in TAA's in-house transaction database. Credit-based transactions involve buyers that are not investing in a project per se, but whose motivation is to have access to a stream of credits for future compliance needs. Project-based transactions involve a more direct investment in the activity generating the offsets.

The next table summarizes credit-based transactions along the lines of confirmed purchases and offers to buy and offers to sell. The interesting aspect is that sellers are willing to sell tons at a premium well below what buyers are apparently willing to pay. This illustrates the heterogeneity and confusion that characterizes the market, since buyers and sellers can have radically different views of what an "offset" is from the standpoints of additionally, guarantees, and other variables.

Table 19. Credit Transaction Summary

Transaction Type	Premium Price [US$ / tCO_2-e]	Strike Price [US$ / tCO_2-e]
Complete	0.50 - 0.75	2 – 3
Offers to buy	0.30 - 0.60	1 – 2
Offers to sell	0.15 - 0.40	1 - 2

Source: © Trexler and Associates, Inc., 2001.

The next chart illustrates the ranges in project-based transactions. As previously noted, project transactions sometimes can be differentiated by the role of public relations, risk management, and marketing advantage motivating the transaction. Not surprisingly, as buyer motivation has shifted from public relations to risk management to marketing advantage, offset prices have risen. Notwithstanding this price trend, opportunities still exist for companies to pursue offsets for marketing advantage for relatively low costs. This is underscored by the fact that the lower bound price for marketing advantage purchases is comparable to some education transactions and many risk management transactions.

Table 20. Project-Based Transaction Summary

Buyer	Price Range [US$ / tCO_2-e]
Public Relations / Education	0.05 - 1.50
Risk Management	1.00 - 2.50
Pre – compliance	2.50 - 6.00
Governments	6.00 – 15.00

Source: © Trexler and Associates, Inc., 2001.

As illustrated by these tables, the Calama Project could potentially go after several alternative market segments, each with potentially distinct financial implications for the project. For example, offering the project's reductions as "options" for the 2008-2012 Kyoto Protocol compliance period, would imply a small payment of offset revenues upfront as premium payments on the options, with a larger payment potentially becoming due in the 2003-2005 time frame if the purchaser "strikes" on the options. Meanwhile, pursuing an institutional buyer such as the Dutch government or World Bank could in principle lead to funding across most of the life of the project in the US$5 – 7 per ton range.

However, while the prices (and associated revenues) are vastly different, so to might be the design characteristics and costs associated with carrying out these alternative transaction structures. Putting GHG emissions reduction options from the Calama Wind Project on to the market would have relatively low up-front costs. Alternatively, the upfront costs involved with going through the RFP review process for ERUPT or PCF funding, and ensuring that the project conforms to the criteria established by these funding processes, would be substantially greater.

An analysis of the most recent transactions of CDM projects in Latin America, indicates that the market prices paid by PCF are lower than expected prices. In the case of the Chacabuquito run-of river hydraulic project, the price was US$3.5 per ton of CO_2e. In the case of the Jepirachi wind project in Colombia, PCF agreed on a purchase price of US$ 4.0 per ton of CO_2e. As it has been mentioned before, the financial modeling of the Calama Wind Project supposed a purchase price at least equal to Jepirachi´s.

6.2.3 CO_2 OFFSET VALUATION FOR CALAMA WIND FARM

The estimation of CO2 emission reductions produced by the Wind Farm of Calama are presented in the following Table, for the different scenarios proposed by Trexler. It is important to mention that the basis of this methodology is to use an index of emissions that is multiplied by the generation of each year, which makes the emission reductions constant in the period of analysis.

The 40 MW , big size of the wind farm , has been used, along with the generation data of the manufacturers that sent a price quotation. It is seen that annual reductions of the project are in the range between 100.000 and 130.000 ton CO_2 (if the scenario of emission is 1.03 tons of CO_2 per MWh, which has been taken as the most probable because it considers generation with coal-pet coke mixes).

This level of annual emissions, above 100.000 tons of CO_2 , is positive for the sale of CERs. Based on analysis of this consultants, this level of emissions reductions of CO_2 facilitates a successful transaction of carbon trading, since it is an appealing volume for an investor and because it allows covering transaction costs (which are elevated for small projects). As a reference, it is worth noticing that the reductions bought by the PCF to Chacabuquito are around 140.000 tons of CO_2 per year. With a referential selling price of 4 US$/ton CO_2 (taken as a

target price for the Wind Farm of Calama, based on recent transactions) the revenues are estimated to be around US$410.000 annually, which represents a cumulative amount of US$ 8.6 million during 21 years.

Table 21. CO2 emission reductions and sell of CERs

	Vestas V52-850 kW	NEG Micon NM54-950 kW	NEG Micon NM82-1650 kW
# Turbines:	47	42	25
Total MW:	39.95	39.9	41.25
Power (kW):	850	950	1650
Generation per turbine (MWh-year)	2,398	2,372	5,131
Generation Wind Farm (MWh-year)	112,688	99,614	128,279
Capacity Factor (without losses) (%)	32.2	28.5	35.5
Scen1: CO2 Emissions (ton CO2) @ 1.04 tCO2/MWh	117,195	103,599	133,410
Scen2:Co2 Emissions (ton CO2) @ 1.03 tCO2/MWh	116,068	102,603	132,128
Scen3:CO2 Emissions (ton CO2) @ 0.548 tCO2/MWh	61,753	54,589	70,297
Scen4:CO2 Emissions (ton CO2) @ 0.387 tCO2/MWh	43,610	38,551	49,644
Scen1: Annual CERs @4 US$/ton CO2	468,781	414,396	533,642
Scen2: Annual CERs @4 US$/ton CO2	464,274	410,411	528,511
Scen3: Annual CERs @4 US$/ton CO2	247,012	218,355	281,188
Scen4: Annual CERs @4 US$/ton CO2	174,441	154,203	198,576
Scen1: CERs 21 years (US$ Million)	9.8	8.7	11.2
Scen2: CERs 21 years (US$ Million)	9.7	8.6	11.1
Scen3: CERs 21 years (US$ Million)	5.2	4.6	5.9
Scen4: CERs 21 years (US$Million)	3.7	3.2	4.2

Source: Deuman based on the data from price quotations.

6.3 NEW BASELINE METHODOLOGY BASED ON THE LOAD DISPATCH OF 2003

This methodology considers: i) The 2003 methodologies submitted to UNFCCC for Jepirach (Colombia), Wigton Farm (Jamaica) and Tamil Nadu (India) wind projects; (ii) the new generation dispatch used to update the electricity price forecast according to SING conditions in 2003.

Results from this new methodology are enclosed to ANNEX J2.

The methodology used to calculate $C0_2$ emission reductions as a result of the Calama wind project operation is based on a comparison between CO_2 emissions generated in the basic scenario (without Calama project) and CO_2 emissions in a scenario which includes the operation of the Calama project. The difference between emission levels under the two different scenarios determines CO_2 emission reductions due to the project.

The basic scenario does not entail the Calama Wind Farm, and the scenario with Calama project introduces the 40MW Wind Farm (but excluding the SIC-SING interconnection as its completion date and transportation capacity in the interconnection line remains uncertain.)

The new Load Dispatch results for every generation unit in the SING, provided by the Coste4 Model, allow for an estimate of fuel consumption level and gross generation per type of fuel for both, the basic scenario and the scenario with the Calama project. Based on such estimates, CO_2 emissions were determined for each case using the IPCC calculation methodology. With such methodology it is possible to calculate CO_2 emission factors per type of fuel based on carbon content unit factors.

Annual fuel consumptions in the SING were multiplied times CO_2 emission factors for each related type of fuel, in order to determine CO_2 emissions in each scenario.

CO_2 emission reductions resulting from the Calama wind project operation were finally determined based on the difference between annual emission levels in the scenario with the Calama project versus the scenario without the project. The table below shows the related results.

Table 22. Annual CO_2 Emission Reductions

Year	Without Project [TCO_2/year]	With Project [TCO_2/year]	Reduction [TCO_2/year]
2003	5,889,056	5,889,056	-
2004	6,317,062	6,198,005	119,058
2005	7,271,229	7,150,693	120,536
2006	8,088,711	7,967,338	121,373
2007	7,536,459	7,416,899	119,560
2008	8,347,517	8,227,165	120,352
2009	9,161,423	9,041,214	120,210
2010	9,962,981	9,845,070	117,910
2011	9,490,848	9,370,172	120,676
2012	10,298,200	10,178,656	119,544
2013	10,569,185	10,453,444	115,741
2014	10,285,821	10,169,031	116,790
Total			**1,311,750**
Average			**119,250**

Source: Deuman

These results change from one year to another, and were used in the Financial Model that simulated the Farm Final Assessments. A value similar to that of 2014 was assumed from 2015 onwards.

6.4 ANALYSIS OF POTENTIAL BUYERS OF CERS

This section briefly describes the different purchasers of GHG emission reductions that are currently operating in the market of global emissions, which could get an interest in the Calama wind project.

6.4.1 PROTOTYPE CARBON FUND (WORLD BANK)

The Prototype Carbon Fund (PCF) is one of the most important purchasers of CERs. The PCF was created in 2000 using funds contributed by 6 governments[7] and 17 private companies from developed countries. It is managed and operated by the World Bank.

The PCF capital is in the order of US$ 180 million, about US$ 106 million of which had been distributed among approximately 26 projects as of August 2002. The table below shows a number of projects in Latin America with negotiations currently well ahead in progress. Among them there are 3 wind projects and the Chacabuquito project. The average price in wind farms is in the order of 3.5 US$/ton CO_2e, although in the Jepirachi project it is 4 US$/ton CO_2e.

Table 23. Transactions of the Prototype Carbon Fund (PCF)

Country	Sector	PCF Contract	PCF ERPA	Total Project	US$/ tCO2e
		US$Million	Ers tCO_2e	Ers tCO_2e	
Colombia	Wind Farm-Jepirachi	3.2	800,000	1,168,247	4.0
Chile	Small Hydro-Chacabuquito	6.7	1,750,000	2,597,400	3.5
Costa Rica	Wind Farm	1.0	284,660	329,100	3.5
Costa Rica	Small Hydro	0.6	172,120	173,700	3.5
Costa Rica	Wind Farm	0.9	262,660	302,800	3.5
Source: Deuman based on Prototype Carbon Fund, Annual Report 2002.					

Jepirachi is a wind farm developed by the public integrated electricity company, Empresas Públicas de Medellín (EEPPM), with 19.5 MW in installed capacity and 85 GWh estimated in annual generation. In late 2002 EEPPM called for bids to purchase generation equipment, and the German firm Nordex was awarded with the sale of 15 turbines and 1.3MW each, in April 2003. It is expected to start commercial operations in early 2004.

Estimated CO_2 emission reductions in the Jepirachi wind project are expected to reach 1,168,000 tons over 21 years (about 56,000 CO2 tons per year.) The PCF

[7] Canada, Netherlands, Finland, Norway, Sweden and Japan, through the Japan Bank for International Corporation.

analyzed the said project and offered EEPPM to purchase part of the total amount of potential CERs, i.e., 800,000 tons of CO_2 , for an approximate total of 3.2 US$ million.

For the current year PCF has submitted a new wind project before UNFCC, namely the Wigton farm in Jamaica (23 turbines of 900kW, for a total of 20.7 MW.)

The advantages for the PCF to purchase CERs in the Calama wind project is the existence of already established PCF procedures in Chile (due to the preparation of the Chacabuquito project.) The PCF could be interested in funding the Calama wind project in Chile to provide a demonstrative sign to other countries in the area.

6.4.2 DUTCH GOVERNMENT

The Dutch government also has funds to buy CERs in CDM projects in developing countries. This fund is managed by the Dutch VROM (Ministry of Environment, Housing and Planning.)

This emission reduction transaction should be made through intermediary agents directly hired by the Dutch government, such as the following in the energy sector: i) International Finance Corporation (IFC); ii) Andean Development Corporation (CAF); and iii) World Bank.

During the recent visit of Chilean government and CONAMA authorities to Europe in March 2003, the Dutch government expressed great interest in funding CDM projects in Chile.

The Dutch government recently purchased CO_2 emission reductions in two wind projects: i) The Wigton Farm in Jamaica (23 turbines of 900kW, for a total of 20.7 MW); and ii) the Tamil Nadu farm in India (17 turbines of 850kW, for a total of 14.5 MW.) According to the information provided by Ecofys, a carbon trading consulting firm also involved in the GHG transactions, this operations would be in the order of 3-5 US$/ton of CO_2.

6.4.3 CANADIAN INVESTORS

The participation of Canadian private companies in Chilean CDM projects is expedited as a result of the Memorandum of Understanding (MOU) signed by the Canadian and Chilean governments in November 2002 for project development and promotion. Thus Chile has been targeted by Canadian industry as a priority market. As a consequence, there are Canadian companies presently interested in the incipient Chilean market of carbon trading.

Canadian companies with an interest in Chilean CDM projects are found in the following industrial sectors: Oil, gas, chemicals, electricity generation, manufacturing, mining, cement and foundry. Such companies are expressing their interest either directly or through brokers. These are some of the Canadian companies with an active participation in the search for GHG mitigation projects in the CDM framework: Transalta Corporation, Epcor, Suncor, among others. Purchasers should be identified through the Canadian Embassy in Chile.

It is important to note that the office of the Clean Development Mechanism and Joint Implementation (CDM & JI) reports that Canadian companies will be principally interested in projects resulting in emission reductions in excess of 100,000 tons of CO2 per annum, given the high transactional costs involved at the present. The Calama Wind Farm meets such threshold in the 40MW size scenario.

6.4.4 MULTINATIONALS IN THE POWER SECTOR

Multinationals operating in the Northern Interconnected System (SING) would be potentially very interested in a CDM project like the Calama Wind Farm.

According to the most recent report prepared by Pricewaterhouse Coopers in November 2003, "Climate Change and the Power Industry", benchmarking for electricity companies that generate CO_2 in the European Union ranks ENDESA ESPAÑA and ELECTRABEL number five and seven, respectively.

ELECTRABEL is the parent company of Tractebel, which in turn has a direct and indirect control over Electroandina and Edelnor in the SING. On the other hand, ENDESA ESPAÑA controls Celta and Gas Atacama, generation companies in the SING. These generation companies are interested in identifying projects in developing countries, in order to meet with the CO_2 emissions reduction goals for the 2008-2012 period.

Therefore, this multinational companies would have a great potential interest in developing CO_2 emission reduction projects of the size of the Calama project, in compliance with their own CO_2 reduction goals.

6.5 MONITORING AND VERIFICATION PROTOCOL FOR THE CARBON CREDITS

6.5.1 GENERAL CONSIDERATIONS

The development of a carbon offset Monitoring Verification Protocol (MVP) is often made out to be a highly complex and technical process. This is because there are no defined standards or protocols for the monitoring and verification (M&V) of carbon offset projects generally, nor have such rules been established for Clean Development Mechanism (CDM) projects. As a result of this uncertainty, M&V of existing offset projects has depended significantly on the preferences of the buyer of the emission reductions.

However, it is not necessary to implement a highly technical MVP, even though this project intends to generate CERs under the CDM. This is because the project will already be conducting activities that serve the purpose of supporting a MVP such as measuring net electricity production. Therefore, this MVP lays out a straightforward reliable approach for tracking carbon benefit performance.

The recommended MVP has two key components:

a) Collecting net electricity production data; and
b) Collecting and documenting information that preserves the baseline selected by Codelco and SeaWest for measuring the rate at which the Project produces CO_2 offsets.

The first task serves a dual purpose, as net output data is necessary for calculating the magnitude of electricity revenues and CO_2 offsets. Further, it does not require the implementation of a new procedure and is highly credible, as tracking electrical output is necessary for determining revenue streams of the Project.

The second task is also simple and straightforward, as the information that underscores the integrity of the project's CO_2 baseline is readily available. However, it is important to collect and maintain this information now, as it might not be available in the future when the project will have to provide evidence that supports the integrity of its selected baseline, which requires that information be collected on a annual basis to determine the rate at which the project reduced CO_2 emissions for the prior year. Although the informational needs vary among the baselines, the requirements are not excessive for any of the baseline choices.

The most information-intensive baseline (the dispatch model baseline), requires dispatch order information, available through the dispatch pricing study prepared by Deuman Ingenieros, as part of the feasibility study process and the biannual study that determines the sales prices charged to distributors, prepared by the

National Energy Commission (CNE). The node pricing study also provides the necessary evidence to document the integrity of the recent capacity additions baseline, and the combined source baseline.

Additional to the above mentioned themes, this section also describes the specialized organizations that could verify and certify the CO_2 offsets of the Calama project. It is worth mentioning that none of these organizations have yet been certified by the Executive Board of the UNFCCC as official Operational Entities (OE), under the CDM rules. This certification does not allow these entities to emit Certified Emission Reductions (CERs), but just to prepare verification and validation reports that the Executive Board will submit to revision.

In the following sections the details of the proposed MVP for the Calama project will be presented, based in the definition of different scenarios.

6.5.2 PROJECT PERFORMANCE

A crucial element of a credit-generating project is monitoring and verifying its performance on a regular basis. This is because project performance outputs, in addition to the CO2 baseline, are an instrumental part of determining the volume of emission reductions generated. The M&V of project performance is relatively straightforward because it involves tracking indicators that would occur anyway as part of the normal operations of the project. That is the tracking of net production of electricity.

The MVP recommends that project performance data be stored monthly in spreadsheets. This spreadsheets will serve the purpose of generating annual M&V reports that will be verified by an independent auditor and sent to the offset buyer and other relevant entities such as the Chilean government.

6.5.3 BASE LINE PRESERVATION

Baselines are an important aspect of any CO2 offset project because they measure the extent to which the project claims to be benefiting the climate. Therefore, baselines are a proxy for the overall environmental integrity of the project. A key aspect of the MVP is to ensure that this integrity is maintained over the life of the project.

Much of the information needed to maintain the integrity of the baseline is available in the initial stages of the project. However, this information is less readily available as time passes. The base line preservation informational aspects will be examined for the following baselines:

- Dispatch Model Baseline;
- Recent Capacity Additions Baseline;
- Natural Gas Combined Cycle Technology Benchmark; and

- Combined Source Baseline.

This analysis is shown in the following sections.

6.5.4 M&V OF DISPATCH MODEL BASELINE

There are two alternatives for constructing a baseline using the dispatch order method, a projection based approach and a dynamic approach. The projection based approach relies on the dispatch model that was developed by Deuman Ingenieros to forecast the electricity prices the project should expect to face over the first 10 years of its 20-year life. In addition to projecting prices, this model provides information identifying the marginal sources of power that would send electricity to the grid "but for" the project. Therefore, this model can be used to develop a static baseline based on the model's projection of the marginal source of power over the next 10 years. Alternatively, a dynamic dispatch approach can be used whereby the baseline is updated annually reflecting the prior year's dispatch order. The potential baseline scenarios are:

- *Base Case*: This scenario assumes the SING would be interconnected with the Argentine grid (SADI) in 2002 and Chile's Central Grid (SIC) in 2004. This baseline assumes that coal-fired generation would be displaced at a rate of 1.00 ton of CO2 per MWh over the next 10 years.
- *SING-SIC Interconnection:* This scenario analyzes the effect of doubling the maximum transmission capacity between the SING and the SIC assumed under the base case. This baseline predicts that predominantly coal plants, and to a lesser extent, diesel would be displaced. The baseline under this scenario is 1.00 ton of CO_2 per MWh.
- *SING – SADI Interconnection:* This scenario explores gradually increasing maximum transmission capacity between the SING and the SADI, relative to the base case. The baseline under this scenario estimates that coal, and to a lesser extent, diesel would be displaced over the next 10 years at a rate of 1.04 tons pf CO_2 per MWh.
- *Coal- Pet coke Fuel Mix:* This scenario evaluates the option in which coal plants reduce operating costs by utilizing a 70/30 mix of coal and pet coke. The baseline under this scenario is 1.00 tons pf CO_2 per MWh, as coal-fired sources would have sent electricity to the grid but for the project.
- *Dynamic Dispatch:* Instead of relying on the dispatch model projection to create a static 10-year baseline, the baseline is determined annually by collecting information on the dispatch order throughout each year of the project life. This baseline is therefore, dynamic in that it changes annually depending on the change in dispatch order.

The informational needs that will document and support the integrity of the dispatch baseline under a future compliance system are the dispatch order data and the fuel consumption figures of the displaced plants. The key distinction between the model projection approach and dynamic approach is the frequency with which the necessary information needs to be collected.

Under the projection approach, the key information to support the baseline is housed in the dispatch price model. In addition, the integrity of this data will be enhanced if it can be compared to real-time dispatch data from a credible third-party source for the year the dispatch model was developed, 2001. Such data is available through the Load Economic Dispatch Center for the SING (CDEC-SING). The dynamic approach also requires purchasing the dispatch order from the CDEC-SING, but on an annual basis.

The National Energy Commission's (CNE) biannual node price setting reports for the SING contain the fuel consumption figures for plants operating in the grid. This information is necessary for determining the amount of CO_2 that would have been released from the marginal sources of power. The static projection approach only requires that information from the October 2000 study be collected. This is because information from this study was used to calculate the CO_2 baseline using the dispatch model's projections on the marginal source of power over the next ten years. The dynamic approach requires annual collection of the node pricing studies throughout the life of the project.

6.5.5 MONITORING AND VERIFICATION OF THE RECENT CAPACITY ADDITIONS BASELINE

The recent capacity additions baseline is based on the weighted average of the plants that have come online since 1995. The rationale behind this baseline is that the sources that were recently added to the grid are representative of the types of sources that would have otherwise come online or come online sooner but for the project. The different sources that are displaced under the recent capacity additions baseline are hydroelectricity, diesel, fuel oil, coal, and gas, with the latter two constituting most of this baseline. The recent capacity additions baseline projects that the Project is displacing emissions at a rate of 0.548 tons of CO_2 per MWh.

Since this baseline is derived from recent grid events, it is important to collect information that documents when the sources that comprise recent capacity additions baseline came online. Additionally, like the dispatch model baseline, preserving the integrity of this baseline will require the fuel consumption figures for the recent units. This information is available in the CNE Node Pricing Study of October 2000.

6.5.6 MONITORING AND VERIFICATION OF THE NATURAL GAS COMBINED CYCLE TECHNOLOGY BENCHMARK

The natural gas technology benchmark is a departure from the above three selections. Instead of being based on the technical attributes of the SING, this baseline establishes a benchmark against which the project would be credited with reducing emissions. A significant number of policy experts are discussing

benchmarked baselines as a means for getting around the complexity associated with attempting to asses in detail the "real" baseline for each of the thousands of potential projects that might be proposed for GHG crediting purposes in the future.

The natural gas technology benchmark credits emission reductions from the Project at a rate of 0.38 tons of CO_2 per MWh.

There are no information collection requirements under this baseline. This is because the natural gas technology benchmark is divorced from ongoing developments in the grid that could trigger revisions for the other baseline candidates. Further, the whole concept of benchmarks is to avoid the need to document project specific conditions that are commonly used for constructing baselines.

6.5.7 MONITORING AND VERIFICATION OF COMBINED SOURCE BASELINE.

The combined source baseline projects the rate at which the Project would displace CO_2 emissions through the application of two different baselines over the life of the project. This baseline combines the "current marginal" source for the Project's first 10 years, with the most likely "future marginal" source for the last 10 years. Such mixed approaches are increasingly recommended to counteract the future uncertainty of rapidly evolving electricity systems or to underscore a definite trend towards a particular generation source. The SING meets both criteria in that it is evolving rapidly and that there is a definite shift towards gas-fired generation.

This baseline assumes that coal is the current marginal source and the Project displaces emissions at a rate of 1.00 tons of CO_2 per MWh for the first 10 years of the Project's life. The "future marginal" source is represented by the weighted average of the natural gas plants operating in the SING. The baseline for years 11 through 20 of the project is 0.387 tons of CO_2 per MWh.

One of the key objectives of this baseline scenario is to verify that coal is the operating marginal source for the first ten years of the project. This is essentially the same requirement as the dispatch model baseline and, therefore, the informational requirements are basically similar.

Much of this information is available in the CNE node pricing study for October of 2000. This would include operating cost information for gas and coal plants and the CO2 intensity for each coal plant currently operating in the SING. The operating cost information is key because the SING dispatches sources based on marginal costs and information illustrating that gas operating costs are lower than those for coal supports the current marginal source for baseline purposes, which is coal.

The future marginal source under this baseline is the weighted average of gas plants operating in the SING. The rationale behind this choice is the significant amount of gas capacity that recently came online and that natural gas is likely the source that would have come online or come online sooner but for the Project. The relevant information includes evidence of how much capacity recently came online, operating costs for gas plants, and gas fuel prices. The data that supports their claim that gas is the most likely future marginal source can also be found in the CNE node price setting study. Therefore, the node pricing report can be used to preserve the integrity of the overall baseline, as it documents the rationale behind both the current and future marginal source of power, which is the basis of the combined source baseline.

6.5.8 COMPARISON OF BASELINE INFORMATION REQUIREMENTS

As is evident in the next Table, the types of information needed to preserve the integrity of the baseline do not vary substantially among the first three baseline options. This is because all are a reflection of operating trends in the SING. However, the frequency of information collection differs, as the dynamic dispatch order approach requires annual collection, while all other approaches have a one-time need. Note that there are no information collection needs for the natural gas technology benchmark.

The dispatch model projection baseline requires the most information sources of these alternatives, as it needs the CNE node pricing study, CDEC-SING order data, and the dispatch model. Additionally, adopting this approach raises the question of what approach to take for constructing a baseline to cover the final 10 years of the project. The obvious suggestion is to construct an updated dispatch model to project a CO2 baseline for the next 10 years; unless an alternative baseline is imposed on the project.

The dynamic approach is the most information intensive in that there is an ongoing need to collect new dispatch order and fuel consumption data so that the baseline can be updated annually. The natural gas technology benchmark requires no collection and maintenance of information to preserve its integrity. This is because this benchmark is not based on project-specific operating conditions. Instead, it is based on a concept whereby a single metric is used to measuring the net climate benefits from a project that falls within a specific sector.

Table 24. Baseline Documentation Requirements

Baseline	Information needs to preserve Baseline	Frequency of Collection
Dispatch Model Projection Baseline	- CNE Node Pricing Study: Carbon Intensity of plants operating in the grid. - CDEC-SING dispatch order data for 2001. - Deuman Ingenieros' dispatch price projection Study and projected dispatch order (2002 – 2011)	One-time need to cover first ten years of the project. Additional information needed for last ten years of the project.
Dynamic Dispatch Baseline	- CNE Node Pricing Studies: carbon intensity of plants operating in the grid for a given year. - CDEC-SING dispatch order data for a given year.	Annual
Recent Capacity additions Baseline	- CNE Node Pricing Study: Information on plants that came online between 1995 and 2000 such as fuel type, capacity, and carbon intensity.	One-time
Natural gas combined cycle technology benchmark	- There are no informational requirements to preserve the integrity of this baseline. This is because it is divorced from grid operating conditions.	No collection requirement
Combined source baseline	- CNE Nodal Pricing Study: Operating costs for coal and for natural gas. Carbon intensity for coal and gas plants that are currently operating.	One-time

Source: © Trexler and Associates, Inc., 2001.

A summary chart of the methodology of monitoring and verification is presented as follows:

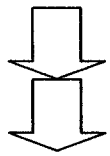
Illustration 10. Methodology for the Estimation of CO2 Reduced emissions of Calama Wind Farm

Data collection of Gross and Net Generation of Calama (MWh)

Analysis of Hourly Dispatch from CDEC-SING to determine the Marginal Plant that was not dispatched due to the dispatch of Calama

Analysis of Emission Factors of the Plant that was not dispatched (tons of CO_2e/MWh)

Multiplication of Net Generation of Calama (MWh) times the Emission Factor of the non-dispatched Plant (tons of CO_2e /MWh), to obtain tons of CO_2e



Adding of the hourly reductions to obtain the daily reductions

Adding of the daily reductions to obtain the monthly reductions

Adding of the monthly reductions to obtain the annual reduction

The detail of the sources of information that must be consulted to comply with the methodology, is the following:

Información a Registrar	Comment	Source
Generation horaria de Calama	Contrast with information of CDEC-SING	Electricity metering of the Wind Farm
Order of Dispatch of the generating plants of SING Hourly Generation of each plant in the SING Specific Consumption of the marginal plant or the following marginal plant that was not dispatched Fuel Consumption of each dispatched plant	Available for consultation in web site, www.cdec-sing.cl A free password must be solicited to CDEC-SING	CDEC-SING

The calculations would be performed once every monthly, including the downloading of information of the web page of CDEC-SING and the processing of the information corresponding to the previous month operations.

6.5.9 MONITORING AND VERIFICATION BUDGET

The estimated costs for M&V will vary on a number of factors such as buyer preferences, and host country government requirements. Additionally, this estimate is subject to change depending on the implementation of international policy and technical guidelines for carbon offset projects under CDM.

Additionally, the project can expect to incur costs associated with having an third party verifier visit the site and audit the information used to calculate the magnitude of CO2 offsets, as part of preparing an M&V report. Such activities should add approximately $7.500 to the overall M&V budget. However the frequency with which site visits are required is dependent on buyer preferences and future policy outcomes. SeaWest and Codelco should not expect to incur this additional cost each year. The overall cost of M&V activities can, as a result, vary from $5.000 to $20.000 per year depending on the type of baseline, the need for a site visit, and who carries out the work.

Under a scenario with a set baseline and readily available plant generation figures, the cost to collect the necessary information, calculate the magnitude of CO2 offsets, and prepare a report is approximately $5.000 per year during the operational phase of the project. This cost would rise to approximately $15.000 per year to carry out the necessary information collection and analytical work under the dynamic dispatch order baseline. Note that a slightly higher cost would be incurred in the start up phase of the project regardless of baseline selection.

These costs are associated with the need to establish a methodology for collecting and reporting the information used to calculate the level of CO2 offsets. Table 2 provides a breakdown of the estimated level of effort and daily rates involved with carrying out the necessary M&V tasks. The biggest distinction is the level of effort required to calculate the volume of CO2 displaced by the project under a static baseline versus a dynamic baseline. Since it requires reviewing the dispatch order and updating the baseline each year, the level of work required under the dynamic approach is much more extensive than the static baseline option.

Additionally, the project can expect to incur costs associated with having an third party verifier visit the site and audit the information used to calculate the magnitude of CO2 offsets, as part of preparing an M&V report. Such activities should add approximately $7.500 to the overall M&V budget. However the frequency with which site visits are required is dependent on buyer preferences and future policy outcomes. SeaWest and Codelco should not expect to incur this additional cost each year. The overall cost of M&V activities can, as a result, vary from $5.000 to $20.000 per year depending on the type of baseline, the need for a site visit, and who carries out the work.

Table 25. Monitoring and Verification Budget Estimate

Task	Person days	Daily rate	Activities	Frequency
CO2 Offsets calculation	A: 2.5	A: US$800	A: - Review net generation statistics; - Calculate volume of CO2 offsets using set baseline; - Prepare report on the CO2 reduction performance of project	Annually
	B: 10	B: US$ 800	B: - Purchase dispatch order data from CDEC-SING (cost to be determined) - Review dispatch order with the project; Determine dispatch order without the project ; - Calculate the difference in CO2 emissions for each scenario using fuel consumption figures; - Calculate volume of CO2 offsets by subtracting CO2 emissions under the with the Project scenario from the without the project scenario; - Prepare report on the CO2 reduction performance of project	
Third party audit	3	$1,000	Review project performance and baseline data; Review CO2 calculation report	Annually
Project Verification	5	$1,500	Site Visit and inspection of key equipment and operations	To be determined

Source: © Trexler and Associates, Inc., 2001.
A: Static Baseline Scenario.
B. Dynamic Baseline Scenario

6.5.10 PROFILE OF VERIFICATION ORGANIZATIONS

Since independent validation is a requirement for a CDM credit generating project, this section profiles several organizations that specialize in environmental auditing services. The role of an auditor is to confirm that the project design meets CDM requirements and that the offsets that it is generating are valid CERs. This process involves carrying out the following services:

- *Validation of project design:* reviewing the project's overall design, baseline and MVP against CDM requirements;
- *Initial audit:* although not a CDM requirement, a buyer might require that the project undergo an initial audit and verification that the project is being implemented as planned and the monitoring systems are in place;
- *Periodic verification of emission reductions:* it is a CDM requirement and the basis for issuing CERs, as the auditor must verify that the project is generating the claimed amount of emission reductions in accordance with the terms of the MVP; and
- *Certification of emission reductions:* upon completion of a successful verification process, the auditor will issue a certificate that the project complies with the requirements of the CDM. This certificate provides the means for receiving CERs from the CDM Executive Board.

The profiled entities were selected because their experience verifying carbon offset projects and because these firms are expected to seek accreditation as a certified auditor of project-based activities under the Kyoto Protocol. Therefore, any of the profiled organizations would be a suitable candidate for providing and auditing services and ensuring that the Calama project adheres to CDM requirements.

Det Norske Veritas

Det Norske Veritas (DNV) is a Norwegian-based company that offers monitoring, verification and certification services. DNV has operations in over 130 countries and has the following credentials:

- Conducted the first verification of CO2 emission reductions, for an energy efficiency project implemented in Mexico under the Activities Implemented Jointly Pilot program;
- Validation of a small hydro project in Chile and a Brazilian bioenergy project receiving carbon funding through the PCF;

- DNV has been used by organizations such as BP Amoco, UNFCCC, the World Bank, OECD and the Governments of Sweden, Norway and Australia.

Additional information is available on DNV's website: http://www.dnv.com

Société Générale de Surveillance Holding S.A.

Société Générale de Surveillance Holding S.A. (SGS) is an international inspection, testing, monitoring and verification organization, based in Switzerland. SGS has launched the SGS Climate Change Programme with the intention of providing validation and verification services for greenhouse gas reduction projects. SGS's auditing activities include:

- Validation of the project design, baseline, and MVP of the Uganda Small Hydro project for the Prototype Carbon Fund (PCF);

- Validation of the biomass portfolio of projects in the Czech Republic receiving funding under the Dutch government's 2000 Joint Implementation tender (ERUPT); and

- Validation and verification of seven forestry projects, including initial work on a 1997 project for the Government of Costa Rica;

Additional information is available on SGS's website: http://www.sgs.com

Pricewaterhouse Coopers

PricewaterhouseCoopers (PwC) provides climate change services within The Global Environmental Services Group. PwC's auditing activities include:

- Validation of a wind project in Poland and two cogeneration projects in Romania receiving ERUPT offset funding through the Government of the Netherlands.
- Verification of the largest GHG emission reductions transaction to date; and
- Verifying and certifying a biomass co-firing project.

Additional information can be found on PwC's website: http//www.pwcglobal.com

ICF Consulting

ICF Consulting (ICF) provides M&V for GHG reduction projects with a concentration on Europe, North America, Asia Pacific, Russia and the Transitional Economies and Latin America. ICF has assisted in the review and design of more than 120 GHG transactions. ICF's experience includes:

- Conducting a due diligence on the first trans-boundary GHG trade;
- Developed the MVP for the Latvia landfill project, the first offset project to receive climate mitigation funding under the PCF;
- Part of a team of auditors that conducted the first ever corporate-wide GHG inventory, protocol and audit; and
- Assisted in the validation of the small-hydro project in Chile that is receiving offset funding through the PCF.

Additional information is available on ICF's website: http://www.icfconsulting.com

7 EQUIPMENT COSTS AND CONSTRUCTION COSTS FOR THE PROJECT

7.1 EQUIPMENT COSTS

Price quotations were requested from two manufacturers, namely Vestas and NEG Micon (see the quotation request format enclosed to ANNEX K.) Quoted prices (ANNEX L1 and L2) are summarized in the following tables:

Table 26. Quotation by NEG Micon

Manufacturer	NEG Micon Opción 1	NEG Micon Opción 2
Turbine Model	NM54-950kW	NM82-1650kW
Tower Height	55	78
Type of Towers	IEC II	IEC II
# of turbines	42	25
Power per WTG (kW)	950	1650
Wind Farm (MW)	39.9	41.25

Items	US$	US$
Turbine + Tower	26,972,384	39,979,387
Containers-flatbeds	794,130	1,139,903
Remote control system	190,518	157,229
Parts for installation	539,447	799,588
Tools for installation	348,315	348,315
(1) Equipment Price FOB	28,844,794	42,424,421
(2) Transport	2,105,376	3,126,656
(% of Equipment cost)	7.30%	7.37%
(3) Equipment Cost CIF= (1) + (2)	30,950,171	45,551,078
(4) Supervision of installation (120 days)	1,120,880	1,182,426
(5) Service and Maintenance -2 years	1,348,625	802,753
(6) Subtotal of Additional Costs= (4)+(5)	2,469,504	1,985,179
(7) Total Equipment & Service Cost=(3)+(6)	33,419,675	47,536,256
Equipment FOB (Cost per kW)	722.9	1,028.5
Transport (Cost per kW)	52.8	75.8
CIF (Cost per kW)	775.7	1,104.3
Total (Cost per kW)	837.6	1,152.4

Vestas in turn quoted the two bids summarized below:

Table 27. Quotation by Vestas

Manufacturer	Vestas	
	Option 1	Option 2
Turbine Model	V52-850kW	V52-850kW
Tower Height	40	40
Type of Tower	IEC I	IEC II
# of generators	47	47
Power per unit (kW)	850	850
Wind Farm (MW)	40.0	40.0
CIF price (US$)	31,137,941	30,530,086
US$/kW	779	764

These quotations include the following items:

- 2-year warranty for towers and turbines
- 2 supervisors during assembly
- Testing and commissioning by Vestas technicians
- 5 maintenance visits by a supervisor

7.2 ESTIMATION OF CONSTRUCTION COSTS

The consulting firm Fluor Daniel Chile conducted a Construction Cost Estimation Study for this project commissioned by SeaWest WindPower, which is enclosed in ANNEX M. The preliminary results for the 37.2MW farm were submitted to Codelco during a meeting held on January 7, 2003, and the related final estimate by Fluor Daniel Chile was finished in August 2003.

Fluor Daniel estimates were based on a conceptual design (Type 3) involving the installation of turbines with 600kW in rated power. Estimations considered two scenarios: a 37.2 MW farm (62 turbines) and a 40.2 MW farm (67 turbines.)

ANNEXES H and I present the layout of the physical infrastructure facilities of the project, including turbine distribution in a three-row matrix, the new substation (known as Wind Farm substation) to increase voltage from 13.8 KV to 110 KV, and the 110 KV transmission line that connects Wind Farm substation with the substation km6-110 KV.

The Table below shows cost estimate results: Costs are in the order of 660 US$ per kW, thus exceeding construction costs seen in actual projects with similar characteristics performed in the USA that SeaWest is aware of. The high construction costs of the Calama project versus those of similar projects conducted in other countries result from a combination of the following factors:

i) Wind projects are generally conducted on the coastal border, thus decreasing equipment transportation and transfer costs;

ii) Difficulties imposed by the Calama works at 2400 meters above sea level, in terms of personnel performance and increased staff and equipment transportation costs.

iii) Equipment (turbines and towers) transportation from the port of Mejillones for about 200 km;

iv) Low availability of suppliers and therefore high rental costs for large size cranes (180 and 600 tons) needed for tower and turbine erection and assembly;

v) Lack of qualified local personnel with experience in assembly tasks, for this would be the first project of this size in the country (thus increasing assembly times with respect to other countries as well as the contingency budget);

vi) High cost of supplies and fuel costs (gasoline for transportation of equipment and staff, etc.) in the area of Calama.

Table 28. Estimation of Construction Costs

Activity	Fluor 37.2 MW 62X600kW US$ 000	Fluor 40.2 MW 67X600kW US$ 000	Escalation 39.9MW 47X850kW US$ 000	Escalation 39.9MW 42X950kW US$ 000	Escalation 41.25MW 25X1650kW US$ 000
1. Underground Cable Laydown 15kV	1,514	1,610	1,610	1,610	1,610
2. Foundations for Transformers and Towers	5,188	5,606	3,937	3,518	2,094
3. Low Voltage Electrical Works	91	99	99	99	99
4. Installation of Towers and Turbines	4,397	4,840	1,963	1,858	1,499
4.1. Installation		3,031	991	886	527
4.2. Crane rental 180tons and 600tons		1,809	972	972	972
5. Site Grading and Roads	653	655	655	655	655
6. Substation at Wind Farm 13.8/100kV	1,665	1,665	1,665	1,665	1,665
7. Transmission line 100 kV	1,595	1,595	1,595	1,595	1,595
8. Expansion of existing substation Km6	316	316	316	316	316
9. Facilities and Services	242	242	242	242	242
10. Pad Mounted Transformers			679		
11. Indirect Costs	9,089	9,747	6,995	6,658	5,653
11.1. Detail Engineering	1,190	1,211	850	759	452
11.2. Construction Management	1,633	1,963	1,377	1,230	732
11.3. Test and Commissioning	524	549	549	549	549
11.4. Spare parts	95	95	95	95	95
11.5. Temporary Facilities	1,362	1,392	1,392	1,392	1,392
11.6. Topographic Work and Soil Mechanics	576	588	588	588	588
11.7. Freight & Duties	237	237	237	237	237
11.8. Import duties of electrical equipment	151	151			
11.9. Freight turbines and towers port to Calama	471	524	357	357	357
11.10. Contingency	2,850	3,037	1,550	1,450	1,250
TOTAL COST	**24,750**	**26,375**	**19,755**	**18,215**	**15,427**
Unitary Cost (US$ per kW)	**665**	**656**	**495**	**457**	**374**

Source: Study of Construction Costs by Fluor Daniel-Chile

Financial modeling was based on the costs estimated by Fluor Daniel, but escalated according to three possible turbine-array configurations: 47 turbines of 850kW, 42 turbines of 950kW and 25 turbines of 1650kW. Such escalations produced final unitary costs ranging from US$460 per kW to US$500 per kW for configurations with 950kW and 850kW models, respectively. The modifications performed on the figures of Fluor and their corresponding justifications are the following:

i) The assembly crane rental period was reduced according to operation days reported by NEG Micon for such activities in its turbine price quotation.

ii) Import duties applicable to electromechanical sets were eliminated due to free trade agreements that have been signed by Chile with the European Union and USA, where such units will come from.

iii) A less conservative criterion was applied to contingency costs.

7.3 ESTIMATION OF TOTAL COSTS OF THE WIND FARM

Below is a summary of the Project's Total Construction Costs for scenarios with and without import duties. Total cost in the duty-free scenario ranges from 1.262 to 1.510 US$ per installed kW:

Table 29. Total Costs of the Wind Farm

	Without import duties			With Import duties (6%)		
	39.9MW 47X850kW US$ thousands	39.9MW 42X950kW US$ thousands	41.25MW 25X1650kW US$ thousands	39.9MW 47X850kW US$ thousands	39.9MW 42X950kW US$ thousands	41.25MW 25X1650kW US$ thousands
Costs of Turbines and Towers	31,209	32,071	46,734	33,041	33,995	49,538
Construction Costs	19,206	18,345	15,557	19,355	18,494	15,706
Total Costs	50,416	50,416	62,291	52,396	52,489	65,243
Costs of Turbines and Towers (US$/kW)	781	804	1,133	827	852	1,201
Construction Costs (US$/kW)	481	460	377	484	463	381
Total Costs (US$/kW)	1,262	1,264	1,510	1,312	1,316	1,582

Note: For the turbine of 850kW, the price of the Pad Mounted Transformers has been included

Source: Quotations from manufacturers and Study of Construction Costs by Fluor

7.4 ESTIMATION OF GENERATION COSTS FOR THE WIND FARM

Generation costs of the wind farm were calculated, based on the cost of turbines for wind generation and construction and installation costs for the different analyzed configurations. The capacity factor of each turbine was used to calculate generation costs in the wind farm, together with a 10% discount rate, 20 years of economic useful life for the project, capital investment costs (including turbine construction and installation costs) and farm operation and maintenance costs.

Results are shown in the Table below, where generation costs range from 62.2 to 69.5 US$/MWh, which are very high values in comparison with generation costs of natural gas projects (in the order of 31 to 37 US$/MWh.) This high generation costs also support the conclusion that the scenario with the Wind Farm selling power in the spot market is an unfeasible option, because even though the wind farm would always be dispatched due to its cero variable costs of generation (like hydraulic plants), it would face high total costs in comparison with other competing plants.

Table 30. Generation Costs for the Wind Farm

	Vestas V47-850kW	NM 54-950kW	NM 82-1650kW
# of turbines	47	42	25
Power per Wind turbine generator (kW)	850	950	1,650
Total Installed Power (kW)	39,950	39,900	41,250
Capacity factor	0.322	0.285	0.355
Generation (kWh-year)	112,687,764	99,614,340	128,279,250
Investments (US$)	52,496,000	52,589,000	65,343,000
Cost per kW	1,314	1,318	1,584
Discount rate =	0.1	0.1	0.1
Years =	20	20	20
Capital Recovery Factor (CRF) =	0.117	0.117	0.117
Investment * CRF	6,166,160	6,177,084	7,675,164
Operation & Maintenance Cost (US$)	845,158	747,108	962,094
O&M Cost (US$ / kWh)	0.0075	0.0075	0.0075
Generation Cost (US$ / kWh)=	0.06222	0.06951	0.06733
Sensitivity (Investment reduced by 10%)	0.05675	0.06331	0.06135
Sensitivity (Investment reduced by 5%)	0.05948	0.06641	0.06434

Source: Estimations by Deuman

The sensitivity of generation costs in relation to a reduction in total investment costs has been duly analyzed too. Proceedings intended to reduce such investments should mainly focus on turbine installation and assembly construction costs (which are high due to the previously mentioned reasons) Equipment costs are hardly susceptible to a general reduction (because they are based on current market prices in consistency with sales of turbines to recent wind projects)

In the turbine configuration with the lowest generation cost (configuration with 47 turbines rated at 850kW), generation costs would decrease by 8.8% (reaching 56.8 US$/MWh) in case the investment decreases by 10% (equivalent to US$5 million, which is highly optimistic). Should investment cost reduction reach 5% (with total investment therefore being in the order of US$ 49.9 million), generation costs would diminish by 4.4%, thus reaching a value of 59.9 US$/MWh.

Therefore, reductions over 10% are hardly possible, because equipment alone cost about US$ 32 million (in the case of turbines in the range of 850kW to 950kW).

8 ENVIRONMENTAL ASPECTS OF THE PROJECT

Deuman Ingenieros and the Canadian company Rescan analyzed the appropriateness of submitting an Environmental Impact Statement (DIA) instead of an Environmental Impact Assessment (EIA) for their BioCOP Prototype Plant project, based on an Appropriateness Analysis, for the BioCOP Prototype Plant project to be environmentally approved. That plant is located in the Division Chuquicamata lands, Region 2, county of Calama, in a site of approximately 250 x 600 meters, next to the Low Grade Sulfide (SBL) plant, relatively near the potential future location of the Calama Wind Plant.

Then from that perspective, the wind plant baseline should not differ greatly from the BioCOP Plant baseline in terms of soil and fauna. Moreover it would have some environmental advantages against the BioCOP Plant. Considering the above and the fact that the Environmental Impact Statement for the BioCOP Prototype plant was approved by the Regional Conama Office in Region 2, below is an Appropriateness Analysis of the Calama Wind Project, in order to decide whether a DIA would fit better than an EIA in the framework of the Calama Wind Project Feasibility Study.

As per Title II of the Regulation for the Environmental Impact Assessment System, under Statutory Decree DS 95/01 issued in 2001, the wind project may be processed in the Environmental Impact Assessment System (SEIA) simply by submitting an Environmental Impact Statement, on condition that none of the following effects, characteristics or circumstances is present:

a) Health and safety risks to population due to the quantity and quality of effluents, emissions or wastes; (section 5 in the Regulation.)
b) Significant negative effects on the quantity and quality of renewable natural resources, including soil, water and air; (section 6 of the Regulation.)
c) Relocation of human communities or significant changes in the life organization and customs of human groups; (section 8 of the Regulation.)
d) Location near human settlements, resources and protected areas that could be affected, or effect on the environmental richness of the intended location territory (section 9 of the Regulation.)
e) Significant changes in the landscape or tourism richness of the zone in terms of size or time length; (section 10 of the Regulation.)
f) Changes in monuments, sites of anthropological, archeological or historical value and generally speaking in cultural legacy sites. (Section 11 of the Regulation.)

Below is the information required to determine that it is not necessary to submit an Environmental Impact Study (Appropriateness Analysis) for the Project, as per the provisions of subsection c, Section 15 of the revised SEIA Regulation.

Regulation Statutory Decree D.S. 95/01	List of contents	Assessment
Section 5		
	The applicant shall submit an Environmental Impact Study if the related project or activity generates or implies health or safety risks to population due to the quantity and quality of generated or produced effluents, emissions or wastes. The above risk potential shall be measured considering:	Considering the quantity and quality of generated effluents, emissions or wastes, the Calama Wind Project generates or implies no health or safety risks to population, because no liquid or solid wastes whatsoever are produced.
Subsection a)	Provisions contained in the applicable primary standards on environmental quality and emissions. In the absence of such standards, the nationally applicable standards referred to in Section 7, Title III of the Regulation will be taken as a reference.	The project meets the applicable primary standards on environmental quality and emissions.
Subsection b)	Composition, hazardousness, quantity and concentration of liquid effluents and airborne emissions.	There are no liquid effluents or airborne emissions resulting from the project operation.
Subsection c)	Frequency, length and location of liquid effluent discharges and airborne emissions.	There are no liquid effluents or airborne emissions resulting from the project operation.
Subsection d)	Composition, hazardousness and quantify of solid wastes.	There are no solid wastes resulting from the Project operation.
Subsection e)	Frequency, length and location of solid waste management.	There are no solid wastes resulting from the Project operation.
Subsection f)	Difference between estimated noise emission levels with the project or activity in place versus the background noise level representative or typical of an environment with permanent human settlements.	Not applicable. The project potential location is approximately 6 km away from the nearest human settlement.
Subsection g)	Forms of energy, radiation and vibration generated by the project or activity.	Not applicable.
Subsection h)	Known effects resulting from the combination or interaction of pollutants released or generated by the project or activity.	Not applicable.
Section 6	List of contents	Assessment

	The applicant shall submit an Environmental Impact Study if the related project or activity generates or implies significant negative effects on the quantity and quality of renewable natural resources, including soil, water, air. The above potential for significant negative effects shall be measured considering:	The Calama wind project generates no significant negative effects on the quantity or quality of renewable natural resources, including soil, water, and air.
Subsection a)	Provisions contained in the applicable secondary standards on environmental quality and emissions. In the absence of such standards, the nationally applicable standards referred to in Section 7 of this Regulation will be taken as a reference.	There are no airborne emissions resulting from the Project operation.
Subsection b)	Composition, hazardousness, quantity and concentration of liquid effluents and airborne emissions.	There are no liquid effluents or airborne emissions resulting from the project operation.
Subsection c)	Frequency, length and location of liquid effluent discharges and airborne emissions.	There are no liquid effluents or airborne emissions resulting from the project operation.
Subsection d)	Composition, hazardousness and quantify of solid wastes.	There are no solid wastes resulting from the Project operation.
Subsection e)	Frequency, length and location of solid waste management.	Not applicable.
Subsection f)	Difference between estimated noise levels emitted by the project or activity in place versus the background noise level representative or typical of an environment that concentrates native fauna associated with the habitat relevant for nesting, breeding or feeding.	No background noise level representative of the project site might be affected by the project implementation. Additionally as the project potential location is a part of the dessert, there is no native fauna or vegetation.
Subsection g)	Forms of energy, radiation or vibration generated by the project or activity.	Electromagnetic radiation is not deemed as an issue for wind turbines given the low voltage associated (600 – 690 Volts.) Transformers raise turbine voltage up to 34.8 kV. Then 35-kV cables carry the power. The main sources of electromagnetic radiation are transmission and substation lines.
Subsection h)	Known effects resulting from the combination and/or interaction of pollutants released and/or generated by the project or activity.	No pollutants are generated by the project operation.
Subsection i)	Relation between pollutant emissions generated by the project or activity and the environmental quality of renewable natural resources.	No pollutant emissions are generated by the project; therefore they cannot possibly affect the environmental quality of renewable natural resources.

Subsection j)	Dilution, dispersion, self-cleaning, assimilation and regeneration capacity of the renewable natural resources found within the influence area of the project or activity.	No renewable natural resources are affected by the project, save for the wind used to produce electricity.
Subsection k)	Quantity and surface area of intervened and/or exploited native vegetation, and related form or intervention and/exploitation.	No native vegetation is intervened and/or exploited.
Subsection l)	Quantity of intervened and/or exploited wild fauna, and related form or intervention and/exploitation.	Not applicable.
Subsection m)	Conservational status of the flora and fauna species to be extracted, exploited, altered or managed as indicated in the national listing of endangered, vulnerable, rare or insufficiently known species.	Not applicable.
Subsection n)	Volume, flow and/or surface area -as the case may be- of water resources to be intervened and/or exploited in. n1) Plains and/or grasslands located in Regions 1 and 2 that might be affected by increased or decreased underground water levels. n2) Wetland areas or zones that might be affected by increased or decreased underground or surface water levels. n3) Underground water bodies containing millenary water and/or fossils. n4) Drainage basin or sub basin diverted to another basin. n5) Lakes or ponds causing level fluctuations.	Not applicable.
Subsection ñ)	Entry to the national territory of flora or fauna species, genetically modified organisms, or organisms modified by other similar techniques in consideration of: ñ1) Existence of such species or organisms in the national territory. ñ2) Possible alterations caused by their presence in other natural and/or artificial environmental elements.	Not applicable.

Subsection o)	Soil surface susceptible to loss or degradation caused by erosion, compaction or pollution.	Wind turbines use lubricant oil and grease. However none of these elements contains compounds listed as hazardous by the US Environmental Protection Agency (EPA.) These elements are used in moderate quantities (under 25 gallons per each 600-Kw turbine) and the possibilities of accidental leakage or spillage is low. Lubricants, hydraulic fluids and oils are checked every quarter -systems are filled if necessary- and replaced every 1 or 2 years, as per the manufacturer's recommendations. Transformers contain cooling oils free from PCB's (Polychlorinated biphenyls.) Foundations for transformers are designed to hold 125% of oil capacity contained by the transformer, which would protect the place in case of leakage.
Subsection p)	Biological diversity in the influence area of the project or activity, and related regeneration capacity.	Biological diversity in the project site is close to cero. The project will therefore cause no effects on such biodiversity.
Section 8	List of contents	Assessment
	The applicant shall submit an Environmental Impact Study if the related project or activity causes human settlements to relocate or significantly changes life organization and customs of human groups. The relocation of human settlements as a result of the project or activity is assessed in consideration of the displacement or relocation of people living in the project or activity site, including associated works and/or actions. Similarly, significant changes in life organization and customs of human groups as a result of the project or activity, including any associated works and/or actions at any stage, are assessed in consideration of changes caused in the following spheres characterizing such life organization	
Subsection a)	Geographical sphere, including the distribution of human groups over the territory, and spatial structure of their relations, in terms of population density and spatial distribution, plot size and land tenancy, and communication and transportation flows.	Not applicable.

Subsection b)	Geographical sphere, including local population structure by age, gender, economic activity, occupation and migratory status, in consideration of urban-rural structure, economic activity and occupation: economically active population; age and gender structure, literacy and instruction levels; and migrations.	Not applicable.
Subsection c)	Anthropological sphere, including ethnical characteristics and cultural expressions, such as ceremonies, pilgrimages, processions, celebrations, festivals, tournaments, fairs and marketplaces.	Not applicable.
Subsection d)	Social and economic sphere, including employment and unemployment, and the presence of productive activities dependant on natural resources extracted by the involved human group either individually or collectively; or	Not applicable.
Subsection e)	Basic welfare sphere, including the access of human beings to goods, equipment and services, such as housing, transportation, energy, health, education and hygienic services.	Not applicable.
Section 9	List of contents	Assessment
	The applicant shall submit an Environmental Impact Study if the related project or activity, including any associated works and/or actions at any stage, is located near a human settlements, resources and protected areas that could be affected, or where the environmental richness of the intended location territory could be affected.	The project will be located in an isolated piece of land, free from vegetation, constructions or population, away from any resources or protected areas that could be affected or that hold significant environmental richness.
Section 10	**List of contents**	**Assessment**

	The applicant shall submit an Environmental Impact Study if the related project or activity significantly changes the landscape or tourism richness of the zone in terms of size or time length. The occurrence of significant changes in the landscape or tourism richness of a zone in terms of size and time length as a result of the related project or activity, including any associated works and/or actions at any stage, is assessed in consideration of:	
Subsection a)	Time length or area obstructing visibility to rich landscape zones.	This is not the case because of the dessert.
Subsection b)	Time length and area by which environmental resources or elements are changed in zones with landscape or tourism richness.	This is not the case because of the dessert.
Subsection c)	Time length and area by which access to environmental resources or elements is not available in zones with landscape or tourism richness.	This is not the case.
Subsection d)	Intervention or location of the project or activity in an area pronounced a national zone or center of tourism interest as per provisions of Statutory Decree 1,224 issued in 1975.	This is not the case.
Section 11	**List of contents**	**Assessment**
	The applicant shall submit an Environmental Impact Study if the related project or activity changes monuments, sites of anthropological, archeological or historical value and generally speaking in cultural legacy sites. The occurrence of changes in monuments, sites of anthropological, archeological or historical value and generally speaking in cultural legacy sites, as a result of the related project or activity, including any associated works and/or actions at any stage, is assessed in consideration of:	There are no monuments, sites of anthropological, archeological or historical value, and generally speaking cultural legacy sites in the wind project potential location.
Subsection a)	Location in or around one of the National Monuments listed by Law # 17,288.	Not applicable.
Subsection b)	Removal, destruction, excavation, transfer, damage or modification of one of the National Monuments listed by Law # 17,288.	Not applicable.

Subsection c)	Modification, damage or location in constructions, places or sites that belong to the cultural legacy in consideration of their construction characteristics, oldness, scientific value, historical background or uniqueness.	Not applicable.
Subsection d)	Location in places or sites where cultural or folklore expressions of some peoples, communities or human groups are performed.	Not applicable.

9 ASPECTS FOR THE ECONOMICAL EVALUATION OF THE PROJECT

9.1 ANALYSIS OF SCENARIOS FOR FINANCIING THE PROJECT

Two different alternatives are considered for the project funding modeling: i) pure or unfunded project, and ii) funded project. The final simulation for a 40MW farm considered that 40% of the required project investment was funded using equity, while the remaining 60% turned to debt. The model allows for amendments in the debt/equity balance assumptions according to the assessor convenience.

In the case of debt, two (2) scenarios were assessed based on the interest rate for the project funding:

- Annual 5.5% interest rate.
- Annual 6.5% interest rate.

The assessment includes a 10-year debt redemption period of time.

Below are the project economic assessment results based on the previously indicated assumptions. The economic assessments presented in this report were prepared using the Financial Model developed for this project, which was previously approved by Codelco.

The interest rate scenarios were applied taking into account scenarios based on recent borrowing operations made in both domestic and international markets. The project profitability is sensitive to the funding rate. Should Codelco implement the project, better financial conditions could be obtained compared to those available for an individual. In order to illustrate the point, the Table below shows the preferential conditions negotiated by Codelco over its most recent borrowing operations. Based on that information, rates in the order of 6.5% or lower could be expected under the current interest rate panorama.

In its last bond placement operation in October 2003, Codelco placed US$ 500 million worth of bonds, attaining 125 basis points in spread, which is the lowest level ever achieved by a Latin-American company over the past five years.

That reflects the investment grade held by Codelco debts. The investment risk rating for Codelco in the Chilean market is AAA under the Fitch and Feller rates, which is the best possible rating for an issuer in Chile. The international risk rating for Codelco is A2 under the Moody's rate, and A- under the Standard & Poor's rate. The investment risk rating for Codelco is twice as good as the overall rating for the Government of Chile. It is also the best-rated company in Latin America.

Table 31. Issuance of Codelco Bonds

Year	Market	Amount	Term	Rate
May 1999	International	US$300 million	10 years	7.375% or spread of 217 basis points
Nov 2002	Chile	UF 7 million= US$163 million	10 years	4%
Nov 2002	International	US$435 million	10 years	6.375% or spread of 228 bp
Oct 2003	International	US$500 million	10 years	5.51% or spread of 125 bp

Source: Deuman based on Codelco Annual Reports and Financial Newspaper Estrategia.

9.2 ANALYSIS OF THE PROJECT TAXATION SCENARIOS

9.2.1 GENERAL ASPECTS

This section analyzes the different taxes the wind project would be subject to. The taxes described below are applicable to both the investment and the project operation.

As a matter of fact and like any other country, the Chilean taxation system levies imported capital goods and revenues from the fiscal year.

In order to set the global framework, each tax applicable to the project is initially described and then the possible taxation scenarios of the project are built based on such taxes.

9.2.2 APPLICABLES TAXES FOR THE PROJECT

9.2.2.1 SALES AND SERVICES TAX (VAT)

The Sales and Service Tax is the principal tax on consumption. It applies a fixed 19% rate on the added value introduced in each stage of the commercialization and distribution chain until the end consumer buys the good. It replaced the sales tax. In practice there few exemptions, and the most important of them are exports.

The Sales and Service Tax impacts the end consumer, but it built up in each stage of commercialization. The sum to be paid results from the difference between fiscal debit -combined taxes added to the sales and services encompassed by one month- and fiscal credit. Fiscal credit is equal to taxes added to purchase invoices and service use invoices. In the case of imports, it is the tax paid for importing the goods.

The Sales and Service Tax is a domestic tax that levies the sales of tangible and intangible property owned by a construction company, totally built by that company or partially built for that company by a third party, as well as services rendered or used in the country. It affects tax authorities, official controlling

authorities, autonomous administration organizations, city halls and each of their corporations or each corporation they have an interest in, even if other laws may free them from other taxes.

Should a balance remain after charging fiscal credit to fiscal debit for the respective period, that remainder will be accumulated for the coming tax assessment period and so forth until depletion using an adjustment system until actual charging. Similarly there is a special mechanism to recover fiscal credit remainders accumulated over six or more consecutive months if they result from the acquisition of fixed asset goods.

Finally VAT-exempted exporters selling abroad are also legally entitled to recover the VAT charged to acquisitions made with a view to such exports, either using the above described system or requesting the related tax return the month after, as per the provisions of Statutory Decree 348 issued in 1975 (the final text of which was passed by the Statutory Decree 79 issued in 1991.)

In July 2003 the National Congress passed a Presidential proposal to raise taxes, including a one per cent increase in VAT, which thus went from 18% up to 19%. The House of Representatives and the Senate finally passed it in August. Law # 19,888 -published by the Official Gazette in August 14, 2002- established the VAT raise would come into force in October 1st, 2003. Therefore this project was first modeled applying 18% VAT, while the final scenario for a 40-MW farm was modeled considering 19% VAT.

On the other hand, upon the request of Codelco, the Financial Model also included the possibility that the wind project would apply for or benefit from the legal VAT recovery mechanisms.

VAT recovery is a mechanism for export promotion. Exporters of export-quality goods and services are entitled to recover the VAT charged to them when paying for the goods, supplies or services inherent to such exports. That is what the Statutory Decree 825 (December 31, 1974) and Statutory Decree 348 (December 31, 1975) provide for.

If the exporter not only sells abroad, but also in the domestic market, the VAT recovery process may proceed through the fiscal credit. That means the VAT recovered from exports will increase the related fiscal credit for the same tax assessment period that gives rise to a fiscal debit due to domestic sales. Recovery adds up to the percentage representing the FOB value of exports in relation to total goods and services sold over the same tax assessment period.

If the exporter is not selling in the domestic market, total fiscal credit is recovered because exports represent total sales for a certain tax assessment period. The Statutory Decree 348 issued by the Ministry of Economy allows for early VAT recovery in the case of investment projects aimed at producing goods and services for export. The application of this benefit may be requested to the

Ministry of Economy with the investment project enclosed. If the Ministry accepts the petition, it will issue a resolution authorizing early VAT recovery before the Internal Revenue Service.

9.2.2.2 FIRST BRACKET INCOME TAX

The First Bracket Tax (Section 20 of the Income Tax Law) levies all income resulting from the capital obtained by trading, industrial and mining companies with an interest rate equal to 15% valid of the trading year 2001. During 2002 and 2003 this tax was applied with rates equal to 16% and 16.5%, respectively. Starting on January 1st, 2004 the tax rate will permanently levy 17%. This tax applies on profits collected or accrued by companies that declare their actually estimated income using complete sets of accounts. The exceptions are agricultural, mining and transportation companies, which can pay taxes based on their assessed income if they comply with the Income Law requirements.

State companies, such as Codelco, must not only the usual First Bracket Income Tax, but also they have to pay a special 40% tax on generated revenues.

Since company owners, partners or stockholders finally pay for taxes, the First Bracket tax paid by companies represents a credit against Complementary or Additional Global taxes applicable to previously mentioned individuals.

9.2.2.3 LAND TAX

The Land or Real Estate Tax (Law # 17,235 enacted in 1969) is defined as a capital tax calculated on the basis of assessed property valuation. Tax collection goes entirely to Chilean city halls, and it represents one of the most important sources of income and funding for local governments.

Property valuation (urban real estate) in Chile is reassessed every five years and the corresponding land taxes are levied considering the new valuation. The last valuation reassessment occurred in 1995, however. In between reassessments, actual property valuation changes as a result of physical modifications to lands and half-yearly revision introduced by the Consumer Price Index (CPI.)

Real estate owners or occupiers must pay this annual tax in four installments, with deadlines in April, June, September and November.

Mayors in some counties decided to bring forward the applicability of reassessed property valuations to early 2000. In those counties, the Land Tax is 1.425% for non-agricultural real estate, except for households assessed in less than $36,790,291 pesos (as of July 1st, 2002) with 1.2%.

Valuation reassessment in 2003 only affects 35% of properties, as the remaining 65% of properties are tax-exempted. At present, properties assessed in $9.7 million or less have to pay no taxes. Now with the Income Law 2, this exemption will also apply to all properties assessed in less than $13 million.

The Land Tax Law includes general exemptions for households and agricultural and special pieces of land, such as lands for worship, education, sports, DFL 2 households, city halls, unions, embassies, fire fighters and aboriginal properties.

9.2.2.4 INTERNATIONAL TRADE TAX

International Trade Taxes are basically the specific and/or *ad valorem* duties defined by Customs Tariffs and currently levy one single 8% rate on all imported merchandise.

Such tariffs have gradually decreased and will be set as 6% starting on January 1st, 2003 (as per Section 1 of Law # 19,589 enacted in 1998.) Specific duties are expressed in dollars and apply to some imported products that are also produced domestically, in order to adjust any price distortions.

Customs tariffs are determined considering the transaction price. It includes all expenses resulting from merchandise transportation to the point of entry to the national territory, such as loading and unloading, transportation, commissions, insurance, brokerage, interests and packages.

In the light of recent trade agreements signed by Chile with other nations, some products are levied with customs tariffs below 8%. In deed the average tariff by mid 2003 reached 6.33% according to the information published by the National Customs Service.

These events have a positive effect on the wind project. The Financial Model has considered a 6% tariff. It is assumed to be cero if the farm turbines and towers come from Europe, in light of the recently signed trade agreement with the European Union. If electric and mechanical equipment and turbines came from the United States, the Model simulated tariff would also be assumed as cero, in light of the free trade agreement with the United States recently passed by the Chilean House of Representatives and Senate during November and December 2003.

9.2.2.5 ADDITIONAL TAX

The Additional Tax (Sections 58 and 60, subsections 1 and 61 of the Income Tax Law) is another form of direct taxation levied on corporations and individuals not residing or domiciled in Chile. The general rate is 35% and applies to the

international withdrawal and transfer of gross revenues or income originated in Chile.

This tax is accrued the year the corporation withdraws or distributes the assessable income and transfers it abroad. Taxpayers levied with this tax are entitled to a credit equivalent to the First Bracket Tax paid by companies on their withdrawn or distributed income.

This tax would only apply if the wind project owner is a corporation not domiciled in Chile.

9.2.3 TAXATION SCENARIOS FOR THE PROJECT

According to the above, the wind project taxation scenario depends on each of the taxes above. Regardless of that, a different scenario could exist if Codelco, being a state corporation, had or received some taxation franchises to change the situation.

The Financial Model includes the previously described taxes, and their related values can be modified to reflect future taxation changes. The first simulation assumed VAT to be 18%, but as this Study progressed and particularly during 2003, the Congress changed VAT to 19%, and that new value was introduced to final simulations. As already stated, in the case of the International Trade Tax, tariffs have been simulated being equal to cero, in light of the trade agreements recently signed by Chile with the European Union and the United States.

As mentioned before with regards to VAT, Codelco requested the Financial Model to include the possibility of using the VAT recovery mechanism.

10 RESULTS OF THE ECONOMICAL ASSESSMENT ANALYSIS

The project was subject to a preliminary economic assessment considering reference equipment prices, as well as reference construction costs taken from projects in the United States, and including different farm sizes (12MW, 21MW, 30MW, 40MW). Later during Final Assessment, the option was made for the 40-MW farm and its related results were presented. For that purpose, formal equipment quotations were requested and the construction costs estimated by a Fluor Daniel-Chile Study were escalated.

10.1 PRELIMINARY ASSESSMENTS FOR FOUR FARM SIZES

The preliminary economic assessments of the project defined different farm sizes, i.e., 12-MW, 21-MW, 30-MW and 40.5-MW. These scenarios considered the reference costs of General Electric 1.5-MW turbines.

10.1.1 ASSUMPTIONS FOR THE PRELIMINARY ASSESSMENTS

Below are the assumptions used for the project preliminary economic assessment for four different farm sizes 12-MW, 21-MW, 30-MW and 40-MW):

- Assessment timeframe: 20 years
- Private discount rate: 10 % a year.
- Income tax rate: 17% a year on revenues.
- Value Added Tax (VAT): 18% (changed to 19% for the final assessment.)
- International trade tax: 8.8% (tariffs equal to cero were assumed for the final assessment considering recently signed economic agreements.)
- Land tax: 1,425%
- Debt funding rates: 7.5% and 9.5%
- Long-term debt redemption term: 10 years
- Project turbine size: 1.5 MW
- Turbine manufacturer: General Electric (Vestas and NEG Micon turbines were considered for the final assessment.)
- Capacity factor: 37.6% (Vestas and NEG Micon values were considered for the final assessment in light of the Calama wind density.)
- Plant commercial operation mode: sales to the spot market
- Acknowledged percentage of firm capacity: 50% of installed capacity, for sales to the spot market
- Reduced CO_2 ton price: US $2.5/ton (4 US$/ton were used for the final assessment.)
- Unit factor for CO_2 emission reduction: 1.03 Ton CO_2/MWh. The Trexler Study dispatch scenario was taken as a baseline for this purpose. It

considers the power plants that run on a coal-pet coke blend for generation as marginal sources of power.

- Turbine cost (FOB): US$ 710.3 per installed Kwh. This number was used as a constant value for all scenarios. No volume purchase discounts were introduced. (The final assessment considered quotations from Vestas and NEG Micon.)
- Operational administration costs (US$/year): 1% in relation to equipment and machinery investment.
- Plant operation and maintenance costs (US$/kWh): 0,0075.
- Administration and sales costs (US$/year): 1.5% in relation to total equipment and machinery investment.
- Costs of representation before CDEC-SING: 3% on sales.
- Linear depreciation over 20 years.
- Legal expenses: MUS$ 24/year in fixed annual value.
- Third party expenses: MUS$ 12/year in fixed annual value.
- Financial positions (commissions): MUS$ 6/year in fixed annual value.
- VAT recovery on the basis of the project credit and debit.

The project construction costs were obtained using the costs of actual projects now installed in the United States, but introducing adjustments to reflect local construction costs.

10.1.2 RESULTS OF THE PRELIMINARY ASSESSMENTS

The tables below summarize the results of preliminary assessments, and show the different effects on the project IRR and NPV caused by the plant size (MW), VAT recovery, interest rate in case of debt, sales of certified carbon emission reduction credits, etc.

EVALUATION WITHOUT VAT
Net Present Value (20 years) in US$ Thousands

	12 MW	21 MW	30 MW	40,5 MW
Scenario A	-9,014	-12,947	-17,096	-21,677
Scenario B	-9,055	-11,186	-13,709	-16,238
Scenario C	-10,772	-13,897	-17,450	-21,146
Scenario D	-8,319	-11,643	-15,234	-19,164
Scenario E	-7,162	-7,926	-9,236	-10,477
Scenario F	-8,873	-10,585	-12,735	-14,889

EVALUATION WITH VAT RECOVERY
Net Present Value (20 years) in US$ Thousands

	12 MW	21 MW	30 MW	40,5 MW
Scenario A	-8,195	-11,372	-14,694	-18,269
Scenario B	-5,048	-5,108	-5,518	-5,749
Scenario C	-8,312	-6,908	-7,859	-8,614
Scenario D	-7,322	-9,899	-12,591	-16,108
Scenario E	-3,350	-2,675	-2,286	-2,543
Scenario F	-4,495	-4,154	-4,146	-4,668

Internal Rate of Return (20 years) in %

	12 MW	21 MW	30 MW	40,5 MW
Scenario A	1.55%	2.45%	2.83%	3.12%
Scenario B	No Positivo	No Positivo	No Positivo	0.04%
Scenario C	No Positivo	No Positivo	No Positivo	No Positivo
Scenario D	2.26%	3.30%	3.70%	4.00%
Scenario E	No Positivo	1.59%	3.20%	4.28%
Scenario F	No Positivo	No Positivo	0.26%	1.70%

Internal Rate of Return (20 years) in %

	12 MW	21 MW	30 MW	40,5 MW
Scenario A	3.26%	4.17%	4.59%	4.91%
Scenario B	3.21%	5.86%	6.82%	7.51%
Scenario C	1.38%	4.39%	5.47%	6.28%
Scenario D	3.99%	4.93%	5.36%	5.45%
Scenario E	5.63%	7.87%	8.70%	8.88%
Scenario F	4.13%	6.70%	7.66%	7.98%

Note: Debt / Equity structure of 50/50
Scenario A: Project without Financing, and without sell of CERs
Scenario B: Financing rate of 7.5%
Scenario C: Financing rate of 9.5%
Scenario D: Without financing and with sell of CERs @ 2.5 US$/ton CO_2
Scenario E: Financing rate of 7.5% and sell of CERs @ 2.5 US$/ton CO_2
Scenario F: Financing rate of 9.5% and sell of CERs @ 2.5 US$/ton CO_2

The results of such scenarios are as follows:

- All scenarios have negative NPV's, as the assumed commercial operation mode is based on plant production sold to the spot market.
- In the assessment without VAT, the highest IRR value is 4.28% (for a farm size equal to 40-MW.)
- In the assessment with VAT recovery, the highest IRR value is 8.88%.
- As naturally expected, the best results are obtained in scenarios with funding and sales of certified carbon reduction emission credits.
- Revenues from the sale of certified carbon emission reduction credits improve the project IRR from 0.71% to 5.0% depending on the scenario. This may be considered very positive as the assessment worked with a fixed price equal to 2.5 US$/ton.
- In all cases the revenues obtained fail to create a project appealing to Codelco or any other agents.

The main conclusion of such preliminary assessments was the decision to implement the most favorable scenario analyzed. That option includes a 40-MW farm. Equipment quotations were requested and a construction cost analysis was conducted in order to have more accurate information on costs.

10.2 FINAL ASSESSMENTS FOR THE 40MW WIND FARM

During the Final Assessment, the option was made for the 40-MW farm and its related results were presented. For that purpose, formal equipment quotations were requested and the construction costs estimated by a Fluor Daniel-Chile Study were used.

10.2.1 ASSUMPTIONS FOR THE FINAL ASSESSMENTS

Below are the assumptions used for the final economic assessment for a 40-MW farm. The main changes in relation to the preliminary assessment are described.

- Assessment timeframe: 20 years
- Private discount rate: 8.5% a year.

Based on the information provided by the Investment Assistant Manager of Codelco, that is the private rate currently used by Codelco and applied to flows before taxes in mining plans and investment projects.

- Income tax rate: 17% a year on revenues.
- Value Added Tax (VAT): 19% as the tax raise (Law # 19,888) came into force in Chile as October 1st, 2003.
- International trade tax: 0%

Average tariffs for 2003 are around 6%, but a tariff-free scenario for imported equipment appears feasible in light of the economic agreements signed by Chile with the European Union and the Unites States during 2003.

- Land tax: 1,425%
- Debt funding rates: 5.5% and 6.5%

Considering the current international scenario of low rates and also the rates negotiated by Codelco for funding during the past year. In addition, the 2003 release of Codelco's Guideline for Investment Project Preparation estimates that the actual interest rate applicable to the actual financial cost of borrowing for Codelco is 5%.

- Long-term debt redemption term: 10 years
- Project turbine size: three scenarios (850-kW, 950-kW and 1,650-kW, the quoted turbines.)

- Turbines manufacturers: Vestas and NEG Micon (to which quotes were requested for having current representation in Chile.)

- Capacity or plant factor in turbines: values from the generation curves reported by Vestas and NEG Micon were considered for the Calama wind density in quotations: (32.2% for the 850-kW turbine; 28.5% for the 950-kW turbine; and 35.5% for the 1,650-kW turbine.)

- Sale price of CER's (Certified Emission Reductions) allowed by the Clean Development mechanism for CO_2 reductions: 4 US$ per CO_2 ton, based on recent wind project transactions worldwide (Jepirachi, Wigton Farm, Tamil Nadu and others.)

- Annual CO_2 emission reductions: 119,250 per annum in the average for the 2004-2014 term. Reductions vary from year to year and have been calculated as explained in Annex J2.

- Turbine cost (CIF): Based on quotations submitted by Vestas and NEG Micon (764.2 US$/kW for the 850-kW turbine; 804 US$/kW for the 950-kW turbine; 1133 US$/kW for the 1,650-kW turbine.)

- Operational administration costs (US$/year): 1% in relation to equipment and machinery investment.

- Plant operation and maintenance costs (US$/kWh): 0,0075.

- Administration and sales costs (US$/year): 1.5% in relation to total equipment and machinery investment.

- Costs of representation before CDEC-SING: 3% on sales.

- Linear depreciation over 20 years.

- VAT recovery on the basis of the project credit and debit.

10.2.2 ELECTRICITY SALE ASSUMPTIONS

Two scenarios were analyzed for the plant commercial operation mode: Sales to the spot market and sales through a long-term Power Purchase Agreement (PPA.)

In the case of sales to the spot market, the remuneration for firm capacity was simulated for three different scenarios: 50%, 40% and 30% of the installed capacity. As previously mentioned, CDEC-SING was consulted about the firm capacity remuneration that would be granted to the wind farm. No precise reply regarding a firm capacity remuneration value was received; therefore the three scenarios above were simulated. No scenarios under 30% were simulated for being unprofitable, and because sales to the spot market is the least appealing option to Codelco, which from the beginning defined this project as an alternative project that would complement the electricity supplies to Chuquicamata mine.

A scenario was also modeled with the Wind Farm selling its power to Codelco under a so-called PPA (Power Purchase Agreement). Annex P contains a Prototype Agreement of that type. Different scenarios were modeled in this case:

1. Assuming Codelco will start the self-generation project:

The selling price corresponds to a monomical electricity price (the compound price that summarizes energy price and power price) that is equivalent to the monomical price that Chuquicamata is currently paying to Electroandina, its present and only provider until 2009. Starting on 2009, the purchase price becomes similar to the market prices that Codelco would receive if it opened a bidding process in order to assure its future electricity supplies at Chuquicamata mine. This value was simulated below its current contractual level (see the price forecasting section 4.2.10), thus using two different values: 33 US$/MWh and 35.6 US$/MWh.

Another simulation scenario that was analyzed was similar to the previous one, except that the monomical selling price is the monomical current price, but it is preserved until 2017 (when the Electroandina Contract with Radomiro Tomic mine of Codelco expires). After year 2017 the selling price descends to 33 and 35.6 US$/MWh, respectively.

2. Assuming a third party investor will start the project:

Two scenarios were simulated, with sale of electricity at monomical prices of 33 and 35.6 US$/MWh, respectively, throughout the entire project.

10.2.3 RESULTS OF THE FINAL ASSESSMENTS

This section presents the assessment results for the 40-MW turbine. Different scenarios are considered for the sale of the Wind Farm electricity: Selling to the spot market, and selling under a Power Purchase Agreement with Codelco.

A scenario was also modeled with the Wind Farm selling its power to Codelco under a so-called PPA (Power Purchase Agreement.) As shown in the Table below, the project profitability is enhanced under these condition.

Selling the plant electricity to the spot market yields profitability levels below 8%, which would stop Codelco and any other interested agents from implementing this project. Such low levels can be accounted for by: i) the marginal cost of energy in the SING is low, ranging from 18 to 20 US$/MWh, favored by natural gas plants operating in the SING; ii) excess capacity installed in the SING; iii) low acknowledgement of the firm capacity offered by the to the wind farm, since wind farms are naturally not able to provide firm capacity.

Low results obtained from selling to the spot market are expectable, given SING characteristics and the fact that no wind projects operating in an open power market have been structured in this way. Wind projects operating around the world are funded via one or more of the following mechanisms: i) Exemption, reduction or deferral of taxes and/or import duties applicable to equipment and/or investment; ii) granting of state or provincial subsidies to wind power purchasers; iii) granting of state or provincial subsidies to power generation companies; iv) obligation for generation companies to include wind-based or renewable components in their power supply; v) obligation for distributors to purchase a part of their power from renewable sources, including wind power.

The alternative of selling electricity under a Power Purchase Agreement (PPA) was simulated for different scenarios of sales to Chuquicamata. Such scenarios considered that the current supply contract between the mining company and Electroandina will expire in 2009. The scenarios were simulated: i) Sales at the current contractual prices (42 US$/MWh) until 2009 and subsequent sales at market prices ranging from 33 US$/MWh to 35 US$/MWh; ii) sales throughout the entire project at market prices ranging from 33 US$/MWh to 35 US$/MWh.

From the above scenarios, the most favorable results (including optimistic assumptions of import duty exemption, sale of certified carbon emission reduction credits and funding at 5.5%) lead to internal rate of return in the order of 12.81%, which is not appealing to Codelco, for IVAN index reaches 0.22 in that case (and the threshold IVAN index set by Codelco to evaluate its investment projects is 1.4).

Such profitability rates and related net present values are not appealing to third parties that might be interested in the project, such as electric companies currently in SING.

The tables below summarize the principal scenarios, and the related detailed data can be found in Annex O. Models for each turbine are also delivered, including their related results in a magnetic file.

Table 32. Results of the Sell of the Electricity to the Spot Market

Case1. Sell to the spot market with Firm Capacity of 50%

100% Devolution of VAT Firm Capacity= 50%= 20MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: Without financing, without CERs	-$21,959	3.46%	-$23,542	3.05%	-$32,341	2.40%
Scen B: Financing @ 5.5% and 10 yrs	-$10,595	4.04%	-$13,711	2.47%	-$25,143	not positive
Scen C: Financing @ 6.5% and 10 yrs	-$13,126	2.92%	-$16,354	1.18%	-$28,553	no positive
Scen D: Without financing, with CERs @4 US$/ton CO_2	-$16,402	4.81%	-$17,936	4.44%	-$26,745	3.55%
Scen E: Financing 5.5%, with CERs @ 4 US$/ton CO_2	-$467	8.32%	-$2,999	7.31%	-$13,104	4.03%
Scen F: Financing 6.5%, with CERs @ 4 US$/ton CO_2	-$2,611	7.48%	-$5,281	6.41%	-$16,238	2.92%

Case2. Sell to the spot market with Firm Capacity of 40%

100% Devolution of VAT Firm Capacity= 40%= 16MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: Without financing, without CERs	-$26,075	2.41%	-$27,591	1.99%	-$36,908	1.53%
Scen B: Financing @ 5.5% and 10 yrs	-$19,130	non positive	-$22,584	non positive	-$34,491	non positive
Scen C: Financing @ 6.5% and 10 yrs	-$21,890	non positive	-$25,344	non positive	-$37,901	non positive
Scen D: Without financing, with CERs @4 US$/ton CO_2	-$20,382	3.85%	-$21,947	3.45%	-$30,974	2.68%
Scen E: Financing 5.5%, with CERs @ 4 US$/ton CO_2	-$7,519	5.42%	-$10,450	4.08%	-$21,834	0.17%
Scen F: Financing 6.5%, with CERs @ 4 US$/ton CO_2	-$9,949	4.41%	-$12,979	2.97%	-$25,244	non positive

Case 3 Sell to the spot market with Firm Capacity of 30%

100% Devolution of VAT Firm Capacity= 30%= 12MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: Without financing, without CERs	-$30,132	1.43%	-$32,340	0.79%	-$43,008	0.09%
Scen B: Financing @ 5.5% and 10 yrs	-$28,183	non positive	-$31,626	non positive	-$43,838	non positive
Scen C: Financing @ 6.5% and 10 yrs	-$30,943	non positive	-$34,386	non positive	-$47,248	non positive
Scen D: Without financing, with CERs @4 US$/ton CO_2	-$24,361	2.85%	-$26,031	2.40%	-$34,839	1.97%
Scen E: Financing 5.5%, with CERs @ 4 US$/ton CO_2	-$15,591	1.43%	-$18,969	non positive	-$31,181	non positive
Scen F: Financing 6.5%, with CERs @ 4 US$/ton CO_2	-$18,306	non positive	-$21,729	non positive	-$34,591	non positive

Table 33. Results of the Sell of Electricity with a PPA

Case 1. 42 USD$/MWh until 2009; 35.6 USD$/MWh from that year on

100% Devolución de IVA	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: without finance, without CERs	-$12,838	5.48%	-$17,731	4.27%	-$19,748	4.73%
Scen B: finan 5.5%, CERs @ 4 US$	$4,884	10.59%	-$941	8.10%	$1,809	9.12%
Scen C: finan 6.5%, CERs @ 4 US$	$3,763	10.09%	-$3,156	7.14%	-$823	8.22%
Scen D: without financ with CERs	-$7,387	6.79%	-$12,172	5.66%	-$14,223	5.82%
Scen E: finan 5.5%, CERs @ 4 US$	$10,234	12.81%	$5,573	10.86%	$7,662	11.10%
Scen F: finan 6.5%, CERs @ 4 US$	$9,221	12.34%	$4,385	10.34%	$6,302	10.62%

Case 2. 42 USD$/MWh until 2017; 35.6 USD$/MWh from that year on

100% Devolution of VAT	47X850 kW		42X950 kW		25X1650 kW	
	NPV Thousand US$	IRR %	NPV Thousand US$	IRR %	NPV Thousand US$	IRR %
Scen A: without financ, without CERs	-$10,158	6.17%	-$15,383	4.92%	-$16,725	5.38%
Scen B: finan 5.5%, CERs @ 4 US$	$7,565	11.60%	$2,039	9.33%	$5,443	10.27%
Scen C: finan 6.5%, CERs @ 4 US$	$6,393	11.09%	$20	8.51%	$3,071	9.49%
Scen D: without financ with CERs	-$4,807	7.41%	-$9,814	6.26%	-$11,184	6.45%
Scen E: finan 5.5%, CERs @ 4 US$	$12,813	13.69%	$7,931	11.73%	$10,702	12.00%
Scen F: finan 6.5%, CERs @ 4 US$	$11,800	13.23%	$6,743	11.22%	$9,255	11.50%

Case 3. 35.6 USD$/MWh during all the horizon of the project

100% Devolution of VAT	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: without financ, without CERs	-$17,334	4.53%	-$21,754	3.43%	-$24,966	3.84%
Scen B: finan 5.5%, CERs @ 4 US$	-$1,559	7.87%	-$9,615	4.37%	-$9,059	5.44%
Scen C: finan 6.5%, CERs @ 4 US$	-$3,830	6.96%	-$12,132	3.24%	-$12,073	4.40%
Scen D: without financ with CERs	-$11,790	5.85%	-$16,188	4.80%	-$19,398	4.94%
Scen E: finan 5.5%, CERs @ 4 US$	$5,779	10.80%	$439	8.67%	$876	8.78%
Scen F: finan 6.5%, CERs @ 4 US$	$5,262	10.52%	-$1,755	7.80%	-$1,840	7.91%

Case 4. 33.0 USD$/MWh during all the horizon of the project

100% Devolution of VAT	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ 000	IRR %	NPV US$ 000	IRR %	NPV US$ 000	IRR %
Scen A: without financ, without CERs	-$20,745	3.68%	-$24,788	2.64%	-$28,845	3.05%
Scen B: finan 5.5%, CERs @ 4 US$	-$7,683	5.26%	-$15,838	1.00%	-$16,759	2.37%
Scen C: finan 6.5%, CERs @ 4 US$	-$10,119	4.21%	-$18,578	-0.61%	-$20,045	1.01%
Scen D: without financ with CERs	-$15,154	5.05%	-$19,138	4.09%	-$23,200	4.19%
Scen E: finan 5.5%, CERs @ 4 US$	$2,100	9.33%	-$4,687	6.58%	-$5,786	6.59%
Scen F: finan 6.5%, CERs @ 4 US$	-$10	8.50%	-$7,028	5.61%	-$8,689	5.62%

Sensitivity to different cost components that affect the project were measured obtaining the following results:

Sensitivity to Turbine Costs:
Should the turbine cost descend by 10%, IRR would grow by 30%, accounting for a 1.46-point increase.

Sensitivity to Construction Costs:
Should the construction cost descend by 10%, IRR would grow by 17%, accounting for a 0.85-point increase.

Sensitivity to CO_2 ton price:
Should a 5 US/ton CO_2 price be attained –equivalent to a 25% increase in relation to the 4 US$/ton CO_2 level– IRR would grow by 18%, accounting for a 0.87-point increase.

Additional conclusions may be drawn from the results obtained from these assessments:

- Realistic scenarios have been simulated for VAT recovery, low funding rates and tariff exemption. They significantly enhance the project profitability, but fail to measure up to Codelco requirements applicable to the implementation of mining projects.
- No land acquisition costs have been assumed for the project, for charge-free applications can be submitted to the relevant state agency (Ministry of National Property). This cost is usually high in similar projects run in other countries and many times it is the decisive factor to invest in wind projects. Even though it is not considered here, the project profitability remains low.
- Certified carbon emission reduction credits improve the project profitability, particularly in the VAT exemption case. This should focus the efforts to a better price for reduced CO_2 ton, even though simulated CER prices are the prices currently traded in the global market of greenhouse effect gas emissions.

11 ACQUISITION PROCEDURE DESIGN

11.1 PREPARATION OF ENGINEERING AND OPERATION AND CONSTRUCTION PLANS

11.1.1 DEVELOPMENT AND CONSTRUCTION PLAN

An Activity Schedule was designed for the project development and construction, assuming a 40-MW farm and the use of 67 wind turbines of 660-kW. That activity schedule is enclosed to ANNEX Q in this report, and it minimizes the project risks, for its design considers that the principal expenses are incurred following approval of the Environmental Impact Statement (DIA.) It also details the different development and construction stages of the project, including their related timeframes, such as: application for permits, detail design and engineering, agreements (equipment purchase, maintenance, equipment warrants, etc.), construction and operation.

This Activity Schedule assumes that Codelco would need approximately two (2) months to assess a course of action regarding its participation in the project. The proposed deadlines must be delayed by three months, for this Report required equipment quotations that were sent on August 18. The Activity Schedule also assumes that Codelco would need approximately two (2) months to assess the participation of a partner in the project development, either as an independent developer or as a turbine manufacturer responsible for a project development area. Once Codelco chooses a partner, the application for permits, Design and Engineering stages and dealings with turbine providers would start immediately.

This Activity Schedule also includes the subcontracts needed to implement the project, thus providing Codelco with a clear vision of the entire project construction process. General contractors might consult it in order to plan the activity sequence of the project in terms of mobilization of subcontractors within the development site.

The Activity Schedule defines the agreement timeframes that must be considered within the project framework. Those agreements include a term sheet for the turbine provider; the Power Purchase Agreement to be negotiated between Codelco and the project developer; an EPC agreement for the developer or general contractor; a SING interconnection agreement; and project warrant, service and operation agreements with the turbine provider. Commonly once the term sheet with the turbine provider is defined, the provider starts manufacturing the turbines as soon as possible, requiring the initial payment for that. Canceling the related purchase order might result in substantial economic penalties. Therefore the term sheet negotiation conclusion depends on whether the project is environmentally approved. The construction stage loan is another significant agreement, which is also scheduled to follow the environmental permit issuance.

The Activity Schedule assumes six (6) months to prepare the EIA and another two (2) months for the office of Conama in the Second Region to sanction it. Deadlines for permit petitions are not yet defined for every activity included in the program, because this is a new kind of project for many of the bodies involved in permit granting. Those deadlines should be conservative.

The project Design and Engineering stage was assumed to proceed in parallel to the application for the environmental permit of the project, on condition that construction permits will be dependent from the final project design.

In the proposed Plan, the permit granting stage would be finished by May 2004, which means the term sheet for the turbine provider could be defined by June 2004. Shipping turbines from their country of origin to the project site takes approximately six months. The construction stage is scheduled to commence in late October 2004, with project construction and final acceptance ending by mid April 2005. The construction stage for this project size is estimated to take six months. Project commissioning, operation and acceptance tests would take about six weeks.

The Activity Schedule details the project development, procurement of materials and every construction stage. Upon inspecting the Final Report and designing a plan to continue developing the project, Codelco may use this activity schedule to estimate the length of time required by the project construction. This Activity Schedule could be expedited if turbines were ordered in advance before receiving the environmental permits, but this implies additional risks as well. Below is a summary of the most important activities and date milestones, and related details are enclosed in ANNEX Q.

Table 34. Schedule of Development and Construction Plan

Stage No.	Task Name	Duration (days)
1	Codelco Analysis	42
2	Development Partner	45
3	Project Agreements	276
4	Pre-Construction Phase	324
	4.1 Permitting	277
	4.2 Engineering and Design	202
	4.3 Contracts & Material Order	102
	4.4 Manufacture and Ship Major Materials	69
5	BOP Construction Phase	134
	5.1 Construction Site Mobilization	3
	5.2 Site Work	131
	5.3 Foundation Installation	45
	5.4 Electrical System installation	80
	5.5 Communication & Monitoring System	57
6	Turbine Installation Phase	75
	6.1 Turbine Delivery, Staging & Prep	40
	6.2 Turbine Installation	67
	6.3 Turbine Electrical	52
7	Final Acceptance Phase	58

Note: Detailed activities are presented in ANNEX Q.

11.1.2 OPERATION AND MAINTENANCE PLAN

A Plan of Operations for Codelco has been developed as an example and enclosed to Annex R in this report. It is a typical operation plant specifying procedures related to the operation of wind plants, staff requirements, maintenance plans, inventories, spare parts, testing and tests. It may be used and modified by Codelco in case the project should be built on a later date.

12 IDENTIFYING INVESTORS AND CREDIT INSTITUTIONS INTERESTED IN THE PROJECT

This activity is aimed at determining potential investors and credit institutions who might take an interest in the project. SeaWest contacted the Inter-American Development Bank (IDB) to determine the IDB's level of interest in projects of this nature, and the eligibility criteria applied to investment projects by the IDB in order to grant loans. SeaWest then developed a Memorandum of Offering for the Calama Wind Project in order to submit to the IDB. That document contains general information on technical respects of the Calama Wind Project, regarding it as a wind project with 40 MW in installed capacity. That information was delivered solely for discussion and analysis by the IDB and has been clearly labeled as confidential information. A copy of the Memorandum of Offering submitted to the IDB by SeaWest is enclosed to ANNEX S in this report.

From the first conversation, the IDB made clear that the minimium threshold capital cost for a project was approximately US$ 30 - US$ 35 million. In addition, it would require Codelco to sponsor some degree of ownership in the project and provide resources during the plant construction and implementation.

The IDB reviewed the Memorandum of Offering prepared by SeaWest, proposing the eligibility criteria below for the Calama project:

a) Project Ownership: The ideal situation would be that a private company - not Codelco- holding 100% of the project ownership. The maximum share of project ownership for Codelco would be 50%, however the ideal arrangement would be for Codelco to participate solely under a long-term Power Purchase Agreement.

b) Equity required for the project is in the order of 30%. A long-term Power Purchase Agreement would suffice, but if the Power Purchase Agreement is not for the long term, the required equity should be higher.

c) The IDB may fund up to 25% of the project costs. This coverage increases if a private company develops the project.

d) Not more than 50% of funding may come from public funds, for instance, if the Danish Development Bank contributed funds.

e) An IDB-member country must provide the principal equipment.

f) The Bank would require some form of guarantee during the construction period of the project and during some time following the construction conclusion.

The Project Development Plan enclosed to ANNEX Q must be analyzed along with the coming steps, for which the IDB requires a description of the technical, economic and legal framework of the project, i.e.:

- Required concessions and licenses;
- Environmental processes;
- Regulatory and legal framework;
- Financial model.

The Bank has experience in wind projects. As a matter of fact its Board of Directors has just approved a wind project for Panama. The standard funding timeframe is 12 years, which might be lengthened to 14 years at the longest in the light of justifiable grounds.

Summarizing, the ideal situation to fund the project development is that Codelco may establish a long-term Power Purchase Agreement, and that a (non-public agency) third party may develop the project and sell the resulting power. That would fit the "large size" project scenario previously described in this report.

13 IDENTIFYING OTHER AGENTS INTERESTED IN THE PROJECT

13.1 GOVERNMENT AGENCIES INTERESTED IN THE PROJECT

Due to its own nature, the Calama Wind Project is a Renewable Energy project, capturing sundry support from different government agencies that would partake in its implementation.

The National Commission of Energy (CNE) deems the Calama wind farm highly interesting, principally because it is a clean generation project that may diversify the power matrix available at the SING, thus slightly diminishing its dependency on Argentinean natural gas, while turning to renewable domestic resources.

CNE has supported the development of wind-related ideas from its jurisdictional sphere, i.e. creating the appropriate conditions to promote the use of wind power in the private sector.

CNE has supported the performance of analyses intended to partially profile domestic wind power potential. During 1992, most of the then available wind-related information was collected and used to assess wind resources in some areas based on reliable information (Assessment of Wind Power Potential in Chile, CORFO.) Given the low density and characteristics of weather stations available, the study failed to provide a comprehensive vision of Chilean wind potential.

On the other hand, CNE and the National Renewable Energy Laboratory (NREL) developed a preliminary wind potential map of the Chiloé archipelago, in order to assess this resource for rural applications not linked to the network. This map was used to assemble a portfolio of Wind-Diesel hybrid projects to supply over 3,100 families scattered in 32 islands of the said archipelago.

The most tangible form of support to renewable energy projects ever shown by energy related authorities in Chile, was the exemption from transmission tolls of the principal transmission grid, benefiting renewable energy projects, that was introduced while the Short Electricity Law was under discussion in 2003. This legal amendment has no direct effect on the Calama wind project, but it is a powerful sign of the interest of the Ministry of Economy and the National Commission of Energy in renewable energy.

The National Commission for the Environment (CONAMA) is also interested in the Calama Wind Project. This project is appealing to Conama because of its contribution to sustainable development, for it generates electricity in a clean environmentally friendly fashion, allowing for the reduction of greenhouse effect gas emissions from the SING.

CONAMA will be directly related to the project if the Clean Development Mechanism (CDM) is chosen for funding, thus selling reduced CO_2 emissions, for Conama is the (DNA) Designated National Authority to manage the Climate Change issues.

The CDM established by the Kyoto Protocol provides that wind project partakers must have a certificate or letter issued by the Designated National Authority (DNA), which indicates that their participation is voluntary and that the project meets the sustainable development goals of the country.

The appointment of CONAMA as the Chilean DNA was made official by the Council of Ministers in May 2003. As the DNA in Chile, CONAMA shall assure that the Calama wind project meets the currently applicable environmental regulations, not only if the project is implemented using domestic investment, but also if it includes foreign investment.

Another form of direct support to the Calama wind project shown by CNE and CONAMA was the promotion they both led of the wind farm project (as part of the Chilean portfolio of CDM projects), during the public-private mission to Europe in September 2003.

This CDM Portfolio Promotion Mission found significant interest in the Calama wind project from institutional purchasers of certified carbon reduction emission credits, and the Dutch, Danish and Spanish governments, as well as from financial organizations, such as KfW, IFU, Rabobank, among others.

14 ANALYSIS OF RENEWABLE ENERGIES PROMOTING REGULATIONS

14.1 INTERNATIONAL REGULATION

Below are different examples of legislation applied to the development of renewable sources of energy. They could serve as a model for Chilean legislators.

Among those examples, there are four important classes of legislation:

1. Reduction of taxes and import duties (Brazilian and Argentinean legislation.)
2. Investment promotion (American and Brazilian legislation.)
3. Price increase (Argentinean and Spanish.)
4. Standard portfolio, i.e. some percentage of energy sold in the market generated from renewable sources (legislation in many countries.)

14.1.1 REDUCTION OF TAXES AND IMPORT DUTIES (BRAZIL AND ARGENTINA)

Argentina

The Argentinean Congress sanctioned Law # 25,019 "National Wind and Solar Power Regime"- on September 23, 1998, which established a especial regime for wind and solar power generation. The President later exercised his veto power against it, but the National Congress finally enacted it on November 11, 1998.

After its enactment and subsequent regulation, investments in Argentina for wind turbine electricity generation became more popular and attractive, as the said law provides for VAT to be deferred for the five years following the first year after final commissioning, or for six years following the investment project approval.

Brazil

Decree N° 4.070. It changed the Industrialized Product Tax (IPI.) Taxes levied on products listed under code 8502.31.00 (wind turbines) were set to cero.

OCMS 93/01 Agreement. It provides ICMS (Value Added Tax) incentives for products listed under code 8502.31.00 (wind turbines,)

14.1.1.1 Investment Promotion (United States of America and Brazil)

Brazil

Resolution 009/2001 issued by the Secretary of Power, Shipping and Oil Industries of the State of Rio de Janeiro.

It introduces deferred ICMS (Value Added Tax) incentives for organizations developing thermal power plant projects. Such benefits apply as of the moment 1% of the thermal power plant investment is allocated to renewable or efficient energy projects, and 0.1% of the thermal power project revenues continue to be allocated to such renewable or efficient energy projects, for the first decade of operations.

United States of America

Production Tax Credit. It grants US$ 0.017 worth of credit per each kWh generated. This credit offsets on a dollar-for-dollar basis any owed income tax for wind plant investors.

14.1.2 PRICE INCENTIVES (SPAIN, ARGENTINA)

Spain

Spain has two different incentive schemes in place for wind plant owners. The wind plant owner can choose to pay either the equivalent of 0.0628 Euros per kWh (US$ 0.06/kWh) or a prime equal to 0.0290 Euros per kWh (US$ 0.03/kWh), in addition to the market price.

Argentina

Law # 25,019 -National Wind and Solar Power Regime (1998.) It introduces a subsidy of $0.01 per kWh for wind power purchasers. In addition, a second subsidy for $0.005/kWh is in place in the Chubut Province.

14.1.3 STANDARD PORTFOLIO LAWS

Austria

A recent amendment to the Austrian electricity law requires 4% of dispatched electricity to be generated from renewable sources of energy, such as wind, photovoltaics, biomass and biogas. Generation companies ought to reach this target by the year 2007; failure to do so will result in the application of penalties.

Australia.

The Australian government will increase the renewable energy input to electricity supply in the country by 2% over the next decade. This requirement will be valid for power distributor and purchasers exceeding 100 MW. Penalties applicable to power distributors and generators that fail to meet this particular requirement are set in US$ 23 per MWh.

Italy, the Bersani Decree.

New legislation was introduced on March 1999 by way of the Bersani Decree – the Decree # 79/1999 implementing the 96/92/EEC Electricity Directive to regulate the common laws that govern the electricity market.

That decree has liberalized the activities related to electricity production, imports, exports, purchases and sales. Electricity transmission and dispatch in Italy are the exclusive tasks of the Gestora della Rete (GRTN), owned by the Ministry of Finance.

The said decree states that renewable sources of energy must be developed and promoted, which requires that importers of electricity generated from exhaustible sources and operators of exhaustible power plants to dispatch into the national electricity network a certain amount of electricity generated from renewable sources. That requirement came into force in 2001 and generation companies must be in compliance with it since 2002.

The said Decree also resolved that all renewable power plants should be inspected and refurbished by March 16, 1999. That requirement applied to electricity imports and production (net: cogeneration, self-consumption and export) in excess of 100 GWh; and the generation percentage based on renewable sources was initially defined as 2% of generation in excess of 100 GWh. This requirement may also be satisfied by totally or partially purchasing the equivalent amount of clean generation from other generation companies or from the transmission system operator. The experts estimate that the market value of green certificates -added to the price of electricity- will range from 190 to 200 Italian liras per KWh (i.e. about 0.1 Euro/KWh.)

In addition to this, power generated from renewable sources of energy has a priority of entry into the electricity network, compared to the power generated from fossil fuels. After 2002, the Italian Ministry of Industry, Trade and Labor will determine the increased percentage of clean power to be dispatched to the national electricity network, considering the variations related to limited emission of Greenhouse Effect Gases, in specific reference to the Kyoto Protocol signed by the Italian government. It also clearly states that Italian regions must define incentives to the use of renewable power, which are expected to range from 25% to 50% of investment cost.

BTM Consult International Wind Energy Development estimates that the Italian wind power market has been developing at an average growth rate of 57.7% per year for the past three years.

The market size created by the Bersani Decree is quite significant. As a matter of fact, past ENEL generation stations now produce about 180 TWh of electricity per year, accounting for 63% of power production in Italy (about 285 TWh.) Assuming that 35% of that electricity comes from hydroelectric or cogeneration plants, the remaining 185 TWh must be adjusted in light of the 3,700 GWh brought by the new wind power plants (in addition to the amount of imported power generated by thermal and nuclear plants.) That means almost 1,500 MW generated by wind plants will be in operation over the next two or three years in order to meet the demand for green certificates from current plants.

Holland.

Dutch regulations require power generation companies to provide project portfolios containing some percentage of renewable power. That percentage has been set as 3% of power sold in 1993.

United States.

The Renewable Portfolio Standard (RPS) has been signed in Texas, Connecticut, Maine, Arizona, Massachusetts, Nevada, New Jersey and Wisconsin. The RPS is still pending for approval in Kansas, Nebraska, Iowa, New Mexico, Vermont and Wisconsin. The most remarkable case is Texas, where not only a percentages, but also actual generation capacity goals have been defined.

The Texas regulation requires 2,880 MW of capacity installed in renewable power plants -or approximately 3% of total expected power capacity- to be in operation by January 1st, 2009. This regulation came into force in May 2000, and allows providers to purchase green certificates in order to meet the required renewable power capacity.

14.1.4 LEGISLATIVE BILLS

India – Mandatory Renewable Power Purchase.

The Ministry of Non-Conventional Energy Sources of India (MNES) has proposed a policy aimed at generating 6% of national power from renewable sources of energy by 2012.

Some of the mechanisms chosen to promote renewable energy are: i) Mandatory purchase of renewable energy with increased subsidies; ii) carbon emission taxes and remote electrification measures; iii) accelerated asset depreciation (80% for the first year); iv) loans on low interest rates; v) tax exemption, including

tariffs; vi) transmission network enhancement in order to facilitate the integration of wind power with the system.

India additionally has a government agency -Indian Renewable Energy Development Agency- to support investment and fund wind project developers, as well as a research and development agency -Center for Wind Energy Technology.

Wind energy has a great potential in India. That policy is aimed at removing barriers that prevented wind power from entering the power matrix supply in India. Such difficulties included high initial costs, price distortion in the conventional power sector, lack of government policies, and inadequate transmission facilities.

As a result of the above measures, India has become the leading wind power market in Asia. Installed capacity as of August 2003 reached 1,912 MW, mostly concentrated in the Tamil Nadu region.

United Kingdom – Mandatory Renewable Energy.

The relevant legislative bill in England will significantly restructure the power sector and is currently being discussed in the Parliament. Known as the Utilities Bill, it was drafted with clauses that would require generation companies to provide some specific percentage of their total electricity generation from renewable sources of power.

The said percentage is likely to be 5% for 2003, and 10% for 2010 and subsequent years.

This requirement is expected to remain applicable until 2025. Renewable energy possibilities will probably encompass a wide range of sources, but hydroelectric plants with installed capacity over 10 MW will not be included, because large-scale plants are considered to be mature enough to compete against thermal power plants.

The Utilities Bill will enable generation companies to meet the new legislation requirements via the purchase of green certificates, which will represent a unit of measure in relation to the chosen class of renewable energy.

United States – Federal Standard.

A national concept for the Renewable Portfolio Standard (RPS) was included in six legislative bills related to electric restructuring during the last session of the American Congress.

The current Congress session is analyzing RPS proposals from senator Jeffords, the republicans Kucinich and Pallone, and from the previous Clinton administration.

The last example, for instance, provides that 7.5% of power sales must be generated from renewable sources of energy by 2010.

14.2 RENEWABLE ENERGIES BILL IN CHILE

In August 2003, the NGO Chile Sustainable publicized the Renewable Energy Promotion Bill, aimed at fostering the generation of electricity based on geothermal, wind and biomass, among other resources.

It defines sundry incentives. First it requires the Economic Load Dispatch Center (CDEC, the organization coordinating the electricity system operation) to maintain records of power purchases among the agents (generation from renewable sources) and appraise them at the same rate applicable to conventional electricity.

This defines an additional price over the node price for generation based on non-conventional sources. The node price is the regulated price at which distributors buy electricity to generators. Such incentive is planned to phase out over time, reaching its final value by 2020, as shown in the table below:

Table 35. Bill Incentives to Renewable Energy

Source	2003-2008	2009-2012	2013-2015	2016-2020	>2020
Microhydraulic > 1 MW and ≤ 10 MW	1.0 times the node price	0.8 times the node price	0.5 times the node price	0.2 times the node price	0.2 times the knot price
Geothermal > 1 MW and ≤ 100 MW	1.0 times the node price	0.8 times the node price	0.5 times the knot price	0.2 times the node price	0.2 times the knot price
Solar Power > 1 MW and ≤ 20 MW	1.5 times the node price	1.2 times the node price	1.0 times the knot price	0.6 times the node price	0.2 times the knot price
Wind Power > 1 MW and ≤ 20 MW	1.5 times the node price	1.2 times the node price	1.0 times the knot price	0.6 times the node price	0.2 times the knot price
Biomass > 1 MW and ≤ 20 MW	1.0 times the node price	0.8 times the node price	0.5 times the knot price	0.2 times the node price	0.2 times the node price

Source: Chile Sustainable

A fund is proposed to finance the additional incentives to generation companies that produce clean energy. One option is sustain the Fund using specific tariffs levied on oil imports, which would produce about US$ 3 or 4 million a year. Another alternative is to increase consumer bills by 1%, which would produce about US$ 15 million.

The recommendation for Codelco is to track this initiative for it is already in Congress for discussion. The evolution of legislative formalities and discussion of this specific bill is uncertain, but the development of the Calama wind power project could be strengthened if it is approved. This Bill only benefits projects with installed capacity below 20 MW, therefore it would be useful to extend these benefits to larger wind projects.

15 CONCLUSIONS AND RECOMMENDATIONS

The main conclusion of the Calama Wind Farm Feasibility Study is that the wind farm is a feasible project from the technical point of view, in consideration of possible cost scenarios and settings that were analyzed. From the financial and economic perspectives, profitability indicators of this project fail to meet Codelco's requirements applicable to its project investments. Below are described the items positively or negatively affecting the wind farm economic feasibility. Recommendations are provided regarding items that imply potentials for improvement in the project.

Wind Resources:

1. The area analyzed for the Calama Wind Farm location has good wind resources with average wind speed of 7.5 meters per second. Air density is low (0.95 kg/m3), in association with the site altitude (2,400 meters above sea level). Wind potential confirms the Meteorological Bureau information, rating this site as the second windiest location in Chile.

2. The analyses of wind records taken from three meteorological towers over 20 months lead to the conclusion that lowest and highest wind speed times are 11 AM and 4 PM, respectively.

3. The highest generation in the wind farm occurs over a nine-hour period (2:00 PM to 10:59 PM). Therefore the highest production times in the farm are ahead of the so-called peak times in the Northern Interconnected System - SING (which occurs in the period 6 PM to 11 PM) This would strongly affect the remuneration that the plant would receive for its firm capacity, if its production is sold to the spot market. However, if this project sells its production to Chuquicamata, Codelco should optimize this generation profile, adjusting its copper production processes so that they are scheduled in the afternoon and evening. This profile is also adjusted if the project were to sell its generation to a city like Calama (a situation excluded from the scope of this study).

Wind Generation Technology:

4. Wind generation technology has significantly advanced over the past 30 years. The first generation of turbines (sold between 1978 and 1981 and ranging from 20 kW to 30 kW) evolved in time to the seventh generation of turbines (ranging from 1,000 kW-1,650 kW to 2 MW.) The maturity of this technology is evidenced by the overall installed capacity, with 31,000 MW worldwide by 2002 and 6,968 MW installed only during the year 2002.

5. The most important manufacturers are German (Nordex, Enercon, Dewind), Danish (Vestas, NEG Micon, Bonus), American (General Electric), Spanish (Gamesa, Ecotecnia) and Japanese (Mitsubishi.)

6. Wind power in Latin America is on the rise: Costa Rica (59.4 MW), Argentina (25.7 MW), Brazil (20.5 MW), Colombia (19.5 MW), Mexico (1 MW), Peru (0.5 MW).

7. Wind technology in Chile is not yet generalized. There are only small wind turbines below 10 kW installed in the South of Chile, and a 1,980-kW wind farm that was installed in late 2001 in Alto Baguales by Edelaysen (three 660-kW turbines.)

8. The finite use of wind power in Chile represents an entry barrier for this technology in consideration of: i) Increased service and maintenance costs for equipment providers; ii) limited experience in turbine assembly, thus increasing the price of construction; iii) potential difficulties and surcharges during installation; iv) insufficient qualified personnel for wind farm installation and operation.

9. Different turbine sizes were analyzed (ranging from 600 kW to 1,650 kW), different turbine manufacturers were studied, which lead to identifying the best performance turbines in the light of Calama winds.

Equipment and Construction Costs:

10. Construction costs in this project are very high, thus causing the installed kW price to exceed that of similar projects in the region. In the case of 850-kW turbines, the cost is 1,314 US$/kW. In the case of 950-kW turbines, the cost is 1,318 US$/kW. In the case of 1,650-kW turbines, the cost is 1,584 US$/kW.

11. There is a very high certainty about the analyzed equipment costs, because quotations were requested from manufacturers with local representatives in Chile. Quoted prices are market prices, which relate to the price of equipment used for wind projects either installed or funded during 2002.

12. Costs are high principally due to construction costs. Certainty about these costs is not as high and control of this costs is reduced because: i) This would be the first large-scale wind project in Chile; ii) the costs of construction, transportation and provision of general supplies are very high in the Calama area; iii) costs are raised due to equipment transportation over 220 kilometers from the Mejillones port to the farm location; iv) costs are additionally raised due to the limited availability of cranes large enough for assembly and limited local experience with this kind of operations.

Electricity Sale Price Scenarios.

13. The farm was modeled under two main scenarios: Selling generation in the sport market, and selling generation to Chuquicamata´s mine under a long-term Power Purchase Agreement.

14. CDEC-SING was consulted about the remuneration of firm capacity that would be granted to the wind farm. No precise reply regarding firm capacity remuneration values was received from CDEC-SING, arguing that no preliminary values can be computed in the absence of plants with similar technology. Therefore firm capacity payments was simulated for three different scenarios (50%, 40% and 30% of the installed capacity.) No scenarios under 30% were simulated for being unprofitable.

15. Wind variability represents a technological barrier. Such variability means that the farm production is fluctuating, which implies that the SING is unable to rely on the energy and power of the Wind Farm at all times, if it needs the plant to respond to the electricity demands from the system. Given its own nature, wind power would be introduced as base generation, subject to the condition that it is available.

16. Selling the plant's electricity to the spot market yields profitability levels below 8%, which would stop Codelco and any other interested agents from implementing this project. Such low levels can be accounted for by: i) the marginal cost of energy in the SING is low, ranging from 18 to 20 US$ /MWh, favored by natural gas plants operating in the SING; ii) excess capacity installed in the SING; iii) low remuneration to the wind farm's firm capacity, given the variable nature of wind generation.

17. Unprofitable results obtained from selling wind generation to the spot market are expectable, given the SING´s characteristics and the fact that no wind project in an open electricity market can be structured in this way. This scenario of selling electricity to the spot market was analyzed as a reference. Wind projects operating around the world are funded via one or more of the following mechanisms: i) Exemption, reduction or deferral of taxes and/or import duties applicable to equipment and/or investment; ii) granting of state or provincial subsidies to wind power purchasers; iii) granting of state or provincial subsidies to power generation companies; iv) obligation for generation companies to include wind-based or renewable components in their power supply; v) obligation for distributors to purchase a part of their power from renewable sources, including wind power; vi) long-term power purchase agreements.

18. The alternative of selling electricity under a Power Purchase Agreement (PPA) was simulated for different scenarios of sales to Chuquicamata. Such scenarios considered that the current supply contract between the mining company and Electroandina will expire in 2009. The scenarios were

simulated: i) Sales at the current contractual prices (42 US$ /MWh) until 2009 and subsequent sales at market prices ranging from 33 to 35 US$ /MWh; ii) sales throughout the entire project life at market prices ranging from 33 to 35 US$ /MWh.

19. From the above scenarios, the most favorable results (including optimistic assumptions of import duties exemption, recovery of VAT, sale of certified carbon emission reductions CERs and funding at interest rates of 5.5%) lead to internal rates of return in the order of 12.81%, which is not appealing to Codelco since in this case the index IVAN reaches 0.21 (Codelco decides investments with IVAN over a 1.4 threshold level). Such results might not be sufficiently appealing to third parties that might be interested in the project.

20. Wind Farm generation costs in the order of 60 to 65 US$/MWh (including investment and operation and maintenance costs, 20-year project life and 10% discount rates) are not competitive compared to generation costs of natural gas or even coal power plants. In the absence of support to renewable power plants, one established SING agent would find that growth based on natural gas is more profitable than constructing a wind farm (this is the case for Electroandina with a planned but postponed unit in Coloso, or for Gas Atacama or Aes Gener in Salta.)

Funding:

21. Long-term debt rating for Codelco is at investment degree. Therefore favorable credit conditions would be in place if Codelco implemented the project. Scenarios simulated with 5.5% and 6.5% rates and 10-year timeframes are consistent with the current low rate conditions.

22. Enhanced funding conditions could be possible in the presence of credit lines from banks located in the same countries as turbine providers.

Sale of Wind Farm's Carbon Credits:

23. The Calama wind farm project meets the conditions required to apply the Clean Development Mechanism (CDM) proposed by the Kyoto Protocol. It is appealing enough to apply that Mechanism and sell its CO2 emission reductions because of the following characteristics: i) it is a non-polluting generation project from the environmental perspective; ii) its size is appealing in terms of reduced CO2 emissions, i.e. above 100,000 tons of CO_2 per year; iii) it is not a feasible project without the funding provided by the sale of certified carbon emission reduction credits (CERs).

24. As gathered from this study analysis, this project is not economically feasible despite all the above, including the sale of certified emission reductions (CERs) and the project is therefore not appealing to Codelco.

25. Multinationals operating in the SING would be potentially very interested in a CDM project like the Calama Wind Farm. As per the most recent report by Pricewaterhouse Coopers from November 2003, benchmarking for electricity companies that generate CO_2 in the European Union ranks ENDESA ESPAÑA and ELECTRABEL number five and seven, respectively. ELECTRABEL is the parent company of Tractebel, which in turn directly and indirectly controls the generating companies Electroandina and Edelnor in the SING. On the other hand, ENDESA ESPAÑA controls Celta and Gas Atacama, generation companies in the SING. These generation companies are interested in spotting projects in developing countries, in order to meet their emission reduction goals defined for the 2008-2012 period. They might even undertake low-profitability projects, such as the Calama wind farm, due to their interest in meeting such CO_2 reduction goals.

Project Development Potentials

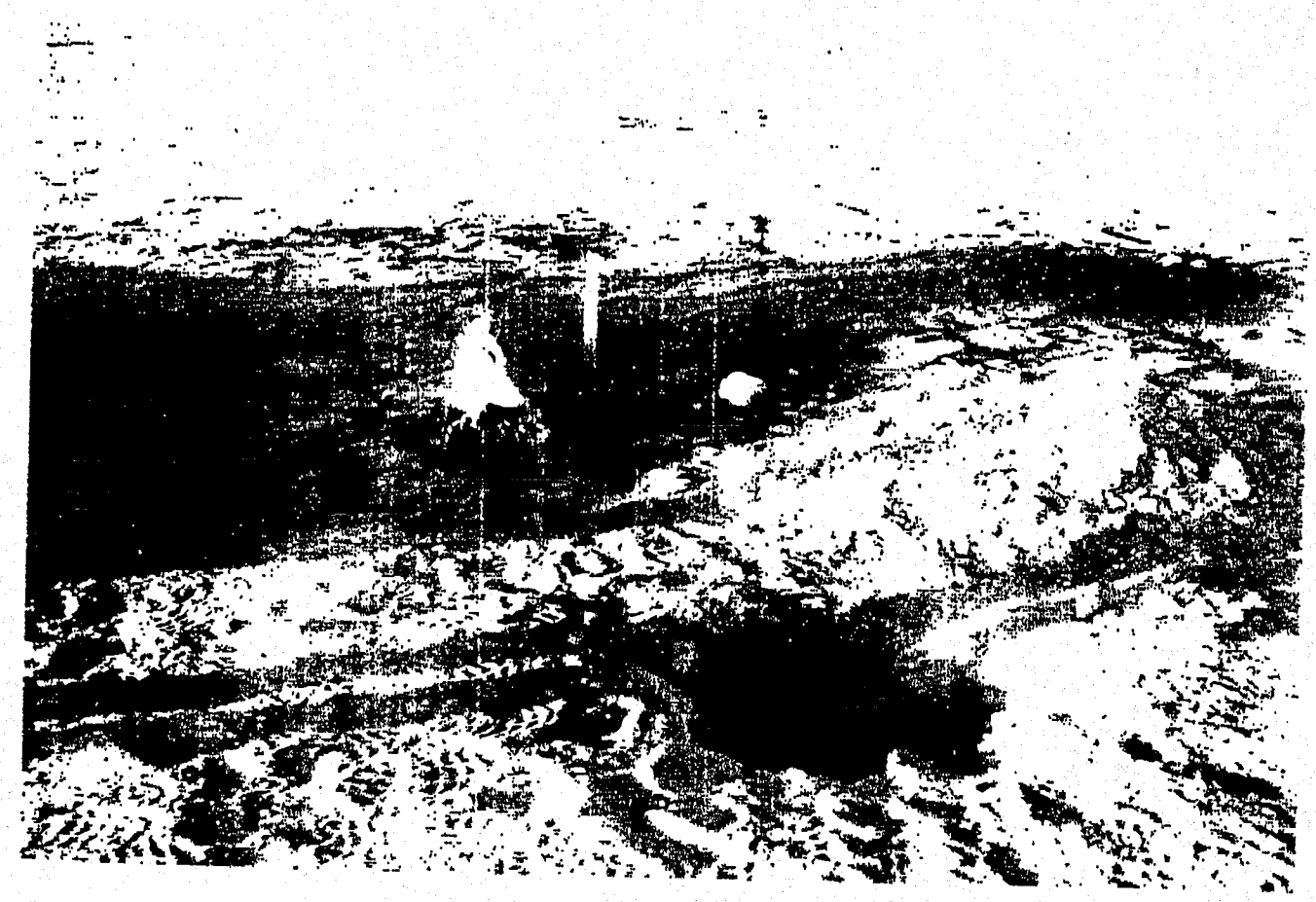
26. Despite its low profitability in light of the market and regulatory conditions prevailing in the SING, the Calama Wind Farm project has the following opportunities and strengths: i) if implemented by Codelco, this mining company could show commitment with sustainable development, and earn advantages over copper producers that are not using green power; ii) if implemented by electricity companies that monopolize the SING generation, they could access forms of CDM funding; iii) if used to supply electricity to the city of Calama, by selling at regulated node prices, either the local distributor ELECDA or a third party could become interested in the project.

27. Codelco must track those initiatives aimed at developing laws and regulation that promotes renewable power. There is a bill being discussed in Congress that provides for support to up to 20-MW wind plants. Even though it seems this bill captures low support, Codelco should track initiatives of that class. The Short Law passed by the House of Representatives in 2003 frees renewable power projects from paying the transmission tolls applicable to the principal transmission grid. Though not a direct benefit to the Calama wind project, it represents the first step to gathering the support required by this kind of renewable and clean projects.

Appendix A

Soil Study for Foundation Met Towers

WIRELESS – ENERGY



REPORT OF: "SOIL MECHANICS FROM A TEST PIT EXCAVATION FOR THE TEST TOWER AT CALAMA"

Work Order no. 231294

Prepared by CESMEC LTD.

SOIL MECHANICS STUDY AND RECOMMENDATIONS FOR FOUNDATION DESIGN
AOA – 23833

Applicant:	Wireless Energy Chile
Work Order:	230943 Cesmec Ltd.
Attention:	Jorge Gonzales M.
Date of Submission:	10/3/2002
Work:	Soil study for monitoring tower, Calama
Client:	Wireless Energy Chile

1.0 Introduction

The present report of soils mechanics was made at the request of the Applicant and intends to analyze the characteristics of the excavated soils of a test pit of 1,5 meters in depth to determine foundation bearing capacity. The following information presents the results of the exploration and ground tests at the location of the new project to establish the basis necessary for project realization.

2.0 Procedure

The subsoil exploration took place by means of a Test pit (Exploration Well). By means of this exploration, it was possible to recognize a fairly consistent soil layer down to a rock bed. In general the identified soil corresponds to a USCS classification of to muddy sands of low energy on a limestone rocky bed.

The following laboratory tests were made on the collected sample: granularity, Atterberg limits, modified proctor test or maximum and minimum vibrated density, soil density and water content. The rocky materials were also subjected to a unconfined compression test, density, and hardness testes. The results of these tests are given in attached report.

3.0 Structural Foundations

Depending on the loads that are induced to the foundation subsoil and of the ground where the structures will be located, the structures can be either spread footings or continuous footings. The characteristics of the prospective foundation will need evaluation based on the properties of the rocky bed.

In order to meet the project requirements, it is recommended that the foundation structures be designed and located above the rock layer to utilize the reinforced concrete foundation with rock anchors.

In the event that the existing soil is not excavated to the rock, the depth of the foundation should be 0.5 meters. A sand bed should be placed under the foundation to a depth of 0.50 TM to fulfill the characteristics indicated in point 6.1 of this report. This way the bottom of the excavation will be located 1,00 TM below the present land level.

4.0 Allowable Bearing Capacity

Next the calculation considers the event of whereby a fine granular filling is placed under the foundation according to 7.0.

4.1 Allowable bearing capacity

The allowable bearing capacity is given by the following relationship:

$$q_f = cN_cS_cd_c + \gamma' D_f N_q S_q d_q + 0.5BN_\gamma S_\gamma d_\gamma$$

Where:

q_f	=	Allowable bearing capacity for non cohesive soils considering: sandy soil (without cohesion), eccentric loading and 20% of the foundation base in bearing with the soil.
C	=	Soil cohesion/ Cohesión del suelo
γ	=	Soil density below the foundation
γ'	=	Soil density above the foundation
B	=	Foundation width
D_r	=	Foundation depth
$S_c, S_q S_\gamma$	=	Correction factors for the footing form
d_c, d_q, d_γ	=	Correction factors for load depth displacement
N_q, N_γ	=	Coefficients depending on the anguiar of internal friction (Φ)
F.S.	=	Safety factor depending on the type of structure/ F.S. = 3

$S_q = 1 + tg\,\Phi\, B/L$. L = Foundation length
$S_\gamma = 1 - 0.4\, B/L$
$S_c = N/A$
$d_q - 1 + 2\, tg\,\Phi\, (1\text{-}sin\,\Phi)^2 D_r/B$
$d_\gamma = 1$
$d_c = N/A$

Allowable Support Capacity of the Granular Soil

For this type of material when the angle of internal friction is 35 deg. And dnowing that the cohesion tends to zero, it is known:

$N\gamma = 34,41$

$Nq = 33,60$

$Sq = 1 + 0.7\ B/L$

$S\gamma = 1 - 0.4\ B/L$

$d_q = 1 + 0.25\ D_f/B$

For Spread footings you have:

$$q_{adm} = 18,10 D_f (1 + 0,25\ D_f/B) + 11,74B\ [t/m^2]$$

For continuous footings:

$$q_{adm} = 18,10 D_f (1 + 0.27\ D_f/B) + 11,74\ B\ [t/m^2]$$

Next, tables with the allowable support capacity are enclosed with the relationship between foundation length and width for widths of 0.5, 1, and 2.

Bearing Capacity with Df = 0.3 m

Table No. 1

B= 0.5

L/B	L (m)	Qadm (t/m²) Spread Ftg.	Continuous Ftg.
1	0.5	14,14	12,11
1.5	0.75	13,46	12,11
2.0	1.0	13,12	12,11
3.0	1.5	12,62	12,11
4.0	2	12,62	12,11
5.0	2.5	12,52	12,11
10.0	5	12,32	12,11
100.0	50	12,13	12,11

Table No. 2

B= 1 Relationship L/B

	L (m)	Qadm (T/m²) Spread Ftg.	Continuous Ftg.
1.0	1,0	16,97	17,58
1.5	1.5	17,17	17,58
2.0	2	17,27	17,58
3.0	3	17,37	17,58
4.0	4	17,42	17,58
5.0	5	17,46	17,58
10.0	10	17,52	17,58
100.0	100	17,57	17,58

Table No. 3

B= 2		Qadm (t/m²)	
L/B	L (m)	Spread Ftg.	Continuous Ftg.
1	2	23,67	29,11
1.5	3	25,48	29,11
2.0	4	26,39	29,11
3.0	6	27,30	29,11
4.0	8	27,75	29,11
5.0	10	28,02	29,11
10.0	20	28,57	29,11
100.0	200	29,06	29,11

Bearing Capacity with Df = 0.6m

Table No. 4

B= 0.5		Qadm (t/m²)	
L/B	L (m)	Spread Ftg.	Continuous Ftg.
1	0.5	27,52	19,99
1.5	0.75	25,01	19,99
2.0	1.0	23,76	19,99
3.0	1.5	22,50	19,99
4.0	2	21,87	19,99
5.0	2.5	21,49	19,99
10.0	5	20,74	19,99
100.0	50	20,06	19,99

Table No. 5

B= 1 Relationship L/B

Relación L/B	**L (m)**	Spread Ftg. **Qadm (T/m²)** Continuous Ftg.	
		Zapata Aislada	**Zapata Corrida**
1.0	1,0	28,28	24,23
1.5	1.5	26,93	24,23
2.0	2	26,25	24,23
3.0	3	25,58	24,23
4.0	4	25,24	24,23
5.0	5	25,03	24,23
10.0	10	24,63	24,23
100.0	100	24,27	24,23

Table No. 6

B= 2

L/B	**L (m)**	Spread Ftg. **Qadm (t/m²)** Continuous Ftg.	
1	2	33,93	35,15
1.5	3	34,34	35,15
2.0	4	34,75	35,15
3.0	6	34,54	35,15
4.0	8	34,85	35,15
5.0	10	34,91	35,15
10.0	20	35,03	35,15
100.0	200	35,14	35,15

Note No. 1:

The foundation bearing capacity is related to the soil bearing capacity and applied loads.

Note No. 2:

For seismic or construction (temporary) loading, the bearing capacities may be increased by 30%.

5. Loading Expected

5.1 Loading determined analytically

Only instantaneous loading was considered based on the characteristics of the subsoil on top of a rock layer. For the determination of the instantaneous loading the following formula can be used:

$$P = q_n B (1 - \nu^2) Ip/E$$

Where:

P = Point Load
q_n = Incremental net effect of the application of the foundation (weight of the structure minus the weight of the excavated soil, divided by the area of the foundation)
B = Foundation width
E = Soil Elasticity
ν = Poissons ratio of the soil
Ip = Coefficient of Influence for the vertical displacement modified by the Presence of a lower stratum incompresible

Based on the actual soil conditions, the following parameters are used:

$E = 300$ kg/cm^2
$\nu = 0.35$

Table No. 7 provides values for I_p based on the theory of elasticity for the displacement in the center and the corner of a uniformly loaded rectangular footing.

In practice, the vast majority of spread footings can be considered rigid.

Table No. 7

Form		Flexible		Rigid	
Rectangular Footing		Center	Corner	Average	
L/B =	1.5	1.122	0.561	0.946	0.82
	2.0	1.358	0.679	1.148	1.06
	3.0	1.532	0.766	1.300	1.20
	4.0	1.783	0.892	1.527	1.42
	5.0	2.105	1.052	1.826	1.70
	10.0	2.540	1.270	2.246	2.10
	100.0	4.010	2.005	3.693	3.47

Note No. 3:
In the case of the foundations the settlements beside the turn predominate.

6. Foundation on a rock layer.

Next the bearing capacity for a foundation on the rock layer is considered.

6.1 Description of the rock

The rock bed is a sedimentary rock of chemical origin comprised of fine grain limestone with little silica presence. At the location of the test pit (place of the main foundation), the rock was located between the levels -0.65 and -1.4 meters below ground level with a minimum thickness 0.75 meters.

6.2 Unconfined compression test on the rock

The unconfined compressive strength of the rock was determined in agreement with 2938 ASTM, point 8.1, preparing the sample in the proportions (L/D from 2,0 to 2,5).

In agreement with the previous results the following was obtained:

Unconfined compressive strength =
$\frac{75000\ N}{2042\ mm^2} = 36.7\ Mpa = 367\ kg/cm^2$

In agreement with this result and the values of permissible load for sedimentary rocks of the limestone type it is suggested to adopt a permissible uplift capacity between 10kg/cm2 and 20 kg/cm2. (**Mecanica De Suelos Y Cimentaciones, ISBN: 9681831659, Author Carlos Cresp, 639 pages)**

7. Specifications for Granular Materials:

7.1 Granular material with not more than 12% passing the #2000 sieve, with a maximum plasticity index of 6% and without organics.

7.2 Maximum size is limited to 2½ inches.

Granulometric band suggested

ASTM Sieve Malla ASTM	MIN	% Passing (by weight) Max 100	
2 ½"	77		100
1 ½"	70	-	90
¾"	58	-	78
3/8"	33	-	64
No. 4	24	-	48
No. 40	15	-	28
No. 200	5	-	12

The material should be compacted in confined layers, of loose thickness of not more than 25 cm depending on the compaction equipment used.

A 95% compaction to the dry maximum density (DMCS) is recommended under all foundations as given by the proctor test. For the remaining layers, the recommended compaction is 90% of the DMCS.

8. It is required that the compaction process be controlled by an official soil mechanics laboratory.

(Signed by)

Carlos Cea Velis
Department Manager, Civil Engineering
Cesmec - Antofagast

APPENDICIES

AOA – 23836

AOA - 23837

ANALYSIS OF SOILS
AOA-23836

cesmec

Client: Wireless Energy Chile Ltd **Work Order:** 231294

Attention: Maurcio Quijada **Date Sent:** 10/03/02

ACCREDITATION : LABORATORIO OFICIAL SERVIU ORD. Nº 667 DEL 31.07.99

Summary:

The scope of work was to analyze a rock sample. The sampling was conducted by Cesmec.

Identification and Results:

Work:	Project to Monitor theWind at Calama
Client:	Wireless Energy Chile LTD.
Sample (#):	1970
Identifcation:	Rock
Sample Location:	At bottom

Granularity (LNV 105)

% by weight passing Sieve

(ASTM)	(mm)	(%)
1"	25	100
3/4"	20	98
3/8"	10	95
Nº 4	5	91
Nº 10	2	88
Nº 40	0.5	76
Nº 200	0.08	28.6

Nota importante al reverso

AOA-23836

cesmec

Atterberg Limits
(NCh 1517 I y II)

(%)	Liquid Limit	:	17.8
(%)	Plastic Limit	:	--
	Plasticity Index	:	N- P

Classification

AASHTO	:	A-2-4 IGO
USCS	:	SM Muddy Sand

Determination of the Maximum and Minimum Soil Density and Cohesivity *(Nch 1726-80)*

(kg/dm³)	Maximum Density:		1249
(kg/dm³)	Minimum Density:		1726

% Total Salt Content: : 1.9

Carlos Cea Véliz
Jefe Depto. Ingeniería Civil

Nota importante al reverso

ENSAYE DE ROCA

AOA-23837

Client:

Attention: : Wireless Energy Chile Ltda.
: Mauricio Quijada

Work Order: : 231294
Date Sent: : 03.10.02

ACREDIDATION : LABORATORIO OFICIAL SERVIU ORD. N° 667 DEL 31.07.99

Summary:
The scope of work was to analyze a rock sample. The sampling was conducted by Cesmec.

Identification and Results:

Work:	Project to Monitor theWind at Calama
Sample (#):	1970
Identifcation:	Rock
Sample Location:	Bottom of test pit

Specific Weight

1. Relative Density: 2.50
2. Unconfined Compression Rc (kgf/cm^2): 367
3. MOHS Hardness: 3 ½

Carlos Cea Veliz
Jefe Dpto. Ingeniería Civil

Nota importante al reverso

Appendix B

Technical Report of SeaWest's Meteorologist

SEAWEST

WindPower for a clean future®

TURNKEY DEVELOPMENT
VALUE-BASED CONSULTING
STRUCTURED FINANCE
ASSET MANAGEMENT

Trip Report

TO:	Calama Wind Farm Site
EMPLOYEE:	Brian Armstrong
DATE:	Week of October 28th
PURPOSE:	Inspection of new met tower location, construction assessment, substation inspection

The purpose of the trip was to perform 5 tasks. The description of the tasks and the results are as follows:

Task 1

Based on the wind data from site 650 and 651, it was decided that site 650 was a more productive site and it was proposed to expand the monitoring at the location of site 650. The purpose of this trip was primarily to assess the topography of site 650 and determine where an additional met tower should be placed to determine how the topography would effect wind speeds across the project site. The initial location of the met tower was provided to Wireless Chile based on topographical maps. The site visit allowed for the actual assessment of the proposed location. The result was that the site chosen for the new met tower was acceptable. It was acceptable because the met tower would receive good exposure to the wind from all directions and was representative of local topography where turbines are proposed. The new met tower would be located at the opposite edge of proposed project site boundary giving good coverage of the possible variations of wind resource across the proposed project site with the two met towers. Wireless Chile was directed to proceed with installation of the met tower. See photograph #1 for the proposed location of met 652.

Task 2

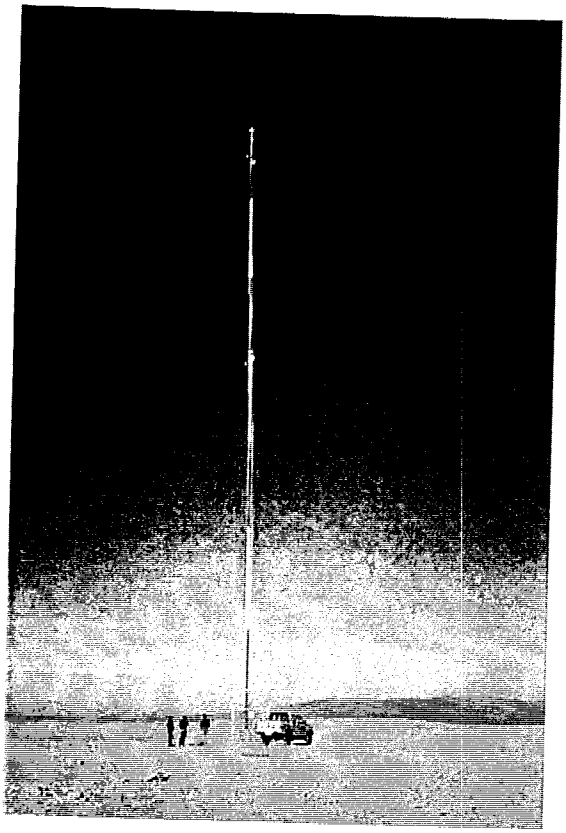
A second task to be performed on the trip was to inspect the first met tower at Site 650 at project site to make sure that it was still operational and aligned to provide meaningful data. The installation of the met tower was performed in a high quality and professional manner. The installation was excellent and professional with all sensors mounted correctly and fully operational, giving assurance that all data is valid. See photograph #2 for met 650.

Task 3
The third task was to perform a visual inspection of various substation/interconnect locations. The closest substation is at the northwest edge of Calama, approximately 9 km from the project site. The next closest substation is at Chugicamata mine, about 15 km from the project. Access to either substation with a transmission line is feasible. The third alternative is to construct a new substation along the 100 kV transmission line that runs between the two substations. This would be the closest location to the project at about 7 km to the north. See photograph #3 and #4 of the two substations.

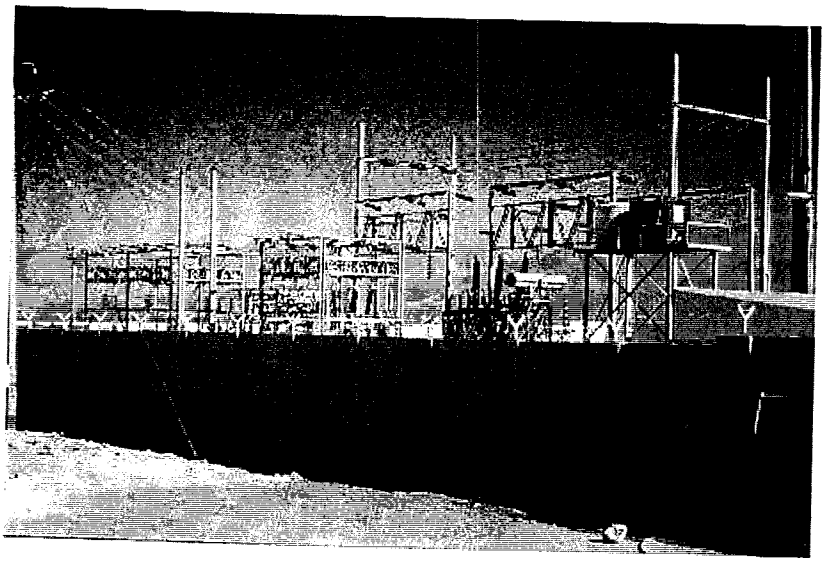
Task 4
The fourth task was to inspect the meteorological equipment at the Calama Airport that is the source of the long-term data so that the quality of the data could be gauged. The wind speed sensor at the airport was moved in October 1999 to the new airport control tower according to the airport operations manager that we met with. That sensor is of high quality and is acceptable as a source of long-term data, and has been in this same location using the same data collection methodology giving us a 3 1/2 year set of data for correlation purposes. See photograph #5 for a picture of the airport sensor.

Task 5
The fifth task was a visual assessment of the site for construction assess and a visual review of the proposed site layout The results of the site survey indicate that the two meteorological towers will adequately capture the variability of the wind resource across the proposed project site. The land form is relatively flat, with only occasional dry river beds, of no more than 5 meters deep, crossing the area. The topsoil across the area appears uniform. The site has good access from the paved highway running east from Calama to San Pedro, suggesting that there are no apparent difficulties regarding construction of this project.

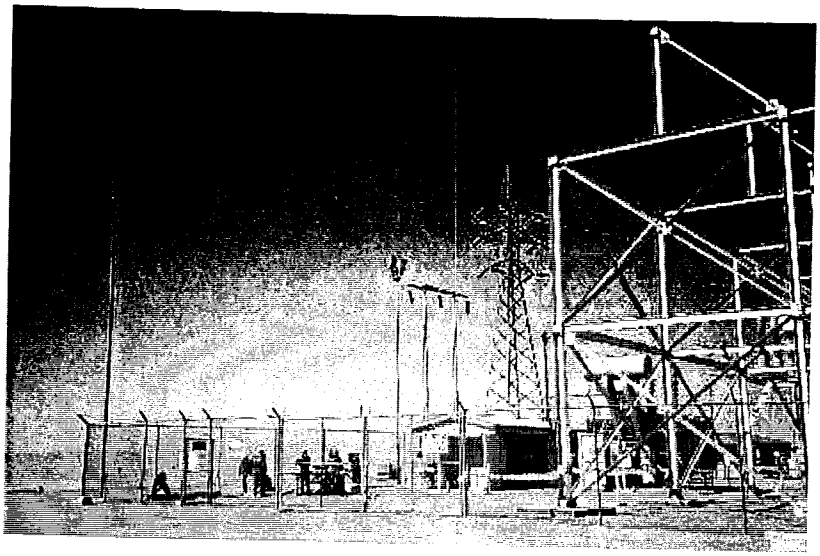
Photograph #1 Proposed location for Met 652



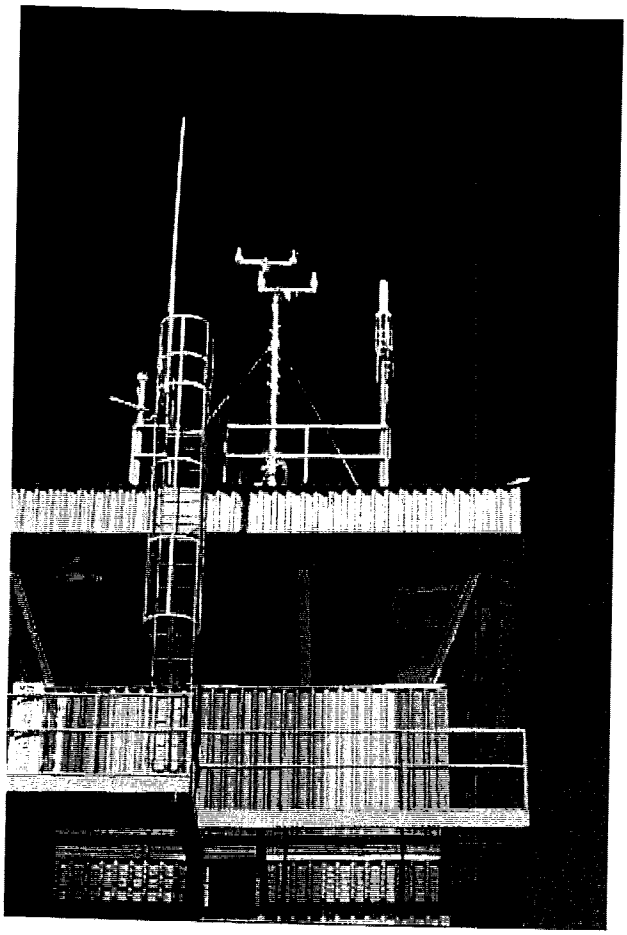
Photograph #2 Met tower #650 in good working order



Photograph #3 Substation at Calama



Photograph #4 Substation at Chugicamata



Photograph #5 Wind Sensors at Calama Airport

Appendix C

Technical Specifications for the Met Equipment

ENGINEERING SPECIFICATIONS OF WIND MEASUREMENT EQUIPMENT: GENERAL DESCRIPTION

The equipment to be installed in each one of both sites selected consists of a 50 meter tilt-up tower with guyed cables, equipped with direction and wind speed sensors and a data to logger to digitally collect the data collected by the sensors. The equipment is manufactured by the company NGR Systems, in Hinesburg, VT, USA.

NRG's 50 meter meteorological tower is designed specifically for measurement of wind resource. The components that make up the tower (sections of 3m and 1.5m of length and 52mm of diameter) are joined with bolts, then the tower is erected from ground level using a post handle and a system with winch. NRG Towers are guyed, in different elevations, with tension cables in 4 directions. The cables are secured to the ground with metal anchors connected to foundations, assuring the stability the tower.

The data logger, the 9200-Plus, is protected by a metal box and is mounted near the base of the tower. The robust construction of this apparatus makes it an excellent tool to be used in a great variety of environmental conditions. This data logger samples and collects data, based on pre-determined time intervals, for wind speed at three elevations, two directional sensors, and a temperature sensor reading. The data collected by the instruments is stored in removable data chips. The data chip is then connected to a computer and downloaded to a hard disk for later analysis. The design of this data logger optimizes data collection through simple operations, protection of the data, and its remarkable ability to resist much temperature and climate variability, such as those seen at the project site.

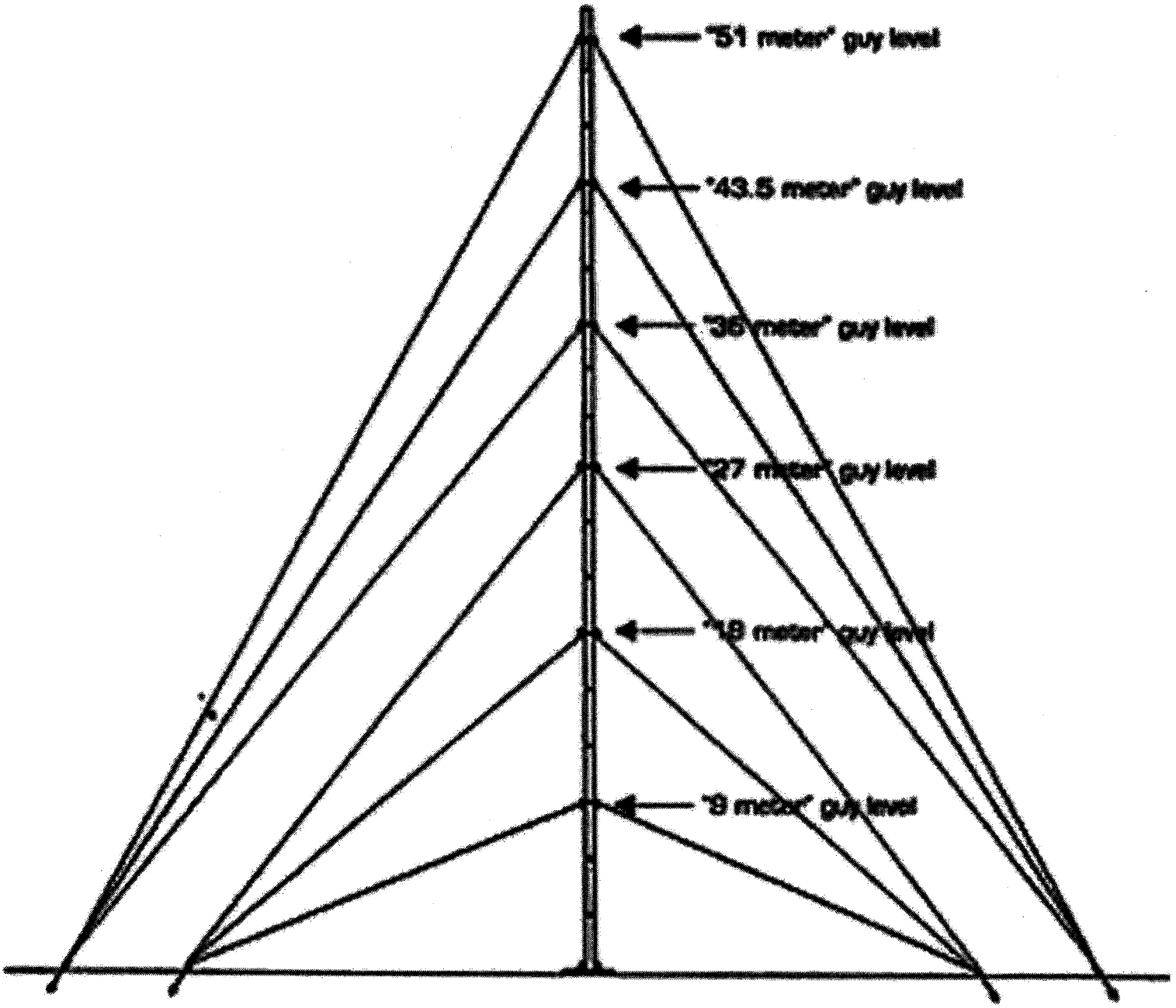
Three anemometers, model NRG#40C maximum, are installed at an elevation of 30 and 50 meters to measure wind speeds. The NRG#40 Maximum anemometer is the industry standard in the wind energy industry. This type of anemometer has registered wind velocities in excess of 96 m/s (214 mph).

Two wind sensors, designated NRG#200P, measure the wind direction at the sites. This type of direction sensor is also a Standard in the wind energy industry. Their plastic and stainless steel components resist corrosion. The wind vane is directly connected to a potentiometer, located in the main body of the apparatus.

The NRG 110 temperature sensor registers the ambient temperature. This temperature sensor consists of an integrated circuit, that although simple is very exact. The #110S is excellent for use in applications with potential for icing, such as at the project sites.

More information on NRG equipment can be found at www.nrgsystems.com. The tower will also be supplied with an installation kit, lightening protection, and aircraft lights. The following diagram shows to a) the guyed tower and holddowns and b) the location of the equipment in the tower.

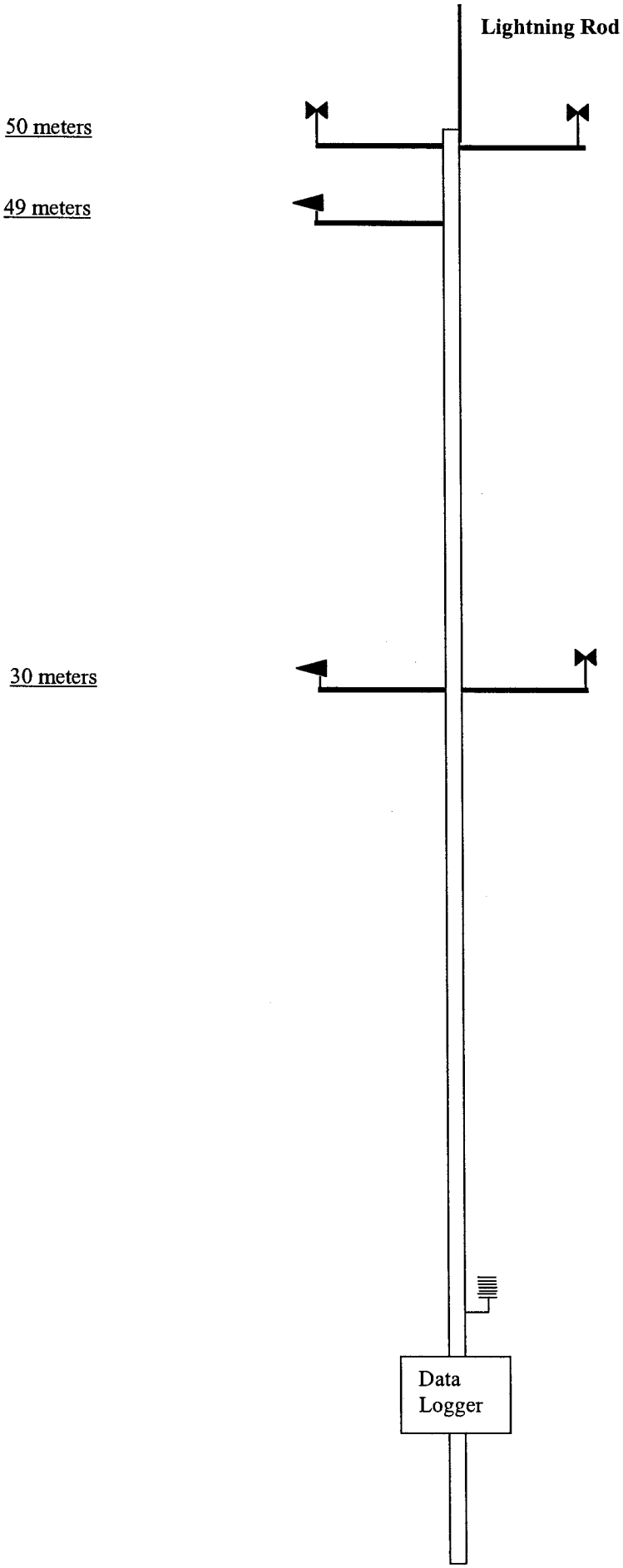
50 m (164 ft.) TallTower



Height: 50.0 meters (164.0 feet)
Diameter: 152 millimeters (6.0 inches)
Guy Radius: 30.48 and 33.52 meters (100 and 110 feet)
Winch Radius: 12.2 meters (40 feet)

Note: Shaded sections of the tower represent 1.5 meter (5 foot) tubes. Unshaded sections represent 3.0 meter (10 foot) tubes. Guy level heights are nominal. Actual heights are less than the nominal heights when tower tubes are assembled.

Source: NRG Systems, Inc.



Met Tower Instrumentation:

2 anemometers at 50 meters
1 wind vane at 49 meters
1 anemometer at 30 meters
1 wind vane at 30 meters.

Booms for the anemometers should be oriented perpendicular to the prevailing wind direction. Booms for the Wind Vanes will be oriented pointing to Magnetic North. The Vane boom at 49 meters will be positioned below the 50 meter anemometer booms so as not to interfere with the anemometer accuracy (approximately one meter below). Care must be taken to ensure that guy wires do not interfere with the sensors.

Temperature sensor mounted at about 10 feet.

Anemometer

Wind Vane

Temp Sensor

GREATER TECHNICAL DETAILS OF THE EQUIPMENT USED FOR MEASUREMENT ARE GIVEN IN FOLLOWING DOCUMENTS.

TYPE 40 MAXIMUM ANEMOMETER

APPLICATIONS

- Anemometer for wind resource assessment instrumentation
- Research measurements in environmental studies
- Control anemometer for new or existing wind turbines
- Sensing wind speeds at sporting events (i.e. Olympics)
- Engineering studies on wind effects on bridges, skyscrapers

FEATURES

- Very simple, elegantly engineered construction
- Dirt and wear resistant, modified Teflon bearing system
- All corrosion-resistant materials
- All 3 cups molded in one piece for repeatable performance
- Frequency output for ease of filtering and long cable runs
- Professional qualities at a minimum price
- Never change bearings; stays accurate many years in hostile environments
- Optional signal conditioners for digital and analog outputs available

SPECIFICATIONS

MECHANICAL:

3 cups of conical cross-section, 51mm (2") diameter
190mm (7.5") swept diameter of rotor
51mm (3.2") overall assembly height
Moment of inertia of rotor assembly = 68 x 10^{-6} S-ft^2
Mounting–(Using a cotter pin and set screw) on a 13mm (0.5") diameter mast with a #35 hole, 11mm (.35") from the top.

Materials:

Cups–one piece injection- molded black polycarbonate (Lexan)
Body–housing is black ABS plastic
Shaft–beryllium copper, fully hardened
Bearing–modified Teflon, self-lubricating. Rated PV factor of 20,000 (at 15 mph, PV is approx. 500; at 100 mph PV is approx. 2,000). Upper bearing is centered in the plane of cup thrust for optimal loading.
Permanent magnet–Indox 1, 25mm (1") dia., 13mm (0.5") long, 4 poles

Threshold:

Starting threshold–0.78 m/s (1.75 mph)
Cup distance constant (63% recovery)–3.0m (10')

Environmental:

Operating temperature -55°C to 60°C (-67 to 150 F)
Operating humidity range 0 to 100% RH
Weight: 0.1kg (0.2 lb)
Shipping Weight: 0.5kg (1 lb)

ELECTRICAL:

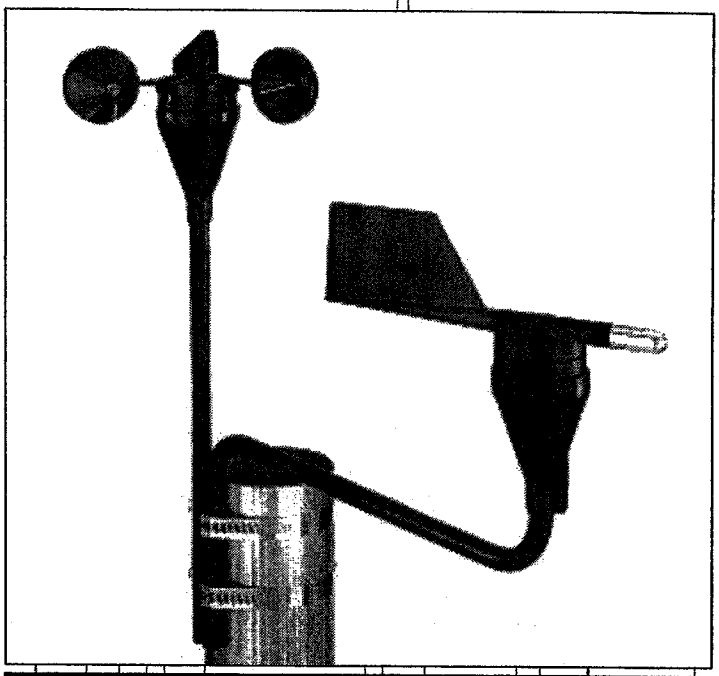
Single coil, bobbin wound, 4100 turns of #41 wire
Voltage is a sine wave with frequency changing linearly with wind speed–60 hz = 45.82 m/s (102.5 mph) [1.7 mph/Hz w/0.78 offset, 0.765 m/s/Hz w/0.35 offset]
Voltage is 2.0 VAC at 60 cycles–minimum (typical is 6 VAC P-P)
Hall Effect (#40H): A Hall Effect switch replaces the single coil. The voltage output is a square wave with the same frequency-to-windspeed relationship as the single coil. Requires a 5 to 24 VDC voltage with 5ma of current.

Custom sensors available for wind turbine control, etc.
Please contact us directly.

SPECIFICATIONS MAY CHANGE WITHOUT NOTICE.

ORDERING INFORMATION:

NRG #40 Anemometer	Cat. No. 40
#40 Hall Effect Output Anemometer	Cat. No. 40H
#40 Calibrated Anemometer	Cat. No. 40C



Shown here is the #40 Anemometer with the #200P NRG wind direction vane.

NRG Systems

MEASURING THE WIND'S ENERGY

110 Commerce Street

Hinesburg, VT 05461 USA

(802) 482-2255

FAX (802) 482-2272

Email: sales@nrgsystems.com

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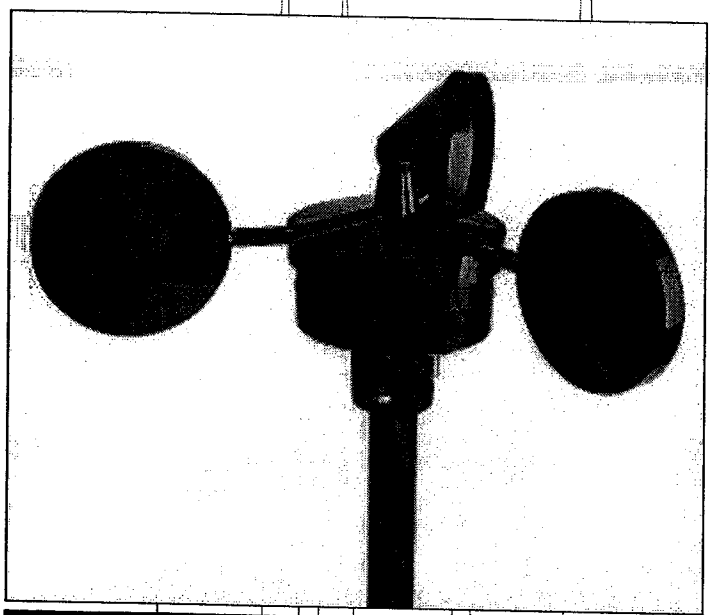
TYPE 40 MAXIMUM ANEMOMETER

NRG Systems

MEASURING THE WIND'S ENERGY



The Maximum #40 has three conical cups molded in one continuous piece. Cup rotation induces a sine wave voltage in a single coil by a four pole magnet. Two sine wave cycles are produced for each revolution of the cups with the frequency directly proportional to windspeed.

■ The Maximum #40 Anemometer has proven to be rugged, reliable and highly accurate. Over 100,000 units are now in use on wind farms, on mountaintops and in thousands of household, wind energy and institutional installations. ■ Maximum cup anemometers have recorded wind to 96 m/s (214mph). Their low moment of inertia and unique bearings permit very rapid response to gusts and lulls. The black Lexan cups (virtually shatterproof) have thermal properties which resist and shed icing far more effectively than metal assemblies. ■ Because of their output linearity, these sensors are ideal for use with various data retrieval systems and controllers. The unique bearing system ensures that wind-blown dirt and moisture will not destroy the bearings or degrade performance. ■ The unbeatable combination of accuracy, simple yet rugged construction and very low cost have made the #40 the first choice for professionals in all fields. Optional digital outputs and calibration are available. The Maximum #40 from NRG Systems: the wind industry standard anemometer.

NRG SYSTEMS

110 Commerce Street

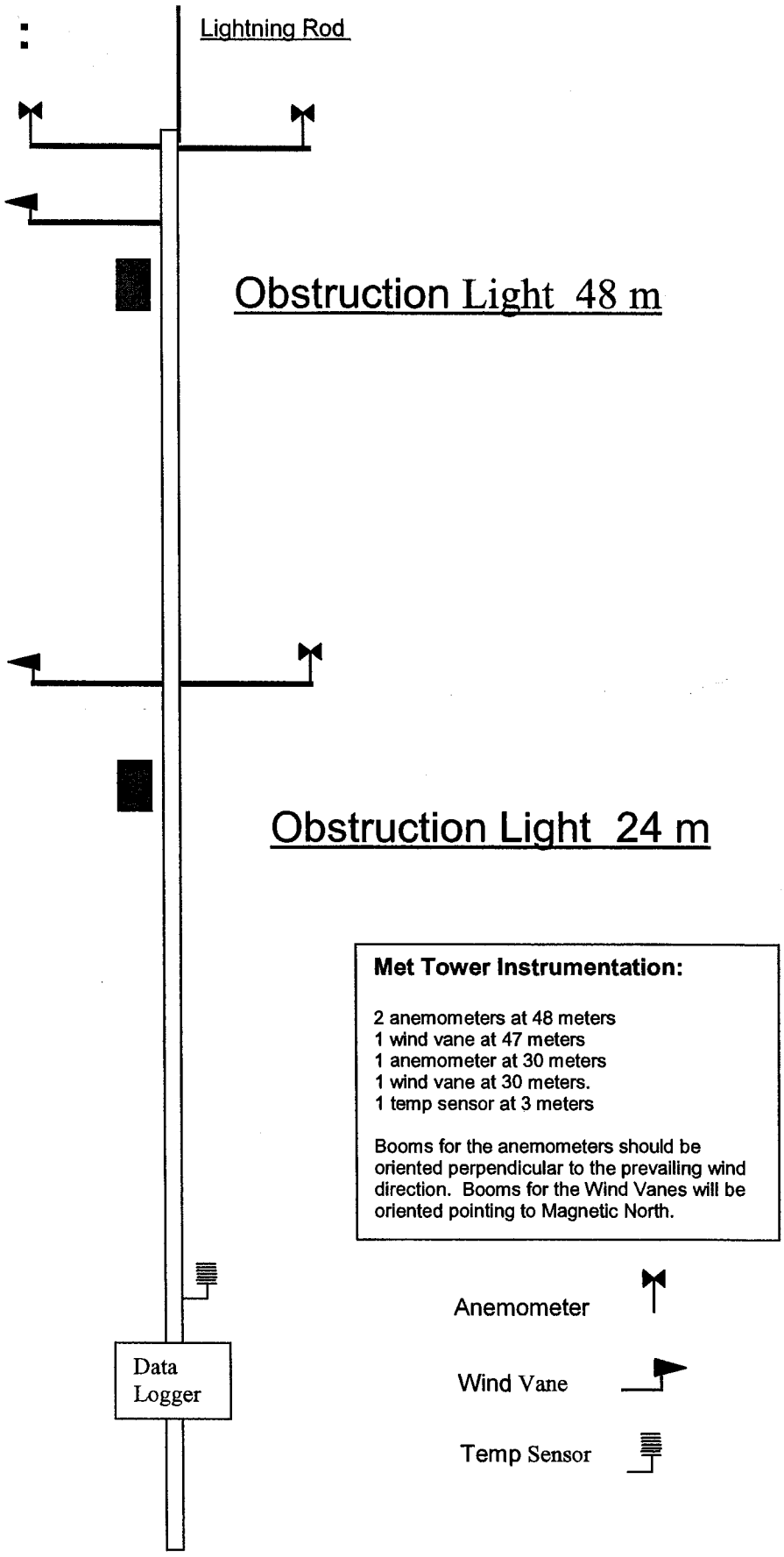
Hinesburg, VT 05461 USA

(802) 482-2255

FAX (802) 482-2272

Email: sales@nrgsystems.com

Configuration :



Met Tower Instrumentation:

2 anemometers at 48 meters
1 wind vane at 47 meters
1 anemometer at 30 meters
1 wind vane at 30 meters.
1 temp sensor at 3 meters

Booms for the anemometers should be oriented perpendicular to the prevailing wind direction. Booms for the Wind Vanes will be oriented pointing to Magnetic North.

Anemometer

Wind Vane

Temp Sensor

Record of Activities at Met Tower Site 650

Site 650

Date	Met tower		
Feb 2 2002	Installed Date:	Feb 2, 2002	Ns
	Site Number:	650	Ns
	Data Chips:	01, 02 installed at 19:45	Ns
	Serial Number:	92100679	Ns
	Logger Setting:	60-3	Ns
	Interval:	60 minute	Ns
	Sensors:	Setting 2:	Ns
	DataChip Interval:	170 Days (2x32)	
	Orientation:	True North (Declination 2 degrees)	
	Sensors:		
	Direction 1	30m	
	Direction 2	50m	
	Velocidad 1	30m	
	Velocidad 2	52m	
	Velocidad 3	52m	
	Temperature	3 m Analog	
	Lighting		
	Obstruction Light 1	48m	
	Obstruction Light 2	24m	
Abr 4 2002	**On Site:**		
	Change Data Chip 01 Y 02 with 03 Y 04		
	Verification of Guy Wires (tensores): OK		
	Verificacion of Foundations: OK		
	Verification of all Sensors: OK		
	Verification of Obstuction Lights (Balizas/Noche): OK		
	EE Reader:		
	1. Download data from chips to base station		
	2. Registered document files:		
	3. Conversion of files from type A to type N		
	4. Send both copies to Seawest		
	5. Save backup copies to server		
	6. Confirm reception of files by Seawest (Date)		

Record of Activities at Met Tower Site 651

Site 651

Date	Met tower		
Feb 2 2002	Installed Date:	Feb 2, 2002	Ns
	Site Number:	651	Ns
	Data Chips:	21, 22 installed at XXXX	Ns
	Serial Number:	92100678	Ns
	Logger Setting:	60-3	Ns
	Interval:	60 minute	Ns
	Sensors:	Setting 2	Ns
	Data Chip Interval:	170 Days (2x32k)	
	Orientation:	True North (Declination 2 degrees)	
	Sensors:		
	Direction 1	30m	
	Direction 2	50m	
	Velocidad 1	30m	
	Velocidad 2	52m	
	Velocidad 3	52m	
	Temperature	3 m Analog	
	Lighting:		
	Obstruction Light 1	48m	
	Obstruction Light 2	24m	
Abr 4 2002	**On Site:**		
	Change Data Chip 21 Y 22 with 23 Y 24		
	Verification of Guy Wires (tensores): OK		
	Verificacion of Foundations: OK		
	Verification of all Sensors: OK		
	Verification of Obstuction Lights (Balizas/Noche): OK		
	Verification Battery Power: ___ Volts (>7)?		
	EE Reader:		
	1. Download data from chips to base station		
	2. Registered document files:		
	3. Conversion of files from type A to type N		
	4. Send both copies to Seawest		
	5. Save backup copies to server		
	6. Confirm reception of files by Seawest (Date)		

Changing Datachips
Checklist:

Precaution: Don't change the DataChip during the data writing cycle (indicated by "L1, L2, L3..." on the 9200 screen)

1. Verify the voltage of the Batteries. Use FUNCTION 5.4: Change with 9-volt batteries.

2. Verify that clock is correct. If the screen indicates 'PL', take note of the actual hour/day and take out datachips.

3. Take out Datachips: Push "STOP" until it indicates'PLL -1"or 'PLL-12' on the screen (you have to wait one second).

If >>> PLL-1, the Data logger did not write to the second DataChip. Take out DataChip 1 and 2 for processing. The 9200 is now in program mode.

Now you can change the batteries (one by one) if it is necessary.

4. Installing New Datachip(s):
The Datachip is always installed with the point up. To install it you first have to insert the lower terminals and then continue with the upper terminals. (Never apply force to the right or left. It can damage the terminals of the DataChip.

5. To Initiate the Data Logger:
Push the 'Start' button. The 9200 shows the size of each of the datachips (pulsing '8 or 32 or ' to the right and left)

Next the screen indicates '---PP--- ', the configuration of the system and number of days to log on the DataChip. Finally, the DataChip shows 1.1 which indicates (Wind Speed-Channel 1).

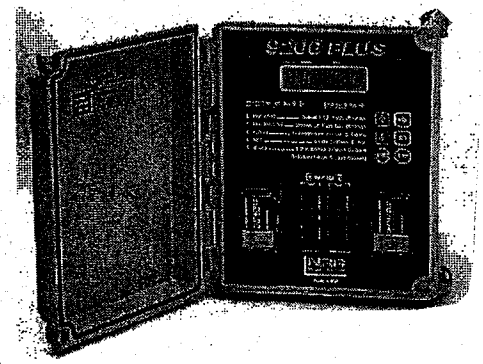
6. If the 9200 indicates --PA--, it is because it has been less than 20 seconds from the last recording cycle and pauses until it ends this cycle. The 9200 resumes writing to the DataChip when this interval ends.

Send data records to:
Brian Armstrong
brian.armstrong@aes.com

If there are problems reading the Datachips, send them to:
Brian Armstrong@ 4542 Ruffner Street, Suite 200, San Diego, CA 92111-2239

Summary of Capabilities

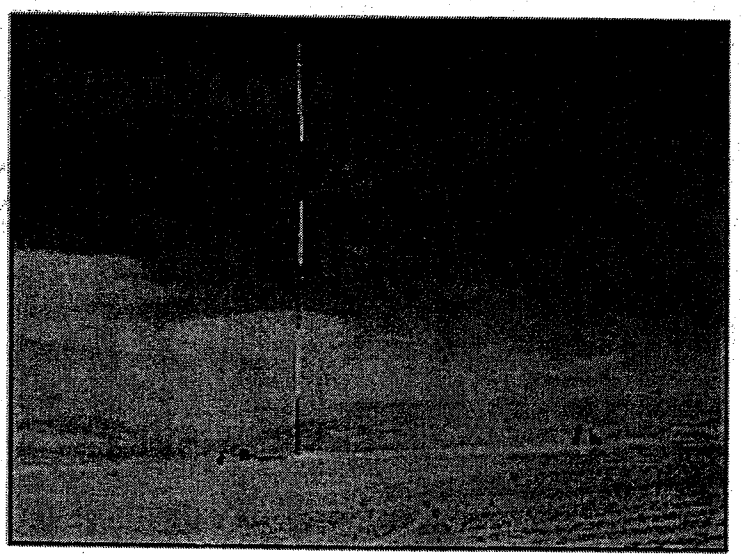
- NRG 9200 Data Logger
  - Global Operation
  - System Configuration>> Codelco Project
  - Recovery of Data, System Information
- Transfer of Data
  - Global Process
  - EE Reader/PC
    - Reading DataChips to a file
    - Send data
  - Safety Features
    - DataChip
    - Processor
    - Verification of data on the PC



- 50m TallTower
  - General Description
  - Maintenance
    - Adjust Guy Wires
    - Sensor Verification
    - Obstruction Light Verification
- Consultants

CODELCO
Wind Farm Study

Data Transfer Capacity of NRG9200 Data Logger



Wireless Energy Chile Ltda.
Nelson E. Stevens
nstevens@wireless-energy.cl

April 4, 2002

9200-PLUS NRG LOGGER

Wind Energy Data Logger

DIGITAL (COUNTER) INPUTS:

Sensor Types:

3 channels: Interface to NRG #40 Maximum Anemometers. Low-level AC inputs with low pass filtering matching the #40 output.
Threshold = 100mV peak to peak AC, 2 second update, count-integrated.
Resolution: 1 count. *Accuracy:* 1 count.
Frequency: 0 to 127.5 Hz

ANALOG INPUTS:

Sensor Types:

2 channels: Interface to NRG #200P Wind Direction Vane. 10K potentiometric wind vanes with 8° or less dead band. Automatic compensation for vane dead band (North crossing).

1 channel: General purpose analog input, 2 second sample.
Sensor Excitation: 5.0 V pulsed.
Range: 0 to 2.55 VDC standard.
Resolution: 8 bits (1 part per 255) 10 mV for a 2.55 VDC full scale signal.
Standard sensors: Li-cor 200SA Pyranometer, NRG #110S temperature sensor, or other generic 0-2.55V output sensor. User-selected with DIP switch.

POWER REQUIREMENTS:

Nominal Voltage: 9.0 Volts. *Minimum Voltage:* 5.6 Volts. *Operating Current:* 200µA average. *Peak Current:* 30 mA maximum when writing to DataChip, once per averaging interval.

DATA STORAGE:

Data stored in 2 removable EEPROM DataChips in protective carriers, 8KB or 32KB. *Capacity:* Data capacity depends on size of DataChip, averaging interval and type of data format selected. For example:

CAPACITY IN NUMBER OF DAYS ON (2) 32K DATACHIPS	10 MINUTE AVERAGES	60 MINUTE AVERAGES	SELECTED LOGGING MODE
	113 Days	682 Days	**Logging Mode 1:** 1 spd., 1 std. dev., 1 dir.
	56 Days	341 Days	**Logging Mode 2:** 2 spd., 2 std. dev., 2 dir., 1 analog
	37 Days	227 Days	**Logging Mode 3:** 3 spd., 3 std. dev., 2 dir., 1 max gust, 1 analog

DATA SAMPLING:

Averaging Interval:
10 and 60 minutes, user-selected with DIP switch.

Sampling Rate:
All inputs at 0.5 Hz (once every 2 seconds).

Statistics:
Average and standard deviation for each interval. Maximum for interval period (Mode 3 only).

Average Speed:

Range: 0 to 127.5 Hz = 0 to 97.4 m/s (0 to 218 mph).

Resolution: 0.0625 Hz = 0.022 m/s (0.05 mph).

Standard Deviation of Wind Speed:
True population standard deviation based on 2-second sampling intervals for each wind speed channel.

REAL-TIME CLOCK:
Programmable date and time, adjusts automatically for leap years. *Accuracy:* +/- 3 minutes per month.

LOGGER DISPLAY FUNCTIONS:
Units are user selected: M/S or MPH.
- Instantaneous wind speed and direction
- Average wind speed and direction (from last averaging interval)
- Peak wind speed and direction of peak speed (from last averaging interval)
- Instantaneous analog sensor reading
- Time, date, year
- Averaging interval
- Logging mode
- Site number (user selectable)
- DataChip number (user selectable)
- Battery voltage
- DataChip capacity remaining (number of days)
- Logger display scaling: 0.764 m/s per Hz (1.708 mph per Hz)

BATTERY VOLTMETER:
Battery voltage: updated every 2 seconds.
Range: 2.55 to 12.0 V. *Resolution:* 0.1 V.

BATTERIES:
Two 9-volt alkaline batteries; 6 to 12 months normal operation. Optional lithium batteries for low temperatures. 5-year battery available.

CONNECTIONS:
Terminal strip for signal inputs and external power sources. Ground stud for electrical grounding.

ENVIRONMENTAL:
Operating temperature range: -40° to 65°C (-40° to 149°F). *Operating humidity range:* 0 to 100% RH, non-condensing.

DIMENSIONS/WEIGHT:
170 mm height x 200 mm width x 110 mm depth (6.4 in x 8 in x 4 in), 2.3 kg (5 lb).

MATERIALS:
Enclosure: Weatherproof fiberglass meets NEMA type 4, 4X and 13 and IEC: IP65 specifications.
Hardware: Stainless steel/polyester.

MOUNTING:
Mounts with 4 bolts to inside of metal shelter box. Shelter box attaches to tower with U-bolts. Four mounting bolts included. Optional steel shelter box highly recommended.

WARRANTY:
2 year limited warranty.

Meets or exceeds all siting standards of the American Wind Energy Association.

Please contact NRG Systems today for more information or a price quotation.

NRG Systems
MEASURING THE WIND'S ENERGY
110 Commerce Street • Hinesburg, VT 05461 USA
TEL (802) 482-2255 • FAX (802) 482-2272 • EMAIL sales@nrgsystems.com

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9200-PLUS NRG LOGGER

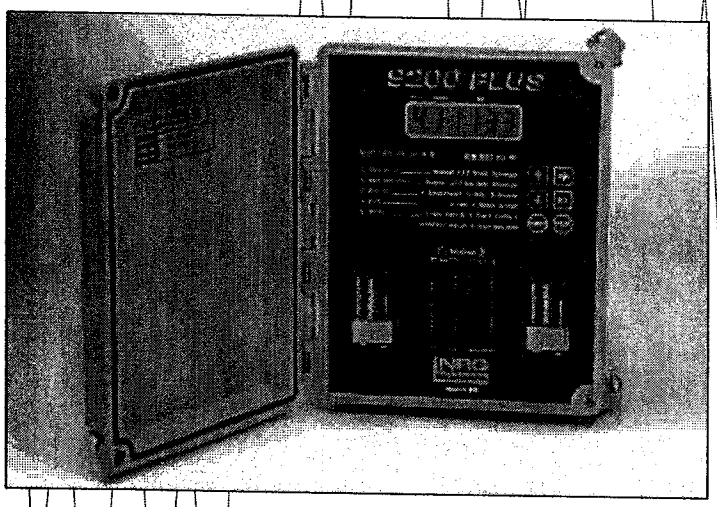
Wind Energy Data Logger

NRG Systems

MEASURING THE WIND'S ENERGY

FEATURES

- *Inputs for up to three anemometers and two wind direction vanes.*
- *Extra analog input for temperature, solar or other types of analog sensors.*
- *Ultra-low power consumption: over six months of operation on two 9-volt batteries. (5-year battery optional).*
- *Data capacity feature tells user how many days of data collection are left on DataChips.*
- *Three different logging modes to maximize data capacity.*
- *Average wind speed and standard deviation calculated for each interval for all wind speed channels.*
- *Turbulence intensity is based on a true population standard deviation of the averaging interval.*
- *Real-time data stored in 2 removable 8 KB or 32 KB DataChips for up to 682 days of unattended operation.*
- *Easy transfer of data to PC via EEReader II.*
- *User-selectable wind industry averaging intervals of 10 and 60 minutes.*
- *Menu-driven, color coded data entry keypad and display make setup and site maintenance easy.*
- *Built-in battery voltmeter allows user to verify battery voltage during site visits.*



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NRG Systems has upgraded our award-winning 9200 series data logger by adding and expanding several features, making it more versatile at the same low price. The 9200-PLUS collects samples from sensors that measure up to three levels of wind speed, two levels of wind direction, and provides an extra analog channel for temperature, solar radiation, or other generic meteorological measurements. Memory is extended by the use of two 32 KB DataChips that can store up to a year of data. Data is stored on these removable DataChips and carried from the site to a PC where it is transferred via an NRG EEReader II (serial port connection) with free BaseStation™ software.

The 9200-PLUS' robust design and rugged construction make it an excellent resource assessment tool for use in a variety of harsh environmental extremes. From hot and humid equatorial climates to the sub-freezing tundra of the Arctic, these loggers have a proven record of delivering a high data recovery rate unrivaled by other systems. Over 2500 of the 9000 Series data loggers have been sold in over 50 countries.

For use in most wind measurement programs, the 9200-PLUS is ideal for wide area wind resource assessments that require many loggers. Compared to more expensive systems, the low cost of the 9200-PLUS can justify the use of more loggers in a project while providing equal or better quality and recovery of data. Used with **MicroSite™ Wind Data Analysis Software**, the 9200-PLUS offers exceptionally high value to the professional wind power developer.

IMPORTANT DATA SAFETY FEATURES

- *Very easy to use: setup and data extraction is very straightforward with little possibility of operator error that can cause accidental (or intentional) data corruption.*
- *Nonvolatile EEPROM DataChips collect and protect data and operating parameters. Data cannot be cleared, altered or erased without EEReader. Compare to RAM cards with internal batteries that can clear and delete data ("zap!") due to low voltage or battery failure (i.e. lightning strikes).*
- *Initial parameters including time, date, serial number, and site remain in memory. No need to reset parameters after changing DataChip, which greatly reduces the chance of data retrieval error.*
- *A field proven logger: channel inputs are low-pass filtered for protection from RF interference which can corrupt data (many generic loggers do not have this feature). Each channel is designed for a specific sensor.*
- *Built-in spark gaps and MOVs help protect from electrostatic discharge (ESD).*
- *Weatherproof fiberglass enclosure with stainless steel latches for weather protection. An external steel shelter box (optional) with padlock hasp to protect from vandalism.*

NRG TALLTOWERS™
Mast Systems

NRG TALLTOWER™ SPECIFICATIONS

All weights and dimensions below include ginpoles (except for the 10 meter TallTower). One ginpole may be used to raise and lower many TallTowers.

10 Meter TallTower™
Tower Height: 10 m (33 ft.)
Tube Diameter: 89 mm (3.5 in.)
Tube Thickness: 1.65 mm (0.065 in.)
Tube Length: 2 m (7 ft.)
Ginpole Length: no ginpole required
Guy Radius (tower to anchor): 5.3 m (17.5 ft.)
Guy Wire Diameter: 3.175 mm (0.125 in.)
Guyset Levels: 8 m (26 ft.)
Shipping Weight: 63 kg. (137 lbs.)
Shipping Dimensions: 0.2 m^3 (7 $ft.^3$)

20 Meter TallTower™
Tower Height: 20 m (66 ft.)
Tube Diameter: 89 mm (3.5 in.)
Tube Thickness: 1.65 mm (0.065 in.)
Tube Length: 2 m (7 ft.)
Ginpole Length: 6 m (20 ft.)
Guy Radius (tower to anchor): 12.8 m (42 ft.)
Guy Wire Diameter: 3.175 mm (0.125 in.)
Guyset Levels: 6, 12, and 18 meters (20, 40, and 60 ft.)
Shipping Weight: 161 kg. (354 lb.)
Shipping Dimensions: 0.5 m^3 (17 $ft.^3$)
Maximum Lifting Winch Load: 189 kg. (415 lbs.)

30 Meter TallTower™
Standard 4.5" Diameter TallTower™
Tower Height: 30 m (100 ft.)
Tube Diameter: 114 mm (4.5 in.)
Tube Thickness: 2.11 mm (0.83 in.)
Tube Length: 3 m (10 ft.)
Ginpole Length: 9 m (30 ft.)
Guy Radius (tower to anchor): 18.3 m (60 ft.)
Guy Wire Diameter: 4.78 mm (0.188 in.)
Guyset Levels: 7.5, 15, 22.5 , and 30 meters (25, 50, 75, and 100 ft.)
Shipping Weight: 393 kg. (865 lbs.)
Shipping Dimensions: 1 m^3 (36 $ft.^3$)
Maximum Lifting Winch Load: 462 kg. (1017 lbs.)

30 Meter TallTower™
Heavy Duty Version 6.0" Diameter
Tower Height: 30 m (100 ft.)
Tube Diameter: 152 mm (6.0 in.)
Tube Thickness: 2.11 mm (0.83 in.)
Tube Length: 3 m (10 ft.)
Ginpole Length: 9. m (30 ft.)
Guy Radius (tower to anchor): 18.3 m (60 ft.)
Guy Wire Diameter: 4.78 mm (0.188 in.)
Guyset Levels: 7.5, 15, 22.5, and 30 meters (25, 50, 75, and 100 ft.)
Shipping Weight: 491 kg. (1081 lbs.)
Shipping Dimensions: 1.8 m^3 (61 $ft.^3$)
Maximum Lifting Winch Load: 627 kg. (1381 lbs.)

40 Meter TallTower™
Tower Height: 40 m (132 ft.)
Tube Diameter: 152 mm (6.0 in.)
Tube Thickness: 2.11 mm (0.83 in.)
Tube Length: 3 m (10 ft.)
Ginpole Length: 9 m (30 ft.)
Guy Radius (tower to anchors, 2 anchors per guy wire):
Inner radius: 21.3 m (70 ft.) for bottom three guy levels
Outer radius: 22.8 m (75 ft.) for top two guy levels
Guy Wire Diameter: 4.78 mm (0.188 in.)
Guyset Levels: 7.5, 15, 22.5, 30 and 39 meters (25, 50, 75, 100, and 130 ft.)
Shipping Weight: 633 kg. (1394 lbs.)
Shipping Dimensions: 2.2 m^3 (75 $ft.^3$)
Maximum Lifting Winch Load: 1114 kg. (2455 lbs.)

50 Meter TallTower™
Tower Height: 50 m (164 ft.)
Tube Diameter: 152 mm (6.0 in.)
Tube Thickness: 2.11 mm (0.83 in.)
Tube Length: 3 m (10 ft.)
Ginpole Length: 12 m (40 ft.)
Guy Radius (tower to anchors, 2 anchors per guy wire):
Inner radius: 30.5 m (100 ft.) for bottom three guy levels
Outer radius: 33.5 m (110 ft.) for top three guy levels
Guy Wire Diameter: 4.78 mm (0.188 in.)
Guyset Levels: 9, 18, 27, 36, 43.5, 51 meters (30, 60, 90, 120, 145, 170 ft.)
Shipping Weight: 785 kg. (1729 lbs.)
Shipping Dimensions: 2.6 m^3 (89 $ft.^3$)
Maximum Lifting Winch Load: 1306 kg. (2877 lbs.)

Surprisingly low shipping costs result in prices often lower than local towers in Europe and many selected countries.

Please call or fax NRG Systems today for a worldwide price quotation, including delivery to your site.

NRG Systems
MEASURING THE WIND'S ENERGY
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TEL (802) 482-2255 • FAX (802) 482-2272 • EMAIL: sales@nrgsystems.com

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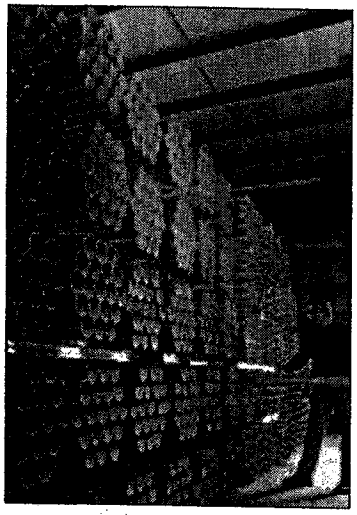
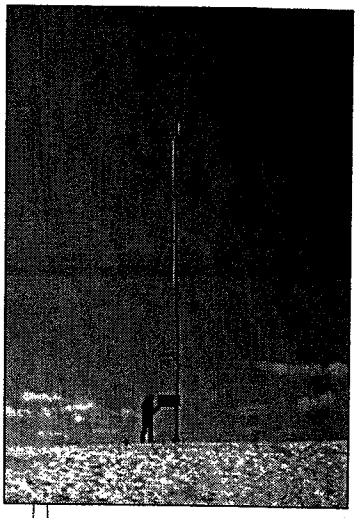
NRG Systems



A large inventory means quick delivery anywhere in the world, by air or ocean.

NRG TallTowers are easy to install. Towers arrive at your site complete—no extra parts are required. Tower tubes slide together without bolts or clamps, then tilt up from the ground with a gin pole and winch. NRG TallTowers are supported with aircraft cable guy wires in four directions at each guy level. The guy wires are anchored with standard screw-in anchors (other anchor types are available for various soil conditions). No cranes or concrete foundations are required.

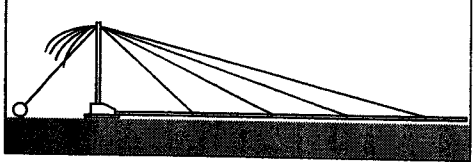


TallTowers have always withstood the harshest environments, from the ice-prone Canadian tundra to the highly corrosive Carribbean coastline.

Screw-in anchors are easy to install in most soil types.

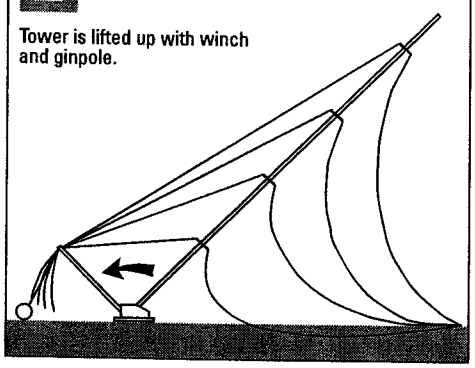
1

Tower is assembled on the ground.



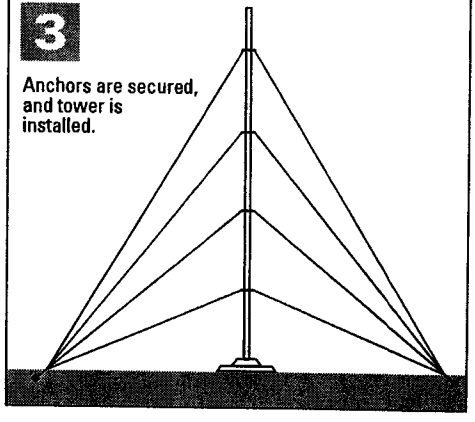
2

Tower is lifted up with winch and ginpole.

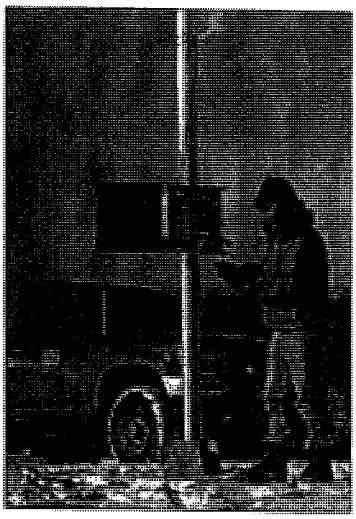


3

Anchors are secured, and tower is installed.



NRG TALLTOWERS™
Mast Systems



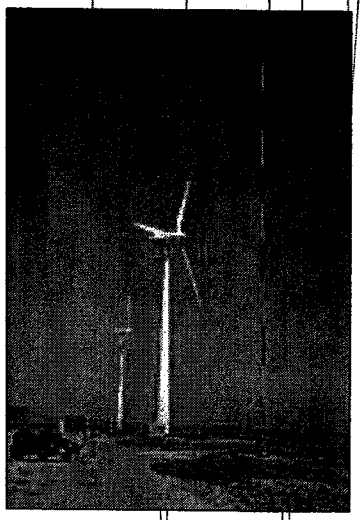
A field technician checks a #9300 Logger on a 30 meter TallTower. NRG offers complete systems including TallTowers, NRG loggers, software, sensors, cables, mounting booms, lightning protection and steel shelter boxes.

INSIST ON THE ORIGINAL NRG TALLTOWER™ FOR SAFETY, RELIABILITY AND EASE OF INSTALLATION.

NRG TALLTOWER™ FEATURES

- **Lightweight tubular design** combines high strength with low weight for reliability and low shipping costs.
- **Withstands high winds** safely up to 55 m/s (120 mph) with 13mm (0.5") of ice (much higher speeds without ice).
- **Tilt-up installation** reduces setup time by eliminating the need for concrete or a crane. This reduces associated labor, material and crane rental costs.
- **Different tower diameters** for different height towers ensure maximum safety while maintaining optimal strength-to-weight ratios.
- **Shipped ready to install,** including all tower tubes, anchors, spooled guy wires, base plate, hardware, and installation instructions. Makes installations at remote sites quick.
- **Shipped in 2 meter (7 ft.) or 3 meter (10 ft.) sections** for ease of shipping, handling and installation.
- **Ginpoles are interchangeable** on same diameter towers so one ginpole can be used to raise and lower different towers in the same area. This saves money.
- **Screw-in earth anchors** for most soil types. Optional arrowhead or rock anchors for other soil conditions.
- **Galvanized steel components** resist corrosion
- **Heavy duty tubing** for high-wind or ice-prone sites (optional).
- **Corrosion-resistant epoxy paint** and stainless steel hardware for marine environments (optional).
- **12 VDC electric winch kit** with pulleys for tower tilt-up (optional, but highly recommended).
- **Grounding kit available** for protection against lightning and static electricity.

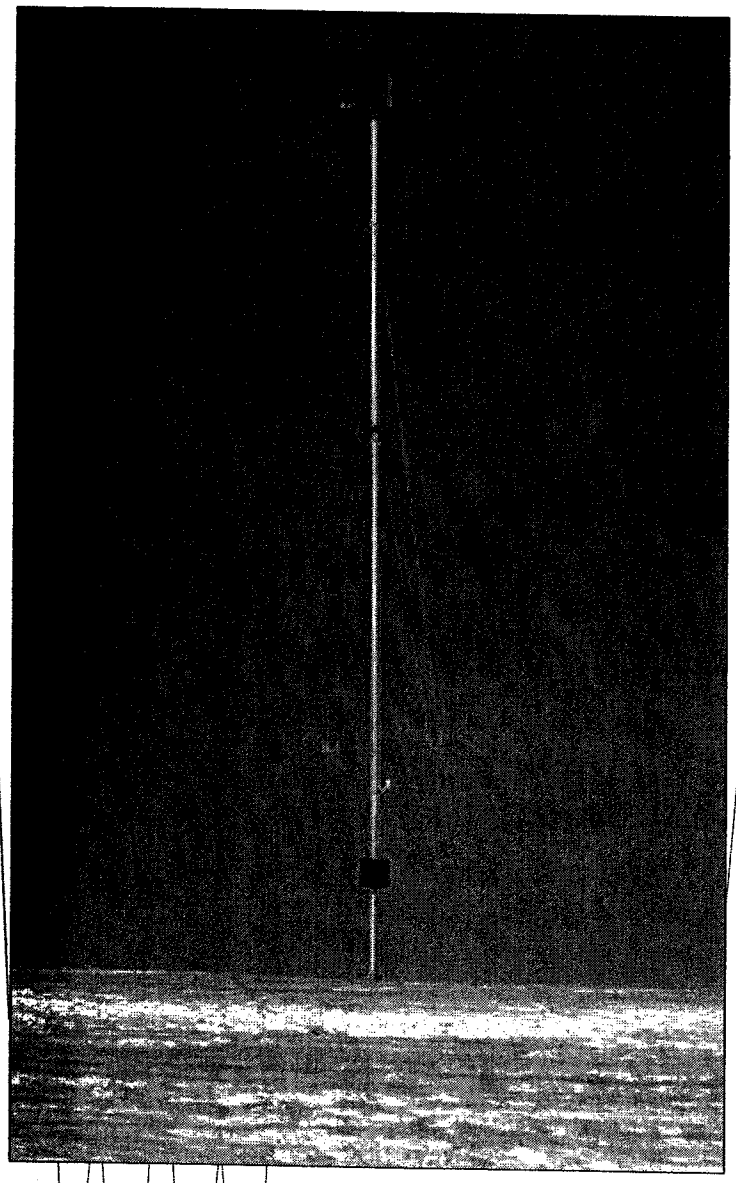
Even after a resource assessment is complete, TallTowers remain useful in wind farm control and power output verification.



NRG TALLTOWERS™
Mast Systems

NRG Systems

MEASURING THE WIND'S ENERGY



■ NRG TallTowers™ are highly versatile meteorological towers designed specifically for wind energy resource measurements. Their lightweight design and sturdy steel tube construction make TallTowers reliable in extreme conditions yet easy to transport to remote sites. ■ In wind energy applications, where anemometers and direction vanes are often installed at wind turbine hub heights, the tilt-up TallTower system is your most efficient alternative to expensive, heavy and labor-intensive lattice towers. The NRG TallTower system is the most cost-effective method to install your sensors at any level up to 50 meters (164 ft). ■ The TallTower often costs less delivered to your destination than a locally made tower. Furthermore, the TallTower's original tilt-up design does not sacrifice safety, reliability or efficiency. It is backed by NRG Systems' unrivaled engineering design, experience, and safety record that we have earned over the last 15 years. ■ NRG TallTowers have consistently withstood extreme high wind, ice accumulation and corrosive marine environments worldwide. For the highest degree of safety, ease of installation, and lightweight transport, insist on the original NRG TallTower.

NRG SYSTEMS

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Appendix E

Study results for the projection of Price and Demand in the SING

WITHOUT INTERCONNECTION SIC-SING
WITH CALAMA WIND FARM PROJECT
GENERATING UNITS WITHIN THE SING [Gwh]; 2003-2014

UNIDAD	2003	2004	2005	2006	2007	2008	2009	2010
CAVA	27.39	27.39	27.39	27.39	27.39	27.39	27.39	27.39
CHAP	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39
MIR1	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09
MIR2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08
GMA1	0.00	0.00	0.00	0.01	0.00	0.02	0.09	0.29
NAEX	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
SULZ	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.13
MIR3	0.00	0.00	0.00	0.01	0.00	0.02	0.07	0.19
MANI	0.00	0.00	0.02	0.11	0.04	0.14	0.41	1.10
TG-I	0.00	0.00	0.00	0.03	0.01	0.07	0.28	0.97
MITS	0.00	0.01	0.06	0.23	0.09	0.27	0.75	1.83
MAN1	0.00	0.00	0.01	0.04	0.01	0.07	0.28	0.80
GAN1	0.00	0.00	0.00	0.01	0.00	0.02	0.13	0.45
TGE3	0.00	0.00	0.01	0.05	0.01	0.11	0.41	1.28
VC14	1.44	206.73	434.84	611.64	323.08	489.36	641.60	776.58
VC15	4.92	435.86	651.06	806.75	519.22	677.88	810.56	872.23
VC12	0.06	6.74	25.37	63.73	21.59	49.11	105.59	192.14
VC13	0.23	18.56	57.86	135.36	46.13	100.67	191.00	302.80
VP10	0.00	0.00	0.05	0.30	0.10	0.44	1.47	4.11
VP11	0.00	0.01	0.11	0.54	0.20	0.77	2.26	5.86
VP09	0.02	0.03	0.25	1.13	0.42	1.49	4.21	10.60
TGT1	0.00	0.00	0.00	0.01	0.00	0.01	0.09	0.34
TGT2	0.00	0.00	0.00	0.01	0.00	0.02	0.12	0.49
TGT3	289.53	0.67	0.12	9.05	2.73	7.32	16.75	34.49
MEJ1	34.28	935.71	1,133.53	1,177.44	996.48	1,130.99	1,175.04	1,181.40
NTO1	119.63	0.51	3.82	11.49	4.33	12.18	30.88	70.47
MBL1	0.00	0.00	0.02	0.14	0.04	0.25	0.80	2.27
NTO2	370.60	3.72	17.52	43.33	15.69	38.45	86.02	180.57
MEJ2	1,202.72	1,237.52	1,247.34	1,247.61	1,238.99	1,246.89	1,247.60	1,247.61
PAT1	753.39	106.27	276.82	501.20	213.63	387.67	589.98	778.00
GA11	1,592.48	1,592.48	1,592.48	1,592.48	1,990.60	1,990.60	1,990.60	1,990.60
GA21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GA22	1,594.46	1,594.46	1,594.46	1,594.46	1,993.07	1,993.07	1,993.07	1,993.07
INCC	1,582.35	1,582.35	1,582.35	1,582.35	1,977.94	1,977.94	1,977.94	1,977.94
CCEL	1,589.75	1,589.75	1,589.75	1,589.75	1,987.19	1,987.19	1,987.19	1,987.19
CTM3	1,596.20	1,596.20	1,596.20	1,596.20	1,995.25	1,995.25	1,995.25	1,995.25
CAL1	0.00	112.64	112.64	112.64	112.64	112.64	112.64	112.64
CC01								
CC02								
total [GWh]	**10,845.84**	**11,134.00**	**12,030.47**	**12,791.88**	**13,553.26**	**14,314.70**	**15,076.97**	**15,837.67**

WITH INTERCONNECTION SIC-SING
WITH CALAMA WIND FARM PROJECT
GENERATING UNITS WITHIN THE SING [Gwh]; 2003-2014

UNIDAD	2003	2004	2005	2006	2007	2008	2009	2010
CAVA	27.39	27.39	27.39	27.39	27.39	27.39	27.39	27.39
CHAP	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39
MIR1	0.00	0.00	0.00	0.00	0.02	0.07	0.11	0.24
MIR2	0.00	0.00	0.00	0.00	0.01	0.06	0.10	0.22
GMA1	0.00	0.00	0.00	0.01	0.05	0.23	0.36	0.79
NAEX	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.10
SULZ	0.00	0.00	0.00	0.00	0.02	0.10	0.16	0.36
MIR3	0.00	0.00	0.00	0.01	0.04	0.17	0.19	0.38
MANI	0.00	0.00	0.02	0.11	0.38	1.15	0.81	1.50
TG-I	0.00	0.00	0.00	0.03	0.20	0.79	1.14	2.37
MITS	0.00	0.01	0.06	0.23	0.70	2.08	1.16	2.14
MAN1	0.00	0.00	0.01	0.04	0.20	0.71	0.82	1.60
GAN1	0.00	0.00	0.00	0.01	0.08	0.35	0.59	1.26
TGE3	0.00	0.00	0.01	0.05	0.28	1.13	1.35	2.78
VC14	1.44	206.73	434.84	611.64	767.40	854.28	445.64	559.96
VC15	4.92	435.86	651.06	806.75	875.21	888.48	584.01	707.14
VC12	0.06	6.73	25.37	63.73	143.32	256.29	83.38	135.57
VC13	0.23	18.56	57.86	135.36	252.51	378.78	142.32	214.36
VP10	0.00	0.00	0.05	0.30	1.19	3.99	3.53	6.68
VP11	0.00	0.01	0.11	0.54	2.01	6.09	4.66	8.50
VP09	0.02	0.03	0.25	1.13	4.04	11.71	7.31	13.29
TGT1	0.00	0.00	0.00	0.01	0.04	0.25	0.52	1.17
TGT2	0.00	0.00	0.00	0.01	0.07	0.34	0.64	1.41
TGT3	289.53	0.67	0.12	9.05	22.94	50.87	14.34	26.05
MEJ1	34.28	935.71	1,133.53	1,177.44	1,181.82	1,182.18	1,002.76	1,096.65
NTO1	119.63	0.51	3.82	11.49	33.99	86.47	38.83	71.35
MBL1	0.00	0.00	0.02	0.14	0.62	2.11	2.22	4.30
NTO2	370.60	3.72	17.52	43.33	106.78	233.52	84.02	151.20
MEJ2	1,202.72	1,237.52	1,247.34	1,247.61	1,247.61	1,247.61	1,208.83	1,237.96
PAT1	753.39	106.27	276.82	501.20	730.01	922.74	418.60	555.86
GA11	1,592.48	1,592.48	1,592.48	1,592.48	1,592.48	1,592.48	2,946.09	2,946.09
GA21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GA22	1,594.46	1,594.46	1,594.46	1,594.46	1,594.46	1,594.46	2,949.75	2,949.75
INCC	1,582.35	1,582.35	1,582.35	1,582.35	1,582.35	1,582.35	2,927.35	2,927.35
CCEL	1,589.75	1,589.75	1,589.75	1,589.75	1,589.75	1,589.75	2,941.04	2,941.04
CTM3	1,596.20	1,596.20	1,596.20	1,596.20	1,596.20	1,596.20	2,950.95	2,952.38
CAL1	0.00	112.64	112.64	112.64	112.64	112.64	112.64	112.64
CC01								
CC02								
total [GWh]	**10,846**	**11,134**	**12,030**	**12,792**	**13,553**	**14,314**	**18,990**	**19,748**

Appendix F

Request to CDEC-SING about Firm Capacity Request

Santiago, November 13, 2003

Mr.
CARLOS FINAT
Tolls and Operations Director
Load Economic Dispatch Center of the Northern Interconnected Grid
CDEC-SING Ltda.
Nueva de Lyon 72, Of. 1202

Dear Mr. Finat:

The National Copper Corporation- CODELCO is preparing a Feasibility Study for the Construction of a Wind Farm in the Northern Interconnected Grid (SING). It is an essential part of the commercial analysis of the project, to know the firm capacity remuneration that will be received by a wind farm operating in the SING.

For this reason, we ask the official pronouncement of the CDEC-SING regarding the firm capacity remuneration received by a 40 MW Wind Farm, and the methodology for its calculation.

The principal characteristics of the wind farm are the following:

- Nominal Capacity of the Wind Farm: 39.95 MW
- Configuration of the Wind Farm: 47 turbines of 850 kW
- Connection to the SING: Transmission line of 20 kms in 110kV, conductor 3X246.9 MCM-AAAC "ALLIANCE", that connects the substation called Wind Farm with the substation called S/E km 6-110 kV

We include an appendix with the estimation of the MWh that would have been generated by the wind farm during the period february 2002 to september 2003.

This estimation was based on wind data registered during 20 months in the Calama zone (hourly data registers), and on power curves for an 850kW turbine for every wind speed (this power curves were provided by a manufacturer of this technology).

We ask you to maintain as confidential all the information we have included. We thank not to copy, reproduce or distribute this document to personnel different to those directly involved in the preparation of the answer to this letter.

We will complement any information that you consider convenient.

Sincerely,

SANTIAGO TORRES
Executive VicePresident for Sustainable Development
National Copper Corporation

Estimation of the Generation of the Calama Wind Farm (Year 2002)

Source: Study by SeaWest-Deuman

	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02
	kWh	KWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
00:00:00	34,075	2,632	40,279	90,005	323,266	224,848	163,607	54,003	41,454	8,930	20,774
01:00:00	16,074	13,959	60,630	203,087	435,596	300,471	322,749	99,499	59,079	34,216	44,039
02:00:00	19,505	30,033	203,980	290,742	478,507	390,805	474,935	199,468	125,725	84,036	78,161
03:00:00	19,552	46,577	299,437	339,763	512,394	402,038	609,825	357,153	197,964	163,560	150,494
04:00:00	45,731	69,043	406,362	388,032	553,801	436,583	645,169	490,962	289,285	244,400	255,821
05:00:00	82,438	94,987	421,872	424,786	597,840	493,265	672,194	526,776	367,681	286,606	342,442
06:00:00	110,027	116,889	522,311	495,192	643,148	481,280	708,525	573,823	445,466	389,583	446,594
07:00:00	137,005	150,964	616,734	534,343	649,634	501,067	714,118	635,675	510,373	446,171	475,687
08:00:00	169,106	190,585	616,264	534,202	693,156	525,883	725,304	666,460	513,898	400,440	435,455
09:00:00	77,785	132,211	509,245	477,191	666,789	531,711	704,765	453,785	218,597	139,261	151,951
10:00:00	8,131	23,453	173,430	229,783	428,687	340,139	356,918	120,273	50,196	8,930	8,319
11:00:00	5,640	11,092	21,009	99,828	163,936	101,379	107,442	9,776	16,638	7,802	31,255
12:00:00	115,244	78,866	35,391	124,268	60,348	77,080	61,288	37,036	103,964	152,562	191,102
13:00:00	363,545	355,179	187,859	267,101	147,063	177,425	163,137	210,231	304,842	453,738	476,439
14:00:00	588,628	669,985	583,505	384,272	345,356	304,231	346,766	470,470	480,622	694,989	709,418
15:00:00	686,764	781,140	768,779	487,719	454,396	403,965	473,478	552,767	646,250	775,312	817,565
16:00:00	704,577	838,245	874,153	554,130	495,380	481,045	517,611	580,497	716,233	753,128	859,724
17:00:00	701,992	819,069	854,178	500,785	418,065	435,737	468,449	585,150	730,474	805,345	845,342
18:00:00	694,331	733,059	809,669	408,524	308,273	361,900	364,015	552,485	723,659	813,006	905,878
19:00:00	772,022	704,953	549,430	297,369	238,760	260,897	294,502	451,623	712,567	857,139	918,427
20:00:00	676,377	547,926	290,272	192,606	109,698	184,428	179,023	361,242	493,030	685,777	727,560
21:00:00	468,872	291,541	52,593	98,418	32,524	135,642	53,439	192,465	273,869	343,053	514,650
22:00:00	222,639	103,447	17,296	27,824	89,723	74,965	24,957	45,214	110,027	140,530	174,464
23:00:00	80,793	16,920	23,782	61,006	194,862	133,292	80,934	20,210	30,362	28,717	54,285
MWh-month	6,801	6,823	8,938	7,511	9,041	7,760	9,233	8,247	8,162	8,717	9,636

MWh in PH	2,834	2,381	1,719	1,025	779	1,018	916	1,603	2,313	2,840	3,241
PH/ 24 hours	42%	35%	19%	14%	9%	13%	10%	19%	28%	33%	34%

PH= peak hours, from 18:00 to 23:00 hrs

Estimation of the Generation of the Calama Wind Farm (Year 2003)

Source: Study by SeaWest-Deuman

	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
	kWh	KWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
00:00:00	23,312	21,056	4,794	88,125	226,446	334,875	182,689	207,928	125,490
01:00:00	14,570	6,298	21,432	176,297	360,020	536,693	272,365	338,776	207,270
02:00:00	48,316	9,118	62,322	265,691	521,136	710,875	322,279	460,083	318,660
03:00:00	85,728	37,506	113,599	356,213	611,658	799,047	376,846	560,475	459,660
04:00:00	121,589	62,933	162,808	464,360	663,828	803,841	433,810	629,518	627,450
05:00:00	154,865	101,144	187,107	531,993	689,067	849,337	490,351	671,207	627,450
06:00:00	178,882	120,743	236,410	607,005	702,979	887,219	503,182	719,805	806,520
07:00:00	208,116	151,199	261,602	610,342	745,138	859,395	531,053	755,948	806,520
08:00:00	190,162	204,920	319,224	676,189	798,671	859,160	599,673	787,297	627,450
09:00:00	74,636	91,227	229,313	589,427	742,694	811,079	612,692	760,225	459,660
10:00:00	7,802	11,609	65,941	254,364	399,265	544,918	412,284	432,212	207,270
11:00:00	27,448	9,964	4,136	41,172	94,188	190,350	160,458	108,006	64,860
12:00:00	188,047	150,588	62,322	59,596	18,424	59,220	25,709	44,885	64,860
13:00:00	542,521	514,979	388,173	174,229	55,977	91,650	113,129	168,401	318,660
14:00:00	794,300	775,077	729,675	467,227	222,921	252,202	286,559	364,391	627,450
15:00:00	914,338	887,172	851,358	642,960	402,085	416,185	427,512	495,662	806,520
16:00:00	932,433	875,704	876,362	648,694	479,118	495,051	478,977	573,635	806,520
17:00:00	923,268	853,990	840,689	636,098	462,950	481,562	466,052	568,794	806,520
18:00:00	968,435	805,533	773,009	556,809	393,813	401,239	396,586	494,064	627,450
19:00:00	919,743	716,750	723,518	417,783	276,172	265,315	306,346	380,324	459,660
20:00:00	712,661	602,164	614,337	260,333	154,113	58,186	158,531	214,320	318,660
21:00:00	478,883	415,480	381,123	139,073	25,333	10,481	32,430	74,730	125,490
22:00:00	225,694	209,103	124,879	42,770	27,260	50,384	38,493	23,312	19,740
23:00:00	68,009	76,845	31,913	60,348	120,085	148,849	92,402	85,305	19,740

MWh-month	8,804	7,711	8,066	8,767	9,193	10,917	7,720	9,919	10,340

MWh in PH	3,305	2,749	2,617	1,417	877	786	932	1,187	1,551
PH/ 24 hours	38%	36%	32%	16%	10%	7%	12%	12%	15%

PH= peak hours, from 18:00 to 23:00 hrs

GOVERNMENT OF CHILE
MINISTERY OF ECONOMY, MINING AND ENERGY

RESOLVES A DISCREPANCY IN THE LOAD DISPATCH CENTER OF THE NORTHERN INTERCONNECTED SYSTEM

Santiago, December 28, 2001

Ministerial Resolution Exta No. 163

DUE TO :

1) The presentation of the President of the Directory of the Load Dispatch Center of the Northern Interconnected System (CDEC-SING), received by November 10, 2000.;
2) The information from the National Energy Commission in its Letter No. 1069 of November 28, 2001;
3) The Supreme Decree No. 327 of 1997, from the Mining Ministry; and
4) The General Law of Electric Services, D.F.L. No. 1 of 1982, from the Mining Ministry.

AND CONSIDERING:

1. That the Directory of the CDEC-SING, with the presentation of the cited documents, has requested the intervention of the Minister of Economy, Promotion and Reconstruction, to resolve a discrepancy produced between its members, pursuant to Article 178 of the General Law of Electric Services. The presentation, which includes the position of every company and the Report by the Committee of Experts, has been duly processed, after confirming that it complies with the legal requirements contained in Article 178. This has been notified to the President of the Directory of the CDEC-SING, by Letter No. 5105 of November 16, 2000.

2. That a discrepancy between the companies that integrate the CDEC-SING, that ocurred in july 28, 2000 in the Extraordinary Session of the Directory No. 163 (E)/2000, has been submitted for the resolution of the Minister of Economy, Foment and Reconstruction. Consequently, the Committee of Experts of the CDEC-SING

emitted a Report dated October 7, 2000, that was sent to the companies during the Extraordinary Session of the Directory No. 175/2000 of November 2, 2000. In this session, the companies did not reach an agreement related to the "Procedure for the Calculation of Firm Capacity and Valuation of Peak Capacity Transfers for year 2000 and for the years thereafter".

3. That the companies that integrate the CDEC-SING have disclosed their arguments to the Committee of Experts pursuant to the Supreme Decree No 327, which have been summarized in the Report prepared by the National Commission of Energy that is part of this Resolution , and that is already known by all the members of the Directory of the CDEC-SING.

4. According to the National Commission of Energy, and independently of the specifical technical aspects associated to the calculation of the firm capacity performed by the Operations Direction of CDEC-SING, there are severe discrepancies between the definitions that each company assigns to the concept of firm capacity.

5. According to the National Commission of Energy, the meaning of the term firm capacity that underlies in the Supreme Decree No 327, is different from the definition that was contained in the regulation prior to such Decree. This explains the existence of different interpretations of the calculations and their values.

6. The National Commission of Energy estimates that the present meaning of what shall be understood as firm capacity, involves in one regulatory concept, two different and independent technical concepts: firm capacity as an acknowledgement of the contribution of the generation turbines to sufficiency, and firm capacity as an acknowledgement of the contribution of the generation turbines to the security of the electrical system.

7. There is an explicit primary market in our regulation, in which there are transactions of the sufficiency of capacity, and that must comply with the legal and regulatory requisites in force. The objective of these requisites is to adjust supply and demand of maximum capacity in a context of normality and predictability; this requisites are basic and common to any electrical system, and are the minimum required to establish the commercial activity in the power market.

8. There is a secondary ambit, not formally established as a market by our regulation, in which there are transactions of contingent capacity. The requisites and objectives of this market are not explicit in the regulation, and its valuation depends on the electrical system in which it is inserted, since it corresponds to the unpredictability of supply and demand. This ambit corresponds to security of electrical service.

9. The National Commission of Energy does not agree with the methodology proposed by the Operations Direction of the CDEC-SING, which includes the characterization of the relative ability of every generating unit to contribute to the recovery and normalization of the electrical supply, after the occurrence of a simple contingency or a Black-Out. The CNE recommends the elimination of the aspects related to the

previous and subsequent measures, preventive and corrective, with respect to a Black-Out. Additionally, such firm capacity model does not produce satisfactory results, because of its treatment of the loss of load probability in the peak hours of the system. The CNE recommends the adoption of the model and the formulation proposed by the Operations Direction of the CDEC-SIC, which on the other hand, has a better quality and is more coherent in its results, in relation to the previous models.

10. Likewise, and in order to avoid distortions in the market of transactions of peak capacity produced by short term events, the price of capacity in every substation where capacity transfers between generators are produced, shall correspond to the basic price of capacity without the adjustment to the band of the non-regulated clients. Such price shall only be modulated geographically by the capacity penalty factors and by the extra charges due to transformation and transport of capacity, that are determined by CNE in every node price tarification process.

11. The definition of firm capacity shall be sustained principally by the basic concept of sufficiency; the attributes of firm capacity that are associated to security shall have a lesser influence, at least as long as there is no regulation that acknowledges such attributes in a different ambit to the calculation of firm capacity. The recommendation from the CNE, which is stated in the attached document, expresses that the calculation of firm capacity shall have three components: one component that considers the sufficiency of capacity, a second component that considers the capacity that is delivered in the processes of load increase, and a third component that considers the capacity that is supplied in the start-up processes of the generating units. The first component shall have the higher ponderation, consistently with the above statements.

I RESOLVE:

1. To establish a method for the calculation of firm capacity in the CDEC-SING, based on the methodology presented in Chapter VI of the Document emitted by the National Commission of Energy, which is attached to the present Resolution and which is an integral part of it.

2. To instruct the CDEC-SING to apply such methodology for the calculation of firm capacity an for the valuation of the definitive peak capacity transfers corresponding to year 2000, considering the parameters and available information.

3. The CDEC-SING shall have a maximum term of 35 days, starting from the notification date of this Resolution to the President of CDEC-SING, to perform the calculation described in the previous numeral, and to send it to CNE.

4. To instruct the CDEC-SING to apply such methodology for the preliminary calculation of firm capacity and the valuation of the peak capacity transfers of year 2001, considering the parameters and available information.

5. The CDEC-SING shall have a maximum term of 60 days, starting from the notification date of this Resolution to the President of CDEC-SING, to perform the calculation described in the previous numeral, and to send it to CNE.

6. That the methodology indicated in the first numeral , shall be an integral part of the Internal Regulation of the CDEC-SING. The CDEC-SING, as a coordinator organism, shall have a term of 70 days, starting from the notification date of this Resolution to the President of CDEC-SING, to draft the modified text and send it to the National Commission of Energy, pursuant to Article 176, letter d) of the Supreme Decree No. 327.

NOTIFY THE PRESIDENT OF THE DIRECTORY OF THE CDEC-SING, AND THE SUPERINTENDENCY OF ELECTRICITY AND FUELS, ATTACHING THE DOCUMENT OF THE NATIONAL COMMISSION OF ENERGY, THE COMMITTEE OF EXPERTS AND THE NATIONAL COMMISSION OF ENERGY.

ALVARO DIAZ PEREZ
MINISTER OF ECONOMY, PROMOTION AND RECONSTRUCTION (S)

CNE

NATIONAL COMMISSION OF ENERGY

REPORT OF THE NATIONAL COMMISSION OF ENERGY

DISCREPANCY OF SESSION N^{O}. 163 (E)/2000 OF THE CDEC-SING DIRECTORY, RELATED TO THE "PROCEDURE FOR THE CALCULATION OF FIRM CAPACITY AND VALUATION OF PEAK CAPACITY TRANSFERS FOR YEAR 2000 AND FOR THE YEARS THEREAFTER". THIS PROCEDURE CORRESPONDS TO THE PROPOSAL OF THE OPERATIONS DIRECTION OF CDEC-SING PURSUANT TO NUMERAL 3 OF THE MINISTERIAL RESOLUTION EXTA N^{O}. 17 AND THE DISCREPANCY OF SESSION N^{O}. 175/2000 OF THE CDEC-SING DIRECTORY, RELATED TO THE REPORT OF THE COMMITTEE OF EXPERTS.

NOVEMBER 2001

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CHAPTER I INTRODUCTION

A discrepancy between the companies that integrate the CDEC-SING, ocurred in the Extraordinary Session of the Directory No. 163 (E)/2000, celebrated in july 28, 2000. The discrepancy is related to the "Procedure for the Calculation of Firm Capacity and the Valuation of Peak Capacity Transfers between the members of CDEC-SING, for year 2000 and for the years thereafter, procedure that was proposed by the Operations Direction of the CDEC-SING pursuant to numeral 3 of the Ministerial Resolution Exenta Nº 17"

The discrepancy was sent to the Committee of Experts by september 7, 2000, with the letter of the presidency of the CDEC-SING Nº 2000/364. The Committee of Experts emitted its recommendation for such discrepancy, in a Resolution dated october 7, 2000.

Later, during the Extraordinary Session of the Directory No. 175(E)/2000 of November 2, 2000, the companies did not reach an agreement related to the proposal of the Operations Direction of the CDEC-SING, which will be referred to as the O.D., and the recommendation of the Committee of Experts. The members of the CDEC-SING presented this discrepancy to the Minister of Economy, Promotion and Reconstruction, by letter of the Presidency Nº 2000/383, dated november 9, 2000.

CHAPTER II DESCRIPTION OF THE DISCREPANCY PRESENTED TO THE COMMITTEE OF EXPERTS

1 AGREEMENTS OF THE SESIONS OF THE DIRECTORY OF THE CDEC-SING

The agreements of the Directory that formulate this discrepancy are the following:

"**Agreement 163(E).1/2000**
There is a discrepancy related to the procedure for the calculation of the Firm Capacity and valuation of the peak capacity transfers, proposed by the Operations Direction according to the stipulations of R.M. EXTA. N° 17. The companies shall send to the Presidency of the CDEC-SING their presentation to the Committee of Experts before 15:00 hours of august 23, 2000".

Dated in july 28, 2000, the agreement is signed by the seven companies members of the CDEC-SING.

"**Agreement 164(E).2/2000**
The Directory of the CDEC-SING agrees to postpone the date of presentation to the Committee of Experts of the discrepancy that arose according to the Agreeement 163(E).1/2000, for Thursday september 7, 2000, before 15:00 hours "

Dated in august 18, 2000, the agreement is signed by the seven companies members of the CDEC-SING.

2 POSITIONS OF THE COMPANIES

The following sections present a synthesis of the positions of the companies which are members of the CDEC-SING.

ELECTROANDINA's SUMMARY

According to the position of ELECTROANDINA, the proposal for the calculation and valuation of the Firm Capacity presented by the O.D. to the Directory of the CDEC-SING, is harmonic and ordered and shall be totally applied, because introducing variations to some of its components, such as the modification of which are the generation units that participate in the calculation, or the replacement of the indexes, can produce implausible results, which would cause the loss of the original sense of the proposition, and the generation companies would end in the starting point of the discussion of the Firm Capacity , adequate for the Supreme Decree No. 327.

For ELECTROANDINA, the methodology presented by the O.D. to determine the Firm Capacity, makes a correct valuation of the available capacity of the different capacity plants according to their technical and economical merits, without discrimination between the generators.

ELECTROANDINA emphasizes that the valuation of the Firm Capacity does not depend on the economical load dispatch of the capacity plants and recognizes the importance of this aspect in the proposal of the O.D. ; at the same time, it indicates that the method of the O.D. shall not be modified, because any partial alteration of the method would alter its logical coherence.

SITRANOR's SUMMARY

For SITRANOR, this discrepancy originates in the adaptation of the calculation of Firm Capacity in the CDEC-SING to the dispositions contained in the S.D. N° 327. Pursuant to R.M. EXTA. N°17/2000, the O.D. made a proposal to the Directory of the CDEC-SING about a procedure for the calculation of the balance of Firm Capacity for year 2000 and for the following years, and for the preliminary balance of Firm Capacity for year 2000.

The position of SITRANOR agrees in general terms, with the methodology proposed by the O.D. in the documents attached to the letter CDEC-SING A-0257/2000, without prejudice of having general observations and comments to the method, and particular comments to the calculation of the preliminary balance for year 2000. SITRANOR requested the Committee of Experts to recommend the incorporation of its own comments and observations to the method for calculating the Firm Capacity and to ellaborate a new preliminary balance for year 2000.

EDELNOR's SUMMARY

For EDELNOR, this discrepancy arises due to Agreements 163 (E).1/2000 and 164.2/2000, once the O.D. , pursuant to the R.M. EXTA. N°17/2000, proposed the Directory of the CDEC-SING a calculation procedure for the balance of Firm Capacity for year 2000 and the following years, and a preliminary balance of Firm Capacity for year 2000.

In general terms, EDELNOR agrees with the procedures proposed by the O.D. in the documents sent with the letter CDEC-SING A-0257/2000. Notwithstanding, the company has comments and observations to the method proposed and to the calculation of the preliminary balance of Firm Capacity for year 2000.

EDELNOR requested the Committee of Experts to recommend the incorporation of such comments and observations to the calculation procedure of Firm Capacity and to ellaborate a new preliminary balance for year 2000.

CELTA's SUMMARY

In relation to the discrepancy of session N°163(E)2000. CELTA requested the Committee of Experts to recommend the following: (i) the calculation procedure shall consider the effect of the load dispatch of the generation units : (ii) to eliminate arbitrary concepts and assumptions that are not coincident with reality, sucha as: thermal power plants that are not dispatched in condition of embanking, the maximum penalty of 15% for the startup time and the unavailability period of 3.6 hours to define a null penalty for startup time; (iii) to consider a window of requirement of maximum 5 hours; (iv) the parameters shall be real, measureable and verifiable; (v) the virtual losses shall be pro-rated according to the Firm Capacity of the generation units; (vi) the transfer prices shall be the ones determined by CNE; (vii) the obligations of peak capacity shall be measured in the hour of maximum demand of the SING; (viii) to include a verification method of the transmission system restrictions, according to the proposal of CELTA and (ix) to correct the Procedure Manual of the Firm Capacity according to the proposal of CELTA.

NORGENER's SUMMARY

In general terms NORGENER agrees to use the calculation procedure of Firm Capacity proposed by the O.D., with corrections to some matters that would improve the procedure or help to correct certain erroneous aspects. With respect to the methodology for the valuation of the capacity transfers, NORGENER requests that the calculation of the penalty factors shall be done according to the regulation in force. Finally, with respect to the calculation proposed by the O.D. for year 2000, NORGENER comments that information from the member companies shall be used and shall be consistent with the decisions of the O.D.

GENER's SUMMARY

This company cites multiple references that indicate that the remuneration for capacity is oriented to incentivate the generators towards a financial stability that continues in the long term, to guarantee electrical supply in the long term. Besides, the price signal, associated to the remuneration of capacity, shall be disconnected from other aspects such as the remuneration of the operational reserve or the retribution for the recovery of service in situations of interruption of supply and that the capacity payments shall be disconnected from the economical load dispatch of the generation units , because this would distort the optimal dispatch.

In general terms GENER approves the procedure proposed by the O.D. Nevertheless, it requests the Committee of Experts to recommend the following: i) independency of the methodology of economical operation, ii) validity of the indexes defined for the startup times and the velocity of response, iii) to consider that the capacity of the generation units is limited to the input model, iv) that the control of the index of unavailability shall be done only during the peak hours of the system , v) that the calculation of the penalty factors shall be done based on the

load flow analysis for the condition of operation of the hour of maximum demand of the system .

On the other hand, with respect to the application of the methodology proposed by the O.D. , GENER requests: i) to recommend the correction of the value used for the input capacity for the gas turbines of SALTA´s power plant, during the testing period of the vapor turbine, and to replace it with the information that has been submitted responsibly by GENER and which implies using all its maximum capacity as input data to the model , ii) to recommend the correction of the value used for the input capacity of SALTA´s combined cycle and to replace it in a correct manner with the information submitted responsibly by GENER, and which implies using all its maximum capacity, iii) to continue considering that the power plants of NOPEL as only one generation unit as long as that company is not able to prove the opposite, iv) that the Capacity Price is the same as the capacity price for the regulated clients, v) to modify the actual consideration that there is only one price for the different withdrawal substations of its client Escondida.

Finally, GENER makes a reference to the fact that different penalty factors for the Firm Capacity and for the Node Capacity Prices, are the cause that in the SIC the distribution company SAESA has not been able to obtain supply contracts with any generator.

NOPEL´s SUMMARY

For this company, the Operations Directory proposed a method for the calculation of the capacity contributions to the SING; although this method includes "conceptually" the modifications established in the S.D. N° 327, at the moment of applying such modifications the modelation calculates indexes that do not reflect the "real contribution" of the generation units at the occurrence of a short term failure.

The position of NOPEL is focused in acknowledging the effective contribution that the generation generation units can realizar to the security of the SING, and through esto, proposes to considerar the economical load dispatch as the principal tool for cuantifying the contribution to the security of the system. Finally, NOPEL presents a large number of specific observations, to the proposal of the O.D. and makes a proposal intended to acknowledge the security and the economical dispatch in the calculation of Firm Capacity.

According to NOPEL, the proposal of the O.D. underestimates the average weight of the attributes of capacity of reaction and startup velocity, deviating the scope to the old practice of incentivating the installation of capacity in the system, without considering the abilities of the generation units to confront situations in the short term.

NOPEL proposed a methodology to the Committee of Experts to measure the real contributions of the generation units to the security of service in the short term. To do so, the methodology penalizes the ease of failure and favors those generation units that "effectively" contribute to avoid the loss of consumptions of the system at the occurrence of short term failures; this generation units correspond with an

adequate speed of reaction and speed at the startup. The proposal of NOPEL includes a methodology to calculate the marginal cost of the capacity to be applied to the payments between members of the CDEC-SING.

CHAPTER III PROPOSAL OF THE O.D. OF THE CDEC - SING

1 GENERAL DESCRIPTION

The proposal of the Operations Direction of the CDEC –SING, for the calculation procedure of the Firm Capacity , is contained in the following documents:

- Antecedents for the Procedure Manual.
- Doc. CDEC-SING-C0015/2000. Versión 2.0
- Procedure Manual for the Internal Rules.
- Doc. CDEC-SING-C0023/2000. Versión 2.0
- Manual for the Calculation of the Spreadsheet for the Calculation of the Firm Capacity and the Valuation of Capacity.
- Doc. CDEC-SING-C0025/2000. Versión 2.0
- Report of the Povisional Calculation of the Firm Capacity for year 2000.
- Doc. CDEC-SING-C0027/2000. Versión 2.0
- Appendix A Report of the Provisional Calculation PF 2000.
- Appendix B Report of the Provisional Calculation PF 2000.
- Appendix C Report of the Provisional Calculation PF 2000.

Without prejudice to the detailed description that will be presented in other sections, a summary of the methodology proposed by the O.D. is presented below:

- A Provisional Balance and a Definitive Balance of the Firm Capacity are established.

- The results obtained are independent of the economical load operation of the SING, which means that the economical load dispatch is not considered in the methodology, and the efforts are focused in the determination of the indexes of startup time and load increase time.

- The calculation of the unavailability index for the power plants operating in the SING is based on international industry standards.

- The methodology seeks the acknowledgement of the attributes of the generation units to support the security of supply in the SING, incorporating indexes that take in account:
  - Necessary times for the startup.
  - Load increases to respond against short term failures

- Although the economical load dispatch is not used in the calculation of the Firm Capacity of the power plants, the determination of the indexes of the startup times and of carry of load is done by considering that the generation units are operating at 85% of their nominal capacity.

- A window of 1 minute was considered to cuantify the index of carry of load.

- In regard to the startup times, the methodology considers that the system is under a Black-Out, and the contribution of the power plants to the recovery of the system is measured by defining two time indexes: T CNE(=3,64 hours) and TRS(=12 hours).

- Some generation units have the possibility of embanking in any moment of the control period, just by declaring this ability. This attribute improves the startup time index of the generation unit s. This ability is considered a priori in the Provisional Balance, and not as a certain operation in the Definitive Balance.

- Once the Firm Capacity for each generation unit has been obtained, the procedure includes the valuation of the transfers of Firm Capacity between generators.

- A Balance of Injections and Withdrawals of Firm Capacity shall be performed, by valuating the peak capacity transfers and the corresponding payments between generators. This means that generators with deficit, pay their deficit of capacity to the generators that have a surplus.

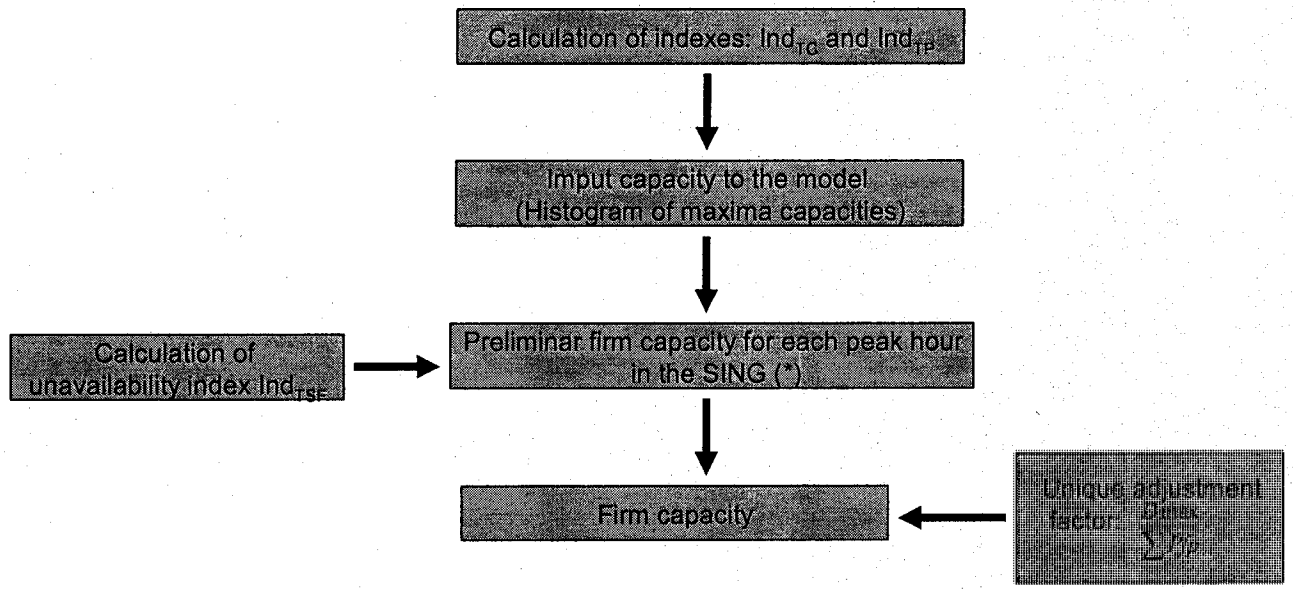
- The valuation shall be done at the instant marginal cost of the capacity in peak hours, which corresponds to the basic price of capacity that is determined by the National Energy Commission in the node price fixation process. This basic price of capacity is determined in the technical report that fixes the node prices[1] and is the price that has not been adjusted by the banda of non-regulated prices.

- For the rest of the substations of the SING, and in respect to the previous item, the instant marginal cost of the capacity in peak hours is calculated based on the instant marginal cost of the most convenient substation, considering the marginal losses of energy of the transmission system that result from the flow of Firm Capacity.

The following schemes describe the stages of the calculation proposed by the O.D. of the CDEC-SING:

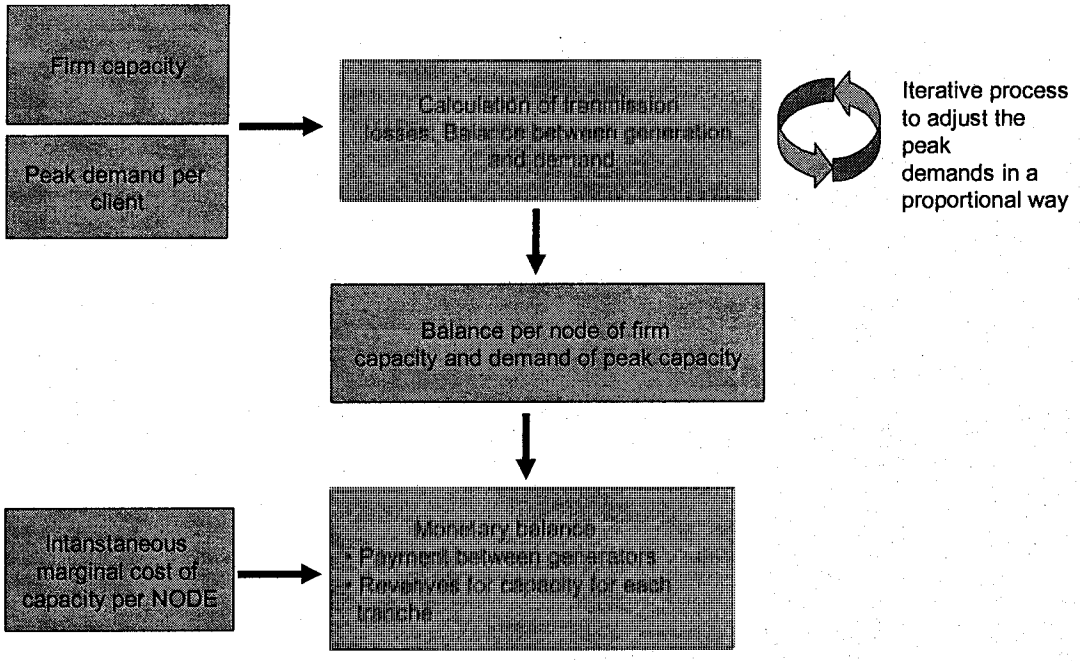
[1] Article 282 of the S.D. Nº 327.

FIGURE N° 1: SCHEME OF THE CALCULATION OF FIRM CAPACITY O.D. CDEC-SING



(*)Calculation Model

FIGURA N° 2: VALUATION SCHEME OF FIRM CAPACITY TRANSFERS BETWEEN GENERATORS



2 SPECIFIC DESCRIPTION OF THE METHODOLOGY PROPOSED BY THE O.D.

2.1 Necessary information to prepare the Provisional and Definitive Balances

For the ellaboration of the bases of the balances proposed by the O.D. of the CDEC-SING, the companies shall submit the following information:

- Hourly average maximum demands contracted with their clients. Information shall be detailed for each month, by date and value, both for peak hours and for non peak hours.
- Date of retirement of the generation units of the SING.
- Date of commercial operation of the generation units that are incorporated to the SING.
- Technical antecedents technical in the files of the CDEC-SING, such as:
  - Gross Capacity and own consumptions.
  - Load increase and startup times.
  - Effective unavailability.
  - Capacity of "embanking".
- Periods of commercial operation for generation units that are in tests.
- Capacity contributions as a function of time.
- Programmed maintenance periods
- Modifications of Firm Capacity Contracts between generators
- Modifications of Peak Demand Capacity supply contracts.
- Transmission system:
  - Topology and parameters of the transmission system.
  - Rights-of-way

2.2 Peak Hours Period and System's Peak Hours

The proposal of the O.D. of the CDEC-SING considers that the Peak Hours Period extends during all the hours of the year, defining the Peak Hours as those hours between 18:00 hours and 23:00 hours of each day in the winter official schedule and the hours between 19:00 hours and 24:00 hours of each day in the summer official schedule, except sundays and holidays.

2.3 Maximum demand

The maximum demand of the SING is equal to the hourly average maximum gross demand during the peak hours of the SING.

2.4 Maximum Net Available Capacity

The maximum net available capacity of a generation unit is defined as the installed capacity, with the deduction of its own consumptions, weighted by the factors that contain the indexes of the time periods necessary for the startup and load increases, that allow the response to sudden capacity requerements.

$$Pdisp = P_{inst} (1-Cp)(1- Ind_{TP})(1- Ind_{TC})$$

With:

P_{inst} : Installed Capacity.
Cp : Own Consumptions expressed in per unit.
Ind_{TP}: Index for time necessary for startup.
Ind_{TC}: Index for load increase .

The determination of the indexes for load increase and startup time are detailed below.

2.5 Unavailability of the Generation units

The O.D. of the CDEC-SING determins the unavailability of the generation units of the SING according to the following expression:

$$q = \frac{r}{r+m}$$

With:

q :Unavailability or failure rate.
r :Average time for the reparation of a failure.
m :Average operating time before failure.
r + m :Average time between failures.

The O.D. of the CDEC-SING specifies in its methodology that the average time for reparation of a failure defined in the formula includes, besides the reparation time, the time between the moment in which the generation unit returns to the system and the instant in which the unit is in conditions of supplying capacity. Consequently, this formula scores the times comprehended between the moment of the reparation until it is available again or in service.

The methodology accepts that each generation unit has its own unavailability index which is the same at any instant of time, particularly in the period defined by the peak hours of the SING.

The unavailability index shall be adjusted according to the times of operation and the times of failure registered in the last period; commonly, each period corresponds to a year and the number of periods that is accepted in the statistics of the CDEC-SING is equal to ten years. Considering the horizon of the analysis, the O.D. of the CDEC-SING proposes that the most recent years are the ones that have a greater incidence in the calculation.

2.6 Capacity histograms

It is considered that the generation units with modular characteristics in its operation, and therefore with multiple production states, can be represented with capacity histograms, where each state is characterized by the maximum available capacity and by the probability of occurrence of such state.

In this way, each generation unit has an histogram of maximum capacities of at least two states, in the following manner:

$$X_i = \begin{cases} 0 & \Pr(Xi=0)=Unavailabi\,lity \\ Ci & \Pr(Xi=Ci)=1-Unavailabi\,lity \end{cases}$$

With

Xi: Random variable of the available capacity for power plant "i".
Ci : Available capacity of the generation unit "i" , for a determined state.

The O.D. of the CDEC-SING indicates that having a histogram of more states to resolve the problem depends on the quality of the historical available information, the size the power plant in relation to the generation park, the number of minor generation units or common components, the design characteristics, and the interest of representing with higher resolution the relevant aspects for the system.

2.7 Index for Own Consumptions of the Generation Units

This index is the ratio between the necessary capacity to the supply auxiliary services of the generation unit and the gross capacity of the unit.

2.8 Load increase Index

The proposal of the O.D. of the CDEC-SING for this index is based in the premise that the planner of the operation of the system and the operator of the system have taken the adequate and convenient corrective actions, with all the necessary available information, in such a way that the system is operated with the priority of preserving the security of the electrical supply at the minimum possible cost. In this context, the system has a fast rotating margin of reserve, known as useful rotating reserve, ready to respond to any sudden requirement of capacity, like the one caused by an increase of the demand or the outage of a large generation unit.

According to the O.D., the value of the useful rotating reserve is set based on the technical and economical optimal conditions for the system, and is consumed by the generation units in proportion to the speed at which they respond to any demand of the system. In this logic, the O.D. of the CDEC-SING considers that an amount of the capacity of the generation park is available principally for the fast generation units, since they are the only units capable of taking advantage of it appropriately, while the slow generation units will only be capable of consuming a reduced percentage of this reserve.

In this way, the Load Increase Index (Ind_{TC}) is established; it is expected that this index gathers the characteristics of the speed of carry of load and the utilization of the rapid rotating reserve of the system by a generation unit, to respond to any sudden requirements of capacity of the system, according to the following formula:

$$Ind_{TC} = r_{giro} - \frac{\overline{\Delta P}}{\overline{P}}$$

$$\overline{P} = Min\left\{\frac{P_{limite}}{1 - r_{giro}}, Pinst\right\}$$

$$\overline{\Delta P} = \frac{1}{\Delta T}\int_{0}^{\Delta T} Min(\Delta P(t), r_{giro}\,\overline{P})\,dt$$

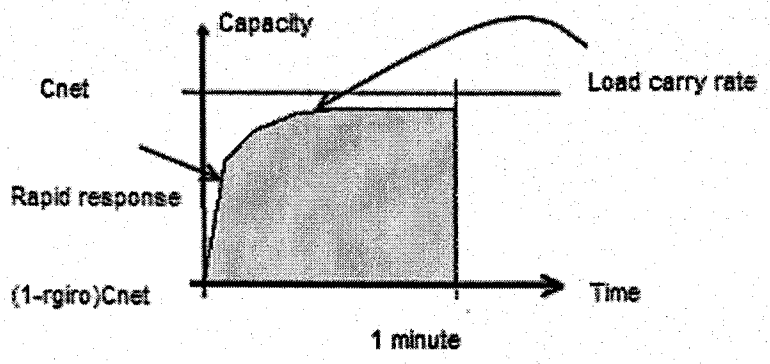
With:

Ind_{TC}	: Load increase Index.
giro r	: Useful rotating reserve expressed in per unit. Defined by the Operations Direction according to the Security Plan.
P_{limite}	: Limit of the dispatched capacity. Defined by the Operations Direction according to the Security Plan.
$\Delta P(t)$	: Capacity that the generation unit is able to increase as a function of time, starting from the limit of dispatched capacity, responding to a requirement of the SING.
ΔT	: Time in which the increase of the generation unit is registered. It is defined equal to one (1) minute.
P_{inst}	: Installed capacity of the generation unit.

The O.D. of the CDEC-SING established a value for the rotating reserve equal to 15% to determine the Firm Capacity for year 2000 in the SING, based in the Security Plan agreed to operate the system. This implies that although the economical load dispatch is not considered to determine the Firm Capacity of the generation units, for the evaluation of the Load increase Index, it is considered that the generation units are always dispatched at least with this margin, being this the starting point to carry load in view of a sudden requirement of capacity in the system.

The O.D. of the CDEC-SING defines the window for the evaluation of the capacity of carry of load, equal to 1 minute, without delivering additional antecedents that support such number.

The following figure illustrates the way in which the O.D. of the CDEC-SING evaluates the load increase of the generation units, the different elements that participate in the response of a generation unit and the percentage of the reserve destined to the action of a requirement of capacity of the system during one minute :



According to the conclusions of the O.D., one can verify that if a generation unit is fast then the index looses incidence, but if a generation unit is slow, then it is penalized because of its incapability to absorb the percentage of reserve that was assigned by the system .

2.9 Startup time Index

The O.D. of the CDEC-SING defines the startup time, as the time that a generation unit needs to synchronize with the SING and to supply load until it reaches its maximum capacity. For the generation units that can embank, the startup time is determined based on the declared time for the condition of being embanked. This condition, is activated only with the declaration of the owner, although, it may be audited by the O.D. of the CDEC-SING at its own decision.

Fundamentally, the idea is to have an index that considers the startup time as a quality to respond to any requirement of capacity of the system. According to the O.D., the importance of this variable is evident when the generation park supplies service with a greater security, from the moment in which it is capable of contributing capacity during the next minutes instead of the following hours or days . Consequently, the degree of incidence of the startup time can be reflected in the deterioration of the security because of the displacement of capacity contribution.

In the limit, two generation units supply the same service of capacity, although they have different startup times, only if the system is able to guarantee the conditions of the security of the supply that allow the delay in the entrance of the fastest generation unit until the instant in which the slowest unit is operating.

The calculation of the startup time index of each generation unit is done by the following expressions, and is defined as an index that pretends synthesizing the characteristics of the commercial operation or startup of a generation unit to respond to short term failures of the system, understanding that this contribution is done when the system has a Black-Out, according to the following formula:

If: $T_{CNE} \leq T_{RS}$

$$Ind_{TP} = \begin{cases} 0 & T_p < T_{CNE} \\ (1-P_{RS}) Min\left(\frac{T_p - T_{CNE}}{T_{RS} - T_{CNE}}, 1\right) & T_{CNE} \leq T_p \leq T_{RS} \\ (1-P_{RS}) & T_p > T_{RS} \end{cases}$$

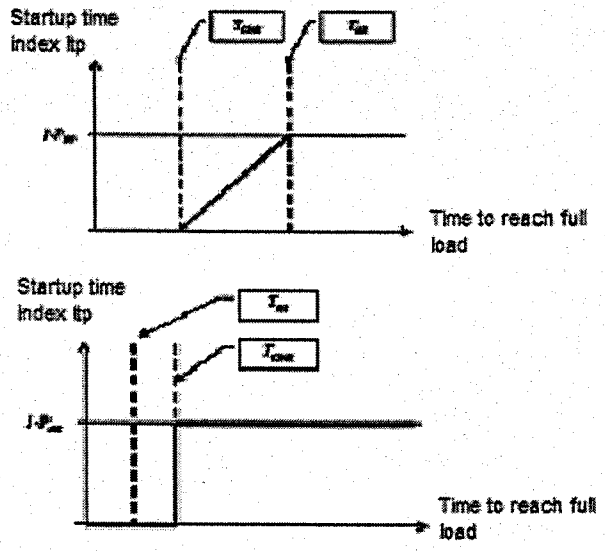
If: $T_{CNE} \geq T_{RS}$

$$Ind_{TP} = \begin{cases} 0 & T_p < T_{CNE} \\ (1-P_{RS}) & T_p \geq T_{CNE} \end{cases}$$

With:

Ind_{TP} : Index of the time necessary for the startup.
T_{CNE} : Time that represents the acceptable unavailability en annual hours of the SING.
The regulation indicates that the acceptable unavailability is equal to the acceptable unavailability of generation plus the acceptable unavailability of transmission.
T_p :Time that a generation unit needs to synchronize with the system and be able to supply load until it reaches its maximum capacity. The time of synchronization includes the posibility of embanking of the generation unit.
T_{RS} :Time of Recovery of service. It is the average time after a total loss of supply, during which the clients of the system are interconnected and with the posibility of being supplied. This time corresponds to the time indicated in the Plan of Recovery of Service of the CDEC-SING.
P_{RS} :Percentage of Recovery of Service. Ratio of the maximum average requirement of the system and the supply of capacity sufficient to supply the demand of the clients, in the instant given by the Time of recovery of service. This percentage is obtained from the Plan of Recovery of Service of the CDEC-SING.

The following figures illustrate the graphical formulation according to the representation of the index of the time necessary for the startup (Ind_{TP}), presented above, as a funtion of the Time of Recovery of Service and the Time of acceptable unavailability of the SING.



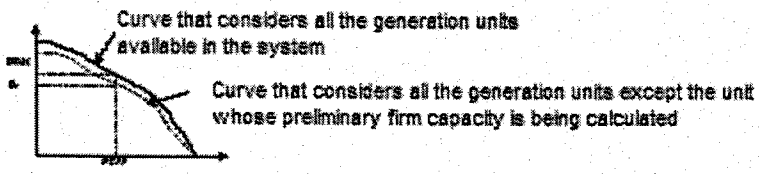
2.10 Model of Firm Capacity

The function of density of probability of the capacity of generation loss of the system is constructed by an operation of recursive convolution, between the random independent discrete variables, that represent the states of capacity of each generation unit and of the system.

The procedure of the O.D., constructs this density function as a continuos distribution, which according to the technical literature, for systems with un great number of generation units and with rates of forced outages relatively high, gives precise results with respect to those obtained with recursive methods.

The description of the proposal of the O.D. of the CDEC-SING in relation to the model of Firm Capacity is presented below; the proposal indicates that since the capacity supply of the available generation units changes during the period of analysis, then the Preliminary Firm Capacity is a function of the hour that is being evaluated, and therefore, acknowledges that the hour of interest belongs to the system´s annual peak hours.

The following figure shows a scheme of the way to obtain the Preliminary Firm Capacity under the described concept.



Therefore, the model proposed by the O.D. of the CDEC-SING has the following secuence to calculate the Preliminary Firm Capacity of each one of the generation units of the system:

- To determine the curve of the supply of capacity versus the probability of exceding of the Firm Capacity. With the objective of increasing the precision and to avoid errors of approximation in the determination of the capacity when using values of exceeding probabilities close to 100%, uses a model that determines the relation in a continuous form.
- To determine the loss of load probability in the peak hours (LOLPhp) that corresponds to the probability that the maximum demand of the system (Dmáx) is greater than or equal to the supply of capacity of all the available generation units in the period defined as peak hours. In other words, determines the probability of exceding the Firm Capacity (PEPP) of the respective peak hour for the maximum demand of the system.

$$LOLPhp(j) = 1 - PEPP(j)$$

Subsequently the generation unit whose Preliminary Firm Capacity is going to be evaluated, is retired. Then the demand that the rest of the available generation units is capable of guaranteeing in the respective peak hour, for the same level of probability of exceding the Firm Capacity calculated previously, is determined.

Then, the difference between maximum demand in peak hours and the total capacity obtained previously, is determined. This difference is defined as the Preliminary Firm Capacity of the respective generation unit, in the peak hour.

$$Pfp_{hp}(i, j) = Dmáx - Di(j)$$

The Preliminary Firm Capacity of a generation unit corresponds to the average of the preliminary firm capacities of all the peak hours of the SING. These firm capacities are not calculated for all the hours but for a set of subperiods (=30), that are defined based on relevant events in the variations of supply of capacity.

With:

Pfp_{hp} (i, j) : Preliminary Firm Capacity of the i-eth generation unit in the j-eth peak hour or subperiod.
Nhp : Number of peak hours in the year or in the subperiod

Notwithstanding, because in low levels of risk, low probability of generation loss, the errors that are obtained by using continuous distributions with respect to the values obtained by recursive methods are unacceptable, the O.D. of the CDEC-SING uses the Fourier transformed based in the expansión of Graham-Charlie, with the objective of obtaining secure distributions and to eliminate the errors due to very high exceeding probabilities.

2.11 Firm Capacity of a generation unit

The Firm Capacity shall be obtained by multiplying the Preliminary Firm Capacity by a unique factor, equal to the ratio between the maximum demand of the system and the sum of the preliminary firm capacities.

2.12 Adjustment Factor

It is the ratio between the maximum demand of the SING and the sum of the preliminary firm capacities of each one of the generation units.

2.13 Balance of Injections and Withdrawals of Firm Capacity

The O.D. of the CDEC-SING proposes that the valuation of the peak capacity transfers and the corresponding payments between generators shall be done according to the following procedure:

a) The injections of Firm Capacity and the withdrawals of peak capacity of each generator involved, shall be determined at the bars of the substations where capacity transfers between generators are produced; this injections and transfers shall be valued at the instantaneous marginal cost of the corresponding peak capacity.
b) For each generator, all the valued net injections and withdrawals referred in letter a) shall be added algebraically. The injections shall be considered with a positive sign and the withdrawals with a negative sign. The resulting value, with its sign, shall constitute the net balance of each generator.

The generators with deficits, shall pay their déficit of capacity to the generators with surplus in twelve monthly installments, during the corresponding year, considering the variation of the marginal cost of the capacity experiments.

2.14 Instant marginal cost of capacity in Peak hours

Corresponds to the basic price of the capacity established by the Commission for the sales of capacity to the distribution companies, contained in the technical report that calculates the node prices and excluding the adjustment of the band of prices of the non regulated clients.

The O.D. of the CDEC-SING considers that this cost is located in the node or the nodes of the SING where the aggregation of a marginal generation unit of installed capacity is more economically convenient.

2.15 Capacity Price in the different substations of the SING

For the rest of the substations of the SING, with respect to the substation mentioned in the previous numeral, the O.D. of the CDEC-SING shall calculate the marginal instantaneous cost of the capacity in peak hours based on the the instant marginal cost defined in the most convenient node, considering the marginal losses of energy of the transmission system that result from the Firm Capacity flow analysis.

In case that the marginal instantaneous cost of capacity in peak hours is calculated in more than one node, the marginal losses shall be referred to the node with which the least value is obtained.

2.16 Firm Capacity Flow Analysis

To determine the losses in the transmission system, the O.D. of the CDEC-SING proposes to run a load flow analysis with the firm capacities of the generation units and the peak hourly capacity demands of the generators, according to the following mechanism:

a) A fictitious power plant is considered to exist in the load center of the SING.
b) The Firm Capacity flow helps to determine the capacity losses, whose value shall be consistent with the aportes of Firm Capacity of the generation units and the demand of peak capacity of each generator.
c) The capacity of the fictitious power plant is obtained; this value guarantees the equilibrium equation between supply of Firm Capacity and the demand for peak capacity.
d) The peak capacity demands of the generators are adjusted in proportion to the variation of the transmission losses, conserving the maximum demand of the SING in each iteration.
e) The process is repeated until the production of the fictitious power plant is eliminated. The peak capacity demands of the generators in the different substations of the SING, are obtained after the iterative process.

2.17 Treatment of the generation units that present extended failures

For the treatment of the generation unit that presents a failure that limits partial o totally its capacity for a period of fifteen (15) or more days, the O.D. of the CDEC-SING proposes that the owner company or the operating company can

request that this event shall be treated in a way that it is not computed in the calculation of the rate of availability; in this case, the installed capacity used for the calculation of the Preliminary Firm Capacity shall be determined based on the available capacity of the generation unit during the hours of the failure.

In this regard, the owner or the operating company shall present a detailed report to the Directory within the first thirty (30) days of the declaration of the failure. The Directory shall approve or reject the request based on the submitted information, requiring a simple majority for the approval.

CHAPTER IV RECOMMENDATION OF THE COMMITTEE OF EXPERTS

Based on the presentations and requests of the member companies of the CDEC-SING; the legal dispositions, the regulation and resolutions, the Committee of Experts recommended the following:

4.1 "To approve in general the unique and complete proposal of the Operations Direction related to the calculation procedure of Firm Capacity the valuation of the peak capacity transfers between members for year 2000 and for the following years, established in the Procedure Manual of the Internal Rules about the calculation of the Firm Capacity and the determination of the balance between member generators, because it satisfies both the electrical regulation and the R.M. Exta. Nº 17."

4.2 "To avoid the modification of the proposal of the Operations Direction including economical dispatch criteria. In relation to embankings, startup times and load increase, it is recommended to maintain the Procedure Manual, without prejudice that a study will be conducted to demonstrates that que the calculation of the Firm Capacity represents appropriately the technical characteristics of the generation units, using sensitivity analysis or other methods of Computer Science for the determination of optimal parameters."

4.3 "To verify the proposal of the Operations Direction about the determination of the Capacity Price."

CHAPTER V ANALISIS OF THE COMMISSION NACIONAL DE ENERGY (CNE)

1 INTRODUCTORY CONCEPTUAL FRAMEWORK

1.1 Introduction

The remuneration of the capacity of generation is still an open debate in the different international electrical regulations, particularly in those countries where reforms have implemented models of competitive markets for the operation of the power sector. The existence of this permanent debate has motivated diverse actions of the regulatory agencies in this issue, whose objectives range from seeking the stabilization of volatile financial revenues in the generation activity to reduce its risk, to remunerating explicitly the capacity by assigning capacity generation through the more diverse forms and procedures, to even obliging the consumers to certain levels of capacity contracting.

The majority of the electrical systems include the remuneration of capacity through the assignment of capacity, with diverse objectives and through different mechanisms. The fundamental objective is to guarantee the supply in the short and long term (Reliability); therefore, the mechanisms of assignment of capacity shall at least seek the reduction of uncertainty or the increase of the stability in the revenues of the generators, reducing also the levels of risk that the new generators must confront.

These concepts are not deeply rooted in our power market; additionally, our regulation does not contemplate the existence of a market of Ancillary Services at the level of generation. These two facts have caused that at the statuitory level, there is a joint recognition of concepts associated to the remuneration of the capacity, on one side, and also the recognition of attributes that support the security of the system, on the other side, in a unique generical and remunerable attribute, namely, the Firm Capacity of the generation units.

Consequently, the presentations of the different companies both in the SIC and the SING in relation to this discrepancies[2], have differences with respect to the definition that shall be given to the concept of Firm Capacity and to its objective in the regulatory scheme. Without prejudice to the discrepancies with respect to specific aspects of the procedure developed by the O.D., the proposals and positions of the companies allow the identification of two basic or fundamental approaches to the concept of Firm Capacity: one approach is in the area of the Adequacy of the system and the other is in the area of the Security.

For this reason, and to introduce the analysis of this Commission, a conceptual introductory summary that precises the terminology will be presented in the following sections of this report.

[2] Discrepancies have been presented in both the CDEC-SIC and the CDEC-SING, with respect to the calculation of the Firm Capacity, with common conceptual discrepancies.

1.2 Reliability

To attain acceptable levels of Reliability in the system, is an objective wished both by the regulator authority and by the consumers; the investors also have the same objective and they also seek that their revenues are consistent with the required or permitted levels of Reliability.

The concept of Reliability, present in the regulations of the USA and in the regulations in Europe, allow the evaluation of the performance of a system through attributes that guarantee the supply in the short and long term. These attributes are the Adequacy, the Security and the Quality, which are different concepts, although necessarily related because, jointly, they allow the characterization of the performance of the electrical system.

1.3 Adequacy

The Adequacy is determined by the quantity of installations and resources sufficient to supply the demand. In the particular case of the segment of generation, this concept is inderstood as the quantification of the total installed capacity of generation, without weighting qualities or attributes of each one of the generation units that are not related with the presence of the generation unit in the system; this presence is not necessarily deterministic.

For the case of the hydraulic park, it is important to recognize that the supply of capacity is highly dependent of the existing hydrological conditions. For this reason, from the point of view of the assignment of capacity, it is relevant to include in the discussion a risk analysis that considers the supply of capacity, and its corresponding assignment, in extreme hydrological scenarios so as to guarantee a level of supply of this park with a high probability.

For the case of the thermal park, in case of the existence of restrictions of the fuel resources, it is consistent to include in the discussion a risk analysis, equivalent to the one of the hydraulic park, considering the vulnerability that can affect the system to count with the supply of the fuels used by its power plants.

In this context of the Adequacy, there are some underlying concepts widely installed in the internacional technical literature, such as the "Loss of Load Probability " (LOLP) and its derivated indexes (LOLH, LOLE, etc.); this concepts are used for the quantification of the probability of not being able to supply the energy and capacity demands in the long term.

1.4 Security

The Security is associated with the capacity of response of the system, or of a part of it, to withstand contingencies and to minimize the loss of consumptions.

In other words, given a condition of supply, it is vital to know if under such condition the system is capable of withstanding different types of disturbances. If the system is not capable of confronting such disturbances without loosing part of the load, it will require the presence and management of a set of technical and

operational resources to improve the capacity of response. These resources can be of different nature, like the following:

- Reserve of active capacity for the regulation of primary and secundary frecuency; to do so, it is vital to have generation units that can carry load rapidly.
- Interruptible consumptions that allow the instantaneous recovery of frecuency.
- Capacity of contributing with reactive capacity in order to control the voltage levels in the different substations of the system.
- Generation units of cold startup to face contingencias; to do so, it vital to have generation units that can startup rapidly and that increase load rapidly.

In this context of the Security underlie diverse deterministic criteria to operate the systems, such as the "Criterion n-1" both for generation and for transmission, or "Rotating reserve" greater than or equal to the biggest generation unit operating in the generation system.

In regulations more advanced than the chilean regulation, the existence and management of these resources has been organizado under the concept of a market of Ancillary Services (SS.CC). The SS.CC. are tradable resources of active and reactive supply available in the installations of the electrical system that allow the maintenance of the equilibrium between supply and demand, in normal conditions and in the presence of disturbances, necessary to make the physical transactions between the different agents and to comply with the basic conditions of Security and Quality .

Therefore, an important conceptual vinculation can be established between Adequacy, Security and SS.CC. The SS.CC. exist because the Security requires them. At the same time, the Security can be obtained, through the SS.CC., because the resources exist or are available in the installations of the system, which means that the Adequacy exists.

1.5 Quality

The system requires to operate with Security because generators and consumers require that the electricity that they trade has some attributes or properties. This set of attributes or properties of the electricity originate the concept of Quality which is subdivided in at least 3 components:

- Quality of the Product to grade the magnitude, frecuency and contamination of the instantaneous voltage of supply and others.
- Quality of the Supply to grade the frecuency, depth and duration of the interruptions of supply.
- Quality of Commercial Service to grade the commercial atention delivered, characterized by terms for reconnection of interruptions, information delivered to the client, punctuality in the delivery of bills or invoices, attention to new clients and others.

Since generators and consumers require trading electricity of a given Quality, then the system shall operate with Security. The resources needed to operate the system with Security and to achieve such Quality are the resources associated to the SS.CC. Finally, there will be coexistence of Security-SS.CC.-Quality, if and only if, there are sufficient installations and physical resources to supply the demand, which is equivalent to having Adequacy.

1.6 Proposals and Positions presented to the CNE

It has been pointed, that both the discrepancy related to the calculation procedure of Firm Capacity that originated in the CDEC-SIC and the one that originated in the CDEC-SING, show the existence of discrepancies about the definition of the concept of Firm Capacity. Without prejudice to the specific discrepancies related to the procedure, and to the discrepancies that originate in the constructive nature of the respective electrical systems, there are two diverging positions with respect to the fundamental concept; this positions will be summarized below.

1.6.1 Firm Capacity as a signal of Investment and Adequacy

This conceptual approach corresponds to the concept in which the Firm Capacity appears as a derivative of the economical good known as capacity, in other words, associated to the complement of the remuneration that added to the remuneration obtained by the sales of energy at marginal cost, permits profiting at a given rate, from a generator park adapted in its investments and optimal in its operation[3]. A conceptualization of this type, plus some statistical (originated in the existence of unavailabilities of the units), hidrologic (to consider the vulnerability of the hydraulic park) and technological sophistications (as a function of the production costs), were the supporting axis of the old methodology of the derogated S.D. N° 6 of 1985.

This conceptualización points to the Adequacy because its application is oriented to dimension the generator park that is sufficient to supply the maximum demand with a given probability, without considerations to the security in the operation, and achieving an optimality in investments and operation that conceives the electical supply as a static phenomenon or of long term.

1.6.2 Firm Capacity as a signal of Investment and Security

This position, llevada a su extremo, contains a conceptual element radically different to the previous position that conceives the Firm Capacity as an attribute of the generation units that ressembles its ability to contribute with the Security of the system and to value the capacity of responding to sudden requirements of capacity.

This conceptual position originates from the "opening" to the issue of the Security that is implícitly generated by the Supreme Decree No. 327 (S.D. N° 327) when it refers, among other aspects, that the calculation of the Firm Capacity shall consider the startup times and the load increase of the generation units (Article 261° of the S.D. N° 327).

In this way, the S.D. N° 327 introduces and aggregates in the conceptualization of the Firm Capacity, the capacity of response of the generation units to the sudden requirements of capacity.

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[3] See Appendix.

2 ANALYSIS OF THE REGULATION

2.1 References to Firm Capacity in the DFL N° 1 of 1982

There is no register in the text of the DFL N°1 of the term "Firm Capacity", or of any similar expression. Neither, a section with a conceptual approximation of the term, or an association of the term with some product with an economical value that shall or can be traded between the generators. The study of the legal relevant regulation associated to the matter in analysis only permits saying that the law indicated the existence of two different economical goods, the energy and the capacity, destined to be supplied to the final electricity consumers.

For example, in the regulation of transmision tolls, the DFL N°1 indicates:

Article 51° B:

"When a power plant is connected to an electrical system whose lines and substations in the area of influence of the power plant are owned by a third party, it shall be understood that the owner of the power plant is using effectively such installations, independently of the place and of the way of trading the capacity and energy produced by the plant; therefore, the owner of the plant shall pay the corresponding tolls to their owner ..."

Article 51° C:

"...The tariff reveneue is the quantity received by the owner of the lines and substations due to the differences produced in the application of the electricity node prices that are valid in the different nodes of the area of influence with respect to the injections and withdrawals of capacity and energy, in such nodes...".

When establishing the different levels of regulated prices, the legal rule indicates:

Article 96° :

"In the electrical systems whose size is greater than 1.500 kilowatts of installed capacity of generation, there shall be two levels of prices subject to regulation:

1. Prices at the level of generation -transport. These prices shall be denominated "node prices" and shall be defined for all the substations of generation -transport where the service is supplyed. The node prices shall have two components: the price of the energy and the price of peak Capacity..."

Article 98°:

"The node prices shall be established every six months in the months of April and October of each year. These prices shall be adjusted pursuant to the stipulations of article 104°, whenever the price of peak Capacity or the price of energy experiment a cumulative variation higher than ten percent, resulting from the application of the indexation formulas that have been determined in the last half-yearly tariffication process."

Article 99º:

"For each half-yearly tariffication process, the node prices shall be calculated in the following way:

1. A programme of generation and transmission proyects is determined, based on a forecast of the demands of peak capacity and energy of the electrical system, for the next ten years; the program considers the existing installations and the works under construction, that minimize the total updated cost actualizado of supply, corresponding to the sum of updated expected costsa of investment, operation and rationing during the study period;

2. With the programme of electrical works defined previously and considering basically the energy demand, the water stocks in the reservoirs, the operation costs of the installations, the rationing costs and the rate of discount indicated in letter d) of article 100º, the operation of the electrical system that minimizes the sum of the updated cost of operation and rationing, during the study period, is determined. For the operation of the system defined previously, the marginal costs of energy of the system are calculated, including the rationing component in the first months of operation, with a minimum of twenty four and a maximum of forty eight months; the values obtained are weighted with ponderation factors that correspond to the updated demands of energy during that period. The value thus obtained is denominated basic price of the energy; the rationing cost is the cost per kilowatthour that was spent in average, by the consumers when they had no energy, and had to generate it with emergency generators, if it was the case. This rationing cost shall be calculated as a unique value and shall be representative of the most frecuent deficits that can occur in the electrical system.

3. The type of generation units that are more economical to supply additional capacity during the hours of maximum annual demand of the electrical system, are dertermined. The marginal annual cost of increasing the installed capacity of the electrical system with this type of generation units, are determined. This value is increased in a percentage equal to the reserve margin of theoretical capacity of the electrical system. The resulting value of the previous procedure is denominated the basic price of the peak capacity;

4. For each one of the substations of the electrical system, a penalty factor for the energy, is determined; the factor multiplyed by the basic price of the energy obtained according to the procedure described in the present article, determines the price of the energy in the respective substation;

5. For each one of the substations of the electrical system, a penalty factor for the peak capacity, is determined; the factor multiplyed by the basic price of the peak capacity determines the peak Capacity Price in the respective substation ;

6. The calculation of the penalty factors of the energy and of the peak capacity, referred in numerals 4 and 5 respectively, is done by considering the marginal losses of transmission of energy and peak capacity respectively, for the

transmission system operating with a level of load such that the system is economically adapted;

7. All the costs that are used in the calculations indicated in the present article, shall be expressed at the prices existing in the months of march or september, accordingly to the month of april or october, in which the tariffication processes was held, of the corresponding year.

Article 101°:

"The companies and entities which are mentioned in article 100° shall communicate to the Commission before March 31 and September 30 of each year, their agreement or their observations to the technical report ellaborated by the Commission. Jointly with their approval or the observations, each company shall communicate to the Commission the capacity, the energy, the point of supply and the average price charged for the sales to non-regulated clients during the last six months.

The Commission can accept or reject total or partially the observations of the companies; nevertheless, the definitive node prices defined by the Commission shall not differ from the non-regulated prices in more than ten percent..."

Also in the structure of costs of the distribution companies:

Article 116°:

"...the exploitation costs for the distribution companies are the value of the energy and of capacity required for the activity of distribution, calculated with the node prices valid in the point of connection with the distribution installations, the operating costs of the distribution system, the costs of conservation and maintenance, the costs of management and the general costs, the taxes and contributions, the insurances, the technical consulting..."

Finally, in the definitions of the Article 150°:

Article 150°:

" For the application of this law, the following must be understood:
...
c) Load Curve: Graphic that represents the capacity produced in the electrical system as a function of the time .
Peak capacity: Maximum capacity in the annula load curve. ..."

Of the transcribed articles, corresponding to all the articles relevant to the present matters, it is clear that the legislative considered the existence of the economical goods energy and capacity as different goods, without prejudice to the relationship of interdependence that both concepts have in the technical aspects. Both, the energy and the capacity correspond to economical goods that are destined to the consumption of the final clients who have supplies subject to price regulation, establishing for each one a different price pursuant to the rules contained in article

96° and in the following articles. The same occurs with the final clients that are not subject to price regulation, to which the law establishes the possibility of a separate trading of the energy and the capacity pursuant to the transcribed Article 101°.

The conclusion is that the idea of "Firm Capacity", in its functional meaning, is the economical good that is traded between the members of the CDEC, and that is destined to comply with the obligations of the supply that are maintained with the final consumers; therefore it is a statutory concept.

The legal omission of the existence of an incidental capacity transfer between the generators - or of Firm Capacity- is obvious when considering the stipulations of the Article 91° of the DFL N°1:

Article 91°:

"...The energy transfers between electrical companies, that posses generation sources operated in synchronism with an electrical system and that are the result of the application of the operation coordination mentioned in article 81°, shall be valued according to the instantaneous marginal costs of the electrical system. These costs shall be calculated by the organism in charge of the coordination of the operation or the economical dispatch load center."

In other words, the legal regulation only established the existence and the form of valuation of the energy transfers between the participants of the generation market, making evident the exclusive statuitory origin of the concept of capacity transfer - or Firm Capacity - between generation companies.

Up to this point, and without prejudice that the existence of capacity transfers between generators are considered under the framework of legal rules, consistent with the economical and regulatory principles that support it, and necessary for the financial stability of the sector, it is concluded that any methodology for the calculation of the Firm Capacity can only be validated administratively under the scope of the regulation in force, without prejudice of its necessary validation in the plane of the technical-regulatory ideal[4].

2.2 The Supreme Decree N° 6 of 1985

Without prejudice that, administratively speaking, both the concept of Firm Capacity and the procedures for its calculation, are delimited by the stipulations of the statuitory regulation in force, it is useful to analize what the old rules, applicable to this matters, established with respect to this concept.

The S.D. N° 6 of 1985, also denominated Rules of Coordination[5], derogated in 1998 by the actual S.D. N° 327, introduced formally the concept of peak capacity transfers between members of the economical load dispatch centers, by defining "Firm Capacity" to the capacity that a generation company can offer to supply its

[4] It is not meant with this, that a firm capacity methodology is exempt, ipso facto, of a reproach of illegality. It means that its definition and objective must be seeked in the statuitory rule.
[5] "Rule of Coordination of the Interconnected Operation of the Generation Centrals and the Transmission Lines".

peak capacity demand. This is not an explícit definition in the derogated Rules, but an interpretation of the following rules:

Article 27° (S.D. N° 6, 1985):

> "The total transfer of peak capacity between a member of the CDEC and the rest shall be equal to the diferencia between its peca capacity demand and its Firm Capacity.
>
> Peak Capacity demand of a member is the maximum average hourly gross demand contracted with its clients in the annual peak hours of the electrical system. It is calculated by the CDEC considering the individual demands of the clients and an estimate of the diversity factor and of the transmission losses.
>
> Peak hours are those hours of the year in which the maximum demand of capacity of the electrical system is produced ...
>
> ... Firm Capacity of a member shall be understood as the sum of the firm capacities of its own generation units ..."

The same article gives more antecedents with respect to the conceptual characteristic of this "supply of capacity" by establishing, step by step, the way in which its value is determined. Effectively, it is established that:

> "The Firm Capacity of each one of the generation units of the system shall be calculated as follows:
>
> 1. The total capacity that the set of all the generation units are capable of guaranteeing in the peak hours, is determined, with a probability higher than or equal to the one defined in the Internal Rules. The minimum value of such probability shall be equal to 0,95.
>
> 2. The same calculation is repeated retiring the generation unit whose Firm Capacity is under evaluation.
>
> 3. The difference between the total capacity obtained in 1, and the total capacity obtined in 2, is calculated. This difference is denominated the preliminary Firm Capacity of the generation unit in evaluation.
>
> 4. The difference between the sum of the preliminary firm capacities of all the generation units of the system, and the total capacity calculated according to 1, is determined. This difference is denominated total residue.
>
> 5. The Firm Capacity of each generation unit is calculated by subtracting from the preliminary Firm Capacity a residue that shall be equal to the proportion of the total residue calculated in 4 according to the difference between the installed capacity of each generation unit and its average capacity. The average capacity of each generation unit

> is the installed capacity multiplyed by its average availability in peak hours ..."

The five steps that lead to the calculation of the Firm Capacity of a generation unit show what was understood as the supply of capacity, pursuant to S.D. N°6 of 1985. The first three steps indicate the underlying concept, while the remaining two steps represent an adjustment that does not improve the basic definition. According to this, an explicit definition of Firm Capacity can be attempted, ressembling the first time that this concept appears in the electrical regulation:

Firm Capacity of a Generation unit (implicit definition in the S.D. N° 6, 1985)

It is the contribution of capacity of each generation unit to the total capacity that the system, or the whole set of generation units, can guarantee with a given probability in the hours in which the maximum demand of capacity of the electrical system is produced.

In this way, it is verified that in the S.D. N° 6 the Firm Capacity is a probabilistic concept that acknowledges a random performance to each generation unit, and to the whole generation park; this randomization in the case of the total generation park is originated precisely in the random performance of its components. Also, and in terms of the Adequacy, the editor of the Decree was interested in achieving that the random performance in the operation of the complete system did not risk the supply of the demand of capacity in the hours in which the maximum value or requirement is produced to the system –peak hours – with a given probability accepted previously.

2.3 The Supreme Decree N° 327 of 1997

The Supreme Decree N°327 of 1997, is the regulation in force since september 1998, and is the basis for the recommendation of resolution container in the presente report. This Decree tackled directly and explícitly the concept of Firm Capacity, changing the orientation of its definition towards a different meaning from the one conceived by the preceding S.D. N° 6. We indicate that it is a "different meaning", and not a "radically different" or "slightly different" because this constitutes the esence of the analyzed discrepancy according to the presentations of the companies in conflict.

The rules of the S.D. N° 327, that are relevant to the matters under analysis, are transcribed below:

Article 257:

> "The transfers of electrical energy that occur between generators shall ver understood as constituted by its basic components of energy, expressed in kilowatt hour, and of peak capacity, expressed in kilowatt."

Article 258:

"The peak capacity of a generator is the maximum average hourly gross demand contracted with its clients in the annual peak hours of the respective electrical system. It shall be calculated by the CDEC, considering the individual demands of those clients and an estimation of the associated diversity factor and of the transmission losses."

Article 259:

"Each generator shall be in conditions of satisfying, in each year, its capacity demand in peak hours, considering the own Firm Capacity and the Firm Capacity bought from other generators that operate in synchronism with the system. For each generator, the CDEC shall verify the observance of this, by performing a balance of Firm Capacity .

The Firm Capacity of a generator is the maximum capacity that it would be cazable of injecting and transporting in the transmission systems in the System's Peak Hours, considering its probable unavailability. The probable unavailability shall correspond to the sum of the firm capacities of its own generation units and of the firm capacities contracted with third parties that operate in synchronism with the system."

Article 261:

"The Firm Capacity shall be obtained by multiplying the preliminary Firm Capacity by a unique factor, equal to the ratio between the maximum demand of the system and the sum of the preliminary firm capacities.

The preliminary Firm Capacity of a generation unit shall be obtained by considering the expected capacity contributed by the generation unit for a security level of the system equal to the probability of exceding the Firm Capacity.

The probability of exceding the Firm Capacity shall be calculated with the following expression:

$$PEPP = 1 - LOLPhp$$

In which:

- PEPP is the probability of exceding the Firm Capacity.
- LOLPhp is the loss of load probability in peak hours.

La loss of load probability in peak hours is the probability that the maximum demand of the system is gratger than or equal to the offer of capacity of the generation units available in the period defined as peak period.

Peak hours are those hours of the year in which there is a greater loss of load probability of the system, in other words, the probability that the demand of the system is greater than o equal to the offer of capacity of the generation units available in those hours.

In the calculation of the preliminary Firm Capacity one must consider the mechanical unavailability, the hidrological variability, the level of the reservoirs and the times necessary for the startup and for load increases of the generation units that permit the response to short term failures of the system. The Internal Rules of each CDEC shall define the procedures to obtain the parameters that shall be used to represent the unavailability, which can be based in national and international statistics and in the characteristics of each generation unit. The CDEC can verify, in the terms established in the Internal Rulles, the effective unavailability of the generation units, by performing operation tests to those generation units.

The Internal Rules shall indicate, explícitly, the procedures that will be used to define the System's Peak Hours, to calculate the loss of load probability in peak hours and the Firm Capacity of each one of the power plants. It shall also indicate the methodology to assign to each generation unit the mechanical unavailability, the hidrological variability, the effects of the level of the reservoirs and the times necessary for the startup of the generation units and for the load increases. The Internal Rules shall indicate the sources of statistical information that shall be used in the case of the existing power plants and of the new power plants."

Article 260:

"The peak capacity transfers between generators shall be valued at the marginal cost of the capacity indicated in article 262.

The calculation of the peak capacity transfers for each year, shall be done in december of the previous year, considering the maximum forecasted demands for each generator interconnected to the respective system. The CDEC shall communicate, before december 31, the corresponding payments that shall be done between generators in the following year. These payments shall be done twelve installments, during the corresponding year, considering the variations experimented by the marginal cost of capacity.

Nevertheless, during the period in which the maximum annual demands of the electrical system occur, the CDEC can recalculate the peak capacity transfers, modifying in the previous calculation only the maximum demands effectively produced, the date of the commercial operation of the power plants that were incorporated to the system and other relevant parameters. The Internal Rules shall establish the way in

which the generators shall pay the differences that were produced by this concept."

Article 262:

"The instantaneous marginal cost of capacity in peak hours (CMgP), shall be calculated in the following way:

$$CMgP = CMCG/DUPA$$

in which:

- CMCG is equal to the annual marginal cost of increasing the installed capacity of generation of the electrical system, calculated according to article 277; and

- DUPA: is the annual availability in per one (0/1) of the more economical generation units to supply additional capacity during the hours of maximum annual demand of the electrical system considered by the Commission for the calculation of the node prices that is in force.

The instantaneous marginal cost of capacity in peak hours defined previously, shall be located in the node or in the nodes of the system that are more convenient economically to aggregate a marginal unit of installed capacity. For the rest of the nodes of the system, the instantaneous marginal cost of capacity in peak hours shall be calculated based on the CMgP, considering the marginal losses of energy of the transmission system in the peak hour of the system. In case that the instantaneous marginal cost of capacity in peak hours is calculated in more than one node, the marginal losses shall be referred to the node with which the lesser value is obtained."

The transcribed articles show the visualization and description that the regulation in force makes of the concept of Firm Capacity.

Please note again the formal definition of Firm Capacity declared in the S.D. N° 327:

Firm Capacity (Article 259°)

"The Firm Capacity of a generator is the maximum capacity that it would be capable of injecting and transporting in the transmission systems in the System´s Peak Hours, considering its probable unavailability"

The previous definition, perfectly formal and declarative, is still very general and unsufficient to limit the concept. Please note the complementary contribution of Article N°261:

> "The Firm Capacity shall be obtained by multiplying the preliminary Firm Capacity by a unique factor, equal to the ratio between the maximum demand of the system and the sum of the preliminary firm capacities.
>
> The preliminary Firm Capacity of a generation unit shall be obtained by considering the expected capacity that the generation unit would contribute for a level of security of the system equal to the probability of exceding the Firm Capacity"

If the first paragraph of Article 261° is interpreted as an adjustment to the procedure -not irrelevant in the practice, but accesory in terms of the concept – then the essential part of the concept "Firm Capacity" is contained in the "preliminar Firm Capacity". Thus, and admiting the force of the second paragraph in its conceptual support, we see that it is similar to the definition extracted from the derogated S.D. N° 6. Effectively, if one considers that the probability of exceding the Firm Capacity is equal to one minus the loss of load probability in the System's Peak Hours, and that this last term is equal to the probability that the maximum demand of the system is greater than or equal to the supply of capacity of the available generation units in the peak period, then the probability of exceding the Firm Capacity is equal to the probability that the maximum demand of the system does not excede the supply of capacity of the available generation units in the peak period.

Then, minimizing the relevance of the characteristic of "preliminary" of the Firm Capacity in the second paragraph, and replacing the expression "probability of exceding the Firm Capacity" by the expression that has been demonstrated to be equivalent, we obtain the following synonym expression for the second paragraph of Article N° 261:

> "The Firm Capacity of a generation unit is the expected capacity that the generation unit would deliver for a given level of security of the system equal to the probability that the maximum demand of the system does not excede the supply of capacity of the available generation units in the period defined as peak period."

It is convenient to stop here in the development of this analysis, to make an explanation of great relevance.

The expression "level of security of the system", or more precisely, the term "security " expressed in the second paragraph of Article N°261, shall not be confused with the security of service that has been referred in the introductory sections of this analysis. Effectively, the "security" that is pointed in the cited rule makes reference to the quality of greater or lesser certainty or confidence in the ocurrente of a possible disruption, in this case, that the demand of capacity does not excede the supply of capacity, and not to the robustness or firmness that the system presents to face any disturbance[6]. In other words, a given probability is assigned to an event to assure or guarantee its ocurrence.

A comparison can be observed between the definition developed from the text of the S.D. N° 327 and the definition extracted from the S.D. N° 6. Both definitions indicate basically the same: that the Firm Capacity of a generation unit is the contribution of capacity that this generation unit can make to guarantee (assure), with a given probability, that the total capacity delivered by the system excedes the maximum demand in peak hours, after observing the randomness in the performance of the generation units that integrate it.

This permits evidencing the stability or conceptual permanence of the Firm Capacity further than a succesion of the two statuitory bodies that define it. Nevertheless, the S.D. N° 327 considered some additional elements. Effectively, the last paragraph of the same Article 261° established additionally the following:

> "... the calculation of the preliminary Firm Capacity shall consider the mechanical unavailability, the hidrological variability, the level of the reservoirs and the times necessary for the startup and for the load increases of the generation units that allow the response to the short term failures of the system..."

The considerations expressed in this paragraph, whose inclusion is obliged in the calculation procedure of the Firm Capacity of a generation unit, cannot be understood as mere components of the procedure oriented to determine the value of its Firm Capacity, with this concept definitively delimited by the preceding paragraphs. Those considerations, because of the nature of the technical phenomena that they represent, necessarily complement and close the final definition of the concept, giving a different meaning to the expression "Firm Capacity" than the one existing in the derogated regulation. The Firm Capacity of the S.D. N° 327, in force, is not the Firm Capacity of the derogated S.D. N° 6; due to this, the calculated mega-watts of Firm Capacity of a generation unit in the context of the derogated regulation, do not add the same quantity of mega-watts that for the same unit shall be calculated according to the present regulation.

To understand the validity of the concepts expressed above, and without loosing the general perspective that sustains this part of the analysis, one can disregard – momentarily- of the considerations relative to the hidrological aspects, this means,

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[6] "Secure: Meaning 3: Firm, constant and that is not in danger of failure or fall.
Meaning 5: Security, certainty, confidence" (Real Spanish Academy Dictionary)

"the hidrological variability" and "the level of the reservoirs", only typical of the electrical systems of hidrothermal nature like the Central Interconnected System. The same can be done with the concept of "mechanical unavailability", that constitutes a characteristic of any generation unit, but that in our concept can be omitted of an analysis oriented to identify the the meaning that the S.D. N° 327 gives to the Firm Capacity. Effectively, the "mechanical unavailability" can only be understood as the technical parameter that considers the rate of failure of the units and that is the origin of the random performance of the capacity supply of the system; this means that the concept is common to the both the regulation derogated and to the one in force. It is also obvious, that such concept is not related -in the logic of the DS° 327- to the other listed aspects of the paragraph in analysis, because it is understood that the non hierarchical enumeration of the listed aspects, is synonym, of their conceptual independence.

The considerations relative to the aspects that are new and also common to the Central Interconnected System and the Northern Interconnected System, and in fact, to any electrical system of the world, are maintained. These are "the times necessary for the startup and for the load increases of the generation units that allow the response to short term failures of the system".

The times required for the startup of the generation units, and the times required for the load increases, as technical attributes that allow the response of the system to short term failures, configure a group of technical aspects that must be taken in account when an electrical system is characterized in terms of its security of service. Rapad times of carry of load, rapad processes of startup, are effectively attributes that make an electrical system more secure because they allow the system to respond to sudden requirements of capacity produced by failures in the components of generation and transmission, or other disturbances such as the sudden disconnection of loads, etc.

Then, the S.D. N° 327 obliges the acknowledgement of these attributes whose presence is desírable in the electrical system, recognizing the fact that they imply an additional economical cost and, thus, need to be adequately remunerated. This is achieved by incorporating such remuneration as part of the remuneration that each generation unit of the system receives for Firm Capacity. This is the new underlying meaning of the expression Firm Capacity in the regulation in force; this means, the contribution of capacity that each generation unit is capable of delivering to the adequacy of the system, understanding that this adequacy is guaranteed with a given level of probability, and the contribution of each unit to the security of service of the electrical system, always in peak hours.

Please note again the formal definition of Article 259°:

Firm Capacity (Article 259°)

"The Firm Capacity of a generator is the maximum capacity that it would be capable of injecting and transporting in the transmission systems in the System's Peak Hours, considering its probable unavailability"

Now the general aspect of the preceding definition is better explained, because it is necessary if the objective is to incorporate under one statuitory concept two technical concepts diverse and independent. In this same sense, the "probable unavailability" mentioned in the definition, can only be understood in its widest sense as the condition, non deterministic, that a generation unit has to confront a requirement of capacity, sudden or programmed.

2.4 Conclusions of the Legal analysis

The following conclusions can be drawn from the reasoning in this report thus far:

The meaning of the expression firm capacity underlying in the text of S.D. No. 327, is different from the meaning this expression had in the preceding overruled legislation, which must lead to expect differences in the values determined as per each concept, provided calculations being equal.

The current meaning of firm capacity includes an only concept ruling two distinct and independent technical concepts. Firm capacity, acknowledging attributes which contribute to adequacy, and firm capacity acknowledging attributes which contribute to electrical system security.

3 CONCEPTUAL RELATIONSHIP AMONG ADEQUACY, SECURITY, AND FIRM CAPACITY

As per the reasoning in the points above, we accept to be valid that S.D. No. 327 redefined the firm capacity concept, increasing its scope regarding the meaning that the same expression had within the legislation that was derogated by the S.D. No. 327. Consequently, firm capacity being a regulatory and remunerable attribute in each generation unit, not only acknowledges the contribution of each unit to the adequacy of the generation park, but moreover the contribution of capacity that this unit is capable of giving to the service security. i.e., it acknowledges the capacity the unit is capable, within a certain probability, of supplying or offering considering programmed capacity requirements and sudden capacity requirements.

The following statements could be made at this point:

- Two units with equal unavailability and capacity will have a different firm capacity if one of them can respond with greater speed than the other in undertaking carry of load processes and in the presence of contingencies. The fastest unit's firm capacity will be greater.

- Two units with equal capacity, load increase rate, and startup times, but with different unavailabilities, will have a different firm capacity, where the one with the better ranking of unavailability will be considered to have a larger firm capacity than the other.

Nevertheless, consider the following case:

- Two units with identical unavailabilities, with different capacities, and different response capabilities for the startup and load increase processes. ¿Which one has a larger firm capacity? The answer depends on how each attribute is relatively weighted.

The issue of weighting all the attributes in one unit in order to assign in one scalar one value that acknowledges all of them simultaneously, underlies the conflict under analysis.

Whereas, as it has been pointed out in previous chapters to this report, more advanced regulations than the Chilean tend to quantify and to value consistently and separately these attributes according to their opportunity costs, which to this Commission's judgment is the correct view of the problem. The regulatory requirement of acknowledging an only value and price associated to an attribute, which is also understood to be unique, justifies in this case an integrating type analysis effort.

In fact, whichever the case, the issue is acknowledging the capacity each unit possesses to provide, with a certain probability (to assure) a certain instant capacity level to the system, i.e. the same physical effect. The issue is when can this capacity be supplied by it, or likewise, if capacity can be supplied when it shall be required. The economic characteristic of the problem lies within the issue above, since it is a matter of matching capacity offer with capacity demand, not only in magnitude, but also in the opportunity in which such demand is produced as well.

Consequently, undertaking the analysis of demand behavior (or instant capacity requirement) and its dynamics should proceed.

System demand, and hence the demand each unit must cope with, varies instantaneously on time. Nevertheless, whichever the speed and the amplitude of its variation, the system must be reasonably prepared at any instant to satisfy the "next instant" demand. Thus, regardless of the type of preparation for future demand, and whether this demand is immediate or within a large time frame, the need to characterize its predictability is implied.

3.1 Predictable Aspect of the Demand

As it has been stated, notwithstanding the fact that instantaneous demand varies upon time, both generation technology, as well as real time operation procedures in systems allow supply and demand matching as long as the latter[7] shows a normal behavior. It is understood here that demand follows a normal behavior when it evolves as per clearly known cycles and when sudden events are absent (sudden and unpredicted disconnection of relevant blocks of demanded or supplied capacity within the system). The possibility of the system following the normal demand evolution appears without drawbacks in large systems, where the load is diversified and follows statistically stable consumption patterns. Likewise, in systems where the load is not too much diversified, or it where it is not diversified at all, as in the SING case, per instance, it is possible to coordinate programmed detachment of relevant loads, with which the system can continue supplying the demand without interruptions.

The above means that, if demand follows a basically predictable behavior, whether as a result of the statistical stability of its cycles, the possibility to co-ordinate relevant disconnections, or both, startup times and carry load rates become indispensable, since there always exists a possibility to activate the offer "construction" process in advance, as required. The only requisite is that the

[7] We are not considering, as part of the analysis, the primary frequency regulation requirements, since the cost of such regulation is associated with an energy associated cost. In fact, in regulated prices (node prices) this cost is incorporated within the node price of the energy.

generation park counts with enough units, and these units are to be mechanically available when the requirement is activated.

Then, within the context thus far stated, it is logical to establish that the greatest probability of facing insufficient offer arises at the moment that the maximum demand is expected. Here, the first effect of utmost importance from an economic point of view can be found, since, with the problem exposed per the reasoning in the preceding paragraphs, there lies an interest in the generation park counting with a large enough number of units, which, considering the possibility of each unit of being unavailable when it is required, it can supply peak demand with a certain degree of probability. The cost of counting on these units, independent on whether or not they are fast or slow, is confronted with the cost of failure to supply maximum demand.

3.2 Non Predictable Aspect of the Demand

If demand only had the statistically stable and consequently, basically predictable behavior described in previous paragraphs, the problem of startup times and load carry rates would become technically and economically irrelevant. Nevertheless, a very difficult statisitical representation of the randomness characteristic of the demand is superimposed on the predictable behavior of capacity demand. In fact, the system is permanently exposed to the effects of unpredicted and indeed undesirable events, such as sudden and not programmed load disconnections, sudden failures in generation units in operation, sudden outages of transmission systems supporting relevant capacity flows, among others, which despite the fact they might be due to causes beyond the system operators' control, generally cause immediately and commonly that the system shall be submitted to a sudden capacity requirement. An inadequate -untimely- response of the electrical system can cause its unstableness, a partial loss of supply, and ultimately a Black-Out, all of them phenomena within the scope of service security.

Thus, a partial or total loss of supply and its consequent economic impact in consumers, leads to the need to count with a robust or safe system (according to the costs to be avoided) that is capable of keeping its stability and integrity whenever it is exposed to a set of reasonable magnitude perturbations.

The existence of such events, despite their "normality" in any electrical system, corresponds to abnormal situations or contingencies, when the supply to cope with demand is conventionally characterized as carried out under normality or within "normal conditions".

3.3 Hierarchy of Regulatory Objectives

The differentiation performed with regards to the aspect of demand predictability, as well as its consequent characterization as normal or contingent, leads to ask the question as to whether the technical, economical, and ultimately regulatory objectives conditioning the development and operation of electrical systems can cope with demand, do prioritize the supply towards one "type" of demand or towards the other.

To this regard, see again the following transcription, corresponding to S.D. N° 327:

Article 258:

> "The peak capacity of a generator is the maximum average gross hourly demand contracted with its clients in the annual peak hours of the respective electrical system. It shall be calculated by the CDEC, considering the individual demands of such clients and an estimation of the diversity factor associated with them and with the transmission losses."

Article 259:

> "Each generator shall be capable of satisfying, each year, its capacity demand during peak hours, considering own firm capacity and the firm capacity acquired from other generation facilities operating synchronized with the system. The CDEC will verify compliance with the above for each generator, by carrying out a firm capacity balance.
>
> A generator's firm capacity is understood to be the maximum capacity it would be capable of injecting and transporting through the transmission systems during the system's peak hours, considering its probable unavailability. It shall correspond to the sum of the firm capacities of its own units, and the ones contracted with third parties which operate synchronized with the system.

Article 260:

> "Peak power transfers among generators shall be valued at the marginal cost of capacity, indicated in article 262.
>
> The calculations of peak capacity transfers for each year shall be performed in December, of the previous year, considering maximum expected demands for each generator interconnected to the system. The CDEC shall communicate before December 31st, the payments to be performed among generators during the following year. These payments shall be performed in twelve monthly installments, during the year to which they belong, considering the variations that the marginal cost of capacity might experience.
>
> Nevertheless, once the period in which maximum annual demands occur upon the electrical system has elapsed, CDEC shall be entitled to re-calculate the peak capacity transfers, modifying only actually produced maximum demands in the previous calculation, the date of commissioning of generation units recently incorporated into the system, and other relevant parameters. The Internal Rules shall establish the manner in which the generators shall pay for the differences which might arise due to this concept."

It is obvious that S.D. Nº 327 is mandatory regarding the fact that each generator must be able to satisfy each year its own peak hour demand, which shall require from it a capacity offer that will be acknowledged, which the aforesaid regulation denominates firm capacity. See the following excerpt:

> "The calculations of peak capacity transfers for each year shall be performed in December, of the previous year, considering maximum expected demands for each generator interconnected to the respective system".

In other words, the S.D. Nº 327 demands that each generator shall be in condition to satisfy with its firm capacity supply, a demand of which a forecast is to be made months in advance. Such condition must be verified by CDEC (also mandatory) through a firm capacity balance. The above appears to make irrelevant startup times and load carry rates for the units, since any unit, let it be slow or fast, is actually enabled to offer, and consequently to establish a commitment for a demand that can be forecasted on a disproportionately larger time than the slowest startup, i.e. maximum demand.

In fact, and on the merely commercial side, it is verified that peak hour demands can be forecast, since they are agreed upon, regarding magnitude and opportunity between producers and consumers, because "each generator shall be in condition to satisfy, during each year, its peak hour capacity demand (Art 259° S.D. Nº 327).

It is obvious that all the foregoing: maximum predictable demand (statistical or agreed upon), the regulated capacity balance, consistent sufficient capacity supply, are concepts which are provided and are related coherently in the dominion of normal system operation.

Another element not yet analyzed within this report, lies within the dominion of coherency: price.

In fact, if establishing the characteristics of the economic good "firm capacity" is a difficult task, a more direct alternative approach to the problem by analyzing its price characteristics might be sought, defining the latter without ambiguousness regarding currently standing regulation. S.D. Nº 327 refers specifically to the subject in the articles transcribed below:

Article 260:

> "Peak capacity transfers among generators shall be valued at the marginal cost of capacity, as indicated in article 262".

Article 262:

> "The marginal instantaneous cost of capacity in peak hours (CMgP), shall be calculated as follows:

$$CMgP = CMCG / DUPA$$

where:

- CMCG equals the annual marginal cost of incrementing the installed capacity of generation of the electrical system, calculated pursuant to article 277; and

- DUPA is the annual availability in per unit (0/1) of the most economic units to supply additional capacity during the hours of maximum annual demand in the electrical system as considered by the Commission for the purpose of the current node price calculation.

The instant marginal cost of capacity during peak hours as defined above shall be understood to be located at the most economically convenient nodes in the system to add a marginal unit of installed capacity ..."

Article 277 itself states expressly:

Article 277:

> "The Commission shall calculate the basic price of the capacity in one or more sub-stations. To this purpose, it shall determine the type of the most economic units to supply additional capacity during the annual peak demand hours in the electrical system.
>
> Basic peak capacity price shall be equal to the annual marginal cost of incrementing installed capacity of the electrical system with this type of units, incremented in a percentage to be equal to the theoretical capacity reserve margin for the electrical system..."

i.e., the price of capacity, or more precisely, the price at which firm capacity is valued and dealt upon, corresponds materially to the cost of incrementing installed capacity with peaking units. This is the marginal cost of adequacy.

As opposed to the above, regulation is not explicit in the context of contingent demand of the electrical system, as to what it requires or demands from the total capacity offer required to cope with it, or at least it is not as explicit as it is with regards to adequacy requirement. The reason for the foregoing lies precisely within the difficulty to characterize the behavior of such contingent demand considering its difficult statistical representation, on the one part, and on the other, the difficulty to outline the group of economic effects derived of an eventual lack of supply to cope with it. Note that even defining conceptually this contingent demand is not an extremely trivial task.

The above allows the statement that the relevance of an adequate recognition of the attributes the generating units have to offer a better "contingent offer" shall depend on a number of factors:

On the origin of contingent demand:

- Level of exposure the electrical system has to different types of unpredictable exogenous events.
- Type and magnitude of exogenous events related to the system's structural robustness.
- Frequency of occurrence of exogenous events
- Structural robustness of the system as related to the type and magnitude of exogenous events.
- Mutually related structure and operation modes of the system components (natural or internal stability, to define them as such)

On the cost of the lack of contingent supply:

- Diversity, size, and location of loads.
- Unit costs of non-provided-for interruption of the system, for each type of load.

Then, what is demanded from a generation unit in order to be able to offer an adequate contingent supply depends on the structural characteristics of the system, its environment, and the physical and economic characteristics of the loads. That is, it depends on the system.

Regarding economic equilibrium, the system will offer an adequate degree of robustness when the cost of incrementing this robustness should be equal to the expected avoided cost of not having it.

This contingent capacity market will then have different characteristics, depending on the system within with it shall be developed, and it might be conceived as a market which is complementary to the primary or main market within which normal operation runs.

The following conclusions could be drawn at this point:

1. There exists an explicit primary or main market within our regulation, within which capacity adequacy is dealt, and which must comply with certain requisites pursuant to currently standing legislation. These requisites are simply aimed at matching maximum capacity supply and demand within a normality and predictability context, whose requisites are basic and common to any electrical system, and which result as minimum to define commercial activity within the electrical market.

2. There exists a secondary ambit, which is not defined formally as a market within our regulation, in which contingent capacity is transferred, whose requisites and objectives are not explicit within the regulation; given the unpredictability of the demand aimed at supplying and its eventual causes, its valuation depends on the electrical system into which it is to be inserted.

3.4 Recommended Treatment

Considering the foregoing, it is clearly shown that S.D. N° 327 sought syncretism between both conceptions, i.e. it added security of service elements to the primary and explicit concept of tariff conception: the payment of capacity, in such a manner that all attributes should be paid for by means of a unique economic concept or product.

Nevertheless, this inclusion of new attributes cannot be understood as displacing totally the basic attribute represented by the capacity "as such". We have underlined that adequacy continues to be the main concept on which the commercial-contractual activity sets upon without the need for further attributes. It has also been pointed out that the transaction price reflects as its definition the economic cost associated with pure capacity (in fact, the manner the price is defined has never changed through successive regulations).

The foregoing, in addition to required stability in regulation, leads necessarily to propose, as a solution to the security-adequacy conflict, that the basic concept which must support in greater measure a definition of firm capacity shall be adequacy, with the attributes associated to security being weighted on a smaller

scale, at least while there does not exist a standard which allows recognizing those attributes within an environment different from firm capacity calculation[8].

Without contradiction to the remarks this Commission has regarding specific aspects of the methodology presented on O.D. expressed in detail on part 4 to this chapter, the solution proposed by CNE in the final methodology presented further within this report, allows breaking up the calculation of firm capacity into three components: one pure capacity or adequacy component, one component which accounts for capacity to be supplied in load increase processes, and one component which accounts for capacity to be supplied in startup processes of the generation units. The biggest part of the weight is given to the first component.

[8] CNE has already stressed that these attributes, as well as others, must be organized to create a specific and formal Ancillary Services market, in which products and their competitive equilibrium prices depend on each electrical system and its characteristics.

4 TECHNICAL ANALYSIS OF THE PROPOSAL OF THE O.D. OF THE CDEC-SING.

The following is the analysis and remarks of CNE regarding specific aspects of the methodology proposed by the Operations Direction of CDEC-SING.

4.1 General Aspects

4.1.1 Input and Analysis by the Committee of Experts

Generally speaking, this Commission shares the proposal presented by several companies which are part of CDEC-SING, regarding the unsatisfactory recommendation which was presented by the Committee of Experts .

It is remarkable that having had the opportunity to carry out a robust analysis that provided input and material improvements to the methodological proposal being discussed, there was a lack of innovation to this respect, keeping and validating the majority position which was stated within the current discrepancy.

4.1.2 Methodology and Black-Out

As to the formal side, regarding the preliminary calculation of Firm Capacity, the methodology proposed by O.D. includes characterization of the relative ability each generating unit has to promote the recovery and normalization of supply upon simple contingency or total system collapse (Black-Out).

This Commission does not share such approach to that problem. This analysis results very much conditioned to the operational particular frame during the last years, i.e. the commissioning of combined cycle units with a large size as compared to the pre-existing generator park, and long testing periods prior to their commercial operation, which brought about an associated deterioration on the service security of the system, despite the correct operational limitations adopted by CDEC-SING in order to minimize Black-Out risks.

4.1.3 Firm Capacity Model

From the analysis and the sensitivities carried out on the "Firm Capacity Model", this Commission does not share its results, and it does not accept its use within the methodology proposed by CDEC-SING.

It is remarkable that, on modeling the SING generator park without considerations further than installed capacity for each central unit and its mechanical unavailability, i.e., omitting the representation of unavailability factors which account for startup times and load increasing times, the results obtained with the proposed "Firm Capacity Model" are very similar to the definitive results proposed by the O.D. of the CDEC-SING considering all attributes contained within the methodology.

Further, inconsistencies are observed in the results with the "Firm Capacity model" by performing some sensitivity analyses. On varying the unavailability of a particular unit at extremely small values, a preliminary Firm Capacity is obtained, which is higher than the input capacity weighted by the maximum demand adjustment factor.

It is definitely observed that the sophistication deployed on characterizing the regulatory requirements and the operating particularities by SING has been superseded by a calculation model which minimizes their effects, delivering results with a low sensitivity.

4.1 Particular Aspects

4.2.1. Embanking

Regarding embanking and how it is recognized by the O.D. of the CDEC-SING, CNE does not share that a particular type of units can declare previously this attribute, which means reducing significantly the declared startup time, without having made this condition effective, and consequently, without the system having ever counted on such input.

Being it the case that to the effect of preserving system service security, counting on the backup of embanked generating units shall be a desirable condition, this is only justified when it is opposed positively versus the avoided costs, whose assessment does not proceed in the environment of capacity remuneration.

Notwithstanding the foregoing, an ex-post calculation should provide account of this input to the system in order not to take mistaken signals, and count on multiple embankable units, which might not be required as such during long periods, and which at the same time might receive benefits due to the simple fact of having declared their embankment capacity.

4.2.2 Security and Dispatch vs. Adequacy

According to the conceptualization presented in the preceding chapters, the concepts adequacy, security, and their relationship with economical load dispatch are not completely exclusive. Their adequate acknowledgement goes through a correct conceptualization of assignment by capacity, the particular characteristics that each system possesses, and consistency with currently standing regulation.

By virtue of the foregoing, currently standing regulation remarks that aspects related to service security must be considered, but in no case this is to mean that economical load dispatch shall be seen as the tool or instrument intended to differentiate the attributes related to each generating unit regarding capacity assignment.

4.2.3 Treatment of load increase time

The time window by means of which the load increase time is assessed, equal to 1 minute, does not seem to have any further justification than the need to differentiate the capacity of response of the generating park to sudden capacity requirements. Considering the above, this window assumes a previous operating condition which does not allow establishing with total certainty the relative ability of one unit to increase its load when it is required. In general, this Commission does not share the qualitative and quantitative conventions adopted to consider the load increase time.

The same conventions quoted above pose a 0.85 limit to the load increase time unavailability factor, whose limit is not shared by this Commission.

Finally it is remarked that the evaluation window and the limitation to the unavailability factor, by themselves or as a set, constitute a limitation that partially explains the insensitivity of the proposed methodology.

4.2.4 Treatment of startup time

The time window by means of which the startup time is assessed, equaling 12 hours, does not seem to have any further justification than the need to differentiate the relative ability of the units within the generating park to provide input to the recovery of supply on partial collapses of the system or Black-Outs. In fact it is declared thus explicit in the presentation of the O.D. of the CDEC-SING, where such 12 hour window corresponds to the adoption of the service recovery time as a window of interest.

Likewise, the window mentioned above accepts a null punishment for units with startup times under "T_{CNE}" index, which lacks any coherence, since it provides a discriminatory treatment to the units whose startup time is above this index. At the same time, the value adopted for this index is the acceptable unavailability for the generation-transmission system, as expressed in hours/year, expected value, consequently non-deterministic, which is essentially associated to the generation-transmission works derived from the determination of the node prices, which has no relationship with the use presented in the methodology for calculating Firm capacity.

Thus, this Commission does not share the qualitative and quantitative conventions adopted to consider startup time.

Furthermore, unavailability factor for startup time is limited to a value equal to 0.85, which is not shared by this commission, since such limit does not allow the objective valuation of the relative ability of generating units with regards to this attribute.

Finally it is remarked that the evaluation window and the limitation to the unavailability factor, and the concept of embankment, by themselves or as a set, constitute a limitation that partially explains the insensitivity of the proposed methodology.

4.2.5 Mechanical unavailability

Regarding the statistical window used to determined the mechanical unavailability of generating units, it results to be too extensive, and it accumulates information on events during longer periods than it is effectively necessary.

The assignment of capacity by means of Firm capacity calculation methodology, considers deterministic parameters, and at the same time, within the security context, considers an expected "performance". Considering the foregoing, the most recent possible information, yet representing the most each generating unit must be available, in order to thus estimate in the best way the expected performance, and "to avoid charging" the performance of a long past period (very far away in time) as the probable forecast for the year undergoing calculation.

To the effect of Firm capacity calculation, it is necessary to reduce the statistical window used to determine mechanical unavailability, notwithstanding the fact this 10 year window can continue to be used for other procedures and/or applications of the CDEC-SING.

Furthermore, the definition of peak hours does not necessarily mean evaluation or control of mechanical unavailability to be restricted only to such period. The information that can be accrued outside peak hours, i.e. during the peak period, becomes necessary in order to thus obtain unavailability indexes which are more representative than the one obtained solely from the peak hours in the system.

The treatment provided to lengthy failures or "losses" which might occur within a generating unit or component of such, is accepted in order for the owner company to be able to decide whether to compute this event as unavailability or alternately to limit its installed capacity for a particular period.

Finally, this Commission understands that the methodological proposal must only be understood to be applied to year 2000 and thereafter; therefore, it does not correspond calculating an unavailability index with the new proposed methodology by the O.D. of the CDEC-SING with the information corresponding to 1999 and before.

4.2.6 Hystogram and Maximum Capacity for Nopel and Salta, respectively

Regarding the remarks presented for the treatment of the Atacama Central and Salta Central Capacity Histogram, the representation made by the O.D. of the CDEC-SING is accepted, notwithstanding the fact that it might be improved shortly, by virtue of better and more information that the O.D. of the CDEC-SING might collect in the future.

4.2.7 Valuation of Withdrawals and Injections

The remark by EDELNOR S.A. regarding the capacity usage which must be accounted for at the point where the transfer or actual commercial transaction is performed, and in no case should these be accounted for at the point of consumption.

4.2.8 Price of Capacity and Penalization Factors

In order to avoid any distortion due to short term situation, and at the same time to generate long term stability conditions, the market of capacity sales to regulated clients, as established in the pricing decree that determines the node prices, must be within a strict consistency with the peak transfer market among generator members of CDEC.

Regarding the discrepancy regarding the price of capacity and its geographical modulation via penalization factors, this Commission estimates currently standing regulation is clear, and does not admit multiple interpretations.

Using the node price of capacity of the Basic sub-station, added to its re-definition as to level and topological location, in order to be then defined through short term penalization factors in the remaining substations in which transfers are produced, lacks any consistency and is it not shared by this Commission.

4.2.9 Verification of Transmission Restrictions

The lack of an explicit treatment regarding the verification of transmission system restrictions is understood by analyzing the proposal of the O.D. of the CDEC-SING. It is then necessary to incorporate into the methodological proposal the necessary references and the corresponding treatment that must be followed on the presence of firm capacities which cannot be injected and transported through the transmission system.

4.2.10 Virtual Losses at pro-rata of Firm Capacity

The remark presented regarding the "virtual loss" assignment criterion to carry out the feasible physical balance among firm capacity, supply, and demand commitments, and withdrawals, is not shared by this Commission.

In order to determine the maximum annual demand in the system, it is not considered to separate the relative weights between effective withdrawals by consumers and transmission losses produced by themselves. Furthermore, the firm capacity calculation methodology is strictly related to the intrinsic characteristics each generating unit has, and it could not be reasonably affected by the distribution of consumption within the system.

Considering the foregoing, this Commission accepts the methodology proposed by the O.D. of the CDEC-SING aimed at carrying out the physical balance between supply and withdrawals, as it does with the corresponding assignment of "virtual losses" pro-rated among the actually performed withdrawals.

CHAPTER VI FINAL METHODOLOGY

The methodology defined by this Commission is based upon the elements proposed by the O.D. of the CDEC-SING, notwithstanding its modifying all issues that have been analyzed in item 4 to Chapter V to this report[9].

This methodology defines the firm capacity calculation procedure and the valuation of peak capacity transfers which must be used by the O.D. of the CDEC-SING within the framework of the current Discrepancy, and pursuant to the Ministry Decree.

The methodology is divided in 2 parts, i.e. Firm Capacity calculation, and Transfer Valuation, both of which are described below.

1 FIRM CAPACITY CALCULATION

1.1 General Considerations

Firm Capacity calculation methodology features three independent calculations in order to quantify Adequacy and Security attributes.

The first calculation (Adequacy Case) corresponds to quantifying the input to Adequacy each generating unit performs. The second and third calculations correspond to quantifying the input to Security performed by each generating unit, through evaluation of startup time (startup time Case) and the load increase time (Load Increase Time Case), respectively, as per the scheme on Figure No. 3.

For each of the cases mentioned above, the initial point used is the Initial Capacity each Central has, which is determined from the corresponding capacity histogram, based upon the proposal presented by the O.D. of the CDEC-SING

For 1999 and before, mechanical unavailability must be calculated with the current methodology for each year. As of 2000, mechanical unavailability must be calculated using the methodology proposed by the O.D. of the CDEC-SING to the effect of the current discrepancy.

Equivalent mechanical unavailability to be used for each year in the calculation shall be obtained from the weighted average, multiplied by the relative weight of the time of validity of each methodology, for a 5 year statistical window, between: mechanical unavailability with methodology for 1999 and before, and mechanical unavailability with methodology for year 2000 and thereafter.

For all effects regarding this report, peak period of the system shall be understood as the period comprised by all hours within the year. At the same time, peak hours shall correspond to hours comprised between 19:00 and 23:00 of each day in official winter time and between 19:00 and 24:00 of each day in official summer time, with the exception of Sundays and holidays.

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[9] By default, assumptions and considerations established in the original proposal of the O.D. of the CDEC-SING shall be assumed to be valid, as long as they do not overrule the methodology defined by this Commission.

In order to represent the periods in which relevant changes may exist in the composition of the system's generating park, due to retirement of units, maintenance, increase or entrance of capacity offer, each of the three calculations quoted above shall be performed on each of the subperiods as it may correspond, according to the proposal of representation by "subperiods", presented by the O.D. of the CDEC-SING in this discrepancy.

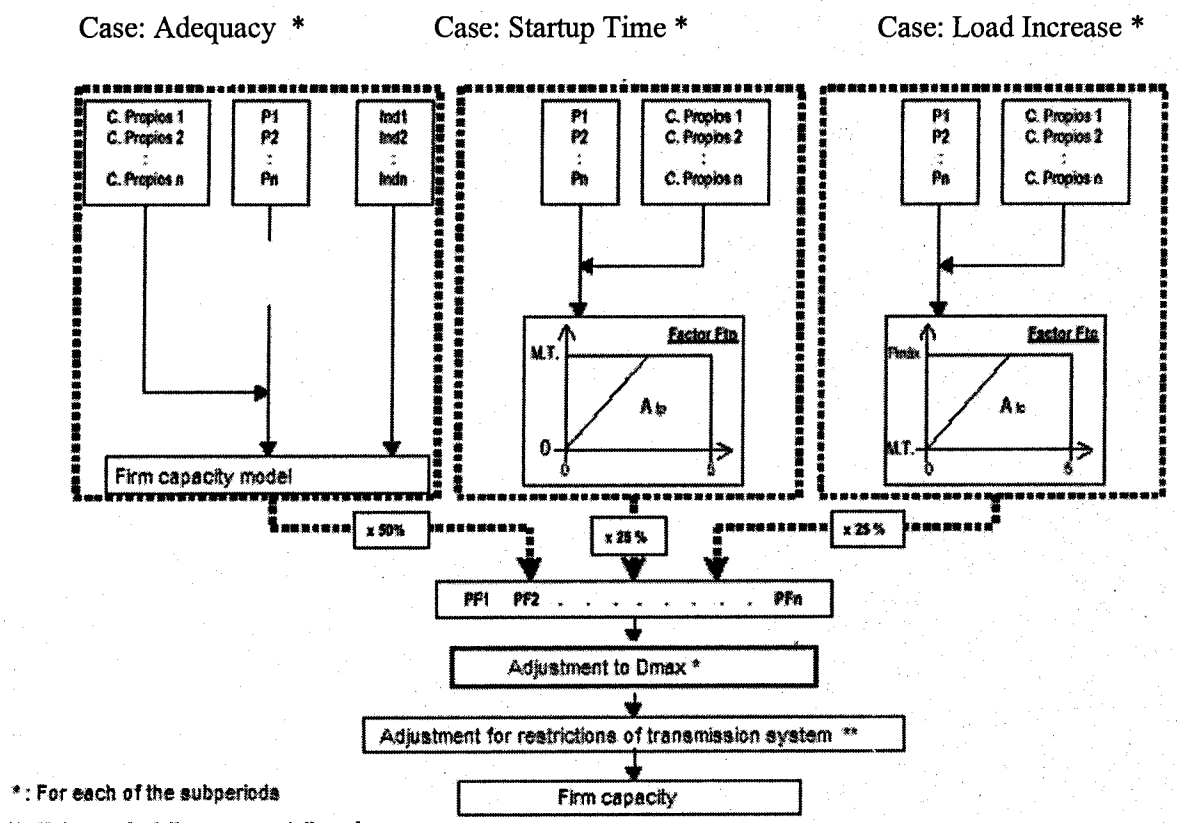

Case: Adequacy *
Case: Startup Time *
Case: Load Increase *
C. Propios 1
C. Propios 2
C. Propios n
P1
P2
Pn
Ind1
Ind2
Indn
Factor Fto
M.T.
0
Firm capacity model
x 50%
x 25 %
x 25 %
PF1 PF2 . . . . . PFn
Adjustment to Dmax *
Adjustment for restrictions of transmission system **
Firm capacity
* : For each of the subperiods
** : Unique calculation representative of all subperiods

Figure No 3

1.2 Initial Capacity

In order to collect the information regarding the capacity limitations presented by diverse units, a "capacity histogram" must be made for each of the centrals in the system, thus accepting the proposal by the O.D. of the CDEC-SING in the report that serves as background for this discrepancy.

Each one of the centrals in the system shall be represented by a sole capacity status or Initial Capacity. This Initial Capacity shall correspond to the equivalent capacity status obtained from the weighted sum of the different states of the correspondent capacity histogram.

For the Adequacy case, this Initial Capacity, discounting own consumption, shall be entered into the "Firm Capacity Model". To this effect, the model proposed by the O.D. of the CDEC-SING shall be replaced by the formulae in the model proposed by the O.D. of the CDEC-SIC.

For startup time and Load Increase cases, Initial Capacity, discounting own consumptions, shall be weighted by the corresponding area factors.

1.3 Adequacy Calculation Case

In this case, considering the Initial Capacity for each central, Adequacy Case Firm capacity calculation is performed as per the considerations stated in the preceding paragraphs.

Thus, Adequacy case Firm Capacity is obtained for each central from Initial Capacity, (discounting own consumption) and associated mechanical unavailability, using the "Firm capacity model" proposed by the O.D. of the CDEC-SIC for each of the subperiods in the year, as it may apply.

1.4 Starting Time Calculation Case

In this case, the starting time attribute is evaluated for all the centrals under the same test, calculating an "Ftp" area factor, according to Figure N° 4, that calculates the Initial Capacity of the centrals, once their own consumptions have been subtracted.

As of the Technical Minimum (M.T.) from the Central Station, expressed in MW, and it's "cold" starting time until reaching the M.T. (tp), expressed in hours, the ability to start is evaluated for the Central.

For a five-hour time window and as of prior information, the ability of the central to start up is evaluated, using the quotient between the area where the central provides capacity and the area defined by M.T. (MW) and 5 (hours). This quotient defines the area factor "Ftp", exactly as illustrated in Figure N° 4. The evaluation of this attribute supposes, by convention, unnamed trees in nine capacity from the origin up to a defined point by M.T. (MW) and tp (hours), both assuming that the central is "cold".

In this manner, the corresponding "Ftp" factor considers the Initial Capacity – minus its own consumption – for all Centrals participating in the calculation thus obtaining the Firm Capacity corresponding to the starting time case for each of the subperiods of the year, accordingly.

1.5 Incremental Load Time Calculation Case

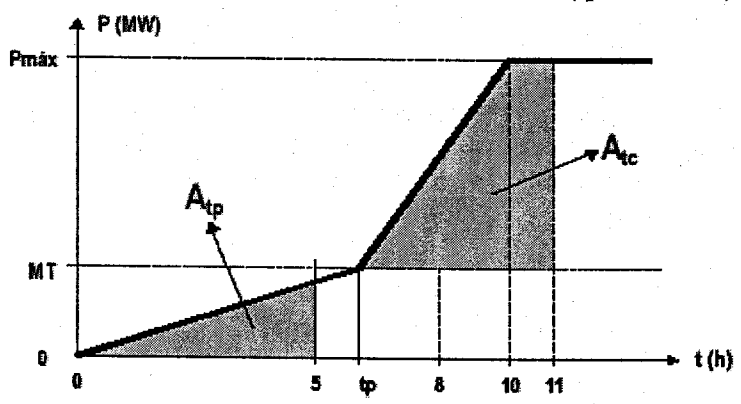
In this case, the incremental load time is evaluated for the load at all Centrals under the same test, calculating the area factor "Ftc", according to Figure N° 4, that considers the initial capacity from a Central once its own consumption has been subtracted.

By knowing the Technical Minimum for a Central (M.T.), expressed in MW, and the rate of load increase (MW/min), as Central is evaluated to see how capable it is to take a load from an initial operational condition equal to M.T. (MW).

For a five-hour time window and as of the previous information, the ability of the Central to carry load is evaluated, by function of the quotient between the area where the Central carries the load and the total area defined by the maximum capacity minus M.T. (MW) and 5 (hours). This quotient defines the area factor "Ftc", just as it is illustrated in Figure N° 4. The evaluation of this attribute supposes, by convention, an increase at a constant constant rate, starting from the condition of M.T. (MW).

In this manner, the corresponding "Ftc" factor considering the Initial Capacity – minus its own consumption – for all Centrals participating in the calculation thus obtaining the Firm capacity corresponding to the Incremental Load Time Case for each of the subperiods of the year, accordingly.

Figure No 4: Area factors (tp= 6 hours)



1.6 Determination of the Firm Capacity of each generation central

The Firm Capacity obtained for each generation central in the three cases specified above, will be weighted according to the following factors, as specified in Figure N° 3:

$PF_{adequacy}$ = Firm Capacity of Adequacy Case x 0,50
$PF_{startup\ time}$ = Firm Capacity of Startup Time Case x 0,25
$PF_{load\ increase\ time}$ = Firm Capacity of Load Increase Time Case x 0,25

Subsequently, the Preliminary Firm Capacity (PFP) of each central is constructed as the sum of these capacities:

$$PFP = PF_{adequacy} + PF_{startup\ time} + PF_{load\ increase\ time}$$

Below, the Preliminary Firm Capacity of each central is adjusted by means of a unique factor defined as the ratio between the maximum demand of the peak hours – of each month of the year – and the sum of the preliminary firm capacities of each central, resulting in the firm capacity of each central.

$$PF_i = PFP_i * \left[\frac{D_{max}}{\sum PFP_i} \right]$$

The procedure specified above is carried out for each one of the pertinent sub-periods. Next, for each central a unique value for the Preliminary Firm Capacity is obtained, adjusted to the Maximum Demand –equivalent- according to the quantity and duration of the defined subperiods.

Finally, the Firm Capacity each central can inject and transport in the transmission system should be verified through a unique calculation. That is to say, with the Preliminary Firm Capacity adjusted to Equivalent Maximum Demand –according with the quantity and duration of the corresponding subperiods– the adjustment due to needed restrictions of the transmission system is carried out.

Those centrals not being able to inject and transport its Firm Capacity through the transmission system shall proportionally reduce the Firm Capacity, in case of being other centrals in the same condition.

So, the centrals being able to inject and transport its Firm Capacity through the transmission system shall proportionally increase their Firm Capacity, so the Firm Capacity of the system is adjusted to the maximum demand.

2 TRANSFER VALUATIONS

Once the firm capacity of each central is defined in accordance as per above, the valuation of the peak capacity transfers is to be carried out between the members of the CDEC-SING.

The valuation of the peak capacity transfers should be carried out through a balance of injections and withdrawals of capacities between substations, so that the respective tariff revenues generated by such transfers in favor of the respective proprietors of the transmission system become explicit, as applicable.

2.1 Capacity pricing

The price of the capacity to be used for the valuation of peak capacity transfers between members will be the basic price of the capacity as calculated by the CNE in the respective setting of node prices without adjustment due to the band of free non-regulated customers.

2.2 Capacity Price in the different substations of the system

The price of the capacity for those main substations where capacity transfers between members occur should be calculated using the Penalty Factors informed by the CNE in each tariffication process.

The price of the capacity for those substations different to the main ones where capacity transfers between members occur, should be calculated using the surcharges for transformation and distance determined by the CNE and effective in each tariffication process.

2.3 Demand for capacity

The proposal of the O.D. of CDEC-SING is accepted as far as defining the capacity demand of a generator at peak hours through its peak capacity and the factor of diversity of the system according to the proposal serving as antecedent for the current divergence.

CHAPTER VII CONCLUSIONS AND RECOMMENDATIONS

1 CONCLUSIONS

After observing the present report, the following conclusions are issued:

1. Without overlooking the specific technical aspects associated to the procedure of calculation of the firm capacity proposed by the Operations Direction of the CDEC-SING, it is evident that in the divergence there are deep discrepancies between the companies as far as the definition of the concept of firm capacity itself. These discrepancies arise from the conceptual differences established for the definition of Firm Capacity between the effective regulations (S.D. N° 327), which incorporated aspects of service security in a concept that traditionally had been understood only as associated to the capacity adequacy, and the regulation preceding it (S.D. N° 6).

2. The meaning of the expression "firm capacity" which comes from the text of the S.D. N° 327, is different to the meaning the same expression had in the derogated preceding regulation; for such a reason, differences in the values determined for the expression according to each conceptualization, and in equality of calculation conditions should be necessarily expected.

3. The present meaning of what is understood by firm capacity encompasses in an unique statutory concept, two different and independent technical concepts: "firm capacity" as recognition of attributes contributing to the adequacy, and "firm capacity" as recognition of attributes contributing to the security of the electrical system.

4. There is a primary or main market explicit in our regulation, where the capacity adequacy is traded and that must fulfill certain requirements according with the effective regulation. These requirements simply aim to adjust supply and demand of maximum capacity in a context of normality and foreseeability, requirements which are basic and common to any electrical system and that turn out to be a minimum to define the commercial activity of the electrical market.

5. There is a secondary environment, not formally defined in our regulation as a market where contingent capacity is traded, whose requirements and objectives are not explicit in the norm, and that given the unforeseeability of the demand it aims to supply and their possible causes, depends for its valuation from the electrical system it is inserted into. This scope corresponds to the service security. The international solution to the subject of how to remunerate attributes of the generation units contributing to the service security is the creation of a formal market of Ancillary Services, market not existing in the Chilean regulation.

6. The methodology proposed by the O.D. of the CDEC-SING includes the characterization of the relative ability of each generator unit to contribute to the recovery and normalization of the supply in case of a simple contingency or a total collapse of the system (Black-Out). This treatment is not shared by the CNE, and for such a reason, all those aspects involving relationship with the measurements,

previous and forthcoming, preventive and corrective, respectively to a Black-Out, have been eliminated.

7. In order to avoid any distortion originated by short term conjunctures which should not be included in the market of peak capacity transfers, the price of capacity in each one of the substations where capacity transfers between generators occur, must correspond to the basic price of the capacity without adjustment by effect of the band of free non-regulated customers, geographically modulated by the penalty factors of and surcharges for transformation and distance, determined by the CNE in each tariffication process for the setting of node prices.

8. The algorithm proposed by the O.D. of the CDEC-SING in order to determine the preliminary firm capacity ("Firm capacity model") through the loss of load probability in peak hours of the system (LOLPhp), does not allow to obtain satisfactory results. As a consequence, the definitive methodology should have a model adapted to the formulation proposed by the O.D. of the CDEC-SIC since the results of such formulation are coherent and of better quality than the equivalent models preceding it, which makes its use suitable.

9. The basic concept that must justify at a greater extent a definition of firm capacity is the adequacy; the attributes associated to the security should be weighted at a minor scale, at least while there is not a norm allowing to recognize these attributes within a scope different from the calculation of firm capacity. The resolution stated by the CNE in this report, allows to disaggregate the calculation of firm capacity in three components: a component accounting the capacity adequacy, a component accounting for the contributable capacity in load increase processes, and a component accounting for the contributable capacity in processes of startingup of the unit, considering the first component as the one to weigh in a greater scale in accordance with the above indicated.

2 RECOMMENDATIONS

As a solution to the analyzed discrepancy, we make the following recommendations to the Minister of Economy, Promotion and Reconstruction:

1. To establish the methodology for the calculation of firm capacity in the CDEC-SING, based on the methodology presented in Chapter VI of this Report.

2. To instruct the CDEC-SING to apply such methodology for the calculation of firm capacity an for the valuation of the definitive peak capacity transfers corresponding to year 2000, omitting the preliminary calculation, and considering the parameters and information available by december 2000.

3. The CDEC-SING shall have a maximum term of 30 days, starting from the notification date of the Resolution of this discrepancy, to the President of CDEC-SING, to perform the calculation described in the previous numeral, and to send it to CNE.

4. The CDEC-SING shall have a maximum term of 60 days, starting from the notification date of the Resolution of this discrepancy to the President of CDEC-SING, to apply such methodology for the calculation of firm capacity and the valuation of the definitive peak capacity transfers of year 2001. This calculation shall be sent to CNE within the same term.

5. That the methodology indicated in the Chapter VI, shall be an integral part of the Internal Rules of the CDEC-SING. The CDEC-SING, as a coordinator organism, shall have a term of 70 days, starting from the notification date of the Resolution of this discrepancy to the President of CDEC-SING, to draft the modified text and send it to the National Commission of Energy, pursuant to Article 176, letter d) of the Supreme Decree No. 327.

CNE, Santiago, november, 2001

VIVIANNE BLANLOT SOZA
EXECUTIVE SECRETARY
NATIONAL COMMISSION OF ENERGY

RIA/CEM/DSJ/JMS/HLM/PBR.

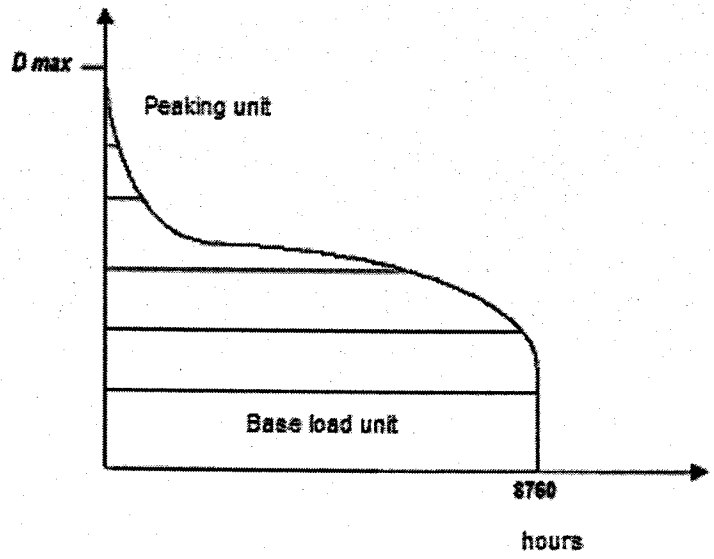
APPENDIX

Concepts of Financial Balance established in the DFL-1

The marginalist tariffication of energy and capacity in generation-transport established in the DFL-1, and its relation to the optimal programme of power projects, is based on well known equations related to the financial balance.

These equations demonstrate that under optimal conditions, when the structure of the generating park is adapted to the demand, the revenues for the sale of energy at marginal cost of the energy, plus the revenues for the sale of capacity at the cost of development of the peak capacity, exactly covers the capital costs plus the operation costs of each one of the producers.

The analysis of the marginalist tariffication, through the curve of duration of the annual demand, and its optimal filling with centrals of different technologies, i.e., different investment costs (a) and different operation costs (b) allows proposing the following expression:



$$\varphi = \int_0^{Dmax} (a + b \cdot t)\, dp \qquad (1)$$

$$da + t \cdot db = 0 \quad (Plan\ \ de\ \ Obras) \qquad (2)$$

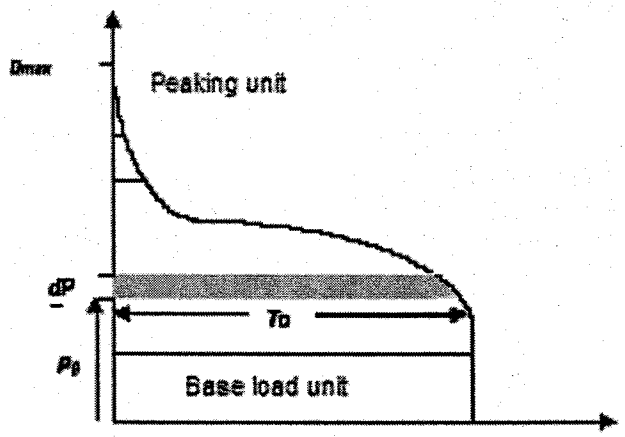
$$\varphi = \int_0^{Dmax} (a + b \cdot t)\, dp = (a + b \cdot t) \cdot p \Big|_0^{Dmax} - \int_0^{Dmax} ((da + db \cdot t) + b \cdot dt) \cdot p \qquad (3)$$

$$\varphi = a(Dmax) \cdot Dmax + \int_0^{8760} p \cdot b \; dt \qquad (4)$$

Where:
- a: AVNR or annual cost of installed kW (US$/kW/year)
- b: Variable operation cost of installed kW (US$/kWh).
- Φ: Annual cost of investment, operation and failure.

From (4) it yields that the first term corresponds to the charge for the maximum demand valued at the installation cost of the peak capacity. For the case of the SING, for example, the unitary installation cost of a 50 MW diesel open-cycle central is adopted. The second term corresponds to the charge for the energy valued at each moment at the marginal cost of the system.

Each "dP" central operating in the system obtains exactly the same profitability. This means that the net revenues (Sales minus Costs), including the capital costs valued at a 10% discount rate must be null.



$$Costos = dP \cdot (a(P_0) + b(P_0) \cdot T_0) \qquad (5)$$

$$Ventas = dP \cdot (a(Dmax) + \int_0^{T_0} (b(t) \cdot dt) \qquad (6)$$

$$\int_0^{T_0} (b(t) \cdot dt) = b \cdot t\Big|_0^{T_0} - \int_0^{T_0} (t \cdot db(t)), \quad pero \quad t \cdot db = -da \qquad (7)$$

$$\int_0^{T_0} (b(t) \cdot dt) = b(P_0) \cdot T_0 + \int_{a(Dmax)}^{a(P_0)} (da) = b(P_0) \cdot T_0 + a(P_0) \qquad (8)$$

The previous equations demonstrate that if an optimal programme of power projects is developed (da + t db = 0), then the reveneue by energy sale at instantaneous marginal cost plus the revenue by capacity sale at cost of development of the peak turbine, defining these as the ones with lowest investment cost and highest operation cost, profit exactly the costs of operation and investment, so that all the agents obtain exactly the same 10% annual profit, with which the programme of power projects is evaluated.

Starting with a generation park exactly adapted to the demand, each central with an installed capacity of P, would have a charge proportional to such installed capacity P, independently from its unavailability, its starting times or its carry load speed.

Nevertheless, a revenue distribution of capacity of such a nature would be unfair, because there are installed capacities which are more reliable than others. This is the origin of the concept of Firm capacity of the different units; this Firm capacity is kind of a safe capacity with which each central backups the system. Then, the centrals delivering the most reliable capacities will obtain the greatest reveneues.

Appendix G

Fluor Daniel's Analysis of Wind Plant interconnection in the SING

SEA WEST

PROJECT # 2314

FEASIBILITY ANALYSIS FOR THE CALAMA WIND PROJECT

2314–65–ES–001

SING INTERCONNECTION ANALYSIS

FOR

SEA WEST

Prepared by

FLUOR CHILE S.A.

APPROVED BY

Project Manager	A. Del Fierro
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Discipline Engineer	
Customer	

REV.	BY	ISSUED TO	DATE	REV. DATE	TECH. APPROVAL
TO	C.Pontt	Internal Coordination	23/Oct/2002		
CUSTOMER'S COMMENTS					

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1. TARGET

This document is aimed at identifying and assessing wind farm performance under both permanent and temporary systems during the connection and disconnection of the SING Norte Grande Interconnected System for the Feasibility Analysis of the Sea West Calama Wind Project.
The electrical engineering scope in this study is based on the principal bar collecting energy from every generator to the SING interconnection. The new involved equipment are a 13.8/110 kV pumping station, a 100 kV transmission line, a SING interconnection yard and the associated protection, control and measurement panels.
This analysis is based on a drill composed of a SING simplified network with principal power and short circuit level flows, including the following Norte Grande Interconnected System facilities. (See the project unilateral chart.)

Tocopilla Thermal power station
"Crucero" 220 kV substation
"Chuquicamata" 100 kV substation
"A" 100 kV substation
"KM 6" 110 kV substation
"Calama" 100 kV substation
200 kV overhead lines L6A and L7A (Tocopilla-Crucero)
220 kV overhead lines L6B and L7B (Crucero-Chuquicamata)
100 kV overhead lines L1, L2 and L3 (Tocopilla-Chuquicamata)
100 kV overhead lines L4 (Tocopilla-KM6
100 kV overhead lines L13 (Chuquicamata-KM6
100 kV overhead lines L14 and L15 (Chuquicamata substation-Sub A
100 kV overhead line 11 (Chuquicamata -Sub 10A)
100 kV overhead line 22 (Sub 10A-KM6)
100 kV overhead line (KM 6 Calama)

Analyses were processed under Etap Power Station 4.04.

Reference standards were:
IEEE Std 399 "Recommended Practice for Industrial and Commercial Power Systems Analysis" y
IEEE Std 141"Recommended Practice for Electric Power Distribution for Industrial Plants"

2. DOCUMENTS

- Unilinear chart of the Electroandina SING Interconnected System.
- Unilinear chart of the SING CDEC SING Interconnected System.
- Power demand forecast for the Chuquicamata electrical system.
- Drawing 26226-16, impedance unilinear chart for the "Chuquicamata" and "A" substations.

3. CONSIDERATIONS

3.1 300 MW in overall demand are expected for Chuquicamata, 20 MW for the Calama substation , 50 MW for the KM 6 substation and 230 MW for the "Chuquicamata" and "A" substations.

3.2 In simplified terms, Chuquicamata is considered to be fed completely by the Tocopilla Thermal Power Station.

3.3 135 MW in net load are considered for the Crucero 220 kV substation, including demand for Lagunas, El Abra, Radomiro Tomic, Escondida and generation from Mejillones, Atacama, Norgener y Gener (Salta).

3.4 A power factor equal to 0.95 induction is considered for every load.

3.5 The "Chuquicamata" and "A" substations have bars regulated at 100 kV at 100% voltage.

3.6 The present generation below is considered as a reference for the Tocopilla Thermal Power Station. 400 MW in 220 kV and 50MW to 100 MW in110 kV.

3.7 All of 110 kV and 220 kV overhead lines in service and operational. Impedance parameters (R, X, B) are based on Electroandina and CDEC SING reports.

3.8 New facilities expected for the wind project:

- New facilities expected for the wind project:
- 13.8 kV wind generation collection bar.
- 50 MVA OA 55°C 13.8/110 kV transformer with LTC (75 MVA OA 55°C for the 50 MW wind generation alternative)
- A wind farm electrical room to host ancillary service panels and protection, control and measurement equipment.

- A 110 kV yard (transmission).
- A single circuit 110kV transmission line, AAAC Alliance lead, 246.9 MCM, thermal capacity of 420 A (73 MVA-100 kV) (75°C).
- A 110 kV yard (reception) and new block in the KM6 substation.
- Ancillary services fed from the KM6 substation. Panels for ancillary services and wind generation protection, control and measurement equipment.

3.9 Two wind generation alternatives are considered: 37.5 MW and 50 MW. Wind energy is injected to the KM 6 substation to the 100 kV L4 line owned by Electroandina.

4. CONCLUSIONS

The following comments and conclusions are provided in consideration of the above results and considerations:

4.1 Under the present condition without wind generation (see chart 1), transformation + SING section transmission losses are estimated in 14 MW, equal to 3.2% of the total 435 MW load. Operating the system with wind generation equal to 37.5 MW (see chart 2) results in losses equal to 12 MW, thus achieving savings equal to 2 MW (17520 MWH a year).

4.2 A second advantage resulting for the wind farm operation is the enhanced voltage regulation at the Chuquicamata 100 kV bars, due to a decreased voltage drop in 220 kV and 110 kV transmission lines.

4.3 A high power factor equal to 0.95 induction is considered for every load represented in the electrical system. As such power factor decreases, both the reduced loss and enhanced voltage regulation increase. However, the power factor should always be > 0.95 induction in consideration of the contractual requirements of SING suppliers and large customers.

4.4 Currently almost all of Chuquicamata demand (95%) is supplied by the Tocopilla Thermal Power Plant, the wind generation plant operation will result in lower cost and cleaner supply to Chuquicamata.

4.5 From the point of view of service quality, SING has a quite peculiar characteristic. In the analyzed network portion, capacitance in transmission lines totaling 172 km and 590 km at 110 kV is equal to 17 MVAR and 40 MVAR condenser banks respectively. Such capacitance helps improve the power factor, but it also results in

sundry frequency resonance in the network, thus rendering the system vulnerable to harmonics distortion and resonant phenomena. On the other hand, most of SING demand comes from large mining companies with high non-linear load, such as electro-winning and electro-refining rectifiers, with a significant production of harmonics not completely filtered by the plants. Even though SING has grown stronger for the past few years as a result of additional generators and interconnection of the Argentine Salta substation, its short circuit capacity is not very high and it remains a weak system vulnerable to transient and stationary distortions. Notwithstanding the high load factor from SING large customer demands, it allows for enough damping to minimize such distortions.

4.6 The inclusion of synchronic generators in the wind plant is a clean alternative as it will not result in harmonics injection and small portion will help strengthen the network.

4.7 The normal ± 2% frequency variation and the ± 10% voltage variation at SING should be considered for the wind generation control and synchronicity system.

4.8 A wind generation interruption caused by a transmission line failure will cause the SING to suddenly increase demand, which in the worst case would be equal to connecting a 50 MW load block with the rest of the system. Increasing the load will cause a temporary < 3% voltage drop in the 110 kV bars of the Chuquicamata Power Station, which soon may be reset back to normal values given the LTC action of autotransformers located in the "Chuquicamata" substation. The highest load may be absorbed by the spinning reserve of generators operating in the system, knowing the spinning reserve is at least equal to the power of the generator with the highest power operating in the system. This load increase is shared among the 200 kV lines L6A and L7A and the 110 kV lines L1, L2, L3 and L4 in ratios defined by the operational generators at the Tocopilla Thermal Power Station.

As a consequence, introducing wind farm generators arguably will not result in distortions with an impact in the normal operation of the SING Interconnected System.

5. ANNEXES

5.1 Chart 1: Load flow without the wind plant

5.2 Chart 2: Load flow with a 37.5 MW wind plant.

5.3 Chart 3: Load flow with a 50 MW wind plant.

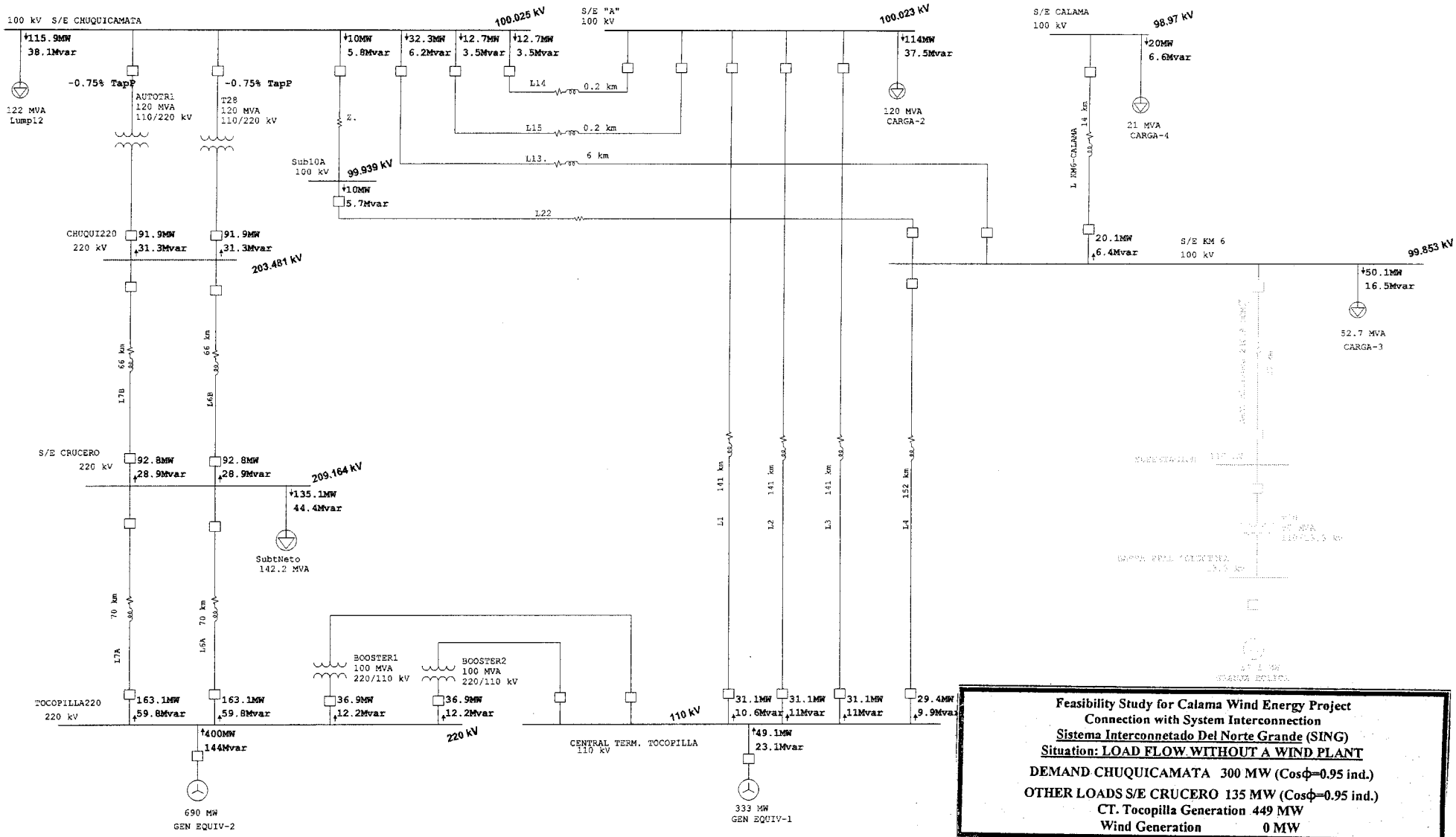
5.4 Chart 4: Load flow and voltage regulation. Interruption of the 50 MW wind generation.

5.5 Chart 5-1: Temporary short circuit analysis (1/2 cycle)

5.6 Chart 5-2: Interruption short circuit analysis (1/2 – 4 cycles)

5.7 Chart 5-3: Permanent short circuit analysis (30 cycles)

One-Line Diagram - DIAGRAMA-1

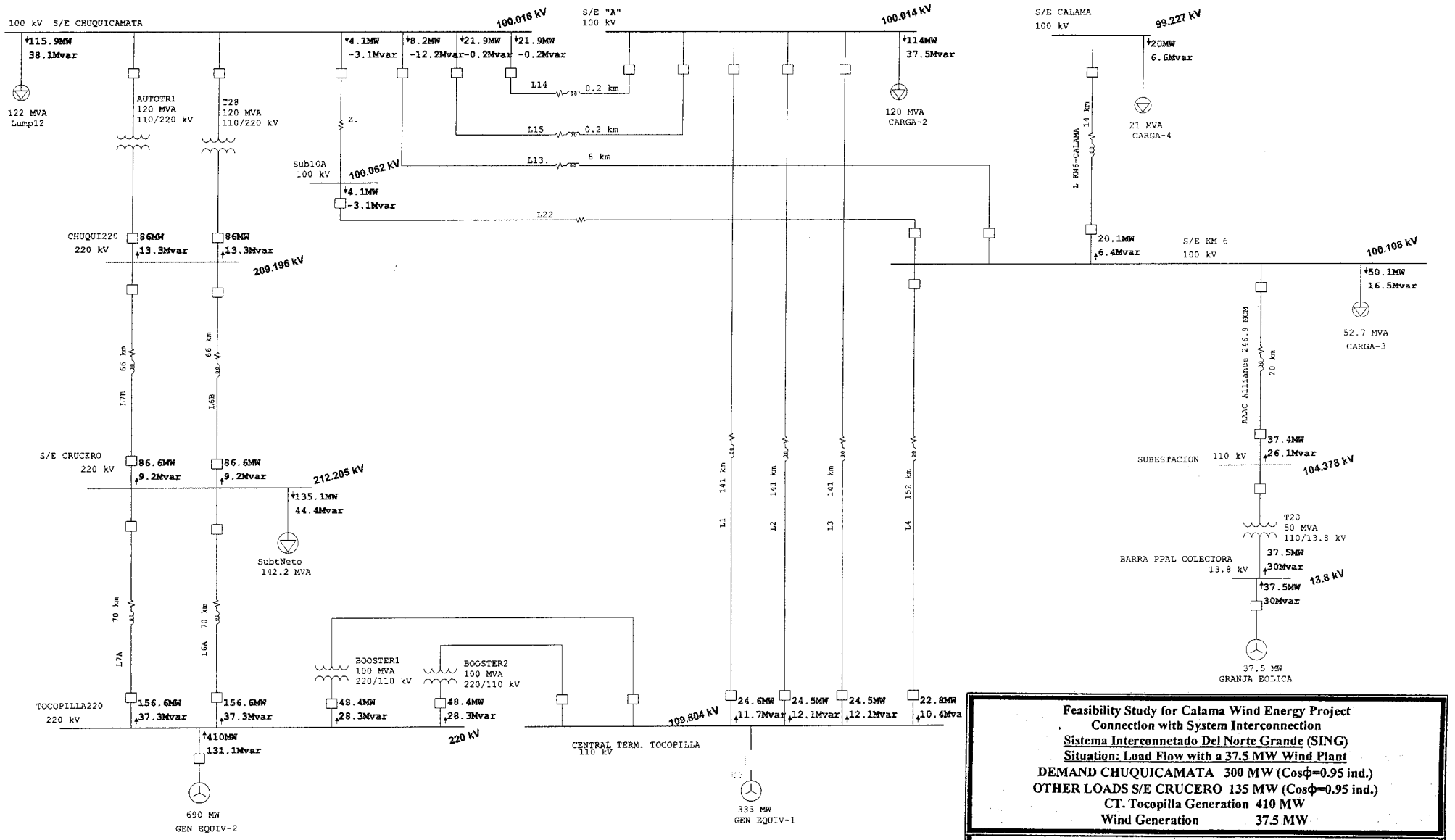


Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)
Situation: LOAD FLOW WITHOUT A WIND PLANT

DEMAND CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
CT. Tocopilla Generation 449 MW
Wind Generation 0 MW

TRANSF+TRANSM Losses 14 MW

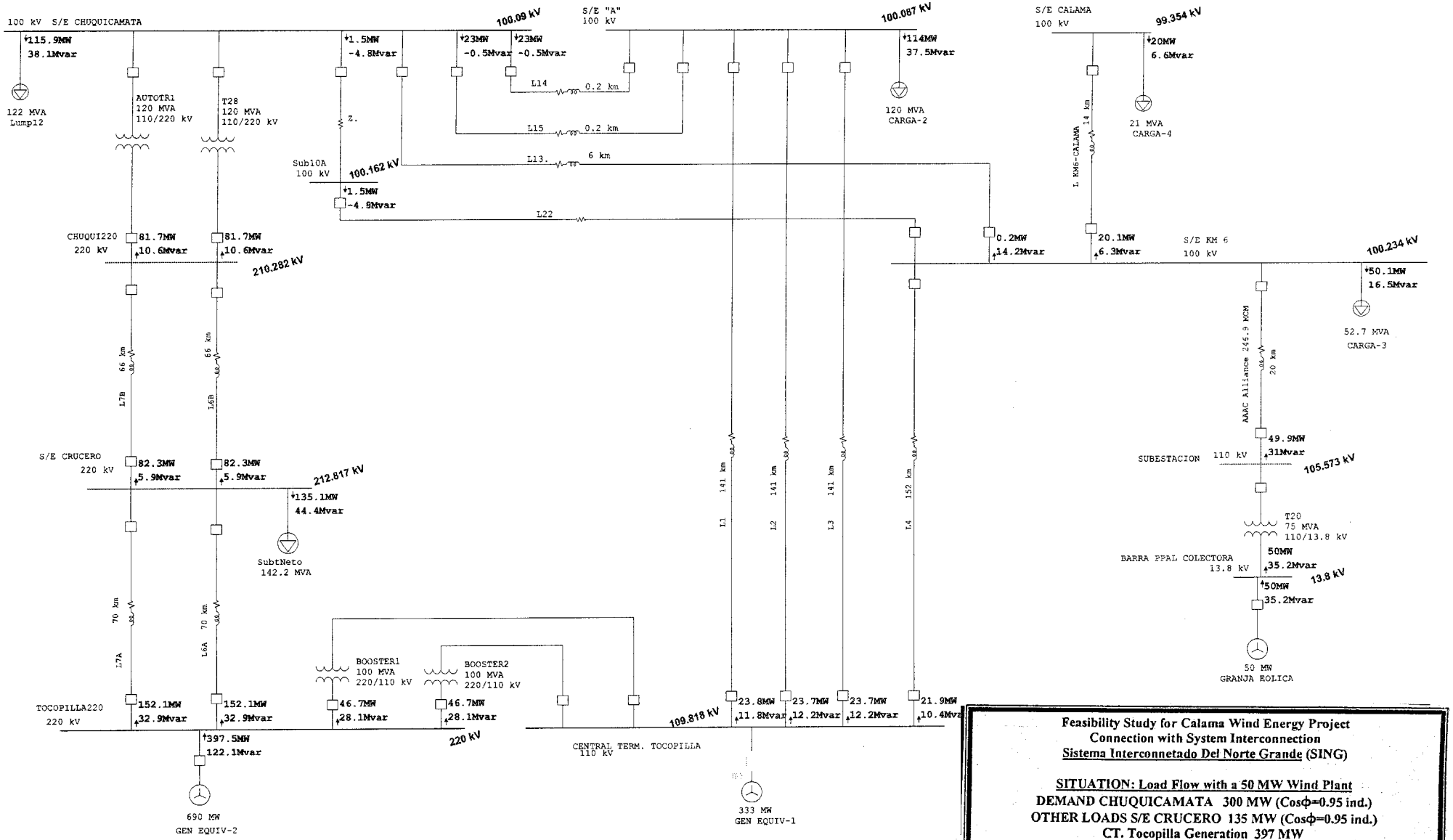
One-Line Diagram - DIAGRAMA-2



Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)
Situation: Load Flow with a 37.5 MW Wind Plant
DEMAND CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
CT. Tocopilla Generation 410 MW
Wind Generation 37.5 MW

TRANSF+TRANSM Losses 12.3 MW

One-Line Diagram - DIAGRAMA-3

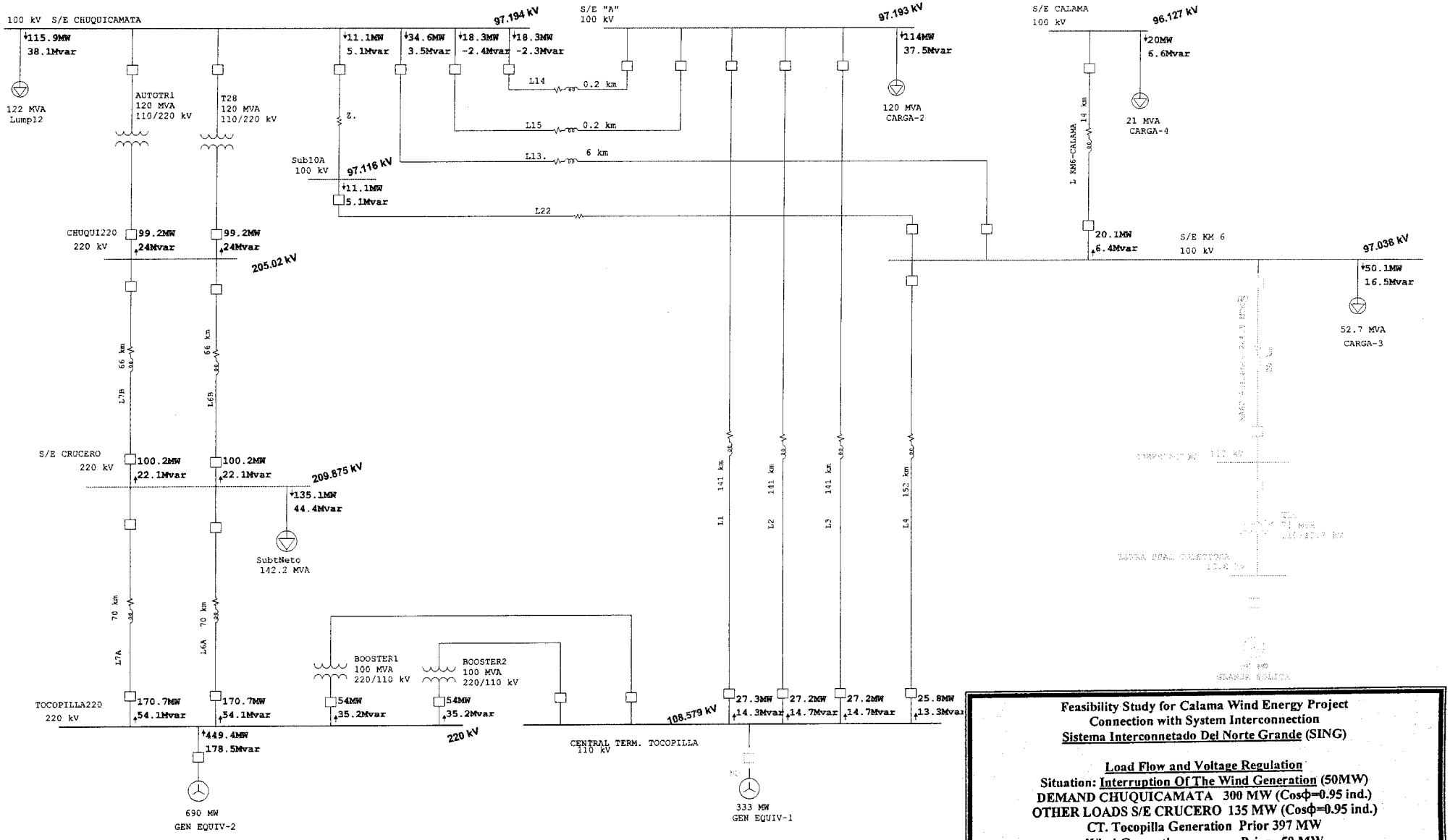


Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)

SITUATION: Load Flow with a 50 MW Wind Plant
DEMAND CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
CT. Tocopilla Generation 397 MW
Wind Generation 50 MW

TRANSF+TRANSM Losses 12 MW

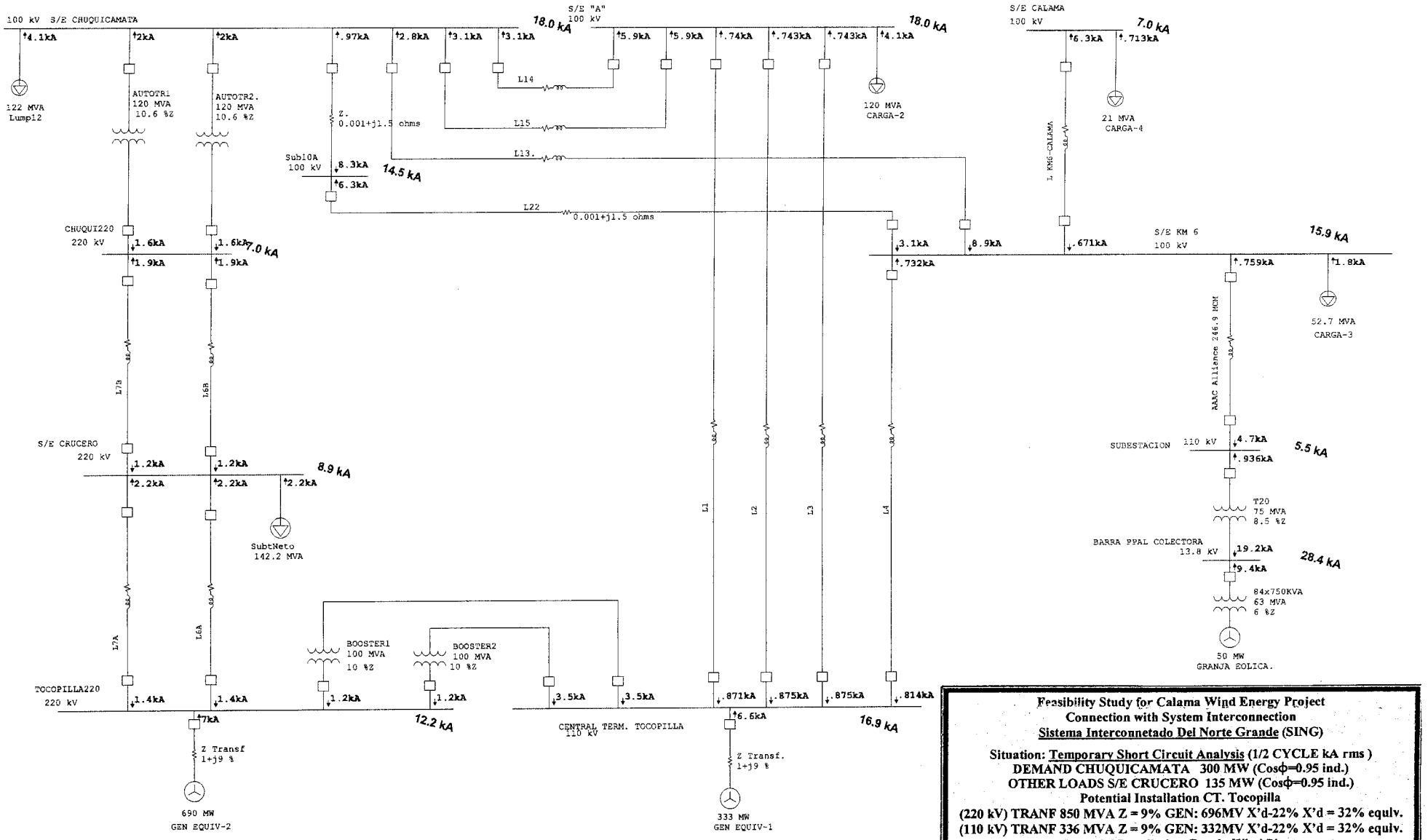
One-Line Diagram - DIAGRAMA-4



Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)

Load Flow and Voltage Regulation
Situation: Interruption Of The Wind Generation (50MW)
DEMAND CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
CT. Tocopilla Generation Prior 397 MW
Wind Generation Prior 50 MW

One-Line Diagram - DIAGRAMA-5-1

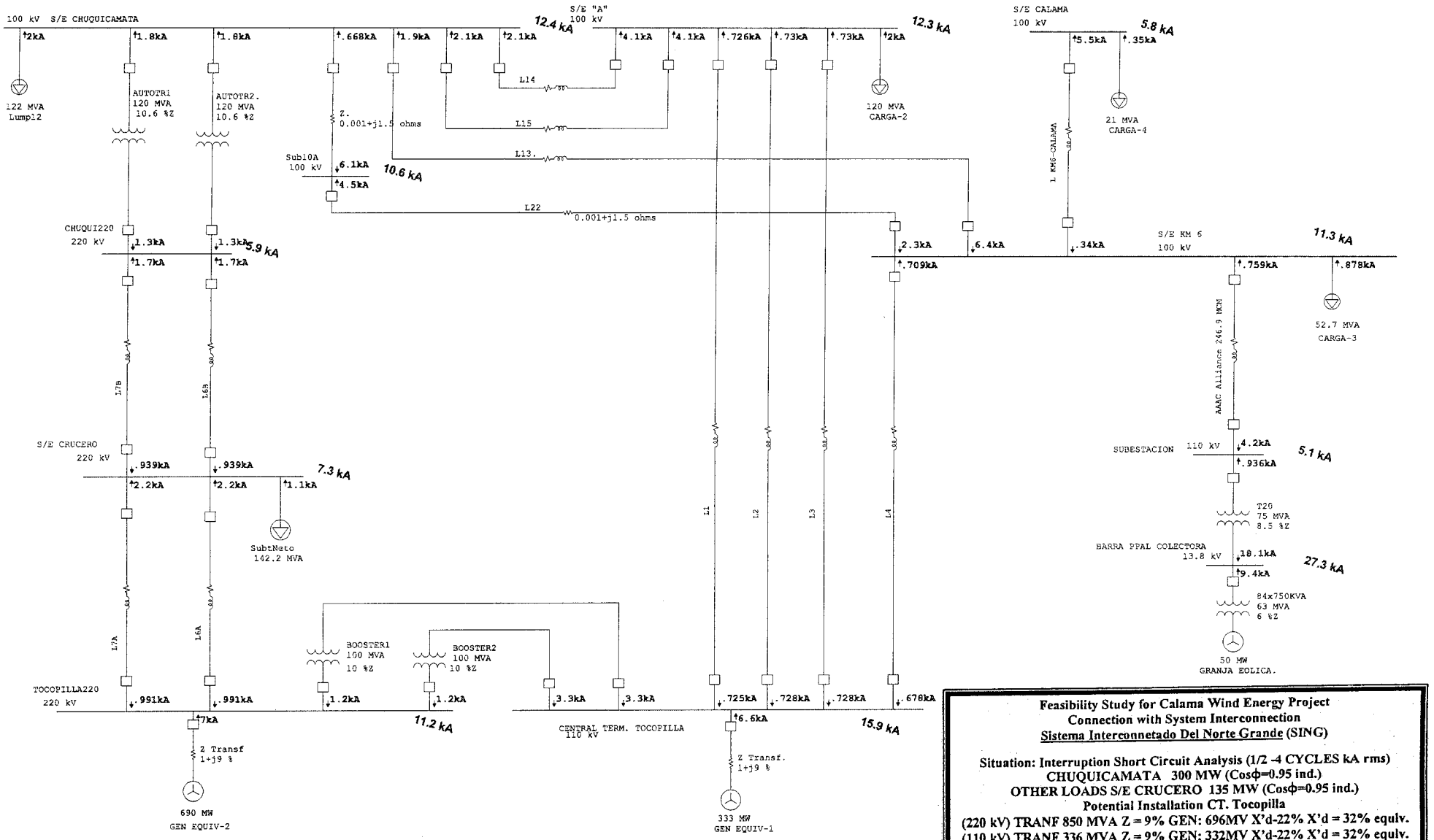


Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)

Situation: Temporary Short Circuit Analysis (1/2 CYCLE kA rms)
DEMAND CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
Potential Installation CT. Tocopilla
(220 kV) TRANF 850 MVA Z = 9% GEN: 696MV X'd-22% X'd = 32% equiv.
(110 kV) TRANF 336 MVA Z = 9% GEN: 332MV X'd-22% X'd = 32% equiv.
Potential Installation Granja Wind Plant
(13.8 kV) TRANF 63 MVA Z = 6% GEN: 50MV X'd-15% X'd = 23% equiv.

Prevailing voltage : 100%

One-Line Diagram - DIAGRAMA-5-2

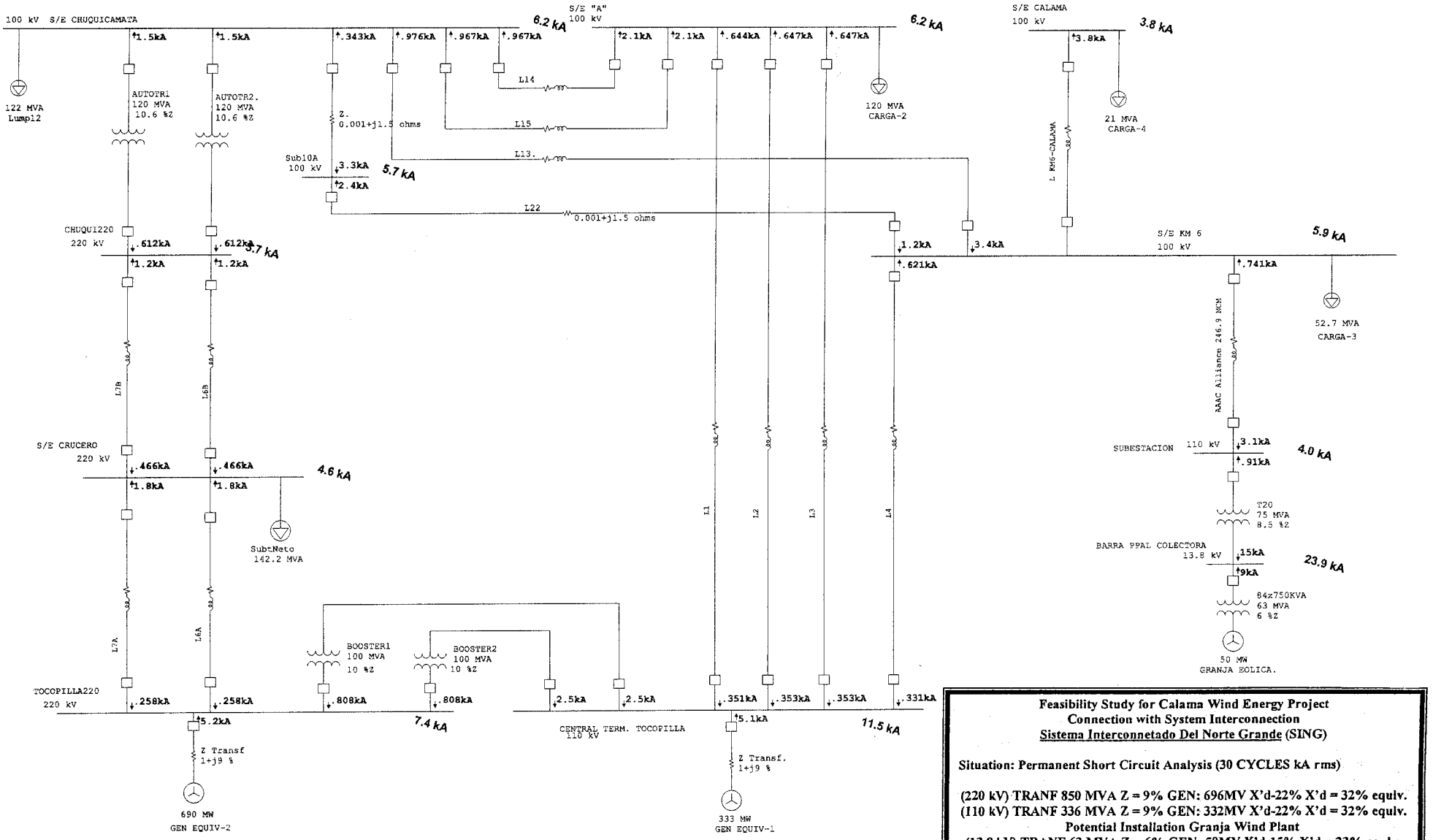


Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)

Situation: Interruption Short Circuit Analysis (1/2 -4 CYCLES kA rms)
CHUQUICAMATA 300 MW (Cosϕ=0.95 ind.)
OTHER LOADS S/E CRUCERO 135 MW (Cosϕ=0.95 ind.)
Potential Installation CT. Tocopilla
(220 kV) TRANF 850 MVA Z = 9% GEN: 696MV X'd-22% X'd = 32% equiv.
(110 kV) TRANF 336 MVA Z = 9% GEN: 332MV X'd-22% X'd = 32% equiv.
Potential Installation Granja Wind Plant
(13.8 kV) TRANF 63 MVA Z = 6% GEN: 50MV X'd-15% X'd = 23% equiv.

Prevailing voltage : 100%

One-Line Diagram - DIAGRAMA-5-3



Feasibility Study for Calama Wind Energy Project
Connection with System Interconnection
Sistema Interconnetado Del Norte Grande (SING)

Situation: Permanent Short Circuit Analysis (30 CYCLES kA rms)

(220 kV) TRANF 850 MVA Z = 9% GEN: 696MV X'd-22% X'd = 32% equiv.
(110 kV) TRANF 336 MVA Z = 9% GEN: 332MV X'd-22% X'd = 32% equiv.
Potential Installation Granja Wind Plant
(13.8 kV) TRANF 63 MVA Z = 6% GEN: 50MV X'd-15% X'd = 23% equiv.

Prevailing voltage : 100%

Appendix H

Transmission Line Plan

Appendix I

Wind Turbine andTower Layout and Installations of Wind Farm

Appendix J 1

Baseline Study of CO_2 Credits

Calama Wind Project Baseline Study

Prepared for:

Corporación Nacional Del Cobre and SeaWest WindPower, Inc.

by:

©Trexler and Associates, Inc.

October 26, 2001

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EXECUTIVE SUMMARY

The Calama Wind Project is the proposed installation of a 37.5 MW wind energy plant near the northern Chilean city of Calama. The Project would be sited near the Chuquicamata mine; this mine is owned and operated by Corporación Nacional del Cobre (CODELCO), the Chilean national copper mining company. The Project is based on a design that was originally advanced in the early 1990s. Two early efforts to implement a wind project near Chuquicamata did not receive sufficient financial support because they were not competitive with grid power prices.

An earlier design of this Project that incorporated revenues from carbon dioxide (CO_2) emission reductions received Chilean and U.S. approval under the Joint Implementation mechanism of the Kyoto Protocol. This submission proposed a static coal-proxy plant baseline of 1.3 metric tonnes of CO_2 per megawatt-hour (tCO_2 per MWh) for quantifying emission reductions as a result of the project. The project was unable to maintain its approval when it lost its U.S. partner. CODELCO and U.S.-based SeaWest WindPower, Inc. are currently conducting a feasibility study to advance this 20-year project as a power generation and CO_2 offset project.

Since CO_2 offsets will be a key revenue stream of the Project, an important task is to develop an updated baseline to measure the Project's net emission benefits. A wealth of detailed information exists regarding the Chilean electricity system; however, no single baseline scenario reflects the obvious choice for evaluating the emissions reduction benefits of the Calama Wind Project. This is partially because we do not yet know what standards will be developed under the Kyoto Protocol or other mechanisms for developing baselines for these types of projects. Thus, this analysis has assessed several potential baselines in order to provide as complete an assessment as possible. The selected baselines include:

1. *Dispatch Model Baseline:* A dispatch model was developed to project the electricity prices the Project could expect to face over the next 10 years should it send electricity into the grid. In addition to projecting prices, this model provides information identifying the marginal sources of power that would send electricity to the grid "but for" the Project. This baseline approach relies on the "but for" dispatch case under four dispatch scenarios developed for the Project as part of the feasibility study.

2. *Recent Capacity Additions Baseline*: This baseline approach has received considerable attention from policymakers and is embodied as a recommended CDM baseline approach to the Secretariat for the U.N. Framework Convention on Climate Change.

3. *Dynamic Marginal Source Baseline*: This baseline approach combines use of the "current marginal" source for the Project's first 10 years, with the most likely "future marginal" source for the last 10 years. Such mixed approaches are increasingly recommended to

counteract the future uncertainty of rapidly evolving electricity systems or to underscore a definite trend towards a particular generation source. The SING meets both criteria in that it is evolving rapidly and that there is a definite shift towards gas-fired generation.

4. *Natural Gas Combined-Cycle Technology Benchmark*: This baseline approach establishes a benchmark against the Calama Wind Project that might be analyzed to quantify the Project's emissions reductions. A significant number of policy experts are discussing benchmarked baselines as a means for getting around the complexity associated with attempting to assess in detail the "real" baseline for each of the thousands of potential projects that might be proposed for greenhouse gas (GHG) crediting purposes in the future. This scenario is underscored by the fact that natural gas is clearly the current fuel of choice and will likely be the fuel of choice for new large-scale capacity additions well into the future.

These four baseline approaches would suggest quite different emissions reductions for each unit of electricity produced by the Calama Wind Project.

Baseline Scenarios	**Baseline (tCO_2 per MWh)**
Dispatch Model Scenarios	1.00 – 1.04
Recent Capacity Additions	0.548
Dynamic Marginal Source	1.00 years 1-10; 0.387 years 11-20
Natural Gas Combined-Cycle Technology	0.38

Source: Trexler and Associates, Inc., 2001.

Based on an assumed average annual generation of 99,923 MWh per year from the Calama Wind Project, these baseline scenarios suggest potential emissions reductions over 20 years ranging from 750,000 to 2,000,000 tonnes of CO_2.

Despite the range of potential emissions reductions suggested by the baseline scenarios, each baseline has technical, market, or policy merits that make it a credible alternative. This report does not specify which baseline is most appropriate, although it investigates the advantages and disadvantages of each one. Baselines are subject to government or buyer preferences (or both), as well as policy developments; thus, it is important to take a holistic view of baseline alternatives in evaluating a project like this one as an emissions reduction project. Further, it is important to understand the implications of baseline selection on emissions credit sales for the Project's economics.

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1.0 BACKGROUND

The proposed Calama Wind Project involves the installation of a 37.5 MW wind energy plant situated near the northern Chilean city of Calama. The Project would be sited near the Chuquicamata mine; the mine is owned and operated by Corporación Nacional del Cobre (CODELCO), the Chilean national copper mining company. The Calama Wind Project would be the first major grid-connected non-hydroelectric renewable energy project in Chile.

The concept behind siting a wind plant in northern Chile was first initiated in 1993 through the efforts of wind energy development company Zond International Development Corp. and its local affiliate Zond Chile S.A. In addition to Zond, another wind energy developer (U.S. Windpower) and a private Chilean utility (EDELNOR) conducted an initial feasibility study of siting a wind farm in northern Chile in the mid-1990s. Neither of these two proposed projects attracted sufficient financial support; the project concepts were not economical given local electricity prices. However, neither of these project proposals considered financial implications from the sale of CO_2 emissions reduction credits.

Based on the U.S. Windpower studies, the nongovernmental organization International Institute for Energy Conservation (IIEC), with U.S. Initiative on Joint Implementation (USIJI) office funding, went to northern Chile to identify potential wind farm sites. IIEC developed a proposal to submit the project to USIJI. Unlike the previous efforts, this version of the Project was designed to attract revenues from the sale of CO_2 emission reductions in addition to electricity sales. IIEC received a host country partner commitment from CODELCO in 1998 to develop a project sited on its Chuquicamata mine near the city of Calama.

The project design submitted by the IIEC–CODELCO team received USIJI and Chile host country approval in 1999. The baseline study in this submission noted that because of the operating cost characteristics in the local grid, natural gas is dispatched before coal. Therefore, the submission contended that coal is the marginal source that would be displaced if the wind project came online and sent power to the grid. The USIJI submission proposed a static baseline based on a proxy coal plant with an emissions rate of 1.3 tCO_2 per MWh to measure the net climate benefits attributable to the project throughout its 20-year lifetime.

About this time, IIEC restructured its organizational mission; as a result, it indicated that it would not be able to maintain an active role in the project. Although the project no longer had a U.S. participant (a requirement for maintaining USIJI approval), CODELCO maintained its commitment to the project. To advance the project concept, CODELCO sought and received funding from the U.S. Trade Development Agency (TDA). CODELCO's request for feasibility funding from the TDA indicated that the sale of CO_2 offsets would be an important financial component of the project. The receipt of TDA funding led to CODELCO's selection of SeaWest WindPower, Inc. in 2000 to conduct an updated feasibility study of the Calama Wind Project.

SeaWest WindPower, Inc. (SeaWest) visited the sites originally proposed for measurement in the Zond study and selected two sites that possess adequate conditions for wind energy project siting. Onsite measurement began in October 2001; new data will be available for improvement of energy production estimates by early 2002.

Since CO_2 offset revenues will be an important aspect of the project, an important task of this updated feasibility study is to revisit the baseline proposal that IIEC initially advanced. The importance of revisiting the baseline analysis is underscored by potential changes in the project design and external electricity system changes. In light of these developments, the objective of this report is to update the project's baseline and present credible scenarios that could serve the project throughout its 20-year life.

1.1 Introduction to Baselines

The objective of this report is to construct and present credible baseline scenarios for the proposed Calama Wind Project. Baselines measure the extent to which a particular project benefits the climate; thus, they are a key determinant of a project's overall quality and marketability.

In this light, project additionality (a key offset criterion) is reflected in the baseline as it lays out the "but for" case that would most likely occur if the project was not implemented. Putting additionality into action has been a challenge for climate change mitigation efforts since the first offset projects were undertaken more than a decade ago. Development of additionality standards for greenhouse gas (GHG) mitigation projects poses a challenge because two types of error can crop up, and one cannot simultaneously minimize for both types:

- *Type I Error (underestimating and failing to credit legitimate reductions):* A Type I error occurs if an additionality standard rejects GHG reductions as being non-additional, when the project (and its reductions) in reality would not have happened otherwise.

- *Type II Error (overestimating and inappropriately crediting non-additional reductions):* A Type II error occurs if an additionality standard credits reductions as being additional, when the project (and its reductions) would have happened anyway.

The baseline standard that ultimately is negotiated as a reflection of a project's additionality inevitably will contain both Type I and Type II errors, given the counterfactual nature of the "but for" determination. Type I and II errors almost certainly will pose a significant problem regardless of the standard, particularly given the range of potential mitigation opportunities, which encompass every possible baseline and "but for" situation. The challenge is in balancing the two types of error in a way that is policy-credible and which maintains the environmental integrity of pursuing project-level mitigation crediting.

Approaches relevant to this project that have been discussed by the Organization for Economic Cooperation and Development and the US Environmental Protection Agency as a means of implementing additionality include:

- ***Project-Specific Additionality Reviews:*** The prevailing project-specific approach to additionality involves a best-estimate construction of a "but for" baseline case at the project level. The difficulty with this approach is that "best estimates" can vary widely. This allows analysts in good faith to make completely different conclusions regarding the apparent "additionality" of projects. As a result, it is difficult to ever know the degree to which Type I and Type II errors are being balanced. The project approach also seems to create incentives for project developers and credit purchasers to creatively overstate a project's GHG benefits. Lastly, developing thousands of project-specific additionality reviews around the world may not be particularly practical and the transaction costs would be tremendous.

- ***Technology Performance Standards and Benchmarks:*** This approach is based on developing standardized technology, sectoral, or other "but for" baselines against which individual projects would be evaluated without having to conduct truly project-specific additionality analyses. Projects exceeding the benchmark would receive GHG credits for the amount of the exceedance. In principle, this approach should be less susceptible to project-level gaming and would be conducive to guiding mitigation projects and activities in desired policy directions. However, it is possible that country-level benchmark gaming would replace project-level additionality gaming. Preliminary work on benchmarks has also shown that it is difficult to avoid significant Type I and II error given the range of contexts against which a benchmark might be applied. Lastly, the development and updating of large numbers of benchmarks, and the associated costs, likely would pose a major institutional challenge.

- ***Static vs. Dynamic Baselines:*** A fundamental additionality challenge at the project level is whether to credit projects on the basis of static or dynamic baselines. A dynamic baseline would set a moving target against which a project's GHG reductions would be calculated; a static baseline would not. A key issue is Type I and II error, but this may not be the primary problem associated with this approach. A dynamic baseline reduces Type II error and might not grossly inflate Type I error. However, it is unclear whether the still-developing carbon market can function with the additional uncertainties associated with application of dynamic baselines at the individual project level.

1.2 Report Organization

Prior to initiating the baseline construction process, it is necessary to understand the background to the project's emissions reductions. This background assessment will significantly

narrow the range of baseline construction options that exist and provide context as to why the selected approaches were chosen. These background elements include:

- Project characteristics;
- demand characteristics of the CODELCO mine that might consume the wind power;
- characteristics of the regional grid (the SING); and
- characteristics of Chilean energy policy that might affect the SING or the Project's environmental additionality.

An in-depth examination of these topics and the baseline primer will provide a context for developing scenarios illustrating the extent to which the Project would displace CO_2 emissions. However, external factors beyond the Project's control ultimately could determine the baseline's structure or necessitate revision at a later date. Two external forces that are likely to be key determinants in the baseline selection process are near-term emissions reduction buyer baseline preferences and long-term policy developments relating to baseline standardization. To that end, this report outlines why it is important to be flexible and consider the implications of different baseline scenarios as the feasibility study process for the Project moves forward.

2.0 PROJECT CHARACTERISTICS

The Calama Wind Project involves the installation of approximately 37.5 MW, although alternative project sizes are being evaluated. The Project's current estimated capacity factor, based on data collected by Zond, is 30.43 percent. Better estimates concerning project size and its capacity factor will be possible once onsite data collection at the two sites selected by SeaWest has begun. Onsite measurement began in October 2001; revisions of expected energy production will be possible by early to mid-2002.

The Calama Project will be sited at CODELCO's Chuquicamata copper mine in Chile's second region. The Project will be located at one of two sites, both located approximately 20 km outside the city of Calama. The Project's approximate cost is US$1,200[1] per kW installed, for a total of US$45 million. The Project has two revenue streams: power generation and CO_2 emission reduction sales.

CODELCO is considering two electricity sales alternatives. The first alternative is to generate revenues through sale of wind-generated electricity into the SING grid. The second alternative would be to consume the power onsite at the Chuquicamata mine, displacing a portion of its dependence on grid power.

[1] All monetary figures are expressed in U.S. currency unless otherwise noted.

Current projected life of wind farms can easily exceed 30 years; this Project assumes a technical life of 20 years. This timeframe will be used for construction of a baseline for measuring the magnitude of CO_2 emissions the Project can expect to displace throughout its life.

Anticipated annual generation of the Project is just under 100,000 MWh. This level is based on a turbine capacity factor of 30.43 percent. Therefore, over the Project's life, the wind turbines are expected to generate approximately 20,000 gigawatt-hours (GWh) of electricity. This electricity will either be dispatched into the SING or to the Chuquicamata mine.

3.0 CHARACTERISTICS OF ENERGY USED BY CODELCO'S CHUQUICAMATA MINE

In 2000, the Chuquicamata mine used approximately 2,135 GWh of electricity. Of this amount, the SING supplies approximately 97.5 percent. Grid electricity purchases are delivered through a power purchase agreement with ElectroAndina. ElectroAndina operates approximately 960 MW of generating capacity, based in Tocopilla; 80 percent of this is coal-fired and gas-fired. CODELCO purchased 2,082 GWh of grid electricity in 2000 through its agreement with ElectroAndina.

The remaining 2.5 percent of the mine's demand was met through an 18 MW onsite oil-fired plant. This plant generates electricity for the copper-smelting process and decreases dependence on grid power during peak demand periods. The onsite plant generated 52.5 GWh of electricity during 2000. CODELCO has no plans to change the onsite plant's operating patterns. Therefore, it will not be expanded to offset the mine's growing demand and will not be displaced by the proposed wind plant.

Table 3.1 summarizes demand characteristics of the Chuquicamata mine for the year 2000. Demand for the year 2001 is expected to be similar to the demand in 2000. CODELCO is preparing a forecast of the mine's energy demand through 2023.

Under the onsite electricity use scenario, the Calama Wind Project would be able to provide approximately four percent of the mine's annual energy needs. While this is a small share of the mine's anticipated energy consumption, adding the Project's power as an additional source of onsite electricity would enhance the mine's ability to control its reliance on external sources of electricity, especially during peak demand periods.

Table 3.1: 2000 Energy Demand at the Chuquicamata Mine

Year 2000	Grid Purchases	Onsite Generation	Total
	MWh	MWh	MWh
January	162,202	4,806	167,008
February	161,261	4,228	165,489
March	175,785	4,746	180,531
April	177,660	4,929	182,589
May	179,018	4,726	183,744
June	169,923	3,826	173,749
July	173,592	3,076	176,668
August	173,124	4,159	177,283
September	172,813	4,565	177,378
October	182,613	4,363	186,976
November	176,358	4,354	180,712
December	178,015	4,727	182,742
Annual Total	2,082,364	52,505	2,134,869
Annual Average	173,530	4,375	177,905

Source: CODELCO, 2001.

4.0 CHARACTERISTICS OF THE GREAT NORTHERN INTERCONNECTED SYSTEM

To gain a better understanding of the Great Northern Interconnected System (SING) and the generation sources that the wind plant might offset over the next 20 years, this section will look at the grid from the standpoint of three time periods. A description of recent grid history (starting from the early 1990s) will be provided. This section will also evaluate current trends and conditions of the SING. Finally, it will outline and discuss how regional generation sources in the SING may change in the future.

The SING came into existence in July 1993 as a result of a national shift towards liberalization in the electricity sector. The grid covers the two most northerly regions of the country, Tarapacá and Antofagasta. The SING is connected to Argentina; the Andes substation is connected to Argentine Central Salta natural gas plant. The transmission grid stretches over a land base of approximately 185,148 km^2. Six generating companies currently operate in the

SING; all of these companies own their transmission networks. Three distribution companies also operate in the SING.

The SING covers 24 percent of Chile's surface area, but serves approximately 5.5 percent of the population. The region is sparsely populated. It contains a significant industrial and mining presence, which consumes approximately 90 percent of power generated within the SING. These sectors have driven the strong demand growth that the SING has experienced since its inception. The mining and industrial activity is the primary reason why more than 33 percent of Chile's installed capacity resides within the SING.

Generation growth has exceeded 15 percent per year from 1993 to 1999 (see Table 4.1). This rate exceeded the national electricity consumption growth rate throughout the 1990s, which grew at a rate of nine percent per year (U.S. Department of Energy, 2001b). The year 2000 was an exception to this trend, as consumption only grew by 3.4 percent. The uncharacteristically low growth rate for 2000 is a lagged response to the economic downturn Chile experienced in 1999.

Table 4.1: Generation Trends in the SING: 1993-2000

Net Generation (GWh)		
Year	**Total**	**Annual Growth Rate**
1993	1,312[a]	
1994	3,394	
1995	3,989	17.5%
1996	4,981	24.9%
1997	5,749	15.4%
1998	6,616	15.1%
1999	8,120	22.7%
2000	8,398	3.4%

Source: CDEC-SING, 2001.
a: July 30-December 31.

To keep pace with this growth rate, installed capacity within the SING has more than quadrupled from 799 MW at its inception in 1993 to 3,041 MW in 2000 (CEDC-SING, 2001). Coal-fired capacity historically has met most demand within the SING; however, much of the increase in capacity now comes from gas-fired units that were introduced in 1999. Table 4.2 illustrates that gas capacity has increased from 0 to 50 percent of annual capacity growth in just two years. This trend is expected to continue with the recent addition of a 380 MW combined-cycle gas plant in Tocopilla.

Table 4.2: Capacity Trends in the SING: 1993-2000

Installed Capacity by Fuel (MW)							
Fuel/Year	1996	1997	1998	1999	2000	% 1996	% 2000
Coal	732	873	1048	1206	1206	63%	40%
Diesel	242	218	242	230	130	21%	4%
Fuel Oil #6	173	173	173	173	173	16%	6%
Hydroelectric	13	13	13	13	13	1%	0%
Natural Gas	0	0	0	1004	1519[a]	0.00%	50%
Total	1160	1277	1476	2637	3041	100.00%	100.00%

Source: CDEC-SING, 2001.
a. This figure includes a 37.5 MW turbogas diesel unit operating with natural gas in 2000.

Table 4.3 further illustrates the shift towards gas. This table outlines power generation trends in the SING. It shows that coal plants supplied virtually all of the grid's power before gas plants began to come online in 1999. Even during 1999 (the first full year of gas plant operation), coal plants supplied more than 80 percent of the power dispatched into the grid. This situation began to change during 2000; coal's share of power generation fell by nearly 30 percent last year. This increase in gas-fired generation also met the small increase in demand.

Table 4.3: Generation Trends in the SING, 1993-2000

Generation by Fuel (GWh)						
Year/Fuel	Coal	Diesel	Fuel Oil #6	Hydroelectric	Natural Gas	Total
1993	2,890	182	229	48	-	3,349
1994	3,200	178	321	46	-	3,745
1995	3,914	205	247	38	-	4,404
1996	5,045	192	263	47	-	5,547
1997	6,106	129	100	56	-	6,391
1998	7,048	178	83	50	-	7,359
1999	7,515	186	206	60	1,033	9,000
2000	5,186	91	76	56	3,918	9,327
(%) 1996	91%	3%	5%	1%	0%	100%
(%) 2000	55%	1%	1%	1%	42%	100%

Source: CDEC-SING, 2001.

The shift towards gas-fired generation in the SING does not result solely from the growth in demand. Another important factor is the recent liberalization of the natural gas market between Chile and Argentina. Argentina is Chile's only source of gas imports. Argentina began shipping substantial gas supplies to Chile shortly after elimination of gas import restrictions in 1995.

Recent figures indicate that Argentina supplies more than half of Chile's natural gas demand; these imports are predominantly used for electrical generation (U.S. Department of Energy, 2001a).

Two natural gas pipelines serve generators in the SING. Both pipelines came into service in 1999. The pipelines have capacities of 7.9 and 8.5 million cubic meters per day; this is sufficient to meet near-term growth in gas-fired generation within the SING. Gas has now displaced coal as the lowest-cost fossil fuel available to generators. The National Energy Commission (CNE) recently surveyed generators in the SING as part of a technical report used to determine sales prices charged to distributors (referred to as node prices in Chile). The CNE survey found that gas prices in the SING are approximately 0.85 mills per MWh equivalent, while coal prices range from 15 to 19 mills per kWh equivalent (see Table 4.4). This gap is expected to persist for the near future, given the oversupply of gas in the SING and the dependence of coal-fired generators on fuel imports.

The markedly different fuel supply markets confronted by gas and coal plants in the SING drive an uncharacteristic situation where gas-fired power is dispatched before coal-fired electricity into the grid. Chilean coal is considered to be low quality and is costly to mine (U.S. Department of Energy, 2001a); thus, coal plants primarily depend on imports from Australia, Canada, Columbia, Indonesia, and Venezuela. Meanwhile, gas plants have access to abundant supplies from Argentina. Currently, gas plants have a fuel cost advantage of approximately 7 mills per kWh over coal plants, while coal plants have roughly a 0.2 mill per kWh non-fuel variable cost advantage over gas plants.

Despite the fuel price differential, the CNE technical report indicates that coal plants generally have lower non-fuel variable costs than gas plants. Generally, coal-fired units fall in the range of 0.80 mills per kWh to 1.09 mills per kWh; gas plants have a variable cost ranging from 1 mill per kWh to 1.2 mills per kWh.

The two pipelines that send gas to the SING are not close to operating capacity. Thus, gas prices are expected to remain at current low levels for the foreseeable future. Gas-fired power is expected to maintain its competitively advantageous position as the baseload fuel of choice in the foreseeable future.

Table 4.4: Operating Cost Characteristics for Coal-Fired and Gas-Fired Plants in the SING (mills per kWh)

Fuel	Fuel Costs 2000	Fuel Costs 2001	Fuel Costs 2002	Variable Costs	Operating Costs (2002)
Coal	15.02-19.24	15.02-19.24	15.02-19.24	0.80-1.09	15.82-20.33
Natural Gas	7.84-9.05	7.77-8.98	7.72-8.91	0.25-1.21	7.97-10.12

Source: Comision Nacional de Energía, 2000c.

To mitigate this operating cost differential, coal-fired generators are exploring the feasibility of mixing coal with petroleum coke (pet coke). Many coal plants within the SING are seeking formal approval to utilize pet coke and are pursuing the Environmental Impact Assessment process before the National Environmental Commission (CONAMA). The proposed fuel mix for most of these plants would be approximately 70 percent coal, 30 percent pet coke.

While this strategy would improve the competitiveness of coal plants by reducing operating costs by approximately 1.5 mills per kWh over the next 10 years, it would be insufficient to change the dispatch structure within the grid because gas plant operating costs would still be lower. The sole impact of the shift towards mixing coal and pet coke for electrical generation would be to reduce the marginal dispatch costs in the grid (Deuman Ingenerios, 2001).

The CNE projects that generation levels will grow to 9,785 GWh in 2001 and 10,568 GWh in 2002 (CNE, 2000c). The dispatch model projects that demand will grow at an average annual rate of 5 percent over the next 10 years (Deuman Ingenerios, 2001). It is important to note that, for the most part, growth in the copper-mining sector drives electricity demand in the SING. Therefore, energy demand projections from CODELCO will provide an indication as to the rate at which generation levels within the SING are actually likely to grow.

Besides the recent introduction of two combined-cycle gas plants at Tocopilla and Atacama, no capacity additions are planned in the SING other than the proposed Calama Wind Project. However, another option could increase the grid's access to additional capacity sources. This option involves connecting the SING with Chile's Central System (SIC) or connecting the SIC with the Argentine Interconnected System (SADI). Grid interconnections are addressed further in the following section.

5.0 RELEVANT CHARACTERISTICS AND TRENDS OF CHILEAN NATIONAL ENERGY POLICY

This section will examine the current status of and future trends regarding Chilean national energy policy. The purpose of this evaluation is to determine the impacts any trends might have

on the magnitude of CO_2 emissions offset by the Calama Wind Project. The analysis will focus on the impact of interconnecting the SING with the SIC and the SADI, on effects on the generation mix in the SING, and on prospects for renewable energy projects in Chile over the next 20 years.

5.1 Interconnection Between the SING and the SIC

As part of its October 2000 node-price study for the SIC, the CNE proposed that the SING be interconnected with the SIC by January 2004. The transmission line would have a potential capacity of 250 MW. However, the construction of transmission infrastructure depends solely on the use of private funds; the decision to interconnect depends on the private-sector generating companies operating in the SIC and the SING. Nevertheless, this proposal represents an important policy signal indicating governmental support for interconnection between the country's two largest grids.

Before assessing the potential implications of interconnection on the SING, it is necessary to describe the SIC's characteristics. The SIC is Chile's primary grid, serving 90 percent of the population and most of the country's commercial and industrial sectors. The grid stretches north from the city of Taltal south to the Isle of Chiloe. Twenty generating companies operate in the SIC with an installed capacity of 6,646 MW.

CNE projects gross electricity generation in the SIC will grow by more than eight percent per year through 2010 (CNE, 2000b). Such growth would more than double gross generation levels, from 29,577 GWh in 2000 to 63,237 GWh in 2010.

Hydroelectricity accounts for 60 percent of the current capacity. Most of this capacity resides in the ninth and tenth regions in southern Chile. Thermal sources that reside in the central and northern parts of the grid constitute the SIC's remaining capacity. Natural gas accounts for 20 percent of installed capacity; coal accounts for 14 percent. Generators utilizing other thermal fuel sources such as diesel, fuel oil, and black liquor supply the remaining 6 percent.

The current dominance of hydroelectric power is consistent with historical trends. In the past, hydroelectricity has provided the majority of power dispatched into the SIC; however, an appreciable shift towards gas-fired generation is anticipated. This shift is in response to the abundant gas supplies in Argentina and to water shortages that have decreased hydroelectric generation levels in the past several years. The persistent water deficit has led to electricity shortages and to rolling blackouts in Santiago, Chile's largest city (U.S. Department of Energy, 2001a).

The recent growth of gas plant installations has been as dramatic in the SIC as in the SING. Approximately 1,359 MW of gas-fired capacity has come online in the SIC since 1997. The CNE's 10-year work plan for the SIC calls for another 2,595 MW of gas-fired capacity (CNE, 2000a). In addition, approximately 970 MW of hydroelectric capacity will be coming

online during this timeframe. The additional capacity would be used to meet the grid's rapidly growing demand for power and would not compete with existing sources. However, since the gas additions depend on investment decisions of private sector generating companies operating in the SIC, some uncertainty exists as to the extent to which industry will respond to the gas-fired plant additions recommended by CNE over the next decade to meet the projected growth in energy demand.

Table 5.1 lays out characteristics of both grids to assist in understanding the implications of interconnection on electricity dispatch structure.

Table 5.1: Characteristics of the SIC and the SING

Sistema Interconectado Central	Sistema Interconectado del Norte Grande
Disperse sources (residential, commercial, and industrial) driving demand growth	Demand dominated by industrial sector, primarily mining industry
More variable load curve	Less variable load curve (small peak at 10 PM)
Concerted effort to decrease dependence on hydroelectricity	Despite rapid natural gas-based capacity growth, gas supplies are currently underutilized
Average marginal costs for 2000: 28.75 mills per kWh	Average marginal costs for 2000: 16.6 mills per kWh

Source: CNE, 2000b; CNE 2000a.

Table 5.1 suggests that an interconnection of the two grids would lead to SING generators exporting electricity into the SIC. Given the 12 mill per kWh difference in average marginal costs, it is difficult to envision a scenario in which SIC generators would export power into the SING. Interconnection is unlikely, therefore, to appreciably change the SING's dispatch structure. Instead, the most likely outcome of interconnection would be an increase in prices in the SING.

5.2 Interconnection between the SING and the SADI

The other prospect that could affect the mix of generation sources in the SING would be an increase in the maximum transmission capacity between the SING and the SADI grid in Argentina. These two grids currently are interconnected from the Salta station in Argentina to the Andes substation in the SING. Before assessing the impacts of interconnection, this section provides some background to the Argentine electricity sector.

Argentina has a deregulated electricity sector that is among the most competitive in South America (U.S. Department of Energy, 2000). The country has a wealth of electricity fuel resources and is a net exporter of electricity. In addition to a planned interconnection with Uruguay, Argentina is working with Brazil and Chile to explore additional regional integration of grids and electricity markets. These measures will benefit Argentine generators and fuel

producers, expanding their export potential to the country's two largest energy export markets: Brazil and Chile.

Natural gas and hydroelectricity supply the bulk of electricity generating capacity in Argentina. Each source has approximately 45 percent of the country's installed capacity. These two sources are expected to maintain or increase their capacity shares, since most of the planned capacity additions in Argentina involve hydropower and natural gas. These additions would come online to meet growing domestic and foreign demand (primarily in Brazil, Chile, and Uruguay).

The Argentine Secretary of Energy and Mines' annual review for 2000 indicates the impact of increasing the level of maximum transmission between the SING and the SADI (Government of Argentina, 2001). The proposal is to interconnect the two grids through a 630 net MW combined-cycle natural gas plant operated by TermoAndina in the Salta province. According to the study, 270 MW of this plant's capacity would generate power that would be dispatched through the SADI; remaining capacity would be used to generate power that would be exported to the SING. Therefore, the effect of expanding the interconnection with the SADI would be to increase the amount of gas-fired generation dispatched into the SING. This would result in increased access to low-cost gas-fired power that would place downward pressure on dispatch prices in the SING.

5.3 Renewable Energy Prospects in Chile

Reviewing Chile's renewable energy prospects assists in understanding the extent to which the Calama Wind Project might be "business as usual" from a baseline standpoint. This section discusses trends in Chile that could affect the extent to which or whether the Project can credibly claim to be environmentally additional (for Kyoto Protocol or similar purposes) over it's proposed 20-year life. This discussion focuses on technical, cost, and market conditions the Project faces today and to what extent these obstacles will persist.

The first steps at fostering a wind power sector in Chile began in the early 1990s when the country undertook a wind resource assessment with international funding. This assessment identified the Calama Valley in the north, central Chile, and the coastal areas of the ninth and tenth regions in the south as prime areas for potential wind power development.

The full potential in these regions has not yet been realized. The level of wind generation in Chile pales in comparison to other renewable sources (excluding large-scale hydroelectric plants), such as solar and small hydroelectric units. CNE's statistics on renewable energy generation indicate that wind plants generated only 45 MWh in 1999 (CNE, 2001). Of this amount, only 4 MWh was produced in the second region, one of the regions identified in the assessment as having significant wind resource potential. Most of Chile's wind power was produced in the southern part of the country. Solar and small hydroelectric units each produced

more than 4,750 MWh in 1999. Table 5.2 compares renewable energy utilization in Chile by region and by technology.

Table 5.2: Renewable Energy Generation in Chile (MWh in 1999)

Region	Wind	Solar	Small Hydro	Geothermal	Biomass	Total
I	0	919	54			974
II	4	1,047				1,054
III		244				244
IV	9	301				310
VI		87				87
VII		48				48
VIII		26	448			474
IX	9	1	2,898			2,908
X	13	42	948		36	1,039
XI	0	6	637			643
XII	10	5	13			27
Metropolitan Santiago		1,915		458		2,373
Total	**45**	**4,769**	**4,998**	**458**	**36**	**10,307**

Source: CNE, 2001.

The primary reason for the distribution shown in Table 5.2 is Chile's National Rural Electrification Program (PER), the country's primary program to promote renewable energy. The program was implemented in 1995, PER's objective is to provide 75 percent of the rural population with access to electricity by 2000 (CNE, 1999). Because significant cost and physical barriers exist for the installation of grid-connected power in many rural areas, the use of distributed renewable energy technologies is a key component of the program. To this end, PER identified implementation of small-scale (less than 1 MW) wind projects in the tenth region and a solar electrification program focusing on regions one through four as key renewable energy priorities. Grid-based renewables do not factor significantly into the PER.

Beyond PER, another option for promoting increased utilization of renewable energy in Chile is through creation of a green power market. Such a market would provide an incentive for renewable energy development through a premium such as an additional five cents per kWh, as is commonly offered in U.S. green power markets. Green power markets have been established in industrialized countries; however, the concept is only in the discussion stage in Chile. The government has not sent any policy signal with respect to this concept, and there have not been any formal studies of the potential for a green power market in the country.

Should a green power market be established in the future, it would most likely operate in the SIC. This is because the branding of green electricity would have many more potential buyers in a market with a significant residential and commercial presence. In contrast, large industrial customers that must compete in global commodities markets dominate the SING. This would suggest that the prospect that the proposed Calama Project could charge a green electricity premium would be unlikely in the SING throughout its lifetime.

The only premium available to SING generators is a firm capacity charge. This premium is available to units that can reliably provide electricity to the grid during peak demand periods. However, demand in the SING generally peaks between 10:00 and 11:00 p.m., when wind conditions are weak. The variability of wind speeds at the potential sites prevents the Project from earning a firm capacity charge imposing another barrier towards its implementation.

As noted in the beginning of this report, previous project designs based solely on grid electricity revenues failed to attract sufficient financial support. The recent trend in dispatch economics has not improved the Project's financial prospects. Introduction of new combined-cycle gas plants has lowered dispatch prices in recent years. Current dispatch economics in the SING are not expected to change significantly in the next 10 years (Deuman Ingenerios, 2001).

The Calama Wind Project is unique in that it is the first major grid-connected non-hydroelectric renewable project in Chile. Unlike smaller renewables projects, this Project would not receive policy incentives such as a tax credit or green power premium. In addition to the lack of public policy incentives, the Project faces cost and technical impediments. Because of its variable output, the Project is unable to receive a firm capacity charge, unlike most of its fossil-fired competitors. Additionally, the dispatch economics are not expected to work to the Project's benefit, as recent gas capacity additions and planned transmission capacity increases should stem any appreciable growth in electricity prices. Therefore, based on current policy and electricity market trends, it appears that the Project is environmentally additional and reasonably should be considered additional over the next 20 years.

6.0 BUILDING A CREDIBLE BASELINE

The discussions in the previous sections laid the foundation to proceed with the construction and evaluation of baseline scenarios for the Calama Wind Project. As discussed earlier, baselines are used to measure the volume of CO_2 emission reductions as a result of a project. Designing a baseline for electricity-sector mitigation projects requires identifying the "but for" alternative to this new source of power. The exercise involves projecting what would happen under a scenario in which the Project is not built.

Because they essentially drive the extent to which a project generates a net benefit to the climate, baselines are a key determinant of a climate change mitigation project's environmental

credibility. Baselines are also crucial in determining the overall quality of the emissions reductions associated with a project, thus forming an important component in valuing and marketing the reductions. Further, there is a need to recognize that baseline construction is not only a technical exercise, but also a policy and market-based exercise; it is important to incorporate signals from policymakers and offset purchasers into the baseline-setting process.

Elements that TAA has drawn upon for selecting credible baseline scenario alternatives for this report are:

- Likely power generation source(s) that would supply electricity to the SING "but for" the project, otherwise known as the marginal sources of power;
- The potential need to periodically revisit and update the baseline to reflect unanticipated changes in the SING and in Chilean energy policy; and
- Signals from policymakers and the GHG mitigation market regarding baselines and baseline standardization.

Four baseline scenarios selected for application to the Calama Wind Project in light of these criteria are:

- Dispatch model baseline;
- Recent capacity additions baseline;
- Dynamic marginal source baseline; and
- Natural gas combined-cycle technology benchmark.

Each of these scenarios was calculated by using guidelines in the Intergovernmental Panel on Climate Change's revised 1996 methodology for calculating national emission inventories (IPCC, 1996). Appendix A describes the steps taken and lists tables illustrating how the reductions associated with the different baselines were calculated, expressed in terms of tCO_2 per MWh.

6.1 Dispatch Model Baseline Scenario

This scenario uses existing modeling of the SING to estimate the marginal power source at any given time; where the Calama Wind Project would be located in the SING's dispatch order; and what generating resources the Project would actually displace. This approach should be accurate; however, this method is not often used for electricity-sector climate change mitigation projects, primarily because of the effort and cost needed to carry out modeling. Because extensive information is available regarding Chile's electricity sector, it was possible to create a dispatch model for the Calama Wind Project.

Before discussing the dispatch model developed for the Project, it is useful to provide some background information on the dispatch structure in the SING. Dispatch of electricity into

the SING is based on an economic model in which units send power to the grid depending on their variable production costs. Therefore, the proposed Calama plant and two run-of-the-river hydro plants currently operating would be the first plants to dispatch electricity, since they have zero variable costs. Based on this least-cost approach, the dispatch order of fossil fuel sources in the SING is as follows: natural gas, coal, and diesel and fuel oil #6.

The dispatch model Deuman Ingenerios developed for the Calama Wind Project is intended to create an understanding of the ranges of dispatch prices the Project would most likely face between 2002 and 2011 (the Project's first 10 years). The model assumes that demand will grow by approximately seven percent in the next five years and taper off to a modest growth rate of less than three percent per year from 2007 to 2011. To understand the range of dispatch implications should the Project go forward, the model considers four dispatch scenarios for projecting prices and the order in which units would dispatch electricity to the grid. The model provides a monthly indication as to which unit would most likely be displaced when the wind Project sends power into the SING. The power sector scenarios under which the Calama Project might operate that Deuman considered are:

1. *Base Case*: This scenario assumes the SING would be interconnected with the SADI in 2002 with a maximum transmission capacity of 230 MW, and with the SIC in 2004 with a maximum transmission capacity of 250 MW.
2. *SING-SIC Interconnection:* This scenario analyzes the effect of increasing the maximum transmission capacity from 250 MW to 500 MW.
3. *SING-SADI Interconnection:* This scenario explores gradually increasing maximum transmission capacity to 230 MW in 2002; 350 MW in 2004; and 400 MW in 2006.
4. *Coal-Petcoke Fuel Mix:* This scenario evaluates the option in which coal plants reduce operating costs by utilizing a 70/30 mix of coal and petcoke.

Under the base-case scenario, the dispatch model predicts that coal would be displaced each month throughout the Project's first 10 years. The weighted average emissions factor for the four coal-fired units that would be ramped back under this dispatch modeling scenario is 1 tCO_2 per MWh. Therefore, this would represent the baseline for the first 10 years, assuming that no new generation units are added after the Calama Project comes online and the SIC and SADI interconnections go as currently planned.

Under the SING-SIC Interconnection scenario, the dispatch model predicts that six coal units and one diesel-fired unit would be displaced in different months throughout the Project's first 10 years. The diesel-fired unit would be the displaced marginal source over a total of six months in 2004. Under this scenario, the maximum transmission capacity between the SIC and SING would be increased. Given the dispatch price differential between the two grids, this scenario would increase the capacity in which SING generators could export power to the SIC. The impact on the SING would be higher dispatch prices relative to the base case. The weighted

average CO_2 emissions factor for the displaced sources under this scenario is 1.00 tCO_2 per MWh.

Under the SING-SADI Interconnection scenario, the dispatch model projects that the Project would displace two diesel-fired units for 25 percent of time over a 10-year period and two coal units for the remaining 75 percent. This scenario models dispatch conditions assuming that the maximum transmission capacity between the SING and SADI is increased. The likely result would be an increase in imports to the SING from the SADI. Exports from the SADI would be gas-fired. This scenario results in a weighted average emissions factor of 1.04 tCO_2 per MWh for the displaced marginal source of power as a result of the Calama Project.

Under the Coal-Petcoke Fuel Mix scenario, the steam coal units currently operating in the SING would change their fuel mix, adding 30 percent petcoke. The dispatch model forecasts that this fuel-substitution strategy would lower variable costs of these coal units by 1.5 mills per kWh. Gas-fired plants would maintain their competitive dispatch position over coal-fired units, though. The Project would displace three coal-fired units over the next 10 years. The coal units that would be displaced under this scenario have a weighted emissions factor of 1.03 tCO_2 per MWh.

In summary, each dispatch scenario predicts that the Calama Project would displace predominantly coal-fired units (see Table 6.1). Two scenarios – Base Case and Coal-Petcoke – forecast that the Project would displace exclusively coal-fired units in the first 10 years, while the SING-SIC Interconnection scenario forecasts that the Project would displace coal-fired units 95 percent of the time throughout its first 10 years of operation. The SING-SADI Interconnection scenario predicts that coal units would be displaced for 90 months, while diesel-fired units would be displaced for 30 months.

Table 6.1: Summary of Dispatch Model Scenario Baselines

Scenario	Baseline (tCO_2/MWh)	Sources Displaced	Period Displaced
Base Case	1.00	4 coal-fired units	Coal for 120 months
SING-SIC Interconnection	1.00	6 coal-fired units 2 diesel-fired units	Coal for 114 months Diesel for 6 months
SING-SADI Interconnection	1.04	2 coal-fired units 2 diesel-fired units	Coal for 90 months Diesel for 30 months
Coal-Petcoke	1.03	3 coal-fired units	Coal 120 months

Source: Deuman Ingenerios, 2001.

Several remaining questions should be considered when utilizing the dispatch model approach. The dispatch model covers only the Project's first 10 years; selecting this approach would impose a dynamic baseline. This raises the question of how to treat years 11 through 20

when designing a baseline. The need to revisit the baseline generates uncertainty, as it is unclear whether another dispatch model would be created, an alternative baseline would be selected, or policy developments would impose a standardized baseline.

Another question would be to consider the conditions under which the model should be revisited – and hence the baseline be revisited – in the first 10 years. While currently no plans exist to add new generating units to the SING, construction of a new plant (especially a large central station such as another gas-fired plant) would almost certainly require that the model (and the baseline) be updated to reflect the change in the dispatch structure in the SING.

6.2 Recent Capacity Additions Baseline Scenario

This approach is intended to proxy for predictable future additions to the SING grid. The intent behind this approach is to use it as an alternative to the existing capacity approach. The problem with existing capacity baselines is that they incorporate the full spectrum of plants in a system, regardless of recent trends. The result is that such baselines tend to be a poor approximation of what the mitigation project displaces. The recent capacity additions approach seeks to add accuracy by focusing on what recently has occurred in an electricity system as an approximation of what would most likely happen "but for" the proposed offset project.

This approach requires more effort and access to data than the existing capacity approach. In addition, the choice of a time period for defining recent additions could have implications for the baseline. Five years is the common period considered for bounding recent additions; however, the Tellus Institute notes that carbon intensity can vary substantially during these five-year clusters (Lazarus, *et al.,* 1999). In the United States, a recent 5-year average (1995-1999) was 0.52 tCO_2 per MWh; the 10-year average was 0.58 tCO_2 per MWh; and the 15-year average was 0.55 tCO_2 per MWh.

This approach has received extensive analysis by the U.S. Environmental Protection Agency (Lazarus, *et al.,* 1999) and the Organization for Economic Cooperation and Development (Bosi and Ellis, 1999), as a potentially viable baseline alternative for projects taking place in Clean Development Mechanism (CDM) countries. This method has been submitted by the United States as a recommended CDM baseline approach to the Secretariat of the U.N. Framework Convention on Climate Change.

Although the SING was established in 1993, it has undergone a profound expansion in the last five years. More than 75 percent of its current installed capacity has come online since 1995. These recent additions and the weighted average emissions factors, which will form the basis for this baseline scenario, are summarized in Table 6.2.

Table 6.2: SING Capacity Additions; 1995-2000

Fuel	Capacity (MW)	Emissions Factor (tCO_2/MWh)	Percent	Weighted Emissions Factor (tCO_2/MWh)
Coal	695.6	0.940	27.69%	0.260
Natural Gas	1,759.8	0.386	70.05%	0.271
Fuel Oil	28	0.634	1.11%	0.007
Diesel	25.7	0.986	1.02%	0.010
Hydro	3.2	0.000	0.13%	0.000
Total	2,512.3		100.00%	0.548

Source: CDEC-SING, 2001.

Much of the new capacity has come in the form of combined-cycle gas turbine plants that began operating as recently as 1999. However, nearly 700 MW of coal-fired capacity have also come online since 1995. Additionally, two new diesel plants and one fuel-oil plant came online since 1995. However, given their small capacity (less than 25 MW) these units would likely act as backup sources and serve peak demand periods in the grid. Given that these other are relatively new to the system, the Calama Project would compete with the units that form Table 6.2. The Project would most likely displace these sources, to varying extents, throughout its life. This indicates that a reasonable baseline approximation for measuring CO_2 emissions displaced would be the weighted average of these sources, which is 0.548 tCO_2 per MWh.

6.3 Dynamic Marginal Source Baseline Scenario

This scenario sticks with the marginal source approach; instead of relying on a dispatch model to construct a baseline, however, it incorporates recent trends such as recent and planned capacity additions into the baseline construction process. It is a dynamic baseline because it combines the current marginal source with the most likely future marginal source of power or a future benchmark.

The Oregon Climate Trust currently recommends this approach for electricity-sector offset projects that it reviews as possible CO_2 offset investments. The Trust requests that U.S. electricity offset projects utilize the current marginal source as a baseline for the first 10 years of a proposed project and then switch to a proxy "best available technology" gas plant as the baseline for the remainder of the project life.

The dynamic marginal approach departs from the operational margin approach in that it attempts to answer what would most likely be built or built sooner to supply electricity to the grid, "but for" the wind project (Lazarus, Kartha, and Bernow, 2001). The advantage of this

approach is that, unlike other options, it attempts to address which source would have been built or built sooner but for the proposed project.

The information required to develop a future marginal source benchmark includes data on recent, planned, and future construction, as well as performance characteristics. This baseline approach uses the current marginal source for the Project's first 10 years and switch to a baseline based on gas plants currently operating in the SING (all of which came online in 1999) for the remaining 10 years of Project life. This split was chosen because the SING is rapidly evolving and there is a definite shift towards gas-fired generation.

The emissions factor for the current marginal source (which is the weighted average of coal-fired units in the grid) is 1.00 tCO_2 per MWh, while recent gas plants have a factor of 0.387 tCO_2 per MWh. The switch to a natural gas-based benchmark indicates that this is the source that the proposed project would most likely displace in the future.

6.4 Natural Gas Combined-Cycle Technology Benchmark

This approach utilizes a proxy plant for constructing a baseline. This method has been used when it is evident that one type of plant is clearly being built today and is most likely to be built in the foreseeable future. Such a baseline could become a reality under the CDM, as this baseline could represent a benchmark. The benchmark would be used for crediting all electricity sector emission reduction projects, at least in individual sub sectors such as solar and wind power.

The benefit of this approach is that a project's additionality is assessed against a better-than-average benchmark. Since the benchmark exceeds the operating characteristics of the electric system, it sets a high standard for conservatism of the resulting estimate. Therefore, while this approach discounts the magnitude of emission reductions relative to average system approaches, it could add perceived quality to the reductions, and perhaps to the value of the CO_2 offsets.

This approach divorces itself slightly from current operating conditions in the SING. A strong case can be made, though, that a natural gas emissions rate benchmark would be a suitable baseline for this Project. This is because it is evident that natural gas would be the fuel of choice for new capacity additions to the SING. Under this scenario, the Project would generate offsets at the rate of 0.38 tCO_2 per MWh, which corresponds to the emissions rate for current combined-cycle gas turbine plants.

6.5 Comparative Analysis of Baseline Scenarios

This report does not intend to present these four scenarios as being an exhaustive list of baseline options. The comparative analysis is intended to guide and offer clarity on the pros and cons with the approaches. The intent is not to recommend one single approach, but rather to

present key characteristics of each approach and assess the appeal of each option to offset buyers and policymakers.

As Table 6.3 illustrated, each approach has unique distinctions. The methods that this report has highlighted were selected because each has technical, policy, and offset market merits. However, each has disadvantages that are important to evaluate as the Project offers CO_2 offsets to the market.

The Dispatch Approach has a technical advantage over the other approaches. However, the level of effort involved and the uncertainty surrounding the fact that it does not project a baseline for the last half of the Project offset this advantage.

The Recent Capacity Additions and Dynamic Marginal Source approach each attempt to address the electricity sources that the Project would displace now and in the future, based on current events in the electricity system. The downside of these approaches is that there is uncertainty as to whether they inflate or undercount the level of emission reductions.

The Natural Gas Benchmark offers the advantage of providing what most observers would agree is a conservative estimate, but it is most likely subject to significant Type I (undercounting of benefits) error. However, the magnitude of Type I error should decline substantially over time, as it is apparent that natural gas is the most likely source that would be added to the SING or added sooner but for the Project.

Table 6.3: Comparative Review of Baseline Scenarios

Scenario	Primary Advantages	Primary Disadvantages
Dispatch Model	* technically accurate * mitigates both Type I and Type II error[a]	* labor and data intensive * uncertainty exists as it does not cover the life of the Project
Recent Capacity Additions	* policy merit * accurate approximation of current events in the electricity system	* susceptible to choice of definition of "recent" * susceptible to both types of error
Dynamic Margin Source	* technically accurate * addresses what Project would most likely displace in the future	* dynamic approach adds uncertainty for buyers * susceptible to both types of error
Natural Gas Benchmark	* A conservative estimate that should be widely accepted * has some technical merit relative to the SING	* could significantly undercount true reductions

Source: Trexler and Associates, Inc., 2001.

a. Recall that Type I error involves underestimating emission reductions, while Type II error overestimates the level of emission reductions.

In addition to the distinctions outlined in Table 6.3, the choice of one of these scenarios has substantial implications for the volume of offsets generated by the Project over its lifetime. Assuming a capacity factor of 30.43 percent, the Calama Wind Project can be expected to generate 99,923 MWh of electricity per year. Further, assuming that the dispatch model scenarios would hold for throughout the life of the Project, the magnitude of offsets could vary by more than 1.3 million tonnes of CO_2.

Table 6.4: Baseline Summary

Baseline Scenario	Baseline (tCO_2 per MWh)	Total Project Life (tonnes of CO_2)
Dispatch Model Base Case	1.00	1,998,460
Dispatch Model SING-SIC Interconnection	1.00	1,998,460
Dispatch Model SING-SADI Interconnection	1.04	2,078,398
Dispatch Model Coal-Petcoke	1.03	2,058,414
Recent Capacity Additions	0.548	1,095,156
Dynamic Marginal Source	1.00; years 1-10 0.387; years 11-20	1,385,932
Natural Gas Benchmark	0.38	759,415

Source: Trexler and Associates, Inc., 2001.

7.0 CONCLUSIONS

The selected baseline scenarios were presented for consideration as suitable candidates for the Calama Wind Project because each could be interpreted as environmentally creditable and could positively influence the marketability and value of the emission reductions. However, the rate at which the Project could claim it benefits the climate varies substantially among the evaluated approaches.

The need to be flexible when viewing baseline options is important, since the Project will operate in a market that lacks clear and uniform signals from policymakers and market players. Given that the mitigation market is still evolving, the possibility exists that the Project will have to adopt a new baseline or revise its original baseline choice at some point during its lifetime.

Since the GHG mitigation market is in a pre-regulatory state, credibility is still largely in the eyes of the beholder. Thus, in the near-term the ultimate baseline determination will likely be driven by the preferences and needs of interested offset buyers. Additionally, the recent agreement at COP6-bis to move forward with the Kyoto Protocol signaled that the CDM market is expected to become operational by 2003. Therefore, the prospect exists that future

negotiations might offer more concrete guidance or determine the baseline the proposed Project would have to adopt to gain approval as a credible CDM project.

The four baselines evaluated do not represent an exhaustive list, and the baseline could ultimately take on many distinct forms depending on policy negotiations. Areas where the baseline could be subject to change, as a result of policy developments or buyer preferences, include:

1. *Level of aggregation:* the SING, Chile, or Latin America.
2. *Timing:* static or dynamic: if dynamic, what would be the frequency of revision (annual, every 5 years, every 10 years?).
3. *CO_2 emissions factor:* average emissions, marginal source emissions, a proxy plant, or a fossil-fired technology benchmark.

The selection of baseline approach will therefore have a significant effect on the potential magnitude of the Project's CO_2 emissions reductions. Because it is not possible to reliably state that one or another of the baselines will be "the" approach agreed to for future crediting purposes, they are all relevant to an analysis of how the Project could play into the CO_2 market. As previously noted, potential buyers may have their own preferences for baseline approach, and may be willing to pay more or less for the reductions based on the confidence they have in the baseline. The more conservative the baseline, the higher the likely price a purchaser will pay. Clearly, the tradeoffs involved in selecting a preferred baseline need to be carefully considered as the feasibility study of the Calama Wind Project moves forward.

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APPENDIX A: METHODOLOGY FOR CALCULATING CO_2 EMISSION FACTORS

The methodology utilized for calculating the CO_2 emissions factors that were used to form the baseline scenarios draws upon the revised 1996 IPCC Guidelines for National Greenhouse Inventories. This discussion will outline the technical steps that were taken to determine the different baselines.

STEP 1: ESTIMATE FUEL CONSUMPTION

CNE (2000c) provided the fuel consumption figures used for this analysis, from its node price-setting study. For the purposes of designing baselines, the weighted average fuel consumption was used for the first three baseline scenarios, which draw upon technical information relating directly to the SING.

STEP 2: CONVERT TO A COMMON ENERGY UNIT

The IPCC guidelines use terra joules, since the objective is to calculate an emissions rate as opposed to aggregate emissions. This analysis, however, uses kilo joules (KJ) as its common energy unit. Several sub-steps were taken to calculate per unit energy consumption based on the provided fuel consumption figures. The first step was to calculate the inferior calorific value-expressed in kilocalories per kilogram (Kcal/Kg). Since only superior calorific value figures were available, estimates of inferior calorific values were calculated using IPCC recommended conversion factors. This process produces an estimate of energy consumption in Kcal and a conversion factor of 4.1868 KJ/Kcal is used to obtain energy consumption in KJ.

STEP 3: MULTIPLY BY CARBON EMISSION FACTORS

The carbon emission factors are taken from IPCC (1996) and expressed in grams per KJ (g/KJ).

STEP 4: CALCULATE FOR CARBON STORED

The figure for determining the carbon content is calculated by multiplying energy consumption (in KJ) by the carbon emissions factor (in g/KJ) and converting to Kg of carbon.

STEP 5: CORRECT FOR UNOXIDIZED CARBON

This calculation is based on fraction of carbon oxidized values provided by IPCC (1996).

STEP 6: CONVERT TO CO_2 EMISSIONS

This conversion is done by multiplying the carbon content by 44 divided by 12, which represent the molecular weights of CO_2 and carbon. In addition, since the objective is to determine per unit emissions for baseline purposes, this calculation is expressed as metric tonnes of CO_2 per MWh.

To glean further insight into how the baseline metric used in this report, refer to the tables in Appendix B. These charts outline how each of the above steps were used to calculate the baseline for each of the four scenarios.

APPENDIX B: CO_2 EMISSION BASELINE CALCULATIONS

This Appendix presents the steps involved for calculating the CO_2 emission baselines utilized for each of the four scenarios.

Table B.1: Dispatch Model Baseline

Table B.1.1: Base Case

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO_2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(g C/KJ)	(Kg C)	%	(tCO_2/MWh)
Coal	0.385	7,000	0.95	6,650	2,560	4.1868	10,719	25.8	0.277	0.98	1.00

Sources: CNE, 2000c, and IPCC, 1996.

Table B.1.2: SING-SIC Interconnection Scenario

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO_2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(g C/KJ)	(Kg C)	%	(tCO_2/MWh)
Coal	0.385	7,000	0.95	6,650	2,560	4.1868	10,719	25.8	0.277	0.98	1.00
Diesel	0.345	10,900	0.90	9,810	3,384	4.1868	14,170	20.2	0.286	0.99	1.039

Sources: CNE, 2000c, and IPCC, 1996

Since two sources are displaced, the baseline is determined by calculating the weighted factors of each fuel. The weighted CO_2 emission baseline for this scenario is 1.00 tCO_2 per MWh, as coal is displaced 95 percent of the time while diesel is displaced 5 percent of the time.

Table B.1.3: SING-SADI Interconnection Scenario

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO_2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(g C/KJ)	(Kg C)	%	(tCO_2/MWh)
Coal	0.406	7,000	0.95	6,650	2,700	4.1868	11,304	25.8	0.292	0.98	1.05
Diesel	0.3373	10,900	0.90	9,810	3,309	4.1868	13,854	20.2	0.280	0.99	1.016

Sources: CNE, 2000c, and IPCC, 1996

The weighted CO_2 emissions baseline for this scenario is 1.04 tCO_2 per MWh.

Table B.1.4: Coal-Petcoke Scenario

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO_2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(Kcal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(g C/KJ)	(Kg C)	%	(tCO_2/MWh)
Coal	0.3967	7,000	0.95	6,650	2,638	4.1868	11,045	25.8	0.285	0.98	1.03

Sources: CNE, 2000c, and IPCC, 1996

Table B.2: Recent Capacity Additions Baseline

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption Rate	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(gC/KJ)	(KgC)	%	(Kg CO2/kWh)
Coal	0.364	7,000	0.95	6,650	2,421	4.1868	10,135	25.8	0.261	0.98	0.940
Natural Gas	0.1967	9,341	0.90	8,407	1,654	4.1868	6,923	15.3	0.106	0.995	0.386
Fuel Oil	0.229	9,599	0.90	8,639	1,978	4.1868	8,283	21.1	0.175	0.99	0.634
Diesel	0.3274	10,900	0.90	9,810	3,212	4.1868	13,447	20.2	0.272	0.99	0.986
Hydro	0	0	0	0	0	0	0	0	0	0	0

Sources: CNE, 2000c, and IPCC, 1996

As indicated by Table 6.2 in the main body of the report, the weighted average CO_2 emissions baseline for recent capacity additions is 0.548 t CO_2 per MWh.

Table B.3: Dynamic Marginal Source Baseline

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption Rate	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(gC/KJ)	(KgC)	%	(Kg CO2/kWh)
Coal	0.385	7,000	0.95	6,650	2,560	4.1868	10,719	25.8	0.277	0.98	1.00
Natural Gas	0.197	9,341	0.90	8,407	1,656	4.1868	6,934	15.3	0.106	0.995	0.387

Sources: CNE, 2000c, and IPCC, 1996

Table B.4: Natural Gas Combined-Cycle Technology Benchmark

IPCC Process	Step 1	Step 2						Step 3	Step 4	Step 5	Step 6
Fuel	Weighted Average Consumption Rate	Superior Calorific Value	Calorific Conversion Factor	Inferior Calorific Value	Energy Consumption	Conversion Factor	Energy Consumption	Conversion Factor	Carbon Content	Oxidization Rate	CO2 Emission Rate
	(Kg/kWh)	(KCal/Kg)		(KCal/Kg)	(Kcal)	(KJ/Kcal)	(KJ)	(gC/KJ)	(KgC)	%	(Kg CO2/kWh)
Natural Gas	0.192	9,341	0.90	8,407	1,614	4.1868	6,758	15.3	0.103	0.995	0.38

Source: IPCC, 1996.

Appendix K

Template for Turbine Price Solicitation

DEUMAN
INGENIEROS

Santiago, june XX, 2003

Mr.
XX
Company name
XX

Ref: Solicitation for Wind Turbine Price Quotation (Calama Wind Power Project)

Dear Mr. XX:

Deuman, on behalf of Corporación Nacional del Cobre (Codelco) is seeking price quotations from wind turbine suppliers for a prospective project currently under development. This form provides prospective wind turbine equipment suppliers with information about the potential project and specifies the type of information that Deuman wishes to obtain from the wind turbine supplier.

1. Project & Site Information

Project Name:	Calama Wind Power Project
Project Owner:	CODELCO
Project Location:	Calama, Chile
Project Size:	40 MW
Equipment Delivery Point:	Port of Mejillones, Chile
Delivery Timeframe:	All units delivered in december 2004
Anual Mean Temperature:	23° Celcius
Extreme Maximum Temp:	In a range between 20 and 24 °C
Extreme Minimum Temp:	In a range between –1 and 5 °C
Yearly average wind:	7.5 meters / sec @ 50 meters
Wind shear exponent:	-0.10 to + 0.10

Turbulence intensity, (for wind speed > 15.0 m/s): 12%
Air density (kg/m3) annual average: 0.95
Maximum in-flow angle (for extreme load): 0 degrees
Maximum in-flow angle 0 degrees
Seismic Classification Zone 1 (Z Factor) 3 UBC

2. Wind Turbine Supply Requested

WTG Model to be Quoted: Manufacturer to specify
Desired Tower Height: Min. height available

3. Equipment Information Requested From Equipment Supplier

a) Turbine model being quoted
b) Tower height(s)
c) Turbine power curve corrected to site mean air density
d) Turbine specifications
e) Turbine assembly & erection manual
f) WTG & tower weights & dimensions
g) SCADA system specifications
h) Information about number and location of similar wind turbines deployed
i) Operational history of the turbine model being quoted

4. Commercial & Warranty Information Requested from Wind Turbine Supplier

a) Number & price of wind turbines FOB port of origin (specify) and CIF delivered to Equipment Delivery Point (Port of Mejillones, Chile)
b) Price of towers FOB port of origin (specify) and CIF delivered to Equipment Delivery Point (Port of Mejillones, Chile)
c) Elapsed time between placing order and first WTG arrives at Equipment Delivery Point
d) Standard payment terms, including required security if any
e) Availability of vendor financing
f) Cost for wind turbine and tower installation (if offered)
g) Cost of installation supervision if not providing WTG and Tower installation
h) Cost for wind turbine commissioning
i) Price for SCADA system
j) Standard warranty terms
k) Cost of 2-year parts & labor warranty (if not included in j) above)
l) Cost of 5-year parts & labor warranty (if not included in j) above)
m) Cost of 2-year availability guaranty (if not included in j) above) and guaranty level(s)
n) Cost of 5-year availability guaranty (if not included in j) above) and guaranty level(s)
o) Cost of annual scheduled maintenance per year for 5 years
p) Information on power curve warranties offered
q) Information and price for any other warranties or performance guarantees offered

Appendix L 1 & L 2

Price Quotations from Vestas and NEG Micon

Vestas V52-850 KW 50 Hz
Turbine Price Quotes

August 2003

August 14th, 2003

Mr. Juan Walker
Marchant Pereira 221 Piso 12
Providencia 6640590, Santiago
j.walker@entelchile.net

Re: Response to request for pricing of Forty Seven (47) Vestas V52- 850kW 50 Hz Wind Turbine Generators

Dear Mr. Walker:

This quotation is provided to you on a confidential basis. Mr. Juan Walker agrees to hold in confidence all trade secrets and proprietary information to which they become privy to as a result of this quotation or any relationship with Vestas - American Wind Technology, Inc. (hereinafter referred to as "Vestas") in response to this quotation.

Attached please find our quotation in response to the above request. Vestas is quoting the project on a supply, installation supervision and commissioning basis for the V52-850 kW wind turbine generator. It is assumed in our pricing that forty seven V52's will be supplied according to the time frame provided within these documents, and delivered to port CIF Mejillones, Chile. If the quantity of turbines ordered is less or more than what is contemplated by this quotation, the pricing and schedule will be adjusted accordingly.

This quotation does not include any provision for the electrical collection system, roads, crane pads, foundations, sub-station or other high voltage electrical equipment and work.

Vestas would like to sincerely thank you for the opportunity to quote on this project. We feel that this response is competitive.

Best regards,

Scott Kringen
Marketing Coordinator

Vestas-American Wind Technology, Inc.

Price Quotation for Forty Seven (47) V52-850 kW WTGs & Forty Seven (47) 40m IEC I Towers

Wind Turbine Generators consisting of:

- Forty Seven (47) V52-850 kW wind turbines with rotor blades
- Forty Seven (47) upper and lower control panel with interconnecting cables in tower
- Low Temperature Package
- Two-year parts warranty on WTGs
- Delivery of WTGs to Mejillones, Chile

40-meter IEC I Tower consisting of:

- Forty Seven (47) 40 meter hub height tubular steel tower
- Forty Seven (47) set of internal lights, ladders and safety cables
- Delivery of Tower Mejillones, Chile

Technical Advice, Start-Up & Commissioning Test consisting of:

- Two (2) Technical advisors on-site during assembly and erection of WTG and the auxiliary equipment.
- Commissioning and testing of WTGs by Vestas technicians
- Includes airfare, board and lodging

Auxiliary Equipment:

- Telecom III for 47 turbines including cable

Service Visits:

- Five (5) maintenance visits by a Vestas supervisor. Please note that this does not include the cost of airfare, or other cost of any consumable and spare part items used in maintenance.

Grand Total **USD 31,137,941**

The above price on equipment imported from Europe is based on an exchange rate of DKK 6.5 : USD 1.00. If the exchange rates are other than this at the time of down payment, the USD-price will be adjusted accordingly.

Address
111 S.W. Columbia, Suite 480
Portland, OR 97201

Phone
+1 503 327 2000

Fax
+1 503 327 2001

Homepage
www.vestas-awt.com

Price Quotation for Forty Seven (47) V52-850 kW WTGs and Forty Seven (47) 40m IEC II Towers

Wind Turbine Generators consisting of:

- Forty Seven (47) V52-850 kW wind turbines with rotor blades
- Forty Seven (47) upper and lower control panel with interconnecting cables in tower
- Low Temperature Package
- Two-year parts warranty on WTGs
- Delivery of WTGs to Mejillones, Chile

40-meter IEC II Tower consisting of:

- Forty Seven (47) 40 meter hub height tubular steel tower
- Forty Seven (47) set of internal lights, ladders and safety cables
- Delivery of Tower Mejillones, Chile

Technical Advice, Start-Up & Commissioning Test consisting of:

- Two (2) Technical advisors on-site during assembly and erection of WTG and the auxiliary equipment.
- Commissioning and testing of WTGs by Vestas technicians
- Includes airfare, board and lodging

Auxiliary Equipment:

- Telecom III for 47 turbines including cable

Service Visits:

- Five (5) maintenance visits by a Vestas supervisor. Please note that this does not include the cost of airfare, or other cost of any consumable and spare part items used in maintenance.

Grand Total **USD 30,530,086**

The above price on equipment imported from Europe is based on an exchange rate of DKK 6.5: USD 1.00. If the exchange rates are other than this at the time of down payment, the USD-price will be adjusted accordingly.

Address
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Homepage
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Price Quotation for Forty Seven (47) V52-850 kW WTGs

Optional Warranty, Maintenance and Service Options (not included in above):

5 Year Option **US$ 10,000 /WTG/year**

- Five (5) year standard warranty on WTGs and Towers
- Five (5) year standard scheduled and non-scheduled service including 3, 6, 12, 18, 24, 30, 36, 42, 48, 54 and 60 month service visits (WTGs and Towers)
- Vestas standard 95 % availability guarantee as measured by WTG controller
- Vestas Power Curve Warranty (95% of Warranted Power Curve according to IEC 61400-12)
- Price subject to annual inflation rate adjustment

The Wind Turbine Generators (WTGs):
WTGs quoted are the Vestas V52-850 kW WTG 50 Hz.

Parts Warranty
Vestas warrants that the WTG will be free from defects in material workmanship (as outlined and agreed to as the Vestas Scope under the Vestas Sales Agreement) and that the WTG will be free from defects in design, each for a period of two (2) years commencing on earlier of (a) the date of Start-Up Testing and Commissioning of the WTG and (b) sixty (60) days following arrival of the WTG at the CIP Destination.

Start-Up & Commissioning Test
The Start-Up and Commissioning Test has to be performed by Vestas – American Technicians.

Quotation Expiry:
December 31st 2003 unless accepted through a Vestas Sales Agreement.

Time of Delivery:
Subject to availability, delivery can take place within 6 months of contract signing and receipt of down payment. Delivery for this quotation is anticipated to begin in 2004. The final Delivery Schedule will be negotiated and finalized prior to signing The Vestas Sales Agreement.

Terms of Delivery:
Terms of Delivery is defined as Incoterms 2000 CIP named destination. Waiting time, demurrage, detention and per diem charges in excess of free time are not included in the freight charges quoted.

Site Locations:
In case the site location deviates from the standard set forth in the General Specifications, Vestas will not be obligated to deliver the WTG for any such site or to modify the WTG for any such site. In case of any modifications to the WTG due to site conditions, Vestas would have to

agree to such modifications as well as the additional price for doing so, prior to undertaking any obligations to make such modifications to the WTG.

Climatic Condition Sheet:
Attached Climatic Condition Sheet will have to be filled in and attached to the Vestas Sales Agreement.

Terms of Payment:
Following are our standard payment terms for this project:

- 20% of total to be paid to Vestas as a non-refundable Down Payment upon contract signing. Buyer to establish Irrevocable Letter of Credit at a Bank acceptable to Vestas for the Balance of the contract value on or before the time the Down Payment is made.
- 50% of total to be drawn on the Letter of Credit against Bill of Lading indicating the WTGs leaving the first Danish port.
- 20% of total to be drawn on the Letter of Credit when the WTGs arrive at the first North American Port.
- 10% of total to be drawn on the Letter of Credit, upon commissioning the of WTGs, but in no event later than 60 days after the wind turbines have arrived at the first North American Port.

EXCLUSIONS:
Please note that any and all expenses related, but not limited to the following are not included in the quotation: installation of WTGs and towers, foundations, roads, staging areas, site selection, surveys, soils test and soil analysis permits, high voltage underground cable, transformer and the instillation of the transformer, grid connection and underground cable and trenching, gathering substation, bonds, exchange rate hedging, financing costs/interest, sales/use taxes, and any other costs not specifically included in quotation.

Vestas is not liable for any special, indirect or consequential damages.

Customer will pay any and all expenses in connection with delays (other than shipping), not caused by Vestas, i.e. interest, storage, trailer rental, container rental and other equipment etc.

Customer is responsible for providing cranes suitable for the erection of the wind turbines.

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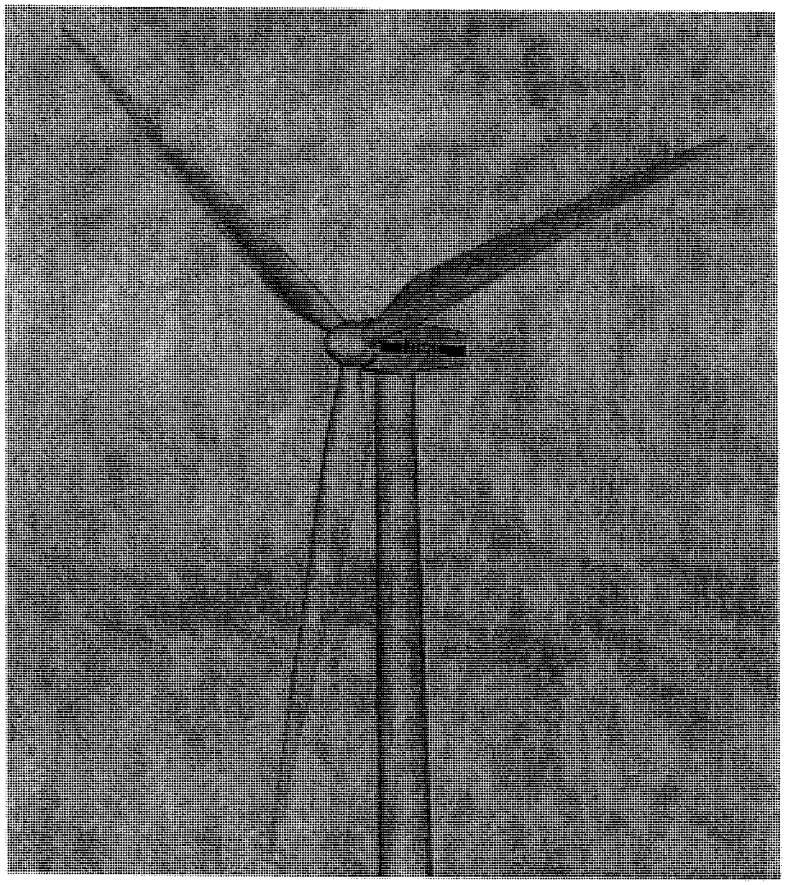
TRACK RECORD FOR VESTAS Wind Systems A/S - 31st December 2002

Country	30-75 kW	90-150 kW	200-300 kW	400-500 kW	600 kW	660 kW	850 kW	1,5-1,65 MW	1,75 MW*	1,8 MW	2,0 MW	3,0 MW	Total
Australia			11		9	17			18				55
Austria			1		13	18	3		11		6		52
Belgium						2		1					3
Brazil			1										1
Canada					4	100				8			112
Cape Verde Islands	3												3
Caribbean Islands		2											2
Chile						3							3
Costa Rica						30							30
Czech Republic			2	6									8
Denmark	485	158	567	152	331	410	62	17	21		88	5	2.296
England	1	1	20	99	22	23					2		168
Finland			1	1	4	1					1		8
France			1	4			1						6
Germany	12	9	172	193	292	378	167	278	73		334	1	1.909
Greece	4		45	1	2	52							104
India	31	26	754	76									887
Israel	1		2										3
Italy		1	4	3	299	461	55		7				830
Jamaica			1										1
Japan			6	5	3	6	14	38					72
Jordan			5										5
Latvia							1						1
Morocco					84								84
Mexico			7		1								8
Netherlands			54	13	22	63	39	35	21		13		260
New Caledonia			20										20
New Zealand			1			48							49
Northern Ireland				30		20							50
Norway	2			8			5	1					16
Peoples Rep. of China	5				98								103
Poland			1				6				9		16
Portugal			2		17	21	1	4	4				49
Republic of Ireland			3	10	40	91	18	1					163
Republic of Korea		2											2
Scotland	3					95			9				107
South Africa						1			1				2
South Korea		1	1		3	4							9
Spain		7	29										36
Sweden	3	5	93	24	56	79	48	6	4		3	1	322
Switzerland					3	1	2						6
Taiwan						4			2				6
Turkey	1				12								13
USA	975	1.105	563	75	4	1.524		15					4.261
Wales					1		18						19
Total	**1.526**	**1.317**	**2.367**	**700**	**1.320**	**3.452**	**440**	**396**	**171**	**8**	**456**	**7**	**12.160**

* The VESTAS 65kW and 75kW turbines are modified to 65kW and 90kW respectively on the US market due to the frequency of 60 Hz.

** The 73 VESTAS V66-1650 kW turbines are optispeed (1750 kW) turbines modified to 1650kW on the German market

* The V47 are adjusted to 600 kW on the Japanese market



General Specification

Vestas V52 – 850 kW

OptiSpeed™ – Wind Turbine

Item no. 946506.R6

(5b)

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1. Wind Turbine Description

The VESTAS V52 – 850 kW is a pitch regulated upwind wind turbine with active yaw and a rotor with three blades.

The VESTAS V52 – 850 kW with a rotor diameter of 52 m operates using the OptiSpeed™ concept. This feature enables the rotor to operate with variable speed (RPM).

All V52-850 kW turbines are equipped with OptiTip®, the special VESTAS pitch regulating system. With OptiTip®, the angle of the blades are constantly regulated so they are always pitched at the optimal angle for current wind conditions. This optimizes power production and noise levels.

The blades are made of glass fibre reinforced epoxy. Each blade consists of two blade shells, bonded to a supporting beam. Special steel root inserts connect the blade to the blade bearing. The blade bearing is a 4-point ball bearing bolted to the blade hub.

The main shaft transmits the power to the generator through the gearbox. The gearbox is a combined planetary and helical gearbox. From the gearbox the power is transmitted via a maintenance free composite coupling to the generator. The generator is a special asynchronous 4-pole generator with wound rotor.

At higher wind speeds the OptiSpeed™ and the pitch regulating system keep the power at nominal regardless of the air temperature and air density. At lower wind speeds the OptiTip® system and OptiSpeed™ optimize the power output by selecting the optimal RPM and pitch angle.

The wind turbine brakes by full feathering the blades. An emergency disc brake system is mounted on the gearbox High Speed shaft.

All functions of the wind turbine are monitored and controlled by several microprocessor based control units. This control system is placed in the nacelle. Changes in the pitch of the blades are activated by a hydraulic system, which enables the blades to rotate 95. This system also supplies the pressure for the brake system.

Two electrical yaw gears rotate the yaw pinions, which meshes with a large toothed yaw ring mounted on the top of the tower. The yaw bearing system is a plain bearing system with built-in friction and a electrical brake on the yaw gear motors.

The glass fibre reinforced nacelle cover protects all the components in the nacelle against rain, snow, dust, sun etc. Access to the nacelle from the tower is through a central opening.

The nacelle houses the internal 250 kg service crane.

Steel tubular tower is supplied painted (please see under 1.3 Climatic Conditions).

1.1 VCS Description, OptiSpeed™

OptiSpeed™, also named Vestas Converter System (VCS), ensures a steady and stable electric power from the turbine.

VCS consists of an effective asynchrounous generator with wound rotor and sliprings. A power converter with IGBT switches. Contactors and protection

VCS enables variable speed operation in a range of approx. 60% of nominal RPM.

VCS together with the pitchcontrol ensures energy optimisation. low noise operation and reduction of loads on the gearbox and other vital components.

VCS controls the current in the rotorcircuit in the generator. This gives precise control of the reactive power. and gives an exact connection of the generator to the grid.

1.2 Type Approvals

The V52 – 850 kW wind turbine is type approved according to the following standards:

Country:	Design criteria for approval:	Conditions:	Tower height
Denmark	DS 472 Teknisk G rundlag	Roughness class 0, 1, 2 and 3	40, 44, 49, 55, 60, 65 & 74 m
Germany	DIBt	Zone II	74, 86 m
The Netherlands	NVN11400/0	Class I_A	40, 44, 49, 55, 60 & 65 m
Germany	DIBt	Zone III	60 & 65 m
IEC	IEC 61400-1	Class I_A	40, 44, 49, 55, 60 & 65 m
IEC	IEC 61400-1	Class II_A	55, 60, 65 & 74 m

1.3 Climatic Conditions

The wind turbine is designed for ambient temperatures ranging from -20°C to +40°C. Special precautions must be taken outside these temperatures (see section 1.5 General Reservations)

The wind turbines can be placed in wind farms with a distance of at least 5 rotor diameters (260 m) between the wind turbines. If the wind turbines are placed in one row, perpendicular of the predominant wind direction, the distance between the wind turbines must, at least be 4 rotor diameters (208 m).

The relative humidity can be 100 % (max. 10 % in time). Corrosion protection according to ISO 12944-2. Class C3 internal and C4 external. For the tower at extreme corrosive sites C4 internal and C5-M external. Corrosion protection is designed for long lifetime.

1.4 Grid Connection

Intermittent or rapid power fluctuations of utility grid frequencies may cause serious damage to the wind turbine. Steady variations within +1/-3 Hz (50 Hz) or within +2/-3 Hz (60 Hz) are acceptable. The voltage operational range must be within +10/-10% of nominal. (Default setting +6/-10%).

Grid drop-outs should only take place once a week as an average over the lifetime of the turbine.

A ground connection of max. 10 Ω must be present. Furthermore, it is recommended that the turbine is connected to a TN-grid.

The earthing system must be accomodated to local soil conditions. The resistance to neutral earth must be according to the requirements of the local authorities.

In case of small independent grids, it will be necessary to check the actual conditions.

1.5 General Reservations

Vestas Optispeed™ technology is not available in United States of America and Canada.

In connection with heavy icing up, interruptions in operation may be expected.

In certain combinations of high wind, high temperature, low air density and/or low voltage power derating may happen to ensure that the thermal conditions of the main components such as gearbox, generator etc. are kept within limits.

It is generally recommended that the grid voltage is as close to nominal as possible. In connection with grid dropout and very low temperatures, a certain time for heating must be expected before the wind turbine can start to operate.

If the terrain within a 100 m radius of the turbine has a slope of more than 10^0, particular considerations may be necessary.

If the wind turbine is placed in more than 1000 m above sea level, a higher temperature rise than usual might occur in generator, transformer and other electrical components. In this case a periodic reduction of rated power might occur, even if the ambient temperature is within the specified limits.

Furthermore, also at sites in more than 1000 m above sea level there will be an increased risc of icing up.

Due to continuous development and updating of our products, VESTAS reserves the right to change the specifications.

2. Main Data

2.1 Wind Climate

Turbulence is a factor to describe short-term wind variations/fluctuations. Below the design conditions for the VESTAS V52-850 kW wind turbine are listed.

IEC class	V_{ave}*) [m/s]	Weibull shape parameter [-]	Turbulence at 15 m/s [%]	Reference wind**) [m/s]	Reference wind***) [m/s]
I_A	10.0	2	18	50	70

*) Annual average wind speed, **) 10 min, 50 years wind, ***) 3 sec, 50 years wind gust.

IEC class	wind gust max. acc. [m/s^2]	Stop wind speed/restart wind speed [m/s]
I_A	10	25/20

Wind speed and turbulence are referring to hub height.

2.2 Power Curve VESTAS V52-850 kW

Power curve calculated on basis of NACA 63.xxx and FFA-W3 blade profiles.
Parameters for calculated curves:

Frequency	:	50/60 Hz
Rotor diameter	:	52 meter
Tip angle	:	Pitch regulated
Turbulence	:	10 %

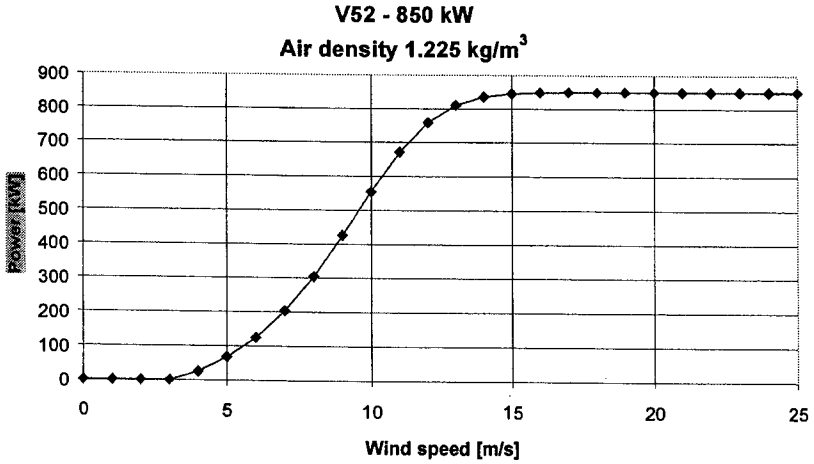
The power curve is measured at the ground controller on the low-voltage side of the transformer, which means that losses in transformer and high-voltage cables are not included.

In order to meet site specific demands for low noise it is possible to program turbine noise emission levels before installation so that turbine operations are customized to meet the specific requirements of the site. When lowering the noise emission level it influences the kWh production compared to standard.

2.2.1 Power Curve V52-850 kW, 104.2 dB(A)

V52-105 kW, 104.2 dB(A)									
V10 [m/s]	**1.225**	**1.060**	**1.090**	**1.120**	**1.150**	**1.180**	**1.210**	**1.240**	**1.270**
4	25.5	20.4	21.3	22.3	23.2	24.1	25.1	26.0	27.0
5	67.4	56.6	58.6	60.5	62.5	64.5	66.4	68.4	70.4
6	125	106	109	113	116	119	123	126	130
7	203	173	179	184	189	195	200	206	211
8	304	260	268	276	284	292	300	308	317
9	425	365	376	387	398	409	420	431	441
10	554	480	494	507	521	534	547	561	572
11	671	595	610	624	637	651	665	679	688
12	759	696	709	720	731	742	753	765	770
13	811	770	780	787	794	800	807	814	817
14	836	815	820	824	827	831	834	838	839
15	846	837	839	841	842	843	845	846	847
16	849	846	847	847	848	848	849	849	849
17	850	849	849	849	849	850	850	850	850
18-->25	850	850	850	850	850	850	850	850	850

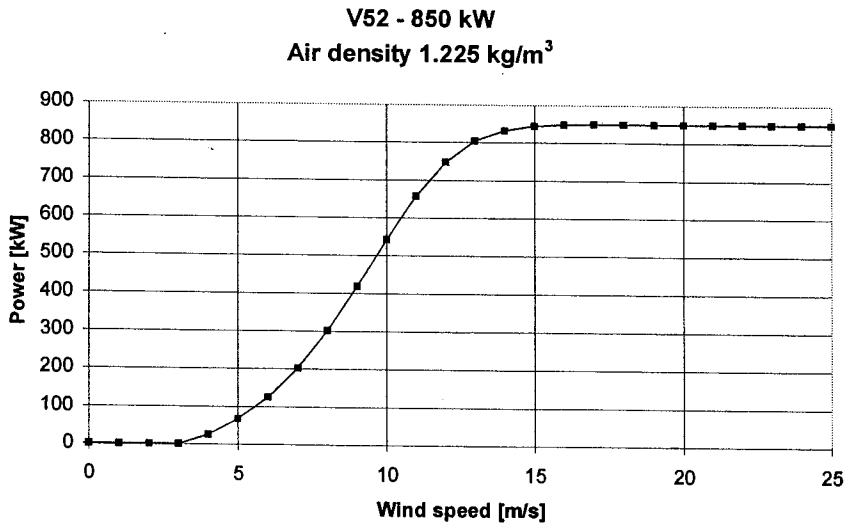
Wind speed as 10 minutes average value at hub height and perpendicular to the rotor plane.



2.2.2 Power Curve V52-850 kW, 103.0 dB(A)

V52-850 kW, 103.0 dB(A)									
V10 [m/s]	1.225	1.060	1.090	1.120	1.150	1.180	1.210	1.240	1.270
4	25.5	20.4	21.3	22.3	23.2	24.1	25.1	26.0	27.0
5	67.4	56.6	58.6	60.5	62.5	64.5	66.4	68.4	70.4
6	125	106	109	113	116	119	123	126	130
7	202	173	178	183	189	194	200	205	211
8	302	258	266	274	282	290	298	306	314
9	418	359	370	381	391	402	413	424	435
10	543	470	484	497	510	523	536	549	562
11	658	584	598	612	625	638	652	665	678
12	748	686	700	710	721	732	742	753	764
13	804	763	773	780	787	794	801	807	814
14	832	811	817	821	824	827	831	834	837
15	844	835	838	839	841	842	844	845	846
16	848	845	846	847	847	848	848	849	849
17	850	849	849	849	849	849	850	850	850
18-->25	850	850	850	850	850	850	850	850	850

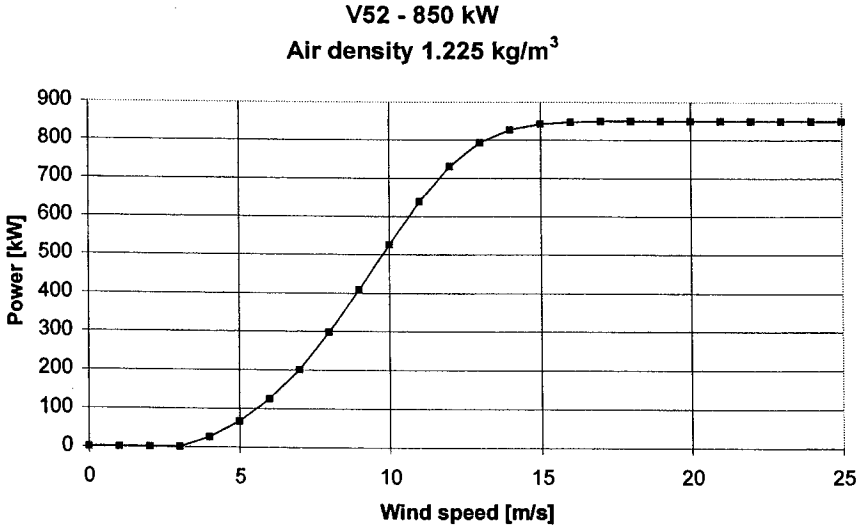
Wind speed as 10 minutes average value at hub height and perpendicular to the rotor plane.



2.2.3 Power Curve V52-850 kW, 102.0 dB(A)

V52-850 kW, 102.0 dB(A)									
V10 [m/s]	**1.225**	**1.060**	**1.090**	**1.120**	**1.150**	**1.180**	**1.210**	**1.240**	**1.270**
4	25.5	20.4	21.3	22.3	23.2	24.1	25.1	26.0	27.0
5	67.4	56.6	58.6	60.5	62.5	64.5	66.4	68.4	70.4
6	124	106	109	112	116	119	123	126	129
7	201	172	177	182	188	193	198	204	209
8	297	254	262	270	278	286	293	301	309
9	408	350	360	371	382	392	403	413	424
10	525	454	467	481	494	506	519	532	544
11	638	561	577	593	606	619	631	644	657
12	730	663	678	694	704	715	725	735	745
13	792	744	756	770	776	783	789	796	802
14	826	799	807	815	818	822	825	828	831
15	842	829	833	837	838	840	841	842	844
16	848	842	844	846	846	847	847	848	848
17	849	848	848	849	849	849	849	849	850
18-->25	850	849	850	850	850	850	850	850	850

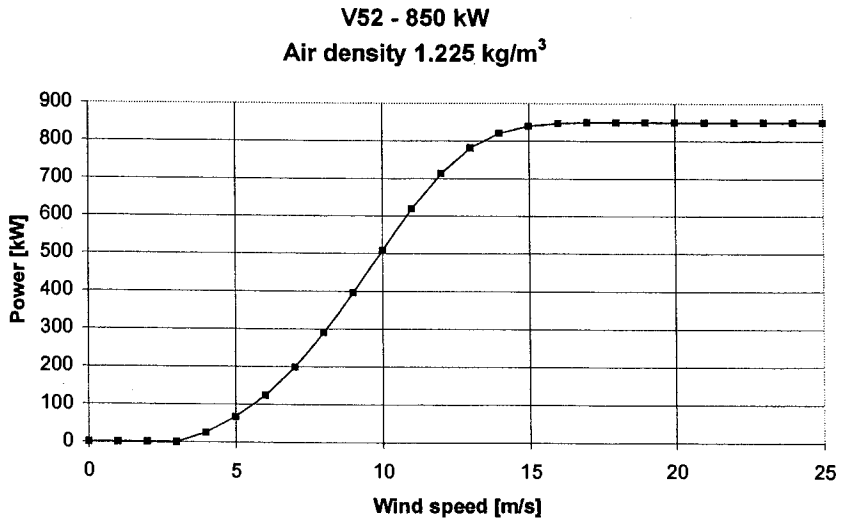
Wind speed as 10 minutes average value at hub height and perpendicular to the rotor plane.



2.2.4 Power Curve V52-850 kW, 101.0 dB(A)

V52-850 kW, 101.0 dB(A)									
V10 [m/s]	**1.225**	**1.060**	**1.090**	**1.120**	**1.150**	**1.180**	**1.210**	**1.240**	**1.270**
4	25.5	20.4	21.3	22.3	23.2	24.1	25.1	26.0	27.0
5	67.4	56.6	58.5	60.5	62.5	64.4	66.4	68.4	70.4
6	124	105	109	112	115	119	122	126	129
7	199	170	175	181	186	191	197	202	207
8	292	249	257	265	272	280	288	296	303
9	396	340	350	360	371	381	391	402	412
10	508	438	451	464	477	490	502	514	527
11	619	540	555	570	585	600	612	625	637
12	714	640	655	670	684	699	709	719	729
13	782	726	737	749	761	772	779	785	791
14	821	787	794	801	809	816	820	823	826
15	840	822	826	830	834	838	839	840	841
16	847	840	841	843	844	846	847	847	847
17	849	847	847	848	848	849	849	849	849
18-->25	850	849	849	849	850	850	850	850	850

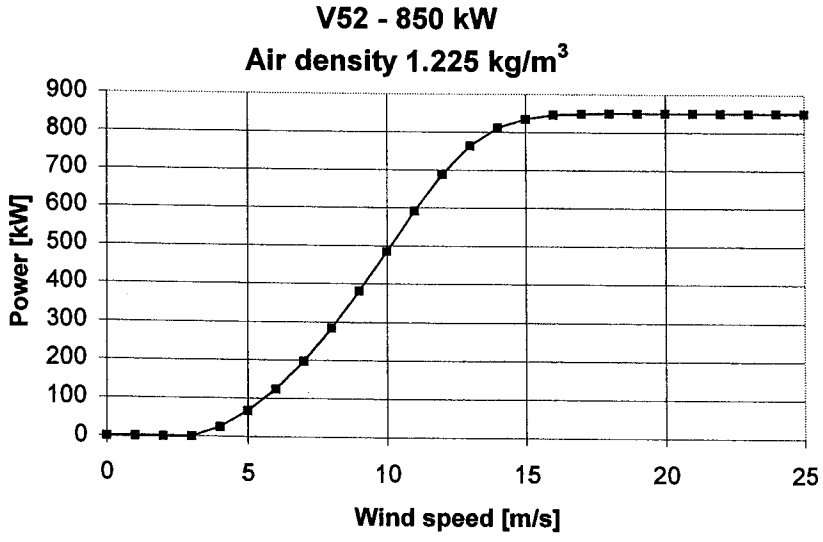
Wind speed as 10 minutes average value at hub height and perpendicular to the rotor plane.



2.2.5 Power Curve V52-850 kW, 100.0 dB(A)

V52-850 kW, 100.0 dB(A)									
V10 [m/s]	**1.225**	**1.060**	**1.090**	**1.120**	**1.150**	**1.180**	**1.210**	**1.240**	**1.270**
4	25.5	20.4	21.3	22.3	23.2	24.1	25.1	26.0	27.0
5	67.4	56.5	58.5	60.5	62.4	64.4	66.4	68.4	70.3
6	124	105	108	112	115	118	122	125	129
7	197	168	173	178	184	189	194	200	205
8	284	243	251	258	266	273	281	288	296
9	381	327	337	347	357	367	376	387	397
10	485	416	429	441	454	466	479	491	503
11	591	512	527	541	555	570	584	598	611
12	688	608	625	640	653	667	681	695	706
13	763	696	712	724	735	746	757	768	777
14	810	764	776	786	793	800	806	813	819
15	834	808	816	822	825	829	832	836	839
16	845	833	837	839	841	842	844	845	846
17	848	844	845	847	847	848	848	849	849
18-->25	850	848	849	849	849	849	850	850	850

Wind speed as 10 minutes average value at hub height and perpendicular to the rotor plane.



2.3 Annual Production V52-850 kW

Below annual production figures for different noise levels. Roughness classes in accordance with DS472. The noise is, according to DS, measured at 8 m/s in 10 m height.

Annual production at 45 m hub height are according to Beldringe Site, Denmark.

Dansk ruhedsklasse - Beldringe korrektion. Produktion i MWh (1.000)				
Mølle – 45 m navhøjde	**0**	**1**	**2**	**3**
V52-850 kW, 104,2 dB(A)	3.210	2.224	1.843	1.309
V52-850 kW, 103,0 dB(A)	3.171	2.195	1.819	1.292
V52-850 kW, 102,0 dB(A)	3.122	2.158	1.789	1.272
V52-850 kW, 101,0 dB(A)	3.073	2.121	1.757	1.251
V52-850 kW, 100,0 dB(A)	2.996	2.063	1.710	1.219

2.3.1 V52-850 kW. C=1.5

C = 1.5						
Turbine	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
V52-850 kW. 104.2 dB(A)	1.315	1.879	2.407	2.864	3.235	3.519
V52-850 kW. 103.0 dB(A)	1.299	1.857	2.380	2.835	3.205	3.489
V52-850 kW. 102.0 dB(A)	1.279	1.830	2.347	2.799	3.168	3.451
V52-850 kW. 101.0 dB(A)	1.259	1.802	2.314	2.763	3.130	3.414
V52-850 kW. 100.0 dB(A)	1.228	1.758	2.262	2.706	3.071	3.353

2.3.2 V52-850 kW. C=2

C = 2.0						
Turbine	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
V52-850 kW. 104.2 dB(A)	1.098	1.733	2.388	3.005	3.549	4.002
V52-850 kW. 103.0 dB(A)	1.086	1.711	2.357	2.969	3.510	3.963
V52-850 kW. 102.0 dB(A)	1.070	1.683	2.319	2.923	3.461	3.914
V52-850 kW. 101.0 dB(A)	1.053	1.653	2.279	2.878	3.414	3.866
V52-850 kW. 100.0 dB(A)	1.029	1.609	2.219	2.806	3.337	3.788

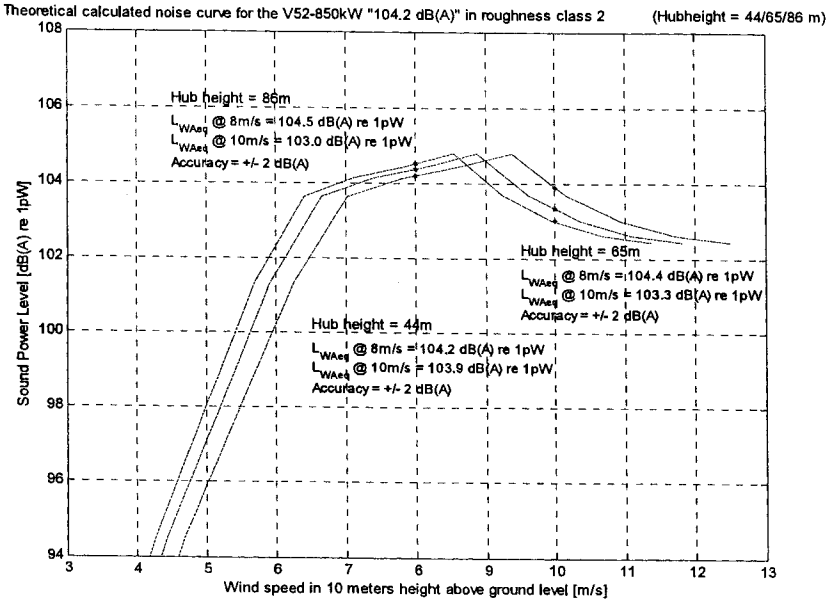
2.3.3 V52-850 kW. C=2.5

C = 2.5						
Turbine	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
V52-850 kW. 104.2 dB(A)	946	1.595	2.317	3.031	3.685	4.251
V52-850 kW. 103.0 dB(A)	938	1.574	2.284	2.989	3.639	4.204
V52-850 kW. 102.0 dB(A)	928	1.549	2.243	2.937	3.580	4.144
V52-850 kW. 101.0 dB(A)	916	1.522	2.201	2.884	3.522	4.085
V52-850 kW. 100.0 dB(A)	898	1.482	2.137	2.802	3.431	3.991

2.4 Noise Emission V52-850 kW

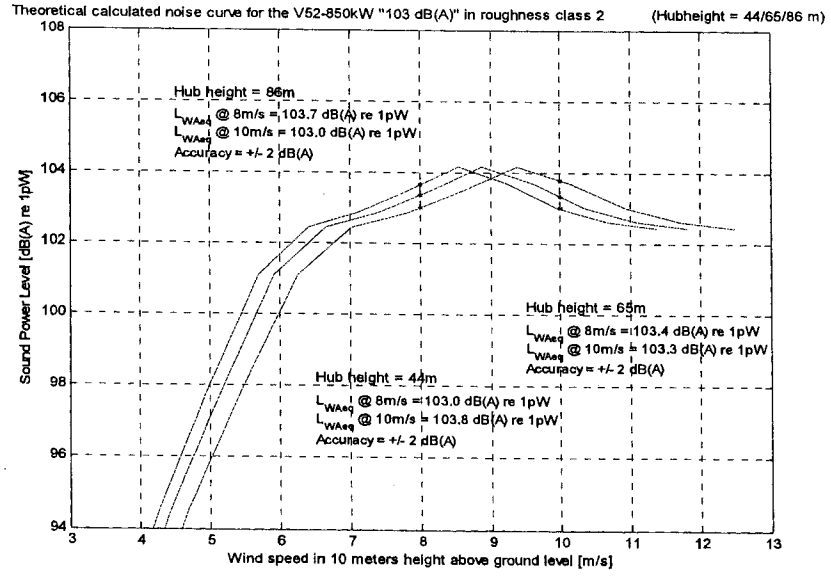
2.4.1 Noise V52-850 kW. 104.2 dB(A)

Noise emission V52-850 kW: 104.2 dB(A) measured at 8 m/s in 10 m height.



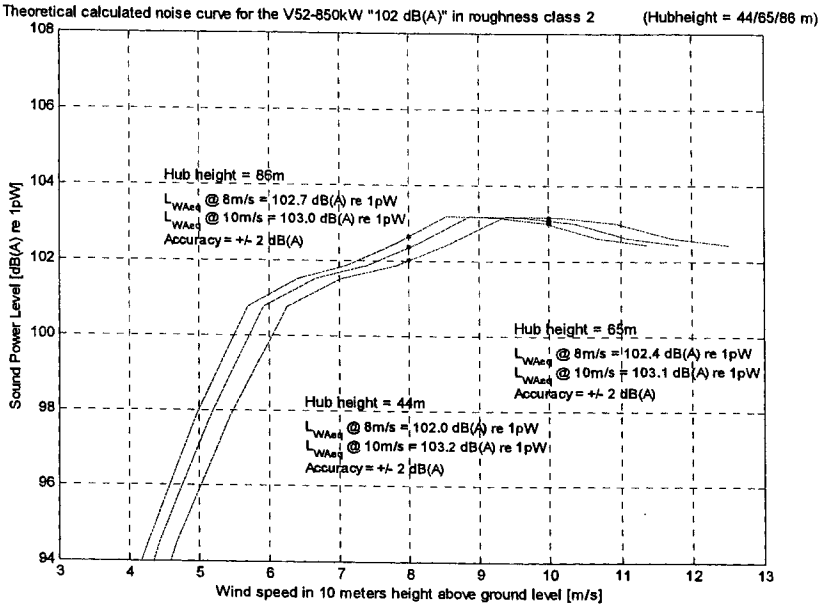
2.4.2 Noise V52-850 kW. 103.0 dB(A)

Noise emission V52-850 kW: 103.0 dB(A) measured at 8 m/s in 10 m height.



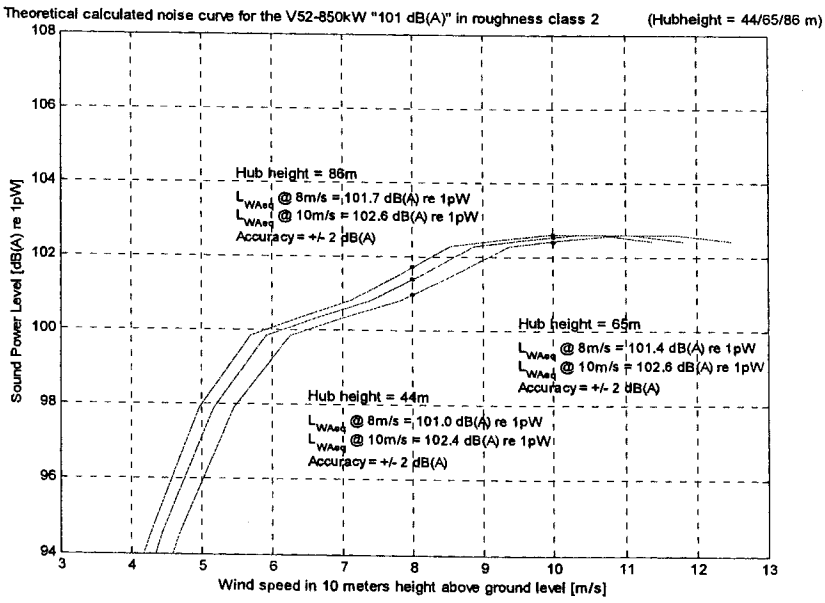
2.4.3 Noise V52-850 kW. 102.0 dB(A)

Noise emission V52-850 kW: 102.0 dB(A) measured at 8 m/s in 10 m height.



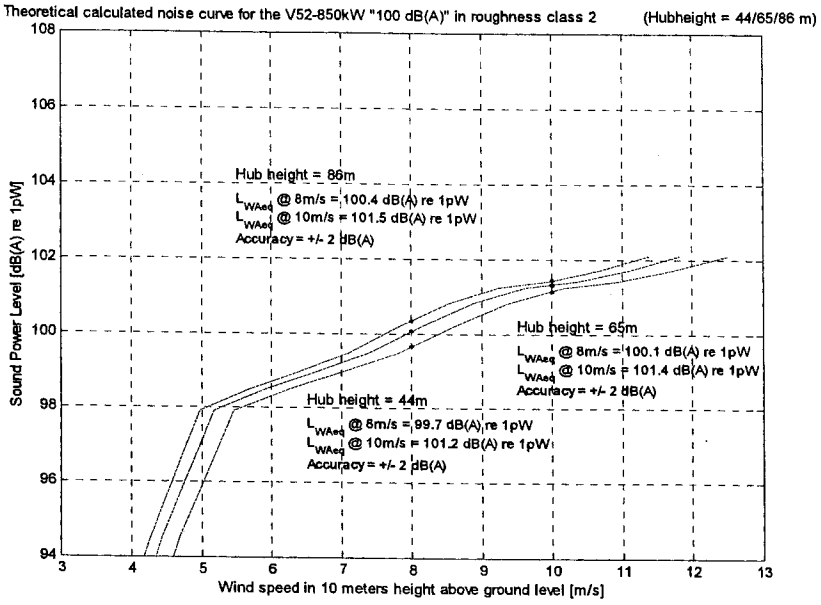
2.4.4 Noise V52-850 kW. 101.0 dB(A)

Noise emission V52-850 kW: 101.0 dB(A) measured at 8 m/s in 10 m height.



2.4.5 Noise V52-850 kW. 100.0 dB(A)

Noise emission V52-850 kW: 100.0 dB(A) measured at 8 m/s in 10 m height.



3. Technical Specifications

3.1 Rotor

Diameter:	52 m
Swept area:	2124 m^2
Rotational speed static. rotor:	26 RPM
Rotational speed. operation interval rotor:	14.0 - 31.4 RPM
Rotational direction:	Clockwise (front view)
Orientation:	Upwind
Tilt:	6°
Blade coning:	3°
Number of blades:	3
Aerodynamic brakes:	Full feathering

3.2 Blades

Principle:	Shells bonded to supporting beam
Material:	Glass fibre reinforced epoxy
Blade connection:	Steel root inserts
Air foils:	NACA63.xxx+FFA-W3
Length:	25.3 m
Chord (width) (blade root/blade tip):	2.3 m/0.33 m
Twist (blade root/blade tip):	16°/0°
Weight:	Approx. 1.900 kg/pcs.

3.3 Blade Bearing

Type:	4-point ball bearing

3.4 Blade Hub

Type:	Cast ball hub
Material:	EN-GJS-400-18U-LT

3.5 Main Shaft

Type:	Forged shaft
Material:	34CrNiMo6

3.6 Bearing Housing

Type:	Cast housing
Material:	EN-GJS-400-18U

3.7 Main Bearings

Type: Spherical roller bearings from recognized suppliers

3.8 Machine Foundation

Type: Combined steel plate and cast steel construction

3.9 Yaw System

Type: Plain bearing system with built-in friction
Material: Forged yaw ring heat treated. Plain bearings PETP
Yawing speed: < 0.5 °/sec

3.10 Yaw Gears

Type: 3 step planetary and 1 step worm gear
Motor: 2.2 kW. 6 pole. asynchronous with electrical brake

3.11 Tower (Steel)

Type: Conical tubular
Material: S 235JO/JR
Surface treatment: Painted
Corrosion class. outside: ISO 12944 C4/offshore C5-M
Corrosion class. inside: ISO 12944 C3/offshore C4
Top diameter for all towers: 2.1 m

	Hub height	Bottom diameter
2-parted modular tower (40 m):	40 m	3.0 m
2-parted modular tower (44 m):	44 m	3.0 m
2-parted modular tower (49 m):	49 m	3.3 m
2 & 3-parted modular tower (55 m):	55 m	3.3 m
3-parted modular tower (60 m):	60 m	3.6 m
3-parted modular tower (65 m):	65 m	3.6 m
3-parted modular tower (74 m)	74 m	4.0 m
4-parted modular tower (86 m)	86 m	4.0 m

Hub height is inclusive 0.4 m (distance from the foundation section to earth) and inclusive 1.6 m from tower top to hub center.

3.12 Gearbox

Type:	1 planetary stage/2 helical stages
Ratio:	50 Hz: 1:62 60 Hz: 1:74.4
Cooling:	Oilpump with oilcooler
Oil heater:	1.5 kW
Manufacturer:	Vestas has more sub-suppliers of gearboxes. All gearboxes are in compliance with Vestas specifications.

3.13 Couplings

Main shaft-gearbox:

Type:	Shrink disc. conical

Gearbox generator:

Type:	Composite shaft

3.14 Generator with VCS

	Generator 50 Hz/60Hz
Type:	Asynchronous. with wound rotor and VCS
Rated power:	850 kW
Voltage:	690 VAC
Frequency:	50 Hz/60Hz
No. of poles:	4
Class of protection:	IP54
Rated speed:	1620/1944 RPM
Rated current:	711 A
Rated power factor. default:	1.0
Power factor range:	0.98_{CAP} - 0.95_{IND} (option) See section 1.5 general reservations.
Manufacturer:	Vestas has more sub-suppliers of generators. All generators are in compliance with Vestas specifications.

3.15 Emergency Disc Brake

Type:	Disc Brake
Diameter:	600 mm
Disc material:	SJV300

3.16 Hydraulic Unit

Pump capacity:	8.7 l/min
Max. pressure:	200 bar
Brake pressure:	44 bar
Oil quantity:	60 l
Motor:	4 kW

3.17 Anemometer

Type:	Ultra-sonic

3.18 Wind Direction Sensor

Type:	Ultra-sonic

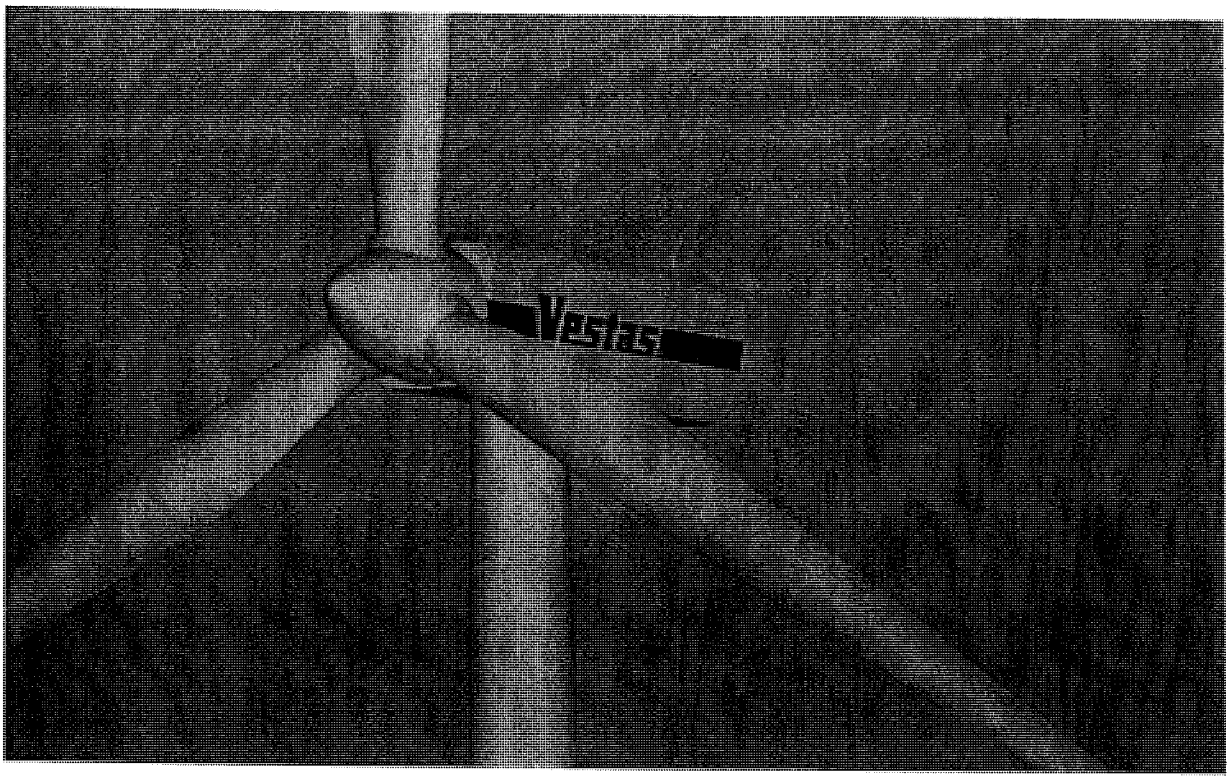
3.19 Control Unit

Power current:	50 Hz / (60 Hz)
Voltage:	3 x 690 VAC. 50 Hz/60 Hz
Lockable circuit breaker:	800 A
Power supply for light:	1 x 10 A. 230 VAC/ (1 x 10A. 110 Vac)
Computer:	
Communication:	ArcNet
Program memory:	EPROM (flash)
Programming language:	C++
Configuration:	Modules
Operation:	Numeric keyboard + function keys
Display:	4 x 40 characters
Supervision/control:	
	Active power
	Reactive power
	Yawing
	Hydraulics
	Environment (wind temperature)
	Rotation
	Generator
	Pitch system
	Grid
	Remote monitoring
Information:	Operating data
	Production
	Operation log
	Alarm log
Commands:	Run/Pause
	Man. Yaw start/stop
	Maintenance routine
REMOTE SUPERVISION	Possibility of connection of serial communication

3.20 Weights

To calculate the total weight of the turbine add the weight of the rotor (10t) and the nacelle (22t) to the weight of the appropriate tower from the table below.

V52-850 kW	DS 472	IEC I^A	IEC II	DIBt III	DIBt II	NVN II
40 m Tower	39t	39t	÷	÷	÷	39t
44 m Tower	43t	43t	÷	÷	÷	43t
49 m Tower	51t	51t	÷	÷	÷	51t
55 m Tower	58t	58t	÷	÷	÷	58t
60 m Tower	70t	70t	70t	70t	70t	70t
65 m Tower	77t	77t	77t	77t	77t	77t
74 m Tower	94t	÷	94t	÷	94t	÷
86 m Tower	÷	÷	÷	÷	109t	÷



Low temperature option

Vestas V52 – 850 kW
Wind Turbine

Appendix to V52 General Specification

Item no.: 946507.R0

(5c)

Contents ..... **Page**

1. LT-Wind Turbine Description **3**

1.1 Description of the "LT (Low Temperature) option" 3
1.2 Climatic Conditions 3

2. Technical description **3**

2.1 Electrical heaters in the nacelle 3
2.2 Controller heating panels 4
2.3 Heating for Ultra Sonic wind vane and anemometer 4
2.4 Battery backup of the brake 4
2.5 Lubricants for LT operation 4

3. Temperature settings for LT-options **4**

1. LT-Wind Turbine Description

The VESTAS V52-850kW Wind Turbine – Low Temperature (LT) is a standard VESTAS pitch regulated upwind wind turbine with active yaw and a rotor with three blades. The VESTAS LT wind turbine is specially equipped to operate in areas, where temperatures below ÷20°C occur. The wind turbine is designed to operate in the ambient temperature range of ÷30°C to +40°C. For non-operational conditions a temperature range of ÷40°C to 50°C is permissible.

1.1 Description of the "LT (Low Temperature) option"

In order to keep the nacelle as tight as possible sealing between the nose cone and the nacelle front end is mounted. Sealing between nose cone and blades are fitted as standard.

The shielding between the nacelle and the nose cone is modified so that warm air from the nacelle can pass through to the nose cone. In this way the hub is heated to at least ÷20°C.

At ambient temperatures below ÷30°C the wind turbine controller will stop the wind turbine using the outdoor temperature sensor. The temperature inside the nacelle will be kept above ÷20°C by two electrical heaters. The heaters are switched off at nacelle temperatures above ÷11°C.

As well the ground controller as the nacelle controller is supplied with a heating panel to warm up the computers and other parts in the controller panels.

Lubricant for the gearbox is specially selected.

1.2 Climatic Conditions

The wind turbine is designed to operate at ambient temperatures ranging from ÷30°C to +40°C. Outside these temperatures the control system stops the wind turbine.

2. Technical description

2.1 Electrical heaters in the nacelle

Two electrical heaters are placed in the nacelle. They keep the temperature above ÷20°C during operation at very low ambient temperature down to ÷30°C. One of the heaters is placed under the main shaft sending warm air under the main bearing and under the gearbox. The other heater is mounted on the right main base frame, sending warm air towards the spinner.

Specification for each of the electrical heaters:

Power:	6.0 kW
Voltage:	690 V ~
Fan:	650 m^3/hour

2.2 Controller heating panels

Heating of ground controller.
An extra heating element of 400W is installed in the ground controller together with the standard installed 400 W, to heat the computer and the panel.

Heating of top controller.
A heating element of 400W is as standard installed in the top controller, to heat the computer and the panel.

2.3 Heating for Ultra Sonic wind direction and speed sensor

The wind vane and anemometer is equipped with a heater. The heater prevents that the wind vane and anemometer is covered with ice.

2.4 Battery backup of the brake

The battery backup of the brake consists of a battery box, which is connected to the top controller. The battery backup of the brake saves the turbine the stress during braking caused by grid drop out.

The battery backup of the brake is described in the turbine manual "Electrical Operating- and Maintenance Manual", item no. 944640.

2.5 Lubricants for LT operation

The LT Wind turbine is supplied with specially selected lubricants. The gearbox is supplied with a semi-synthetic LT oil or a synthetic LT oil and on the yaw friction faces synthetic LT grease is used. The hydraulic system is supplied with a special LT oil.

3. Temperature settings for LT-options

The default temperature settings on the Controller for the LT-wind turbine are set according to figures below. At all sites the special temperature and wind conditions can necessitate alternative setting.

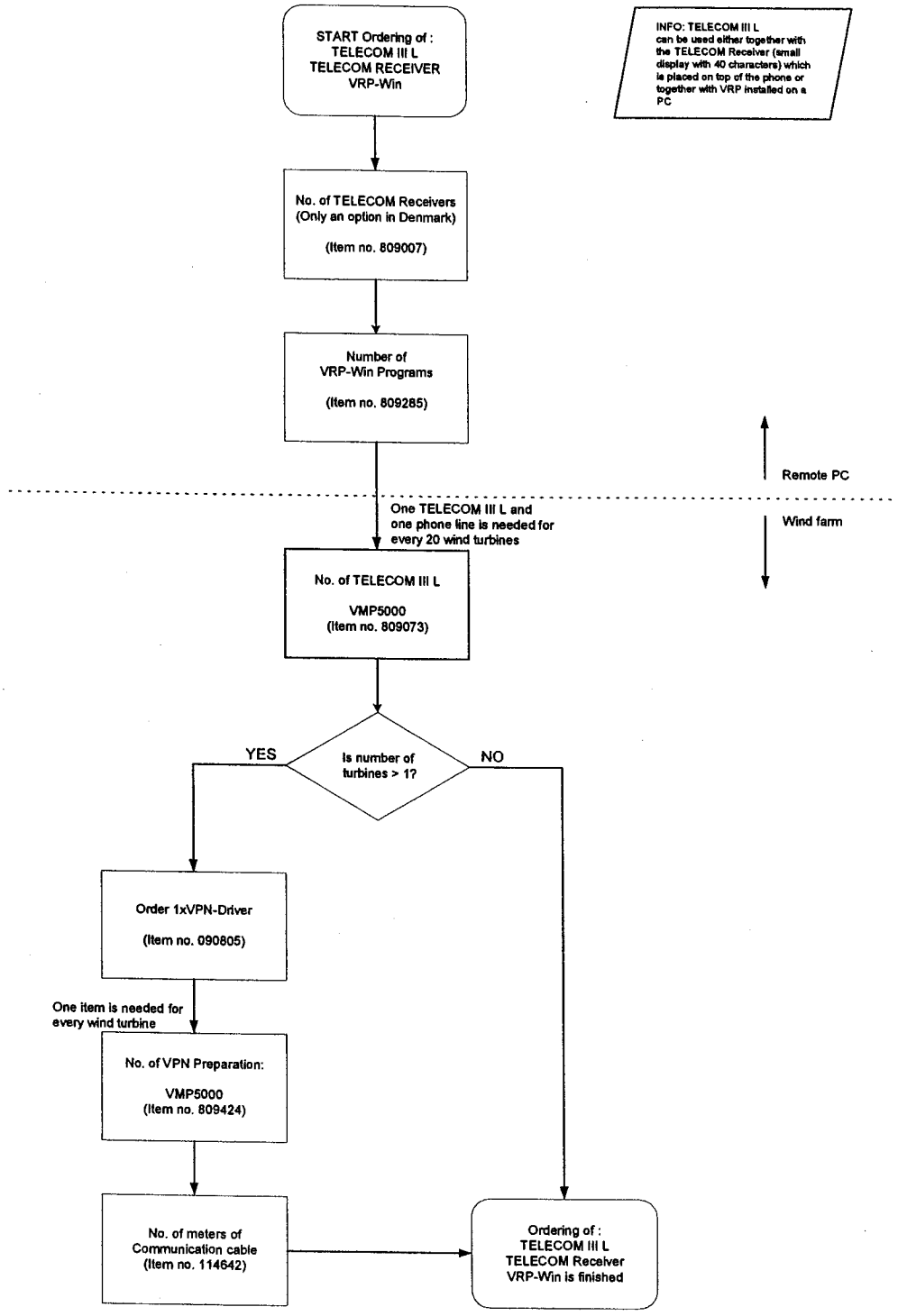
Option:	start temp.	stop temp	Back up:	Action:
Electrical heaters in nacelle	- 14°C	- 11°C		start heating stop heating

Vestas

TC III L for VMP5000 (Opti-Speed)

Item no. 951434.R0

Class I


START Ordering of :
TELECOM III L
TELECOM RECEIVER
VRP-Win
INFO: TELECOM III L can be used either together with the TELECOM Receiver (small display with 40 characters) which is placed on top of the phone or together with VRP installed on a PC
No. of TELECOM Receivers
(Only an option in Denmark)
(Item no. 809007)
Number of
VRP-Win Programs
(Item no. 809285)
Remote PC
Wind farm
One TELECOM III L and one phone line is needed for every 20 wind turbines
No. of TELECOM III L
VMP5000
(Item no. 809073)
YES
Is number of turbines > 1?
NO
Order 1xVPN-Driver
(Item no. 090805)
One item is needed for every wind turbine
No. of VPN Preparation:
VMP5000
(Item no. 809424)
No. of meters of Communication cable
(Item no. 114642)
Ordering of :
TELECOM III L
TELECOM Receiver
VRP-Win is finished

NEG Micon NM 82-1650

and

NEG Micon NM 54-950
Turbine Price Quotes

August 2003

PROJECT PROPOSAL

Project Proposal for the Calama Wind Farm Project in Chile project no. 12374

With reference to your inquiry, NEG Micon A/S (hereinafter called "the Contractor") is pleased to submit to CODELCO (hereinafter called "the Purchaser") the present Project Proposal concerning the WTG type described herein. It must be emphasised that the price stated in the present Project Proposal is an estimate and thus not binding on the Contractor.

The final price and terms of purchase will be agreed upon after further clarification of the terms of delivery, including the Contractor's scope of works and liability.

Introduction

The Contractor was formed on 4 July 1997, the date of incorporation being 1 April 1997, as a merger between Nordtank Energy Group A/S and Micon A/S, two Danish WTG manufacturers highly recognised internationally and with 15-20 years of experience within the wind energy industry.

The Contractor, which is listed on the Copenhagen Stock Exchange, is today a leading, global supplier of wind energy systems and has installed more than 5,500 MW. This corresponds to some 11500 wind turbines erected worldwide or a global market share of approximately 20 per cent.

The Contractor's mission is to contribute to meeting an increasing demand for energy worldwide and to reducing pollution by developing, marketing, manufacturing and servicing reliable and efficient wind energy systems.

On this basis, the Contractor supplies complete solutions by assisting customers throughout the execution of their projects, i.e. from realisation of the initial idea through the useful life of the power plant to its decommissioning.

The Contractor is represented by a network of subsidiaries and agents in more than twenty countries, and assembly of nacelles takes place in Denmark, USA, Spain, India, China and Japan.

Today, the Contractor's product competence includes all main component areas (blades, control units and towers), and the Group is therefore ready to take on the challenge of intensifying competition in future.

The Contractor's products range from 750 kW to 2,75 MW WTGs. The primary objective of the Contractor's development work is to increase the competitiveness of its WTGs in terms of price per kWh by 5-10 per cent relative to the previous generation of wind turbines.

The Contractor's development programme is increasingly focussed on the development of offshore wind turbines. The Contractor is active in the development project DOWEC (Dutch

Offshore Wind Energy Converter) in which the Contractor is working to develop offshore WTGs of 4 MW and more.

The Contractor is certified in accordance with ISO 9001 by Det Norske Veritas (DNV).
The corporate head office is located in Randers, Denmark and at present the Group has more than 2400 employees worldwide.

Please refer to Appendix 1.1 for a list of the Contractor's references.

Clause 1. Project Proposal

1.1 The following documents shall constitute the Project Proposal, and each shall be read and construed as an integral part of the Project Proposal:

1.2 The present Project Proposal (including the attachments hereto)

(A) Enclosure 1. Conditions, including:

- General Conditions for the Supply and Erection of Mechanical, Electrical and Associated Electronic Products, ORGALIME SE 94
- Special Conditions for the Supply and Erection of Wind Power Plant
- Appendix
  - **1.1** List of references
  - **1.2** Data sheet
  - **1.3** Insurance Requirements
  - **1.4** Power Performance Guarantee
  - **1.5** Site Specific Power Curves
  - **1.6** Type approval
  - **1.7** Main Specification/Project Main Specification
  - **1.8** Technical Description
  - **1.9** Weight, Dimension and Transportation Guidelines

(B) Enclosure 2. Project Specifications, including:

- Appendix
  - **2.1** Description of the SCADA System
  - **2.2** Installation and Service Data
  - **2.3** Description of Integrated Grid Connection (IGC)

(C) Enclosure 3. Payment, including:

- Appendix
  - **3.1** Breakdown of the Contract Price
  - **3.2** Trade Terms
  - **3.3** Payment Terms
  - **3.4** Form of Letter of Credit

1.3 In the event of any ambiguity or conflict among the Project Proposal documents listed above, the priority of the Project Proposal documents shall be as follows:

1. Project Proposal
2. Special Conditions
3. Appendices (including the Schedules thereto)
4. General Conditions.

Clause 2. Scope of Works

2.1 Project Description

The present Project Proposal concerns WTG type NM54/950 hub height 55 meters
This type of WTG is designed for operation under conditions as defined in **IEC class II**

The technical specifications are listed in Appendices 1.2, 1.6, 1.7 and 1.8.

NOTE:

- The Contractor has not had access to data to determine if the intended site is suitable for WTGs designed for IEC class II
- The WTGs have not been specially designed to withstand earthquake loads.
- The necessary quality and quantity of site-specific wind and site data shall be made available to the Contractor 60 days in advance of contract negotiations in order for the Contractor to substantiate if the WTGs are suitable for erection at the site. If not, this Project Proposal shall lapse.
- Please note that the insurance prices are based on our bank setting the guarantees directly.

2.2 Supplies Included

- Standard foundation drawings and foundation load data. The specific foundation design must be determined by the Purchaser.
- Embedded cylinders for foundation.
- Extra cooling for "tropical" conditions.
- WindMan Client/Server control and monitoring system including installation (excl. inter-cabling between server and WTGs). Please refer to Appendix 1.2
- RTU implementation (Type Crete). Please refer to Appendix 2.1.

- Insurance of the Contractor's Works. Please refer to Appendix 1.3.

2.3 Services Included

- Liability for defects in accordance with Clause 8.
- Maintenance and service for a period of 2 year(s).
- Please refer to Appendix 2.2.
- Packing of the equipment for transportation.
- Transportation of the equipment CIF Port of Mejillones (Incoterms 2000).
- Supervision of installation and commissioning: 4 supervisors for a maximum period of 17 weeks, with a minimum of 6 working days a week. The price includes rental of specialised tools, board and lodging, local and international travel expenses for the Contractor's supervisors.
- Should the included installation period be exceeded due to the Purchaser's delay or weather conditions, any additional costs will be invoiced to the Purchaser.

2.4 Supplies not Included

The following supplies shall not be included in our Project Proposal and thus the obligations of the Purchaser are:

- Acquisition or purchase of land for the WTGs and clearing of occupants and structures.
- Surveys including wind and geo-technical studies, and micro-siting.
- Access roads and hard stands must have the necessary capacity and space to allow transport to site, assembly of the WTGs and operation of the cranes.
- Foundations and other civil engineering works.
- Medium voltage collection system from the individual WTGs.
- Site office with lighting, heating, air-conditioning, furniture, cupboards, telephone, fax and toilet facilities for staff only and room for SCADA.
- Power and water consumption during construction.
- Live grid established before start of erection.
- Transportation from CIF Port of Mejilliones to site.
- Unloading and storage - if so required - on site. For long-time storage (in excess of two weeks) clean, dry and heated storage facilities are required.
- Crane works for the erection of electrical and mechanical equipment.
- Customs clearance and import taxes.
- Building permits, environmental permits and other necessary local permits.
- Any taxes, stamp duties, other duties or fees payable in the Purchaser's country, also in respect of the staff.
- Insurance of Purchaser's Scope of Works. Please refer to

Appendix 1.3.

- Visa/work permits for the Contractor's staff.
- Financing, disbursement of payments, etc.
- Installation

Clause 3. Contract Price

3.1 The Contractor's estimated quotation for the performance of the Contract is:

The Contract price is: 33,419,676 USD

Any breakdown of the Contract Price is given in Appendix 3.1 (Breakdown of Contract price).

3.2 Unless otherwise agreed, the Price shall be a firm lump sum not subject to any alteration except in the event of a variation in the Works or as otherwise provided in the Project Proposal or in a Contract Agreement.

3.3 Foreign Currency Exchange Rate
In the event of a decrease in the relevant exchange rate relative to EURO of more than 2 per cent from the date of the Project Proposal mentioned in Clause 12 until the end of the validity period of the Project Proposal, a price adjustment shall be carried out on the basis of the official exchange rate fixed at the date of the final Contract.

Clause 4. Terms of Payment

4.1 The Price is based on the terms set forth in Appendix 3.3 (Terms of Payment).

4.2 The Purchaser shall not later than 7 days after the date of signing a Contract Agreement deliver to the Contractor an irrevocable letter(s) of credit issued by a first class bank in the form set forth in Appendix 3.4.

In the event that the Price or any other term of the Contract changes after the issue of the letter(s) of credit, the Purchaser shall arrange for such letter(s) of credit to be amended to reflect such change as soon as possible thereafter.

Clause 5. Time for Delivery

5.1 Time Schedule

The indicative delivery time is six (6) months (excl. transportation) from the time of signing of a Contract Agreement. A fixed date for delivery will be agreed upon at the time of signing the Contract Agreement.

5.2 Liquidated Damages for Delay

If the Contractor fails to attain Completion of the Works or any part thereof within the time agreed upon or within such extended time to which the Contractor shall be entitled under SE 94, Clause 39 as supplemented in the Special Conditions, the Contractor shall as sole remedy to the Purchaser pay liquidated damages to the Purchaser in accordance with SE 94, Clause 40. The total aggregate amount of such liquidated damages shall in no event exceed seven and a half per cent (7.5 %) of the Contract Price or the Contract Price properly attributable to such part of the Works as cannot in consequence of the delay be used as intended by the Parties.

Clause 6. Insurance

6.1 The insurance to be taken out and maintained by the Contractor shall be as specified in Part I of Appendix 1.3 (Insurance Requirements) hereto.

6.2 The insurance to be taken out and maintained by the Purchaser shall be as specified in Part II of Appendix 1.3 (Insurance Requirements) hereto.

Clause 7. Power Performance Guarantee

The Contractor guarantees the attainment of the Power Performance Guarantee subject to and upon the conditions specified in the said Appendix 1.4.

Clause 8. Liability for Defects

Pursuant to SE 94, Clauses 51-65 and Special Conditions the Contractor shall remedy any defect in the Works resulting from faulty design, materials and workmanship which appear within a period of 2 (two) year from taking-over or a maximum of thirty months from first shipment/dispatch, whichever is the earlier.

Clause 9. Limitation of Liability

The maximum aggregate liability for liquidated damages for delay and defects, and liability for damage caused by the Works and liquidated damages payable to the Purchaser under the Power Performance Guarantee or under any warranty or any other liability arising out of or in connection with the Contract shall not exceed ten per cent (10%) of the Contract Price.

All the guarantees and warrantees are subject to the condition that the Contractor is responsible for maintaining and servicing the wind turbines during the guarantee/warranty period in accordance with Appendix 2.2.

Clause 10. Governing Law and Language

10.1 The governing law of the Contract shall be Danish law.

10.2 The governing language of the Contract shall be English.

Clause 11. Arbitration

11.1 Arbitration shall be conducted in accordance with SE 94, Clause 72.

11.2 The tribunal of arbitration shall consist of three (3) arbitrators, unless otherwise agreed between the Purchaser and the Contractor.

11.3 Pursuant to SE 94, Clause 72, the place of any arbitration shall be Copenhagen.

11.4 The language of the arbitration shall be English.

Clause 12. Further Information

If the Contractor has not heard from you before 10.11.03 the present Project Proposal shall lapse.

Should you require any further information, please do not hesitate to contact us.

Yours sincerely,

NEG Micon A/S
Alsvej 21
8900 Randers
Denmark

Appendix 3.1

Breakdown of the Contract Price

- Confidential -

Date: **08-08-2003**

NEG Micon A/S offers to supply NM 54/950 kW Turbines according to the enclosed specifications, at the below mentioned prices:

Pcs./set/days	Description	EURO (EUR)
42	NM 54/950 NEG Micon A/S Wind Turbines, Wind ClassIEC II	
	hub height=55 metres including foundation rings, and transformers	24.005.422
42	Packed in containers and/or flatbeds	706.776
1	Park management/remote control system excl. phone line	169.561
130 days	Supervision of installation and handing over	997.583
Total price, Ex Works Micon A/S Randers, Denmark (excl. VAT)		25.879.342
	Transport from NEG Micon A/S to the site at: Port of Mejillones	1.873.785
Total price, equipment and project, CIP as per INCOTERMS 2000 (excl. VAT)		27.753.127
	Estimated price in USD	**31.183.289**
1	Set of Spare parts, CIF site	480.108
1	Set of Special tools, CIF site	310.000
2 years	Complete service and maintenance of the Wind Park	1.200.276
Total price, services, CIF as per INCOTERMS 2000 (excl. VAT)		1.990.384
	Estimated price in USD	**2.236.387**
Total price for total project, CIF as per INCOTERMS 2000 (excl. VAT) in USD		**33.419.676**

The prices in USD are based on the following exchange rate between 1 USD and EUR, and will be adjusted at the time of signing a contract according to the exchange rate at the date of signing. Rate=0,89 USD/EUR.

All offered prices are CIF site but excluding import taxes and handling. As well as any taxes, duties or livies that can be imposed on NEG Micon A/S in relation to the Project. According to Incoterms 2000.

Validity of the offer until: 10-11-03.

Delivery: Four to six months after signing of contract, prepayment has been received, and Letter of Credit has been opened and confirmed.

Terms of Payment:

- 20% of the Total Price shall be paid upon signing the contract.
- 80% of the Total Price shall be effected under an irrevocable Letter of Credit opened by a first class bank and advised through a Danish bank with Their confirmation, and payable with said Danish bank as follows:
  - 75% of the total price at shipment against presentation of Bill of Lading.
  - 5% of the total price at commissioning against presentation of signed Taking over Certificate, but not later than 2 months after last shipment.

NEG Micon A/S

Karin F. Nielsen Ass. Sales Manager Latin America

P12374.doc

Together we will create a powerful future

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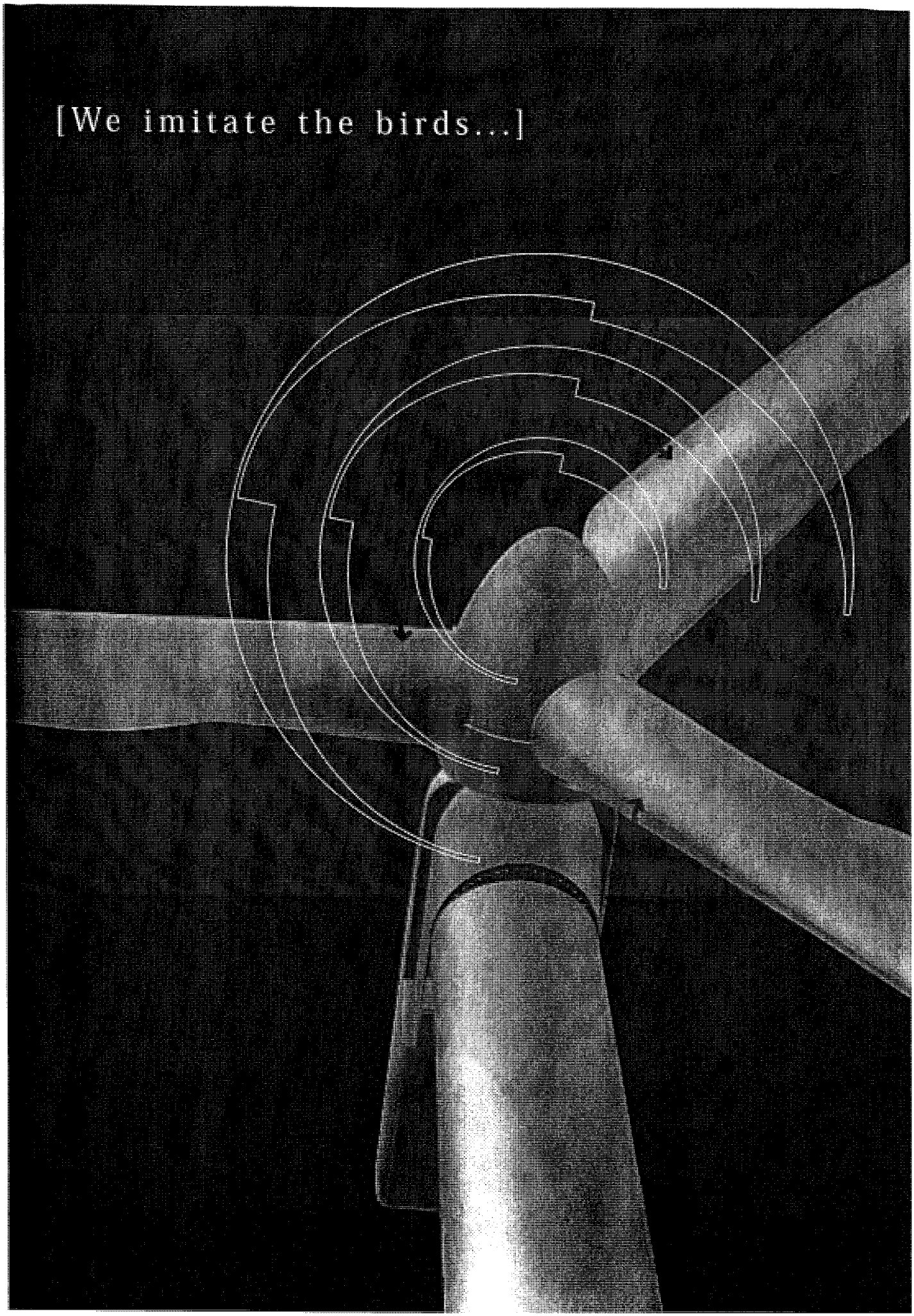
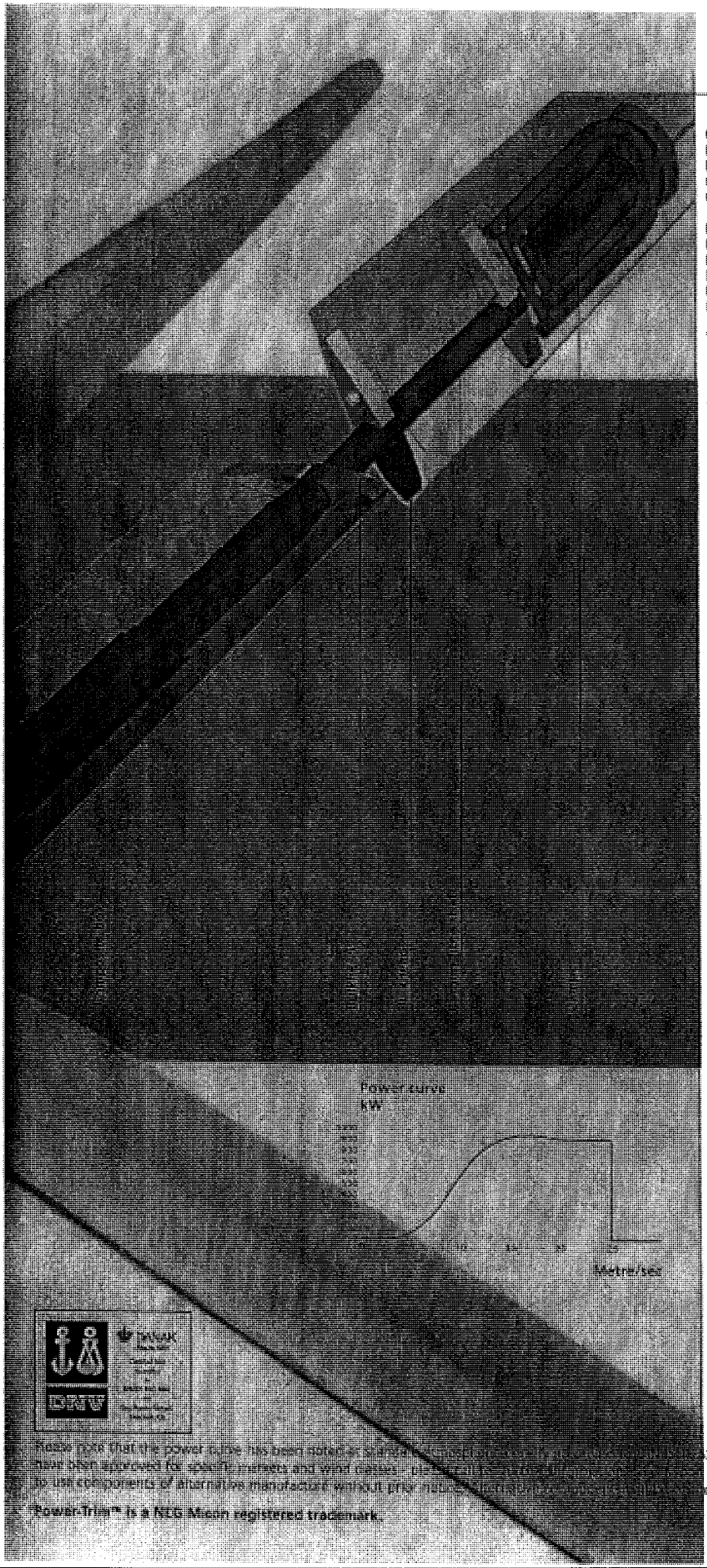
www.neg-micon.com

N·E·G MICON®
- for a powerful future


[We imitate the birds...]



Technical data

Operational parameters:

Nominal output	950 kW
Power regulation	Stall
Cut-in	3.5 m/s
Cut-out	25 m/s

Rotor

Rotor diameter	54.5 m
Rotor swept area	2333 m2
Number of blades	3
Rotor revolutions	22/15 rpm
Rotor placing	Upwind rotor

The control of Power-Trim TM is based on:

1. The controller works to ensure that the blade pitch is adjusted to the optimal position for the current conditions
2. Measurements of wind speed and temperature are used to determine the power level of the wind turbine
3. The actual power achieved is compared to that expected
4. The blade pitch is adjusted to give the expected power level thereby correcting for both air density variation and any blade contamination
5. The 950 kW rated power is attained regardless of air density and contamination
6. The blade pitch position is typically reviewed every 30 minutes
7. High power correction: immediate blade pitching action is taken in order to avoid high power levels
8. In case of any malfunction in the pitch system the turbine continues operating as a passive stall regulated turbine and the blade pitch is held in its current position
9. Any loss of power or control causes a fail-safe shutdown of the turbine using the tip brakes. The Power-Trim system has no active role during safety system shutdown

Brake system

Blade tip air brake	Hydraulic, fail-safe
Disc brake	1 pcs. hydraulic, fail-safe

Drive train

Gear type	Planetary – parallel axle
Ratio	1:67.5 (1:81.0 - 60 Hz)
Main shaft	Forged shaft and flange
Main bearing	Spherical roller bearing
Cooling	Heat exchanger with pump

Generator

Type	Asynchronous, 4-6 pole
Nominal voltage	690 V (600 V - USA)
Nominal frequence	50 Hz (60 Hz - USA)
Name plate rating	950/200 kW
Cooling	Liquid-cooled with pump

Yaw system

Type	Sliding bearing
Drive mechanism	3 electrical planetary gears

Tower

Type	Conical, steel, painted
Hub height	According to type approvals

Controller

Type	Computer controlling
Cut-in system	Soft with thyristors
Phase compensation	Generator no load compensation
Remote control	By modem

Sensors

RPM sensors	Rotor, generator, yaw system
Temperature sensors	Gear, generator, controller, ambient
Vibration sensors	Nacelle, rotor
Meteorology	Anemometer, wind vanes
Hydraulic systems	Pressure transducers

Lightning protection

According to standard	IEC 1024 class 1
Blades	Receptor in the blade tips
Nacelle	Air rod

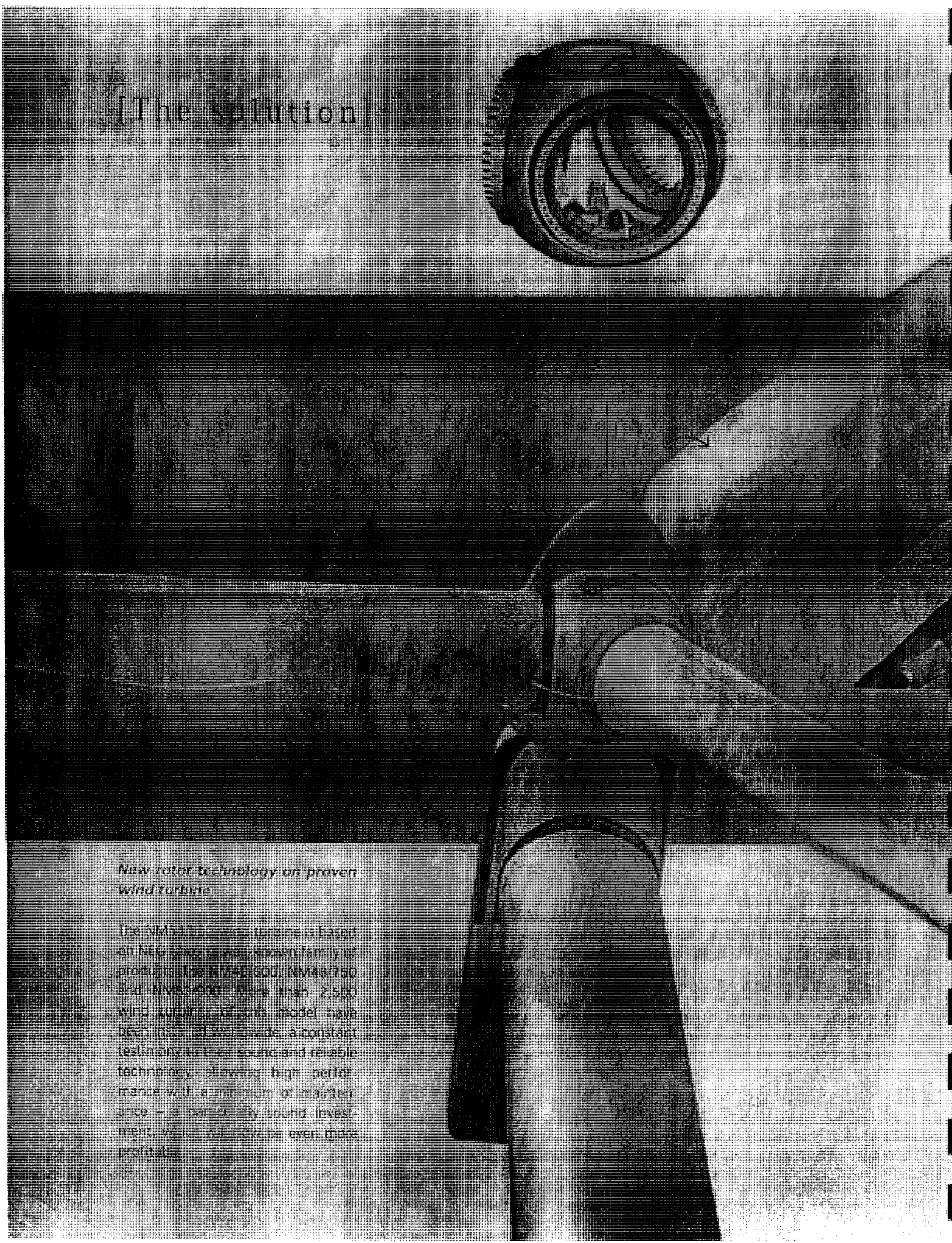
Please note that the power curve has been noted at standard conditions (15°C, 1013 mbar). The power curve has also been approved for specific markets and wind classes - please contact your local NEG Micon dealer for more information.

Due to continuous development we reserve the right to change specifications and to use components of alternative manufacture without prior notice.

Power-Trim™ is a NEG Micon registered trademark.

33. Please note that the rotor and the hub heights
A/S reserves the right to change specifications and
same high quality and standard as in this survey.

[The solution]

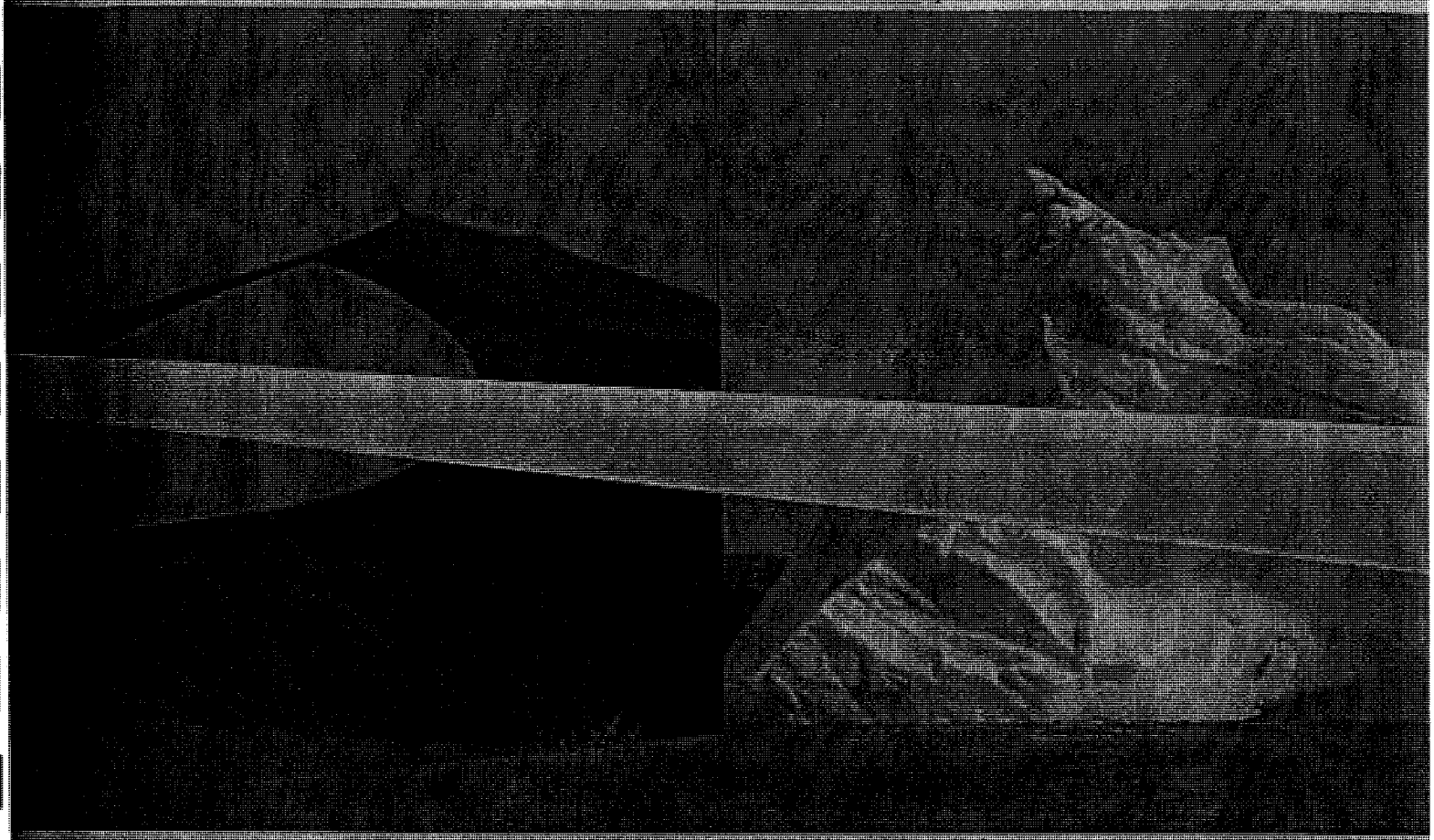


New rotor technology on proven wind turbine

The NM54/950 wind turbine is based on NEG Micon's well-known family of products, the NM48/600, NM48/750 and NM52/900. More than 2,500 wind turbines of this model have been installed worldwide, a constant testimony to their sound and reliable technology, allowing high performance with a minimum of maintenance – a particularly sound investment, which will now be even more profitable.

[Regardless of climate...

...total control]



NEG Micon has created the intelligent Passive Stall wind turbine, one that always renders optimum performance, as the turbine itself ensures optimal pitching of the blades irrespective of climate conditions – from arctic cold to the dry heat of the desert.

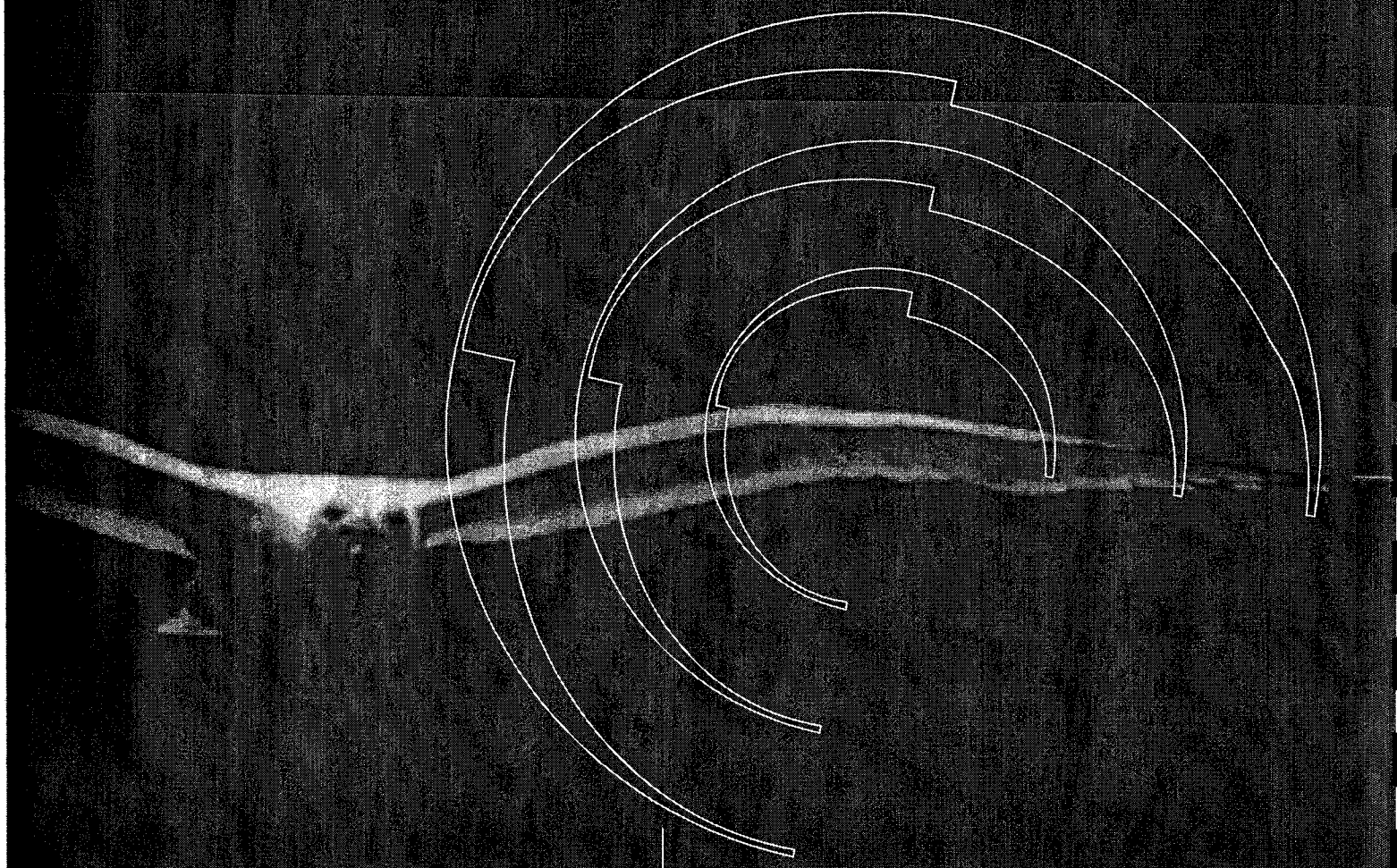
NEG Micon has created the Power-Trim™ technology – and we have integrated it into one of the market's most reliable and widely used wind turbines.

Power-Trim®

The computer-based control system of Power-Trim gathers and processes information on: wind speeds, air density (temperature/pressure) and blade alignment. The information is correlated with the calculated power production at a given stall level and should the actual power production be less than the calculated power production, the system changes the pitch angle. This is achieved with the help of the newly developed Power-Trim hub.

Through the use of three hydraulic actuators the new hub allows the Power-Trim turbine to alter the angle of the blades by typically 3° – 5° degrees, thus always maintaining optimum stall levels despite variations in air density and contamination of the blades caused by frost, dirt or insects.

[How to improve wind turbine output in all climates]



[NM54/950 | Power-Trim™]

N·E·G MICON®

– for a powerful future

PROJECT PROPOSAL

Project Proposal for the Calama Wind Farm Project in Chile project no. 12374a

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Introduction

The Contractor was formed on 4 July 1997, the date of incorporation being 1 April 1997, as a merger between Nordtank Energy Group A/S and Micon A/S, two Danish WTG manufacturers highly recognised internationally and with 15-20 years of experience within the wind energy industry.

The Contractor, which is listed on the Copenhagen Stock Exchange, is today a leading, global supplier of wind energy systems and has installed more than 5,500 MW. This corresponds to some 11500 wind turbines erected worldwide or a global market share of approximately 20 per cent.

The Contractor's mission is to contribute to meeting an increasing demand for energy worldwide and to reducing pollution by developing, marketing, manufacturing and servicing reliable and efficient wind energy systems.

On this basis, the Contractor supplies complete solutions by assisting customers throughout the execution of their projects, i.e. from realisation of the initial idea through the useful life of the power plant to its decommissioning.

The Contractor is represented by a network of subsidiaries and agents in more than twenty countries, and assembly of nacelles takes place in Denmark, USA, Spain, India, China and Japan.

Today, the Contractor's product competence includes all main component areas (blades, control units and towers), and the Group is therefore ready to take on the challenge of intensifying competition in future.

The Contractor's products range from 750 kW to 2,75 MW WTGs. The primary objective of the Contractor's development work is to increase the competitiveness of its WTGs in terms of price per kWh by 5-10 per cent relative to the previous generation of wind turbines.

The Contractor's development programme is increasingly focussed on the development of offshore wind turbines. The Contractor is active in the development project DOWEC (Dutch

Offshore Wind Energy Converter) in which the Contractor is working to develop offshore WTGs of 4 MW and more.

The Contractor is certified in accordance with ISO 9001 by Det Norske Veritas (DNV).
The corporate head office is located in Randers, Denmark and at present the Group has more than 2400 employees worldwide.

Please refer to Appendix 1.1 for a list of the Contractor's references.

Clause 1. Project Proposal

1.1 The following documents shall constitute the Project Proposal, and each shall be read and construed as an integral part of the Project Proposal:

1.2 The present Project Proposal (including the attachments hereto)

(A) Enclosure 1. Conditions, including:

- General Conditions for the Supply and Erection of Mechanical, Electrical and Associated Electronic Products, ORGALIME SE 94
- Special Conditions for the Supply and Erection of Wind Power Plant
- Appendix
  - **1.1** List of references
  - **1.2** Data sheet
  - **1.3** Insurance Requirements
  - **1.4** Power Performance Guarantee
  - **1.5** Site Specific Power Curves
  - **1.6** Type approval
  - **1.7** Main Specification/Project Main Specification
  - **1.8** Technical Description
  - **1.9** Weight, Dimension and Transportation Guidelines

(B) Enclosure 2. Project Specifications, including:

- Appendix
  - **2.1** Description of the SCADA System
  - **2.2** Installation and Service Data
  - **2.3** Description of Integrated Grid Connection (IGC)

(C) Enclosure 3. Payment, including:

- Appendix
  - **3.1** Breakdown of the Contract Price
  - **3.2** Trade Terms
  - **3.3** Payment Terms
  - **3.4** Form of Letter of Credit

1.3 In the event of any ambiguity or conflict among the Project Proposal documents listed above, the priority of the Project Proposal documents shall be as follows:

1. Project Proposal
2. Special Conditions
3. Appendices (including the Schedules thereto)
4. General Conditions.

Clause 2. Scope of Works

2.1 Project Description

The present Project Proposal concerns WTG type NM 82/1650 hub height 78 meters. This type of WTG is designed for operation under conditions as defined in **IEC class III**

The technical specifications are listed in Appendices 1.2, 1.6, 1.7 and 1.8.

NOTE:

- The Contractor has not had access to data to determine if the intended site is suitable for WTGs designed for IEC class III
- The WTGs have not been specially designed to withstand earthquake loads.
- The necessary quality and quantity of site-specific wind and site data shall be made available to the Contractor 60 days in advance of contract negotiations in order for the Contractor to substantiate if the WTGs are suitable for erection at the site. If not, this Project Proposal shall lapse.
- Please note that the insurance prices are based on our bank setting the guarantees directly.

2.2 Supplies Included

- Standard foundation drawings and foundation load data. The specific foundation design must be determined by the Purchaser.
- Embedded cylinders for foundation.
- Extra cooling for "tropical" conditions.
- WindMan Client/Server control and monitoring system including installation (excl. inter-cabling between server and WTGs). Please refer to Appendix 1.2
- RTU implementation (Type Crete). Please refer to Appendix 2.1.
- Insurance of the Contractor's Works. Please refer to Appendix 1.3.

2.3 Services Included

- Liability for defects in accordance with Clause 8.
- Maintenance and service for a period of 2 year(s).
- Please refer to Appendix 2.2.
- Packing of the equipment for transportation.
- Transportation of the equipment CIF Port of Mejillones (Incoterms 2000).
- Supervision of installation and commissioning: 4 supervisors for a maximum period of 17 weeks, with a minimum of 6 working days a week. The price includes rental of specialised tools, board and lodging, local and international travel expenses for the Contractor's supervisors.
- Should the included installation period be exceeded due to the Purchaser's delay or weather conditions, any additional costs will be invoiced to the Purchaser.

2.4 Supplies not Included

The following supplies shall not be included in our Project Proposal and thus the obligations of the Purchaser are:

- Acquisition or purchase of land for the WTGs and clearing of occupants and structures.
- Surveys including wind and geo-technical studies, and micro-siting.
- Access roads and hard stands must have the necessary capacity and space to allow transport to site, assembly of the WTGs and operation of the cranes.
- Foundations and other civil engineering works.
- Medium voltage collection system from the individual WTGs.
- Site office with lighting, heating, air-conditioning, furniture, cupboards, telephone, fax and toilet facilities for staff only and room for SCADA.
- Power and water consumption during construction.
- Live grid established before start of erection.
- Transportation from CIF Port of Mejilliones to site.
- Unloading and storage - if so required - on site. For long-time storage (in excess of two weeks) clean, dry and heated storage facilities are required.
- Crane works for the erection of electrical and mechanical equipment.
- Customs clearance and import taxes.
- Building permits, environmental permits and other necessary local permits.
- Any taxes, stamp duties, other duties or fees payable in the Purchaser's country, also in respect of the staff.
- Insurance of Purchaser's Scope of Works. Please refer to Appendix 1.3.

- Visa/work permits for the Contractor's staff.
- Financing, disbursement of payments, etc.
- Installation

Clause 3. Contract Price

3.1 The Contractor's estimated quotation for the performance of the Contract is:

The Contract price is: 47,536,257 USD

Any breakdown of the Contract Price is given in Appendix 3.1 (Breakdown of Contract price).

3.2 Unless otherwise agreed, the Price shall be a firm lump sum not subject to any alteration except in the event of a variation in the Works or as otherwise provided in the Project Proposal or in a Contract Agreement.

3.3 Foreign Currency Exchange Rate
In the event of a decrease in the relevant exchange rate relative to EURO of more than 2 per cent from the date of the Project Proposal mentioned in Clause 12 until the end of the validity period of the Project Proposal, a price adjustment shall be carried out on the basis of the official exchange rate fixed at the date of the final Contract.

Clause 4. Terms of Payment

4.1 The Price is based on the terms set forth in Appendix 3.3 (Terms of Payment).

4.2 The Purchaser shall not later than 7 days after the date of signing a Contract Agreement deliver to the Contractor an irrevocable letter(s) of credit issued by a first class bank in the form set forth in Appendix 3.4.

In the event that the Price or any other term of the Contract changes after the issue of the letter(s) of credit, the Purchaser shall arrange for such letter(s) of credit to be amended to reflect such change as soon as possible thereafter.

Clause 5. Time for Delivery

5.1 Time Schedule

The indicative delivery time is six (6) months (excl. transportation) from the time of signing of a Contract Agreement. A fixed date for delivery will be agreed upon at the time of signing the Contract Agreement.

5.2 Liquidated Damages for Delay

If the Contractor fails to attain Completion of the Works or any part thereof within the time agreed upon or within such extended time to which the Contractor shall be entitled under SE 94, Clause 39 as supplemented in the Special Conditions, the Contractor shall as sole remedy to the Purchaser pay liquidated damages to the Purchaser in accordance with SE 94, Clause 40. The total aggregate amount of such liquidated damages shall in no event exceed seven and a half per cent (7.5 %) of the Contract Price or the Contract Price properly attributable to such part of the Works as cannot in consequence of the delay be used as intended by the Parties.

Clause 6. Insurance

6.1 The insurance to be taken out and maintained by the Contractor shall be as specified in Part I of Appendix 1.3 (Insurance Requirements) hereto.

6.2 The insurance to be taken out and maintained by the Purchaser shall be as specified in Part II of Appendix 1.3 (Insurance Requirements) hereto.

Clause 7. Power Performance Guarantee

The Contractor guarantees the attainment of the Power Performance Guarantee subject to and upon the conditions specified in the said Appendix 1.4.

Clause 8. Liability for Defects

Pursuant to SE 94, Clauses 51-65 and Special Conditions the Contractor shall remedy any defect in the Works resulting from faulty design, materials and workmanship which appear within a period of 2 (two) year from taking-over or a maximum of thirty months from first shipment/dispatch, whichever is the earlier.

Clause 9. Limitation of Liability

The maximum aggregate liability for liquidated damages for delay and defects, and liability for damage caused by the Works and liquidated damages payable to the Purchaser under the Power Performance Guarantee or under any warranty or any other liability arising out of or in connection with the Contract shall not exceed ten per cent (10%) of the Contract Price.

All the guarantees and warrantees are subject to the condition that the

Contractor is responsible for maintaining and servicing the wind turbines during the guarantee/warranty period in accordance with Appendix 2.2.

Clause 10. Governing Law and Language

10.1 The governing law of the Contract shall be Danish law.

10.2 The governing language of the Contract shall be English.

Clause 11. Arbitration

11.1 Arbitration shall be conducted in accordance with SE 94, Clause 72.

11.2 The tribunal of arbitration shall consist of three (3) arbitrators, unless otherwise agreed between the Purchaser and the Contractor.

11.3 Pursuant to SE 94, Clause 72, the place of any arbitration shall be Copenhagen.

11.4 The language of the arbitration shall be English.

Clause 12. Further Information

If the Contractor has not heard from you before 10.11.03 the present Project Proposal shall lapse.

Should you require any further information, please do not hesitate to contact us.

Yours sincerely,

NEG Micon A/S
Alsvej 21
8900 Randers
Denmark

Active Stall regulation

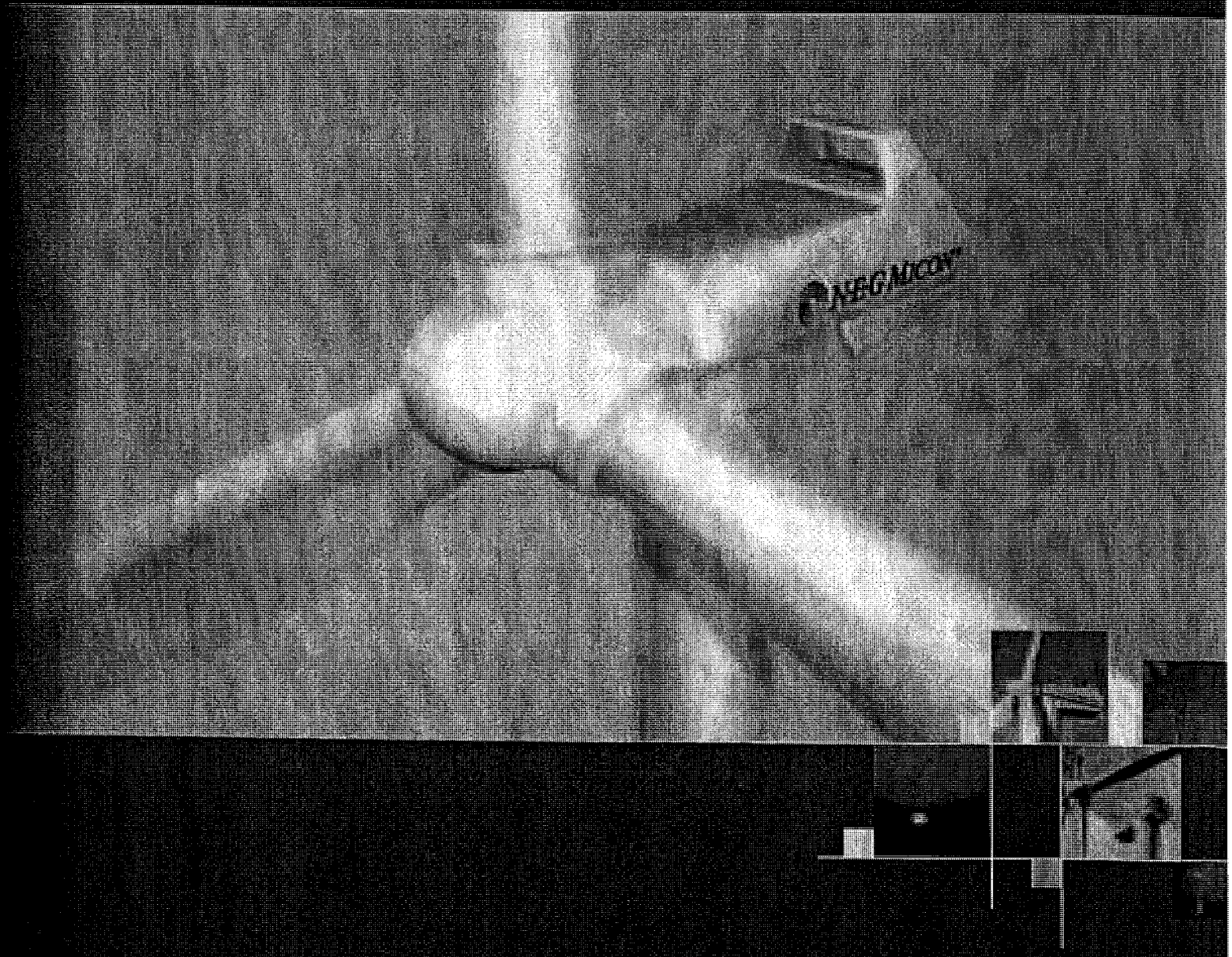
Proven concept

Large rotor and large swept area kvm/kW

Optimized for low and middle wind areas

Excellent grid compatibility

NM82



N·E·G MICON®

- for a powerful future

[NM82]

Optimized for low and middle wind areas

Proven concept
As with all NEG Micon turbines, the NM82 is approved by DNV according to appropriate standards. The nacelle builds on the well-tested and proven design of the NM60/1000, NM64C/1500 NM72C/1500 and NM82/1500.

Robust design
Both nacelle and tower are designed to meet the relevant type approval area and special market requirements.

ACTIVE STALL rotor
The rotor is based on the NEG Micon hydraulic ACTIVE-STALL® technology and has proven itself in climates ranging from the Orkney Islands off Scotland (11 m/s annual mean wind speed) to inland low wind areas.
The ACTIVE-STALL® technology enables the rotor to harness maximum energy from the available wind while minimising loads and providing fail-safe shut down of the turbine in all conditions.

Excellent grid compatibility
The ACTIVE-STALL® system enables the turbine to start up efficiently in low wind speeds, connect smoothly to the grid in high wind start-ups, and to shut down safely and speedily when conditions demand.

Grid compliance system on request
- Full load and dynamic phase compensation supporting reactive power regulation to maintain power factor within specified range
- Uninterrupted power supply back-up to maintain full operation of all auxiliary systems in the wind turbine during grid disturbances
- Continuous regulation of active and reactive power to support power and voltage balance in the grid
- Fault ride through capability at grid disturbance

Track record beyond 11,000 installed WTGs
By the end of 2002 NEG Micon had installed about 11,000 wind turbines in almost 40 countries.

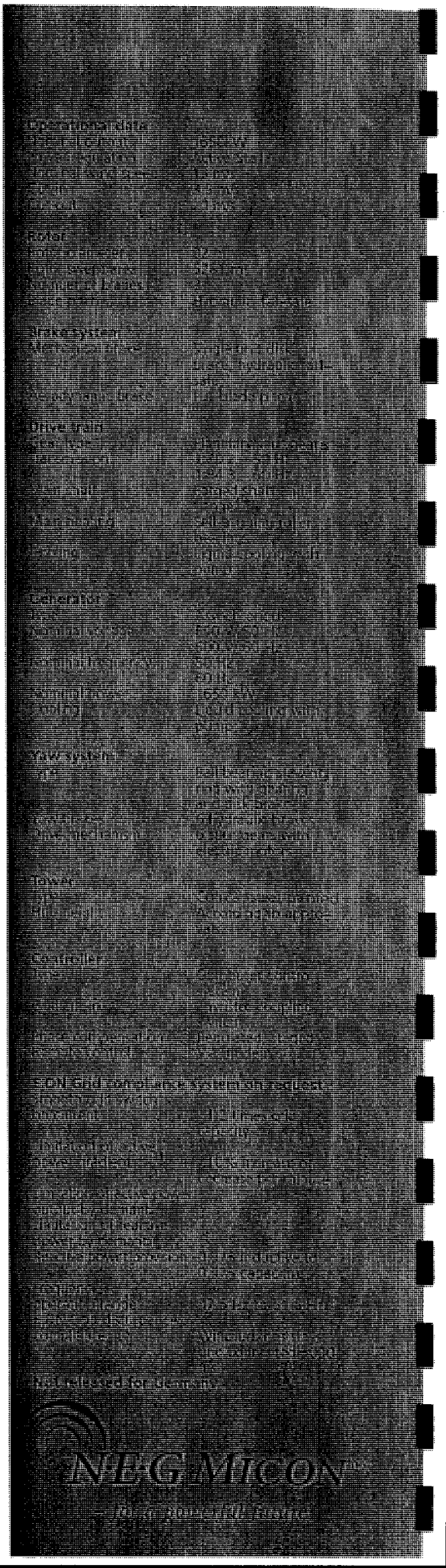
Pioneer inside wind industry
NEG Micon has been inside the wind industry business since the early start of the 1980'ies.

World's broadest product program
NEG Micon offers the markets broadest product portfolio, which enables us to adjust products and technologies to the conditions of individual sites. The product program is optimised continuously through intensive product development. The ability to identify and supply tailored solutions is one of NEG Micon's core competencies achieved through years of experience with product development. NEG Micon's philosophy behind its broad product program is to be able to supply the correct and competitive turbine for a specific site. The days are over where one wind turbine model could be erected on all sites, irrespective of wind regime, temperature, temperature movements, air humidity, service availability, etc.

High proven availability
In 2002 the average availability of NEG Micon turbines was 98.12%.

Global/Local monitoring
Wherever it is, NEG Micon offers to monitor the turbines.

Turbines in all climates
Experience from almost every corner of the world.



NEG Micon A/S, Alsvej 21, DK-8900 Randers, Tlf.: +45 8710 5000, Fax: +45 8710 5001
E-mail: mail@neg-micon.com, www.neg-micon.com

Appendix 3.1

Breakdown of the Contract Price

- Confidential -

Date: **08-08-2003**

NEG Micon A/S offers to supply NM 82/1650 kW Turbines according to the enclosed specifications, at the below mentioned prices:

Pcs./set/days	Description	EURO (EUR)
25	NM 82/165 NEG Micon A/S Wind Turbines, Wind ClassIEC II hub height=78 metres including foundation rings, and transformers	35.581.654
25	Packed in containers and/or flatbeds	1.014.514
1	Park management/remote control system excl. phone line	139.934
130 days	Supervision of installation and handing over	1.052.359
Total price, Ex Works Micon A/S Randers, Denmark (excl. VAT)		37.788.461
	Transport from NEG Micon A/S to the Port of Mejillones	2.782.724
Total price, equipment and project, CIP as per INCOTERMS 2000 (excl. VAT)		40.571.185
	Estimated price in USD	**45.585.601**
1	Set of Spare parts, CIF site	711.633
1	Set of Special tools, CIF site	310.000
2 years	Complete Service and Maintenance of the Wind Park	714.450
Total price, services, CIF as per INCOTERMS 2000 (excl. VAT)		1.736.083
	Estimated price in USD	**1.950.655**
Total price for total project, CIF as per INCOTERMS 2000 (excl. VAT) in USD		**47.536.257**

The prices in USD are based on the following exchange rate between 1 USD and EUR, and will be adjusted at the time of signing a contract according to the exchange rate at the date of signing. Rate=0,89 USD/EUR.

All offered prices are CIF site but excluding import taxes and handling. As well as any taxes, duties or livies that can be imposed on NEG Micon A/S in relation to the Project. According to Incoterms 2000.

Validity of the offer until: 10-11-03.

Delivery: Four to six months after signing of contract, prepayment has been received, and Letter of Credit has been opened and confirmed.

Terms of Payment:

- 20% of the Total Price shall be paid upon signing the contract.
- 80% of the Total Price shall be effected under an irrevocable Letter of Credit opened by a first class bank and advised through a Danish bank with Their confirmation, and payable with said Danish bank as follows:
  - 75% of the total price at shipment against presentation of Bill of Lading.
  - 5% of the total price at commissioning against presentation of signed Taking over Certificate, but not later than 2 months after last shipment.

NEG Micon A/S

Karin F. Nielsen Ass. Sales Manager Latin America

P12374a.doc

Payment Terms

The parties have agreed on the following terms of payment:

The payment shall fall due as follows:

- **20 %** of the Contract Price shall be paid as an advance payment no later than 7 days after signing of the Contract.

- **80 %** of the Contract Price shall be covered by an irrevocable and confirmed Letter of Credit in favour of the CONTRACTOR stipulating payment as follows:

    - **75 %** of the Remaining Works Price shall be payable against presentation of: NEG Micon Invoice and copy of shipping documents.

    - **5 %** of the Remaining Works Price shall be payable against presentation of copy of Taking-over Certificate, however payment shall in any event take place no later than 9 months at the latest from the date of final shipment, against a Request Certificate issued by NEG Micon.

    Irrevocable Letter of Credit to be advised, confirmed and be payable at sight, at the counters of a first-class Danish bank, preferably Nordea Copenhagen.

    Letter of Credit to stipulate part shipment and trans shipment allowed.
    Validity Date for presentation of documents: ....
    All banking charges outside Denmark for the account of the Applicant.
    All banking charges inside Denmark for the account of the Beneficiary.

SPECIAL CONDITIONS for the Supply and Erection of Wind Power Plants

PREAMBLE 4

Re clause 1. 4

DEFINITIONS 4

Re clause 2. 4

PRODUCT INFORMATION 4

Re clause 3. 4

DRAWINGS AND DESCRIPTIONS 4

Re clause 4. 4

Re clause 5. 4

TESTS BEFORE SHIPMENT 5

Re clause 6. 5

Re clauses 7.-9. 5

PREPARATORY WORK AND WORKING CONDITIONS 5

Re clause 10. 5

Re clause 11. 5

Re clause 12. 5

Re clause 13. 6

Re clause 14.a) 6

Re clause 14.b) 6

Re clause 14.c) 6

Re clause 14.d)e)f) 6

Re clause 15. 6

Re clause 16. 6

Re clause 17. 6

LOCAL LAWS AND REGULATIONS 6

Re clause 18. 6

Re clauses 19.-20. 6

VARIATIONS 6

Re clauses 21.- 25. 6

Re New clause 25A 7

PASSING OF RISK 7

Re clause 26 7

TAKING-OVER TESTS 7

Re clause 27. 7

Re New clause 27A. 7

"SHARING OF REVENUE" 7

Re clause 28. 7

Re clause 29. 7

Re clause 30. 7

Re clauses 31.-32. 8

TAKING-OVER 8

Re clauses 33. -35. 8

COMPLETION CONTRACTOR'S DELAY 8

Re clauses 36. -38. 8

Re clause 39. 8

Re clause 40. 8

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PAYMENT 8

Re clauses 43.-47. 8

RESERVATION OF TITLE **8**

Re clause 48. ..... *8*

LIABILITY FOR DAMAGE TO PROPERTY BEFORE TAKING-OVER **9**

Re clauses 49.-50. ..... *9*

LIABILITY FOR DEFECTS **9**

Re clauses 51.-62. ..... *9*

Re clause 63. ..... *9*

Re clauses 64.-65. ..... *9*

DIVISION OF LIABILITY FOR DAMAGE CAUSED BY THE WORKS **9**

Re clause 66. ..... *9*

FORCE MAJEURE **9**

Re clause 67. ..... *9*

Re clause 68-69. ..... *9*

ANTICIPATED NON-PERFORMANCE **9**

Re clause 70. ..... *9*

CONSEQUENTIAL LOSSES **10**

Re clause 71. ..... *10*

DISPUTES AND APPLICABLE LAW **10**

Re clause 72. ..... *10*

NEG MICON A/S

Special Conditions for the Supply and Erection of Wind Power Plants

(Hereinafter called "Special Conditions")

These Special Conditions include supplementary provisions to, modifications of or deviations from "General Conditions for the Supply and Erection of Mechanical, Electrical and Associated Electronic Products, ORGALIME SE 94" (Hereinafter called "SE 94").

References below are made to the headings and clause numbers of SE 94.

PREAMBLE

Re clause 1.

The parties agree that these Special Conditions and SE 94 shall form part of the Contract.

DEFINITIONS

Re clause 2.

A Wind Energy Glossary and supplementary definitions, if any, will be enclosed in Enclosure 1. (Conditions) if applicable.

PRODUCT INFORMATION

Re clause 3.

No amendment.

DRAWINGS AND DESCRIPTIONS

Re clause 4.

No amendment.

Re clause 5.

If the Purchaser so requests, the Contractor will provide said information and drawings in the English language, unless another language is specifically agreed.

TESTS BEFORE SHIPMENT

Re clause 6.

Where applicable, the scope and the technical requirements of tests before shipment will be specified in Enclosure 2. (Project Specification).

Re clauses 7.-9.

No amendments.

PREPARATORY WORK AND WORKING CONDITIONS

Re clause 10.

Information required for preparation of suitable foundations, access roads, crane stands, assembly areas, storage areas, site protection and transformer foundations will only be provided by the Contractor if the Purchaser shall perform the work.

Where the Purchaser shall perform the work in relation to the foundations he shall e.g. be obliged to carry out soil investigation of each wind turbine site, design and calculate the specific wind turbine foundation and work in accordance with national and local norms and requirements, earthquake zones, the wind turbine foundation loads informed by the Contractor, take out foundation samples and secure independent quality control and similar precautions. The Purchaser shall perform the work in accordance with said requirements stated by the wind turbine approving authority, which is a condition made in connection with issue of the type certificate.

If the Contractor shall perform foundations or other civil works, such work will be detailed in Enclosure 2. (Project Specification).

The Purchaser shall upgrade, maintain and clear the access routes to the Site in the construction period until the Works are finally taken over and the defects liability period has expired. The access routes shall be able to carry all cars, lorries, cranes and other construction material and equipment necessary to execute the Work.

Re clause 11.

Preparatory works performed either by the Purchaser or by the Contractor will be detailed in the Project Specification.

Re clause 12.

Where the preparatory work is to be performed by the Contractor, the following shall apply:

The Contract Price does not include expenses incurred in connection with the lowering of ground water, bunging, and other precautions necessitated by the soil conditions or obstacles in the soil.

Re clause 13.

No amendment.

Re clause 14.a)

No amendment.

Re clause 14.b)

First sentence shall be substituted by the following wording: "The Purchaser shall, as soon as possible, and no later than at the date of signing the Contract, inform the Contractor of all relevant safety regulations in force at the Site".

Re clause 14.c)

No amendment.

Re clause 14.d)e)f)

To the extent possible the technical details regarding the Purchaser's obligations will be specified in Enclosure 2. (Project Specification). Otherwise, the Purchaser will be informed in reasonable time of the Contractor's requirements as regards the items mentioned.

Re clause 15.

No amendment.

Re clause 16.

As part of this Contract the Works have been insured according to the stipulations contained in Enclosure 1. (Conditions).

Re clause 17.

No amendment.

LOCAL LAWS AND REGULATIONS

Re clause 18.

The Purchaser shall provide the relevant information on laws, regulations and rules, which are applicable to the Works as soon as possible and no later than at the date of signing the Contract. To the extent possible, information will be specified in Enclosure 1. (Conditions).

Re clauses 19.-20.

No amendments.

VARIATIONS

Re clauses 21.- 25.

No amendments.

Re New clause 25A

"SUBSTITUTION The Contractor reserves the right to substitute any of the machinery, apparatus, materials, and articles to be supplied under the Contract, provided that the substitution is at least equal in terms of quality and capacity to the item originally selected.

The Purchaser shall be advised of major substitutions, if any."

PASSING OF RISK

Re clause 26

No amendment.

TAKING-OVER TESTS

Re clause 27.

Taking-over tests are specified in Enclosure 1. (Conditions). The Contractor will notify the Purchaser not less than 7 days in advance of the date of the taking-over tests.

Re New clause 27A.

"SHARING OF REVENUE"

From the start of the taking-over tests, say when the wind turbines have been connected to grid, the wind turbines will generate power and thus produce a revenue for the Purchaser. The revenue thus produced in the period until the taking-over of the Works has taken place shall be shared by the Contractor and the Purchaser with either party receiving 50 per cent. The Purchaser shall pay to the Contractor the 50 per cent share of the revenue within thirty (30) calendar days of the Purchaser having received payment from the power utility.

Re clause 28.

The Contractor will provide such special test equipment as is specified in Enclosure 2. (Project Specification).

Re clause 29.

No amendments.

Re clause 30.

Taking-over tests have been completed when the activities listed in (Checklist for Turbine Erection) and (Commissioning & Component Report) included in Enclosure 1. (Conditions) have been carried out.

Re clauses 31.-32.

No amendments.

TAKING-OVER

Re clauses 33. -35.

No amendments.

COMPLETION CONTRACTOR'S DELAY

Re clauses 36. -38.

No amendments.

Re clause 39.

Add the following subclauses:

f) as a result of late supplies or services furnished by the Purchaser.
g) when precipitation, low temperature, strong wind, or other weather conditions, which prevent or delay the work, occur to an essentially greater extent than what is usual for the season and the region concerned.
h) when sensible erection activities and/or taking-over tests are prevented or delayed due to weather conditions.
i) due to public orders or bans.

Re clause 40.

In the fifth paragraph the wording "six months" is deleted and substituted by "three months".

Re clauses 41-42.

No amendments.

PAYMENT

Re clauses 43.-47.

Supplementary provisions to, modifications of or deviations from clauses 43-47 will, if applicable, be stated in Enclosure 3. (Payment).

RESERVATION OF TITLE

Re clause 48.

No amendment.

LIABILITY FOR DAMAGE TO PROPERTY BEFORE TAKING-OVER

Re clauses 49.-50.

No amendments.

LIABILITY FOR DEFECTS

Re clauses 51.-62.

No amendments.

Re clause 63.

The Contractor's liability does not cover consumables and wearing parts such as grease, oil, brake pads, fuses and the like.

Re clauses 64.-65.

No amendments.

DIVISION OF LIABILITY FOR DAMAGE CAUSED BY THE WORKS

Re clause 66.

No amendment.

FORCE MAJEURE

Re clause 67.

The fourth line "...onerous by any of the following circumstances: ..." shall be substituted by the wording "...onerous by, but not limited to, any of the following circumstances..."

As circumstances entitling either party to suspend performance shall be added: "interference by authorities, lack of power supply, unusual natural events such as earthquake, landslide, volcanic activity, flood or inundation, tidal wave, typhoon or cyclone, hurricane, storm, lightning, or other inclement weather condition".

Re clause 68-69.

No amendment.

ANTICIPATED NON-PERFORMANCE

Re clause 70.

No amendment.

CONSEQUENTIAL LOSSES

Re clause 71.

No amendment.

DISPUTES AND APPLICABLE LAW

Re clause 72.

Before entering into arbitration, the Parties shall attempt in good faith to resolve any dispute arising out of or relating to this Contract promptly by negotiation between executives.

Appendix M

Construction Cost Estimate from Fluor Daniel Chile

CONSTRUCTION COST ESTIMATE
FOR THE CALAMA WIND POWER PROJECT

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1.2 Scope of the Estimate 1

1.3 Cost Summary 1

1.4 Estimate Development 3

1.3 Reference Documents 3

1.4 Labor Rates 3

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Appendix 2: Estimate Detail *10*

CONSTRUCTION COST ESTIMATE

1.1 Introduction

The Construction Cost Estimate for the Calama Wind Power Project Study, corresponds to a Type 3 estimate with ±25% accuracy level and a confidence level of 85% after contingency. The Estimate has been developed in a semi-detailed format in collaboration between Seawest and Fluor.

1.2 Scope of the Estimate

The Calama Windfarm Project is located in the second region, 7.5 km east of Calama by road at an elevation of 2400 . m.a.s.l.

The estimate is aligned with the base case defined by Seawest, i.e., the 62 wind turbines, rated 600 kW each, capable of producing a peak output of 37.2 Mw.

The estimate includes the cost for the engineering and construction period of the project starting from the approval of the study by Seawest up to the finalization with the commissioning of each area of the plant. All cost after the plant commissioning of each area is part of the plant operating cost. The estimated cost includes temporary facilities, ancillaries and wind farm direct and indirect construction cost, but excludes wind tower and transformer capital cost and owner's cost. The scope of facilities included in the estimate is described with more detail in the Closeup Report for this study.

1.3 Cost Summary

The summaries prime and by area are shown in this section in tables 1.3.1 and 1.3.2. Detail of the estimate is presented in the supporting documentation included in Appendix 2 of this report

Code	Discipline Description	Estimated Amount [US $ 1000]
0	Earthwork & Civil	1,512
1	Concrete	5,261
2	Structural Steel and FRP Structures	0
3	Architectural	231
4	Mechanical Equipment (*)	4,446
5	Piping	5
6	Electrical Equipment and Bulk Materials	4,172
7	Instrumentation and control Systems	34
8	Painting, coating and insulation	0
9	Indirect Cost & Contingency	9,089
	Total	**24,750**

(*) Includes crane rental

Table 1.3.1 Cost Summary by Discipline

AREA	Area Description	Estimated Amount [US $ 1000]
010	WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN	1,514
020	TURBINE TOWER AND TRANSFORMER FOUNDATIONS	5,188
030	LOW VOLTAGE ELECTRICAL WORK	91
040	WIND TURBINE GENERATOR TOWER INSTALLATION	4397
050	SITE GRADING AND ROADS	653
060	13.8 / 100 KV WIND FARM MAIN SUBSTATION	1665
070	100 KV OVERHEAD TRANSMISSION LINE	1595
080	EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)	316
090	FACILITIES AND SERVICES	242
100	INDIRECTS	9,089
	TOTAL PROJECT	**24,750**

Table 1.3.2 Cost Summary by Area

1.4 Estimate Development

Unit rates and productivity's were either token from Fluor privious works developed in locations close to Calama (concrete, earthworks, electrical), or based on Fluor standard manhours adjusted for this specific project conditions. Price basis for the estimate was also consolidated through quotations that were obtained during this stage of the study for major equipment.

1.3 Reference Documents

Following documentation was available for the development of the Construction cost.

- General Arrangement, Dwg. N° 2314 - 00 - 65 - 003
- Concrete design sketches and calculations (for major structures, provided by Seawest)
- Site Plot Plans, (Lay Out), Dwg. N° 2314 - 00 - 10 - 002
- Site survey (provided by Seawest)
- Soil Study Reports by geotechnical consultant
- Budgetary Quotations of major equipment
- Electrical Single Line Diagram , Dwg N° 2314 - 00 - 65 - 001
- Electrical Operational Diagram , Dwg N° 2314 - 00 - 65 - 002
- Wind Tower Lay Out, Electrical Details, Dwg. N° 2314 - 00 - 65 - 004
- Engineering Material Take-off by discipline for main items

1.4 Labor Rates

The craft base wages used are from historical data and actual rates experienced in the area on recent projects. The crew make-up is prepared based on Chilean practices for similar projects. The work shift considered is 20 days on site and 10 days off. The labor rates are considered "all-in" in US dollars and are inclusive of the following to facilitate the allocation of costs to contract packages:

- Base labor rate, payroll burdens and benefits, completion bonus, incentives, overtime premiums and transportation to point of hire
- Contractor mobilization and demobilization
- Small tools and consumables including welding rods, sealants, adhesives and lubricants
- Safety clothing and safety supplies
- Contractor supervision above the level of general foreman
- Transportation to and from project site
- Transportation within the site
- Contractors' receiving and warehousing
- Contractors' temporary facilities
- Contractors' head office overhead and insurance

- Contractors' mark-up and profit
- Contractors' bonding and financial guarantees
- Construction Equipment (except cranes for wind turbine erection)
- Lodging and Catering
- Water for temporary facilities
- Electrical power for construction

Table 1.4.1 Labor Rates by Discipline

Discipline	Rate
Civil and Earthworks (*)	$24.47
Concrete	$16.01
Structural Steel (**)	$17.46
Architectural	$16.11
Mechanical (**)	$17.57
Piping	$21.96
Electrical	$18.80
Instrumentation	$18.16
Painting and Insulation	$16.28

(*) High percentage of heavy equipment
(**) Cranes for wind tower mechanical and structural erection are shown separate from the labor rate.

1.5 Unit Man-hours

Unit installation rates have been established based on actual information obtained from executed and bid contracts, historical database and complemented with Fluor standards for unit man-hours. The particularities of this project have been taken into account when unit man-hours were assigned.

1.6 Construction Equipment

Construction equipment costs including rental, fuel, insurance, maintenance and operators are included in the all-in labor rate, except cranes for wind tower mechanical and structural erection are shown as a item. Pricing for 600 ton crane rental were token from budgetarial quotations.

1.7 Equipment Capital Cost

Equipment capital cost has been excluded for the wind farm facilities estimate in accordance with Seawest instructions for the scope of work assigned to Fluor in this project.

Major equipment for the remaining facilities,budgetary quotations were obtained. Minor equipment and material costs are based on historical data.

All costs are ex-works. Freight and import duties are included in the indirect cost.

1.8 Bulk Materials and Civil Works

1.8.1 Material Take-off and Pricing

The material take-off is done either from drawings, sketches or from engineering calculations. Quantities have been estimated from documents developed for this study and from reference documents from previous Seawest projects of similar facilities.

Earthworks Take-off: The project does not consider major sitework. The main quantities are required to develop the construction platforms and access road for the wind turbines & towers. Only an allowance to divert rainwater from a dry river crossing the windfarm site is included. Minor local excavation quantities were taken-off from similar projects derived from Seawest drawings.

Preliminary geotechnical work done for the site, indicate there is a rock layer present starting between 0.8 and 1.4 m depth with a thickness between 1 and 2 meters. The underlying natural soil is made up of, gravel and sand.

Concrete Quantities: take-off for wind turbine tower foundations were derived from Seawest typical foundation drawings for the most appropriated one as per the type of soil encountered on site (30'-8" square base). Take off for equipment foundations were based on similar designs done for other projects.

The take-off includes cubic meters by type of concrete grouped by standard quantity of formwork and reinforcing steel per cubic meter.

Structural Steel: Structural steel assembly for wind turbine towers is included in the tower assembly labor.

Architectural: Administrative and maintenance building was dimensioned based on Seawest requirements and priced based on a per square meter cost for prefabricated buildings.

Piping: only an allowance for the water and sewer of the administration building was included in the estimate for piping.

Electrical Bulk Material: The electrical bulk material and equipment take-off has been divided into the following main groups:

- The main 100 kV overhead line, based on a standard design for such powerlines
- The main 100 kV substation: takeoff was based on preliminary design, equipment layout and single line diagram.
- Changes to the existing Codelco substation.
- Underground cable: A detail take-off was produced which includes cable, conduit and duct bank. Trenching is included based on typical duct sections. This take-off is based on preliminary equipment layouts and preliminary single lines.
- Low voltage electrical work & grounding: A take-off was done according to Seawest designs specific to each area.

Instrumentation: Instruments are generally provided with the mayor equipment.

1.9 Currency Base Date and Exchange Rates

The base date of the cost estimate is fourth quarter 2002. The estimate is expressed in US dollars with no allowance for escalation beyond this date.

For reference, the currency conversion rates used during the estimate preparation were:

CLP-Chilean Peso	700	=	1 USD
UF (Unidad de Fomento)	1.0	=	16,650 CLP

1.10 Exclusions

The following items were excluded from the construction cost estimate:

- Escalation beyond 4rth quarter 2002
- All taxes
- Plant operating and maintenance manuals
- License and Royalty fees
- Land purchasing cost
- Any remediation work to cross over water pipelines that block access to Windfarm Site.
- CIF cost of wind turbines and towers.
- No allowances are made for special incentives (schedule, safety, royalty, or others)
- Sustaining or deferred capital costs
- Cost changes due to currency fluctuation
- Force Majeure issues
- Owners cost prior to project approval.
- Sunk cost

APPENDIX 1: ESTIMATE SUMMARY

The Construction Cost Estimate reports have the following format:
The detail report is sorted by area, by workpackage, by discipline and by item.
Each Area has its own code as listed in the table shown below:

AREA	Area Description
010	WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN
020	TURBINE TOWER AND TRANSFORMER FOUNDATIONS
030	LOW VOLTAGE ELECTRICAL WORK
040	WIND TURBINE GENERATOR TOWER INSTALLATION
050	SITE GRADING AND ROADS
060	13.8 / 100 KV WIND FARM MAIN SUBSTATION
070	100 KV OVERHEAD TRANSMISSION LINE
080	EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)
090	FACILITIES AND SERVICES
100	INDIRECTS

Table 1. Area Descriptions

Within each area there are defined workpackages that group related items. Within the workpackage the items are grouped by discipline, according to the Fluor standard shown on the following table:

Discipline	Code
Civil and Earthworks	0
Concrete	1
Structural Steel	2
Architectural	3
Mechanical	4
Piping	5
Electrical	6
Instrumentation	7
Painting and Insulation	8

Table 2. Discipline Descriptions

Each item shows following fields on the Detail report:

Code : Discipline code
Description : item Description

Quantity: Item Quantity
Unit: Item unit of measure
U_MHR: Unit man-hours for the installation of the item
MHR: Total man-hours required for the installation of the item (=U_MHR * Quantity)
Labor: The cost of the installation of the item (=MHR * Labor Rate)
Loc_Matl: Item cost of local materials, i.e materials fabricated in Chile.
Imp_Matl: Item cost of imported materials.
Loc_Eq: Item cost of local Equipment, i.e Equipment fabricated in Chile
Imp_Eq: Item cost for imported equipment.
Subc: items classified as subcontract, i.e the subcontractor supplies all materials, equipment and labor.
Total: corresponds to the total cost of the item.

APPENDIX 2: ESTIMATE DETAIL

FLUOR®

CLIENT: SEAWEST

CALAMA WIND PROJECT PRELIMINARY FEASIBILITY STUDY

SCENARIO: 37.2 Mw with 62 turbines rated at 600 kw **Currency: US Dollar**

Capital Cost Estimate: Summary by Area

Area	Area Description	MHRS	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subcontract	Total
010	WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN	40,450	754,550	141,320	611,660	6,088	0	0	1,513,618
020	TURBINE TOWER AND TRANSFORMER FOUNDATIONS	180,150	3,072,855	2,108,095	6,982	0	0	0	5,187,932
030	LOW VOLTAGE ELECTRICAL WORK	4,855	91,266	0	0	0	0	0	91,266
040	WIND TURBINE GENERATOR TOWER INSTALLATION	155,000	2,723,350	0	0	0	0	1,674,000	4,397,350
050	SITE GRADING AND ROADS	22,952	557,637	95,572	0	0	0	0	653,209
060	13.8 / 100 KV WIND FARM MAIN SUBSTATION	16,147	294,070	86,925	26,035	187,896	1,064,431	5,500	1,664,857
070	100 KV OVERHEAD TRANSMISSION LINE	42,449	809,789	200,488	584,400	0	0	0	1,594,676
080	EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)	8,018	147,609	60,561	18,979	53,296	35,500	0	315,945
090	FACILITIES AND SERVICES	4,136	29,823	7,147	0	19,460	750	184,800	241,980
100	INDIRECTS	20,616	0	0	95,000	0	0	8,993,668	9,088,668
Grand Total		**494,772**	**8,480,948**	**2,700,107**	**1,343,057**	**266,740**	**1,100,681**	**10,857,968**	**24,749,501**

FLUOR®

CLIENT: SEAWEST

CALAMA WIND POWER PROJECT PRELIMINARY FEASIBILITY STUDY

SCENARIO: 40.2 Mw with 67 turbines rated at 600 kw each. **Currency: US Dollar**

Capital Cost Estimate: Summary by Area

Area	Area Description	MHRS	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subcontract	Total
010	WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN	43,374	809,037	151,829	642,722	6,088	0	0	1,609,676
020	TURBINE TOWER AND TRANSFORMER FOUNDATIONS	194,683	3,320,780	2,278,112	7,563	0	0	0	5,606,454
030	LOW VOLTAGE ELECTRICAL WORK	5,246	98,627	0	0	0	0	0	98,627
040	WIND TURBINE GENERATOR TOWER INSTALLATION	172,500	3,030,825	0	0	0	0	1,809,000	4,839,825
050	SITE GRADING AND ROADS	22,993	558,651	96,362	0	0	0	0	655,013
060	13.8 / 100 KV WIND FARM MAIN SUBSTATION	16,147	294,070	86,925	26,035	187,896	1,064,431	5,500	1,664,857
070	100 KV OVERHEAD TRANSMISSION LINE	42,449	809,789	200,488	584,400	0	0	0	1,594,676
080	EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)	8,018	147,609	60,561	18,979	53,296	35,500	0	315,945
090	FACILITIES AND SERVICES	4,136	29,823	7,147	0	19,460	750	184,800	241,980
100	INDIRECTS	20,616	0	0	95,000	0	0	9,652,560	9,747,560
Grand Total		**530,162**	**9,099,211**	**2,881,422**	**1,374,699**	**266,740**	**1,100,681**	**11,651,860**	**26,374,613**

FLUOR®

CLIENT: SEAWEST

CALAMA WIND PROJECT PRELIMINARY FEASIBILITY STUDY

SCENARIO: 37.2 Mw with 62 turbines rated at 600 kw

Currency: US Dollar

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 **WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
010-ZC-001	**Civil Earth Work**											
0	TRENCH EXCAVATION	2,928.2	m3	0.3	937	22,929	0	0	0	0	0	22,929
0	SELECT FILL PURCHASED	1,281.5	m3	0.3	449	10,975	14,917	0	0	0	0	25,892
0	SAND / GRAVEL	1,281.5	m3	0.3	384	9,407	37,548	0	0	0	0	46,955
1	CONCRETE SLAB ON GRADE	349.7	m3	15.6	5,455	87,327	63,989	0	0	0	0	151,317
6	RED WARNING TAPE	6,656.0	m	0.0	87	1,627	1,065	0	0	0	0	2,692
6	3" PVC SCH 40 EMBEDDED CONDUIT	915.0	m	1.0	897	16,858	0	6,182	0	0	0	23,040
SUBTOTAL	**010-ZC-001 Civil Earth Work**				**8,208**	**149,124**	**117,519**	**6,182**	**0**	**0**	**0**	**272,825**
010-ZE-001	**Lay Down of 1 x 3 c 350 MCM, Cable**											
6	3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE	10,000.0	m	0.7	6,500	122,200	0	580,000	0	0	0	702,200
SUBTOTAL	**010-ZE-001 Lay Down of 1 x 3 c 350 MCM, Cable**				**6,500**	**122,200**	**0**	**580,000**	**0**	**0**	**0**	**702,200**
010-ZE-002	**Lay Down of Fiber Optic Cable**											
7	OPTIC FIBER, 12 STRINGS, INSTALLATION ONLY, UNDERGROUND	9,500.0	m	0.2	1,748	31,744	0	0	0	0	0	31,744
SUBTOTAL	**010-ZE-002 Lay Down of Fiber Optic Cable**				**1,748**	**31,744**	**0**	**0**	**0**	**0**	**0**	**31,744**
010-ZE-003	**Lay Down of 1/0 AWG Ground Cable**											

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 **WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
6	BCW STRANDED, #1/0	9,500.0	m	0.3	2,470	46,436	19,038	0	0	0	0	65,474
SUBTOTAL	**010-ZE-003 Lay Down of 1/0 AWG Ground Cable**				**2,470**	**46,436**	**19,038**	**0**	**0**	**0**	**0**	**65,474**
010-ZE-004	**Installation of 2x7m, 6" PVC Conduit**											
6	6" PVC SCH 40 EMBEDDED CONDUIT	868.0	m	2.5	2,161	40,633	0	9,426	0	0	0	50,059
6	6" PVC SCH 40 CONDUIT ELLBOW	124.0	ea	6.6	818	15,386	0	2,170	0	0	0	17,555
SUBTOTAL	**010-ZE-004 Installation of 2x7m, 6" PVC Conduit**				**2,979**	**56,019**	**0**	**11,596**	**0**	**0**	**0**	**67,615**
010-ZE-005	**Installation of 3x 7m,2" PVC Conduit**											
0	TRENCH BACKFILL	3.3	m3	0.3	1	28	0	0	0	0	0	28
6	2" PVC SCH 40 EMBEDDED CONDUIT	2,006.0	m	0.7	1,444	27,153	0	6,981	0	0	0	34,134
6	2" PVC SCH 40 CONDUIT ELLBOW	248.0	ea	1.0	248	4,662	0	774	0	0	0	5,436
SUBTOTAL	**010-ZE-005 Installation of 3x 7m,2" PVC Conduit**				**1,693**	**31,844**	**0**	**7,755**	**0**	**0**	**0**	**39,599**
010-ZE-006	**15 Kv Power Cable Joint**											
6	CABLE SPLICE 3/C #350MCM (185mm2) 15KV Cu+G	4.0	ea	33.6	134	2,527	0	2,944	0	0	0	5,471
SUBTOTAL	**010-ZE-006 15 Kv Power Cable Joint**				**134**	**2,527**	**0**	**2,944**	**0**	**0**	**0**	**5,471**
010-ZE-007	**15 kV Elbow Cable Connection**											
6	CABLE TERMINATION, 3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE	118.0	ea	16.8	1,982	37,269	0	0	0	0	0	37,269
SUBTOTAL	**010-ZE-007 15 kV Elbow Cable Connection**				**1,982**	**37,269**	**0**	**0**	**0**	**0**	**0**	**37,269**
010-ZE-008	**Elbow Surge Arrester Grd. Connec.**											
6	CABLE TERMINATION, ONLY LABOR, 3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE	6.0	ea	16.8	101	1,895	0	0	0	0	0	1,895

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 010-ZE-008	**Elbow Surge Arrester Grd. Connec.**				**101**	**1,895**	**0**	**0**	**0**	**0**	**0**	**1,895**
010-ZE-009	**15 kV Stress Cone Connec.at Swgr.**											
6	CABLE TERMINATION, INDOOR 3/C #350MCM (185mm2) 15KV Cu+G	7.0	ea	16.8	118	2,211	0	1,792	0	0	0	4,003
SUBTOTAL 010-ZE-009	**15 kV Stress Cone Connec.at Swgr.**				**118**	**2,211**	**0**	**1,792**	**0**	**0**	**0**	**4,003**
010-ZE-010	**Pad Mounted Transf. Installation**											
6	TRAFO 0,6/13.8 Kv, 750 KVA INSTALLATION ONLY	62.0	ea	220.0	13,640	256,432	0	0	0	0	0	256,432
SUBTOTAL 010-ZE-010	**Pad Mounted Transf. Installation**				**13,640**	**256,432**	**0**	**0**	**0**	**0**	**0**	**256,432**
010-ZE-011	**Power Supply to MET Tower**											
0	TRENCH EXCAVATION	132.0	m3	0.3	42	1,034	0	0	0	0	0	1,034
0	TRENCH BACKFILL	132.0	m3	0.3	46	1,131	0	0	0	0	0	1,131
1	LEAN CONCRETE - 1500 PSI (10MPa)	5.3	m3	3.5	18	294	558	0	0	0	0	852
6	2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6	4/C #12 (2.5mm2) 6OOV CU POWER CABLE TYPE XTMU	300.0	m	0.1	21	395	657	0	0	0	0	1,052
6	BCW STRANDED, #1/0	300.0	m	0.3	78	1,466	601	0	0	0	0	2,068
7	OPTIC FIBER, 12 STRINGS	600.0	m	0.2	110	2,005	0	0	0	0	0	2,005
SUBTOTAL 010-ZE-011	**Power Supply to MET Tower**				**532**	**10,385**	**1,816**	**1,044**	**0**	**0**	**0**	**13,245**
010-ZE-012	**Installation of Service Transf.at MET**											
6	DISTRIBUTION TRANSFORMER 0.5 kVA	3.0	ea	10.0	30	564	0	0	600	0	0	1,164
SUBTOTAL 010-ZE-012	**Installation of Service Transf.at MET**				**30**	**564**	**0**	**0**	**600**	**0**	**0**	**1,164**

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 **WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
010-ZE-013	**Power Supply to Oper.& Maint. Bldg.**											
0	TRENCH EXCAVATION	44.0	m3	0.3	14	345	0	0	0	0	0	345
0	TRENCH BACKFILL	44.0	m3	0.3	15	377	0	0	0	0	0	377
1	LEAN CONCRETE - 1500 PSI (10MPa)	15.8	m3	3.5	55	883	1,674	0	0	0	0	2,557
6	2" PVC SCH 40 EMBEDDED CONDUIT	100.0	m	0.7	72	1,354	0	348	0	0	0	1,702
6	4/C #4 (16mm2) 6OOV CU POWER CABLE TYPE TC	100.0	m	0.2	21	395	1,072	0	0	0	0	1,467
6	BCW STRANDED, #1/0	100.0	m	0.3	26	489	200	0	0	0	0	689
6	ADMINISTRATION SUBSTATION DISTRIBUTION PANEL	1.0	ea	27.0	27	508	0	0	2,000	0	0	2,508
7	OPTIC FIBER, 12 STRINGS, INSTALLATION ONLY, UNDERGROUND	200.0	m	0.2	37	668	0	0	0	0	0	668
SUBTOTAL	**010-ZE-013 Power Supply to Oper.& Maint. Bldg.**				**267**	**5,017**	**2,947**	**348**	**2,000**	**0**	**0**	**10,312**
010-ZE-014	**Inst.Service Transf.at Op.& Main Bdg**											
6	DISTRIBUTION TRANSFORMER 50 kVA	1.0	ea	47.0	47	884	0	0	3,488	0	0	4,372
SUBTOTAL	**010-ZE-014 Inst.Service Transf.at Op.& Main Bdg**				**47**	**884**	**0**	**0**	**3,488**	**0**	**0**	**4,372**
SUBTOTAL AREA: 010	**WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**				40,450	754,550	141,320	611,660	6,088	0	0	1,513,618

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 020 TURBINE TOWER AND TRANSFORMER FOUNDATIONS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
020-ZC-001	**Civil Work for Turbines**											
0	STRUCTURAL EXCAVATION, ROCK	7,766.0	m3	1.3	10,096	247,044	0	0	0	0	0	247,044
0	STRUCTURAL EXCAVATION	7,169.8	m3	0.6	4,302	105,267	0	0	0	0	0	105,267
0	STRUCTURAL BACKFILL	7,774.8	m3	0.8	6,220	152,199	0	0	0	0	0	152,199
1	LEAN CONCRETE - 1500 PSI (10MPa)	585.9	m3	3.5	2,051	32,831	62,281	0	0	0	0	95,112
1	CONCRETE FOUNDATIONS	6,835.5	m3	16.1	109,710	1,756,453	1,406,814	0	0	0	0	3,163,268
1	ANCHOR BOLTS	179,676.0	kg	0.2	35,935	575,323	521,060	0	0	0	0	1,096,383
1	GROUT - NONSHRINK, NON-METALLIC, 1IN	32.6	m3	100.0	3,255	52,113	43,943	0	0	0	0	96,055
SUBTOTAL	**020-ZC-001 Civil Work for Turbines**				**171,568**	**2,921,230**	**2,034,098**	**0**	**0**	**0**	**0**	**4,955,329**
020-ZC-002	**Civil Work for Transformers**											
0	STRUCTURAL EXCAVATION	498.3	m3	0.6	299	7,316	0	0	0	0	0	7,316
0	STRUCTURAL BACKFILL	212.3	m3	0.8	170	4,156	0	0	0	0	0	4,156
1	LEAN CONCRETE - 1500 PSI (10MPa)	16.8	m3	3.5	59	941	1,786	0	0	0	0	2,727
1	CONCRETE FOUNDATIONS	273.0	m3	16.1	4,382	70,150	56,186	0	0	0	0	126,336
SUBTOTAL	**020-ZC-002 Civil Work for Transformers**				**4,909**	**82,564**	**57,972**	**0**	**0**	**0**	**0**	**140,536**
020-ZC-003	**Insert and Embeddeds**											
6	0.5" PVC SCH 40 EMBEDDED CONDUIT	227.0	m	0.3	59	1,110	0	172	0	0	0	1,281
6	2" PVC SCH 40 EMBEDDED CONDUIT	378.0	m	0.7	272	5,117	0	1,315	0	0	0	6,432

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 020 **TURBINE TOWER AND TRANSFORMER FOUNDATIONS**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
6	3" PVC SCH 40 EMBEDDED CONDUIT	378.0	m	1.0	370	6,964	0	2,554	0	0	0	9,518
6	6" PVC SCH 40 EMBEDDED CONDUIT	20.0	m	2.5	50	936	0	217	0	0	0	1,153
6	2" PVC SCH 40 CONDUIT ELLBOW	186.0	ea	1.0	186	3,497	0	580	0	0	0	4,077
6	3" PVC SCH 40 CONDUIT ELLBOW	372.0	ea	2.2	818	15,386	0	1,701	0	0	0	17,087
6	6" PVC SCH 40 CONDUIT ELLBOW	7.0	ea	6.6	46	869	0	122	0	0	0	991
6	3" PVC SCH 40 END BELLS	248.0	ea	2.2	545	10,257	0	321	0	0	0	10,578
6	BCW STRANDED, #1/0	2,834.0	m	0.3	737	13,853	5,679	0	0	0	0	19,532
6	COPPER GROUND ROD, 5/8" X 10' (15.9mm x 3.05m)	310.0	ea	1.5	465	8,742	9,363	0	0	0	0	18,105
6	1/0 AWG COPPER TO 2 HOLE COMPRESSION LUG	248.0	ea	0.5	124	2,331	982	0	0	0	0	3,313
SUBTOTAL	**020-ZC-003 Insert and Embeddeds**				**3,672**	**69,061**	**16,025**	**6,982**	**0**	**0**	**0**	**92,068**
SUBTOTAL AREA: 020	**TURBINE TOWER AND TRANSFORMER FOUNDATIONS**				180,150	3,072,855	2,108,095	6,982	0	0	0	5,187,932

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 030 LOW VOLTAGE ELECTRICAL WORK

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
030-ZE-001	**Low voltage cable underground installation**											
6	WIRE TERMINATION #350MCM (185mm2) 1/C, CU, 6OOV.XTU, INSTALLATION ONLY	1,116.0	m	3.0	3,348	62,942	0	0	0	0	0	62,942
6	#350MCM (185mm2) 1/C, CU, 6OOV.XTU, INSTALLATION ONLY	5,580.0	m	0.3	1,507	28,324	0	0	0	0	0	28,324
SUBTOTAL	**030-ZE-001 Low voltage cable underground installation**				**4,855**	**91,266**	**0**	**0**	**0**	**0**	**0**	**91,266**
SUBTOTAL AREA: 030	**LOW VOLTAGE ELECTRICAL WORK**				4,855	91,266	0	0	0	0	0	91,266

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 040 **WIND TURBINE GENERATOR TOWER INSTALLATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
040-ZM-001	**Wind turbine generator installation**											
4	WIND TURBINE & TOWER ERECTION ONLY	62.0	lot	2,500.0	155,000	2,723,350	0	0	0	0	0	2,723,350
4	180 TON CRANE RENTAL	310.0	Day	0.0	0	0	0	0	0	0	651,000	651,000
4	600 TON CRANE RENTAL	310.0	Day	0.0	0	0	0	0	0	0	1,023,000	1,023,000
SUBTOTAL	**040-ZM-001 Wind turbine generator installation**				**155,000**	**2,723,350**	**0**	**0**	**0**	**0**	**1,674,000**	**4,397,350**
SUBTOTAL AREA: 040	**WIND TURBINE GENERATOR TOWER INSTALLATION**				155,000	2,723,350	0	0	0	0	1,674,000	4,397,350

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 050 SITE GRADING AND ROADS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
050-ZC-001	**Civil Earth Work**											
0	MASSIVE EXCAVATION, COMMON SOIL	49,449.4	m3	0.2	9,890	242,005	0	0	0	0	0	242,005
0	COMMON BACKFILL	28,237.0	m3	0.3	8,471	207,288	0	0	0	0	0	207,288
0	ROAD BASE MATERIAL	8,824.2	m3	0.3	2,206	53,982	81,183	0	0	0	0	135,165
SUBTOTAL	**050-ZC-001 Civil Earth Work**				**20,567**	**503,275**	**81,183**	**0**	**0**	**0**	**0**	**584,458**
050-ZC-002	**Culverts for Road crossings**											
0	STRUCTURAL EXCAVATION, ROCK	339.9	m3	1.3	442	10,813	0	0	0	0	0	10,813
0	STRUCTURAL EXCAVATION	800.8	m3	0.6	480	11,757	0	0	0	0	0	11,757
0	STRUCTURAL BACKFILL	805.2	m3	0.8	644	15,763	0	0	0	0	0	15,763
0	CULVERT GALVANIZED STEEL D = 1.0 m (2 mm THICKNESS)	132.0	m	1.5	198	4,845	10,296	0	0	0	0	15,141
SUBTOTAL	**050-ZC-002 Culverts for Road crossings**				**1,765**	**43,178**	**10,296**	**0**	**0**	**0**	**0**	**53,474**
050-ZC-003	**Concrete Trenches under Roads**											
0	STRUCTURAL EXCAVATION, ROCK	33.0	m3	1.3	43	1,050	0	0	0	0	0	1,050
0	STRUCTURAL EXCAVATION	78.1	m3	0.6	47	1,147	0	0	0	0	0	1,147
0	STRUCTURAL BACKFILL	73.7	m3	0.8	59	1,443	0	0	0	0	0	1,443
1	CONCRETE WALLS	17.9	m3	26.4	471	7,545	4,094	0	0	0	0	11,638
SUBTOTAL	**050-ZC-003 Concrete Trenches under Roads**				**620**	**11,184**	**4,094**	**0**	**0**	**0**	**0**	**15,277**
SUBTOTAL AREA: 050	**SITE GRADING AND ROADS**				22,952	557,637	95,572	0	0	0	0	653,209

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
060-BD-001	**Prefabricated Elect. Building Includg**											
0	STRUCTURAL EXCAVATION	77.0	m3	0.6	46	1,131	0	0	0	0	0	1,131
0	STRUCTURAL BACKFILL	33.0	m3	0.8	26	646	0	0	0	0	0	646
1	CONCRETE FOUNDATIONS	36.8	m3	16.1	590	9,443	7,564	0	0	0	0	17,007
3	AIR CONDITIONING	1.0	ea	120.0	120	0	0	0	0	0	5,500	5,500
3	PREFABRICATED ELECTRICAL ROOM	1.0	lot	140.0	140	2,255	0	0	38,600	0	0	40,855
SUBTOTAL	**060-BD-001 Prefabricated Elect. Building Includg**				**922**	**13,475**	**7,564**	**0**	**38,600**	**0**	**5,500**	**65,139**
060-CB-011	**110 Kv Circuit Breaker**											
6	POWER CIRCUIT BREAKER 138 Kv	1.0	ea	200.0	200	3,760	0	0	0	45,000	0	48,760
SUBTOTAL	**060-CB-011 110 Kv Circuit Breaker**				**200**	**3,760**	**0**	**0**	**0**	**45,000**	**0**	**48,760**
060-SG-002	**Main Switchgear**											
6	MEDIUM VOLTAGE METAL CLAD SWITCHGEAR MAIN SUBSTATION	1.0	ea	600.0	600	11,280	0	0	0	375,000	0	386,280
SUBTOTAL	**060-SG-002 Main Switchgear**				**600**	**11,280**	**0**	**0**	**0**	**375,000**	**0**	**386,280**
060-SW-001	**100 kV Switching Equipment**											
6	DISCONNECT SWITCH 138 KV, 3 POLE & GROUNDING SWITCH	2.0	ea	110.0	220	4,136	0	0	0	22,000	0	26,136
SUBTOTAL	**060-SW-001 100 kV Switching Equipment**				**220**	**4,136**	**0**	**0**	**0**	**22,000**	**0**	**26,136**
060-TR-001	**100 kV Potential Transformers**											
6	138 Kv CLASS POTENTIAL TRANSFORMER 100 KV/120 V RATIO	3.0	ea	176.0	528	9,926	0	0	36,000	0	0	45,926
SUBTOTAL	**060-TR-001 100 kV Potential Transformers**				**528**	**9,926**	**0**	**0**	**36,000**	**0**	**0**	**45,926**

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
060-TR-010	**100 kV Current Transformers**											
6	138 Kv CLASS CURRENT TRANSFORMER 1200 / 5A	3.0	ea	64.0	192	3,610	0	0	27,000	0	0	30,610
SUBTOTAL	**060-TR-010 100 kV Current Transformers**				**192**	**3,610**	**0**	**0**	**27,000**	**0**	**0**	**30,610**
060-TR-020	**50 MVA , 13.8 / 100 kV power Transf.**											
0	STRUCTURAL EXCAVATION, ROCK	165.0	m3	1.3	215	5,249	0	0	0	0	0	5,249
0	STRUCTURAL BACKFILL	77.0	m3	0.8	62	1,507	0	0	0	0	0	1,507
1	CONCRETE FOUNDATIONS	84.0	m3	16.1	1,348	21,585	17,288	0	0	0	0	38,873
6	POWER TRANSFORMER 50 MVA 13.8/100 kV.	1.0	ea	2,900.0	2,900	54,520	0	0	0	600,000	0	654,520
SUBTOTAL	**060-TR-020 50 MVA , 13.8 / 100 kV power Transf.**				**4,524**	**82,861**	**17,288**	**0**	**0**	**600,000**	**0**	**700,149**
060-VL-001	**HV Lightning Arresters**											
6	SURGE ARRESTER CLASS 138 KV- MCOV 67 KV	3.0	ea	48.0	144	2,707	0	0	0	13,500	0	16,207
SUBTOTAL	**060-VL-001 HV Lightning Arresters**				**144**	**2,707**	**0**	**0**	**0**	**13,500**	**0**	**16,207**
060-ZC-002	**Site Preparation**											
0	MASSIVE EXCAVATION, COMMON SOIL	244.2	m3	0.2	49	1,195	0	0	0	0	0	1,195
0	SAND / GRAVEL	70.4	m3	0.3	21	517	2,063	0	0	0	0	2,580
0	CURB AND GUTTER, PRECAST, 150mm x 300mm, STRAIGHT SECTION, 0.9 m LONG	77.0	ea	1.0	77	1,884	0	385	0	0	0	2,269
0	FENCE, 9 GA(2.9mm), GALV.2.4m HIGH PLUS 3 STRANDS BARBED WIRE	77.0	m	2.3	177	4,334	4,620	0	0	0	0	8,954
SUBTOTAL	**060-ZC-002 Site Preparation**				**324**	**7,930**	**6,683**	**385**	**0**	**0**	**0**	**14,997**
060-ZC-003	**Ground Mesh**											

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
0	TRENCH EXCAVATION	232.1	m3	0.3	74	1,817	0	0	0	0	0	1,817
0	TRENCH BACKFILL	232.1	m3	0.3	81	1,988	0	0	0	0	0	1,988
6	BCW STRANDED, #1/0	640.0	m	0.3	166	3,128	1,283	0	0	0	0	4,411
SUBTOTAL	**060-ZC-003 Ground Mesh**				**322**	**6,934**	**1,283**	**0**	**0**	**0**	**0**	**8,216**
060-ZC-004	**Foundation for Equipment & Structure**											
0	STRUCTURAL EXCAVATION	275.0	m3	0.6	165	4,038	0	0	0	0	0	4,038
0	STRUCTURAL BACKFILL	154.0	m3	0.8	123	3,015	0	0	0	0	0	3,015
1	CONCRETE FOUNDATIONS	117.6	m3	16.1	1,887	30,219	24,203	0	0	0	0	54,422
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER	11.7	t	50.0	585	10,998	0	17,550	0	0	0	28,548
SUBTOTAL	**060-ZC-004 Foundation for Equipment & Structure**				**2,761**	**48,269**	**24,203**	**17,550**	**0**	**0**	**0**	**90,022**
060-ZC-005	**Cable Trench**											
0	STRUCTURAL EXCAVATION, ROCK	46.2	m3	1.3	60	1,470	0	0	0	0	0	1,470
0	STRUCTURAL EXCAVATION	106.7	m3	0.6	64	1,567	0	0	0	0	0	1,567
0	STRUCTURAL BACKFILL	88.0	m3	0.8	70	1,723	0	0	0	0	0	1,723
1	CONCRETE WALLS	44.2	m3	26.4	1,166	18,675	10,133	0	0	0	0	28,808
SUBTOTAL	**060-ZC-005 Cable Trench**				**1,361**	**23,434**	**10,133**	**0**	**0**	**0**	**0**	**33,567**
060-ZC-201	**Control Panel**											
6	CONTROL PANEL	1.0	ea	350.0	350	6,580	0	0	50,000	0	0	56,580

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 060-ZC-201	**Control Panel**				**350**	**6,580**	**0**	**0**	**50,000**	**0**	**0**	**56,580**
060-ZE-014	**3000 A, 15 kV Cable Duct**											
6	CABLE TERMINATION, 1/C #750MCM (396mm2) 15KV EPR SHIELDED CU CABLE OH INSTALL	36.0	ea	9.8	353	6,633	0	3,060	0	0	0	9,693
6	1/C #750MCM (396mm2) 15KV EPR SHIELDED CU CABLE UG INSTALLATION	216.0	m	0.6	119	2,233	0	3,996	0	0	0	6,229
SUBTOTAL 060-ZE-014	**3000 A, 15 kV Cable Duct**				**472**	**8,866**	**0**	**7,056**	**0**	**0**	**0**	**15,922**
060-ZE-016	**H V Connections**											
6	138 kV CONNECTIONS	1.0	ea	1,215.0	1,215	22,842	7,500	0	0	0	0	30,342
6	GUARD GROUND CABLE	1.0	lot	104.0	104	1,955	1,000	0	0	0	0	2,955
6	TESTING & COMMISSIONING OF SUBSTATION	1.0	lot	900.0	900	16,920	1,500	0	0	0	0	18,420
6	ISOLATOR SUPPORT, 138 KV	6.0	ea	11.4	68	1,286	0	0	22,500	0	0	23,786
SUBTOTAL 060-ZE-016	**H V Connections**				**2,287**	**43,003**	**10,000**	**0**	**22,500**	**0**	**0**	**75,503**
060-ZE-017	**Outdoor Lighting**											
6	BRACKET ARM FOR STEEL LIGHT POLE - 1 ARM	6.0	ea	16.0	96	1,805	864	0	0	0	0	2,669
6	STEEL LIGHTING POLE 18 M	6.0	ea	22.5	135	2,538	5,502	0	0	0	0	8,040
6	2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6	#8 (6mm2) THW 1/C, CU, 6OOV WIRE STRANDED	1,200.0	m	0.0	47	880	864	0	0	0	0	1,744
6	HPS ROADWAY LIGHTING FIXTURE 250W, TYPE PS2A	6.0	ea	7.5	45	846	2,542	0	0	0	0	3,388
6	EMERGENCY LIGHTING EQUIPMENT	2.0	ea	27.0	54	1,015	0	0	3,796	0	0	4,811

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 060-ZE-017	**Outdoor Lighting**				**593**	**11,145**	**9,772**	**1,044**	**3,796**	**0**	**0**	**25,756**
060-ZE-115	**Battery & Battery Charger**											
6	BATTERY RACK FOR EMERGENCY SYSTEM.	1.0	ea	14.0	14	263	0	0	0	2,881	0	3,144
6	BATTERY CHARGER FOR EMERGENCY SYSTEM	1.0	ea	33.0	33	620	0	0	0	6,050	0	6,670
SUBTOTAL 060-ZE-115	**Battery & Battery Charger**				**47**	**884**	**0**	**0**	**0**	**8,931**	**0**	**9,815**
060-ZM-015	**Fire Detection and Extinguishing**											
4	FIRE PROTECTION SYSTEM	1.0	ea	300.0	300	5,271	0	0	10,000	0	0	15,271
SUBTOTAL 060-ZM-015	**Fire Detection and Extinguishing**				**300**	**5,271**	**0**	**0**	**10,000**	**0**	**0**	**15,271**
SUBTOTAL AREA: 060	**13.8 / 100 KV WIND FARM MAIN SUBSTATION**				16,147	294,070	86,925	26,035	187,896	1,064,431	5,500	1,664,857

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 070 **100 KV OVERHEAD TRANSMISSION LINE**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
070-ZC-002	**Topographic Work and Soil Mechanic for overhead line**											
6	TOPOGRAPHY FOR OVERHEAD POWERLINE	10.0	km	0.0	0	0	41,000	0	0	0	0	41,000
SUBTOTAL	**070-ZC-002 Topographic Work and Soil Mechanic for overhead lin**				**0**	**0**	**41,000**	**0**	**0**	**0**	**0**	**41,000**
070-ZC-006	**Construction Road**											
0	SURFACE PREPARATION	44,000.0	m2	0.1	2,200	53,834	0	0	0	0	0	53,834
SUBTOTAL	**070-ZC-006 Construction Road**				**2,200**	**53,834**	**0**	**0**	**0**	**0**	**0**	**53,834**
070-ZE-003	**Galvanized Steel Towers**											
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER	250.0	t	50.0	12,500	235,000	0	375,000	0	0	0	610,000
SUBTOTAL	**070-ZE-003 Galvanized Steel Towers**				**12,500**	**235,000**	**0**	**375,000**	**0**	**0**	**0**	**610,000**
070-ZE-004	**Tower Fundations**											
0	STRUCTURAL EXCAVATION	3,764.2	m3	0.6	2,259	55,266	0	0	0	0	0	55,266
0	STRUCTURAL BACKFILL	3,104.2	m3	0.8	2,483	60,768	0	0	0	0	0	60,768
1	CONCRETE FOUNDATIONS	630.0	m3	16.1	10,112	161,885	129,660	0	0	0	0	291,545
SUBTOTAL	**070-ZE-004 Tower Fundations**				**14,853**	**277,919**	**129,660**	**0**	**0**	**0**	**0**	**407,579**
070-ZE-005	**Tower Grounding**											
0	TRENCH EXCAVATION	330.0	m3	0.3	106	2,584	0	0	0	0	0	2,584
6	BCW STRANDED, #1/0	1,500.0	m	0.3	390	7,332	3,006	0	0	0	0	10,338
6	COPPER GROUND ROD, 5/8" X 10' (15.9mm x 3.05m)	300.0	ea	1.5	450	8,460	9,061	0	0	0	0	17,521
6	CADWELD AVERAGE	600.0	ea	2.0	1,200	22,560	5,760	0	0	0	0	28,320

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 070 **100 KV OVERHEAD TRANSMISSION LINE**

Discipline		Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL	**070-ZE-005**	**Tower Grounding**				**2,146**	**40,936**	**17,827**	**0**	**0**	**0**	**0**	**58,763**
070-ZE-007		**Conductor, Insulators Hardware,Acc.**											
6		SUSPENSION INSULATORS CHAIN 138 KV.	300.0	ea	4.5	1,350	25,380	0	137,400	0	0	0	162,780
6		ALLIANCE AAAC CONDUCTOR, 246,9 MCM	60,000.0	m	0.1	7,200	135,360	0	72,000	0	0	0	207,360
6		OVERHEAD GROUND CABLE	20,000.0	m	0.1	2,200	41,360	12,000	0	0	0	0	53,360
SUBTOTAL	**070-ZE-007**	**Conductor, Insulators Hardware,Acc.**				**10,750**	**202,100**	**12,000**	**209,400**	**0**	**0**	**0**	**423,500**
SUBTOTAL AREA: 070		**100 KV OVERHEAD TRANSMISSION LINE**				42,449	809,789	200,488	584,400	0	0	0	1,594,676

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
080-SW-001	**100 kV Switching Equipment**											
6	DISCONNECT SWITCH 138 KV. 3 POLE & GROUNDING SWITCH	2.0	ea	110.0	220	4,136	0	0	0	22,000	0	26,136
SUBTOTAL	**080-SW-001 100 kV Switching Equipment**				**220**	**4,136**	**0**	**0**	**0**	**22,000**	**0**	**26,136**
080-TR-010	**100 kV Current Transformers**											
6	CURRENT TRANSFORMER 138 KV 1200 / 5A	3.0	ea	64.0	192	3,610	0	0	27,000	0	0	30,610
SUBTOTAL	**080-TR-010 100 kV Current Transformers**				**192**	**3,610**	**0**	**0**	**27,000**	**0**	**0**	**30,610**
080-VL-001	**HV Lightning Arresters**											
6	SURGE ARRESTER CLASS 138 KV- MCOV 67 KV	3.0	ea	48.0	144	2,707	0	0	0	13,500	0	16,207
SUBTOTAL	**080-VL-001 HV Lightning Arresters**				**144**	**2,707**	**0**	**0**	**0**	**13,500**	**0**	**16,207**
080-ZC-002	**Site Preparation**											
0	MASSIVE EXCAVATION, COMMON SOIL	244.2	m3	0.2	49	1,195	0	0	0	0	0	1,195
0	SAND / GRAVEL	70.4	m3	0.3	21	517	2,063	0	0	0	0	2,580
0	CURB AND GUTTER, PRECAST, 150mm x 300mm, STRAIGHT SECTION, 0.9 m LONG	77.0	ea	1.0	77	1,884	0	385	0	0	0	2,269
0	FENCE, 9 GA(2.9mm), GALV.2.4m HIGH PLUS 3 STRANDS BARBED WIRE	77.0	m	2.3	177	4,334	4,620	0	0	0	0	8,954
SUBTOTAL	**080-ZC-002 Site Preparation**				**324**	**7,930**	**6,683**	**385**	**0**	**0**	**0**	**14,997**
080-ZC-003	**Ground Mesh Extension**											
0	TRENCH EXCAVATION	232.1	m3	0.3	74	1,817	0	0	0	0	0	1,817
0	TRENCH BACKFILL	232.1	m3	0.3	81	1,988	0	0	0	0	0	1,988
6	BCW STRANDED, #1/0	640.0	m	0.3	166	3,128	1,283	0	0	0	0	4,411

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 **EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 080-ZC-003	**Ground Mesh Extension**				**322**	**6,934**	**1,283**	**0**	**0**	**0**	**0**	**8,216**
080-ZC-004	**Fundation for Equipment & structure**											
0	STRUCTURAL EXCAVATION	220.0	m3	0.6	132	3,230	0	0	0	0	0	3,230
0	STRUCTURAL BACKFILL	110.0	m3	0.8	88	2,153	0	0	0	0	0	2,153
1	CONCRETE FOUNDATIONS	110.3	m3	16.1	1,770	28,330	22,691	0	0	0	0	51,020
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER	11.7	t	50.0	585	10,998	0	17,550	0	0	0	28,548
SUBTOTAL 080-ZC-004	**Fundation for Equipment & structure**				**2,575**	**44,711**	**22,691**	**17,550**	**0**	**0**	**0**	**84,952**
080-ZC-005	**Cable Trench**											
0	STRUCTURAL EXCAVATION, ROCK	46.2	m3	1.3	60	1,470	0	0	0	0	0	1,470
0	STRUCTURAL EXCAVATION	106.7	m3	0.6	64	1,567	0	0	0	0	0	1,567
0	STRUCTURAL BACKFILL	88.0	m3	0.8	70	1,723	0	0	0	0	0	1,723
1	CONCRETE WALLS	44.2	m3	26.4	1,166	18,675	10,133	0	0	0	0	28,808
SUBTOTAL 080-ZC-005	**Cable Trench**				**1,361**	**23,434**	**10,133**	**0**	**0**	**0**	**0**	**33,567**
080-ZE-016	**H V Connections**											
6	OUTDOOR HV CONNECTIONS	1.0	ea	1,215.0	1,215	22,842	7,500	0	0	0	0	30,342
6	GUARD GROUND CABLE	1.0	lot	104.0	104	1,955	1,000	0	0	0	0	2,955
6	TESTING & COMMISSIONING OF SUBSTATION	1.0	lot	900.0	900	16,920	1,500	0	0	0	0	18,420
6	ISOLATOR SUPPORT, 138 KV	6.0	ea	11.4	68	1,286	0	0	22,500	0	0	23,786

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)

Discipline		Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL	**080-ZE-016**	**H V Connections**				**2,287**	**43,003**	**10,000**	**0**	**22,500**	**0**	**0**	**75,503**
080-ZE-017		**Outdoor Lighting**											
6		BRACKET ARM FOR STEEL LIGHT POLE - 1 ARM	6.0	ea	16.0	96	1,805	864	0	0	0	0	2,669
6		STEEL LIGHTING POLE 18 M	6.0	ea	22.5	135	2,538	5,502	0	0	0	0	8,040
6		2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6		#8 (6mm2) THW 1/C, CU, 6OOV WIRE STRANDED	1,200.0	m	0.0	47	880	864	0	0	0	0	1,744
6		HPS ROADWAY LIGHTING FIXTURE 250W, TYPE PS2A	6.0	ea	7.5	45	846	2,542	0	0	0	0	3,388
6		EMERGENCY LIGHTING EQUIPMENT	2.0	ea	27.0	54	1,015	0	0	3,796	0	0	4,811
SUBTOTAL	**080-ZE-017**	**Outdoor Lighting**				**593**	**11,145**	**9,772**	**1,044**	**3,796**	**0**	**0**	**25,756**
SUBTOTAL AREA: 080		**EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)**				8,018	147,609	60,561	18,979	53,296	35,500	0	315,945

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 090 FACILITIES AND SERVICES

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
090-BD-001	**Operation & Maintenance Building (Prefabricated)**											
0	STRUCTURAL EXCAVATION	495.0	m3	0.6	297	7,268	0	0	0	0	0	7,268
0	ESTABILIZADO	330.0	m3	0.3	83	2,019	3,036	0	0	0	0	5,055
1	CONCRETE FOUNDATIONS	1.2	m3	16.1	19	310	249	0	0	0	0	559
1	CONCRETE SLAB ON GRADE	5.4	m3	15.6	84	1,337	980	0	0	0	0	2,317
3	PREFABRICATED BUILDING	264.0	m2	10.0	2,640	0	0	0	0	0	184,800	184,800
SUBTOTAL	**090-BD-001 Operation & Maintenance Building (Prefabricated)**				**3,122**	**10,934**	**4,265**	**0**	**0**	**0**	**184,800**	**199,999**
090-TK-001	**Potable Water tank, 25 m3**											
0	STRUCTURAL EXCAVATION, ROCK	15.2	m3	1.3	20	483	0	0	0	0	0	483
0	STRUCTURAL BACKFILL	12.1	m3	0.8	10	237	0	0	0	0	0	237
1	CONCRETE WALLS	2.7	m3	26.4	72	1,154	626	0	0	0	0	1,780
4	WATER PUMP	1.0	ea	35.0	35	615	0	0	0	750	0	1,365
4	CARBON STEEL TANK 25 M3	1.0	ea	290.0	290	5,095	0	0	9,460	0	0	14,555
5	PIPING SYSTEM FOR ADMINISTRATION & MAINTENANCE BUILDING	1.0	ea	120.0	120	2,635	2,000	0	0	0	0	4,635
SUBTOTAL	**090-TK-001 Potable Water tank, 25 m3**				**546**	**10,219**	**2,626**	**0**	**9,460**	**750**	**0**	**23,055**
090-ZM-001	**Sewage treatmemt Plant**											
0	STRUCTURAL EXCAVATION	55.0	m3	0.6	33	808	0	0	0	0	0	808
0	SELECT FILL PURCHASED	22.0	m3	0.3	8	188	256	0	0	0	0	444

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 090 FACILITIES AND SERVICES

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
0	STRUCTURAL BACKFILL	33.0	m3	0.8	26	646	0	0	0	0	0	646
4	SEWAGE WATER TREATMENT PLANT	1.0	lot	400.0	400	7,028	0	0	10,000	0	0	17,028
SUBTOTAL	**090-ZM-001 Sewage treatmemt Plant**				**467**	**8,670**	**256**	**0**	**10,000**	**0**	**0**	**18,926**
SUBTOTAL AREA: 090	**FACILITIES AND SERVICES**				4,136	29,823	7,147	0	19,460	750	184,800	241,980

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 INDIRECTS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
100-BA-001	**Engineering Services**											
9	DETAIL ENGINEERING	1.0	lot	0.0	0	0	0	0	0	0	1,190,000	1,190,000
9	CONSTRUCTION MANAGEMENT	1.0	lot	0.0	0	0	0	0	0	0	1,633,000	1,633,000
SUBTOTAL	**100-BA-001 Engineering Services**				**0**	**0**	**0**	**0**	**0**	**0**	**2,823,000**	**2,823,000**
100-DA-009	**Test and Commissioning**											
9	VENDOR REPRESENTATIVES	1.0	lot	816.0	816	0	0	0	0	0	83,300	83,300
9	PRECOMISSIONING ASSISTANCE	1.0	lot	19,800.0	19,800	0	0	0	0	0	440,600	440,600
SUBTOTAL	**100-DA-009 Test and Commissioning**				**20,616**	**0**	**0**	**0**	**0**	**0**	**523,900**	**523,900**
100-DB-001	**Spare Parts**											
9	SPARE PARTS	1.0	lot	0.0	0	0	0	95,000	0	0	0	95,000
SUBTOTAL	**100-DB-001 Spare Parts**				**0**	**0**	**0**	**95,000**	**0**	**0**	**0**	**95,000**
100-DM-001	**Temporary Facilities**											
9	TEMPORARY BUILDINGS	1.0	lot	0.0	0	0	0	0	0	0	396,472	396,472
9	FIELD DISTRIBUTABLE COSTS	1.0	lot	0.0	0	0	0	0	0	0	91,500	91,500
9	CONSTRUCTION UTILITIES	1.0	lot	0.0	0	0	0	0	0	0	179,280	179,280
9	CONSTRUCTION SERVICES	1.0	lot	0.0	0	0	0	0	0	0	694,645	694,645
SUBTOTAL	**100-DM-001 Temporary Facilities**				**0**	**0**	**0**	**0**	**0**	**0**	**1,361,897**	**1,361,897**
100-DM-005	**Topographic Work and Soil Mechanic**											
9	THIRD PARTY SERVICES	1.0	lot	0.0	0	0	0	0	0	0	576,470	576,470

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 INDIRECTS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 100-DM-005	**Topographic Work and Soil Mechanic**				**0**	**0**	**0**	**0**	**0**	**0**	**576,470**	**576,470**
100-FR-001	**Freight & Duties**											
9	FREIGHT	1.0	lot	0.0	0	0	0	0	0	0	236,741	236,741
9	IMPORT DUTIES	1.0	lot	0.0	0	0	0	0	0	0	150,660	150,660
9	FREIGHT FOR WIND TOWER FROM ANTOFAGASTA TO SITE	1.0	lot	0.0	0	0	0	0	0	0	471,000	471,000
SUBTOTAL 100-FR-001	**Freight & Duties**				**0**	**0**	**0**	**0**	**0**	**0**	**858,401**	**858,401**
100-ZZ-001	**Contingency**											
9	CONTINGENCY	1.0	lot	0.0	0	0	0	0	0	0	2,850,000	2,850,000
SUBTOTAL 100-ZZ-001	**Contingency**				**0**	**0**	**0**	**0**	**0**	**0**	**2,850,000**	**2,850,000**
SUBTOTAL AREA: 100	**INDIRECTS**				20,616	0	0	95,000	0	0	8,993,668	9,088,668

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 **INDIRECTS**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
TOTAL PROJECT					494,772	8,480,948	2,700,107	1,343,057	266,740	1,100,681	10,857,968	24,749,501

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 **WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
010-ZC-001	**Civil Earth Work**											
0	TRENCH EXCAVATION	3,164.7	m3	0.3	1,013	24,781	0	0	0	0	0	24,781
0	SELECT FILL PURCHASED	1,384.9	m3	0.3	485	11,861	16,120	0	0	0	0	27,981
0	SAND / GRAVEL Sand bedding & cover	1,384.9	m3	0.3	415	10,167	40,578	0	0	0	0	50,744
1	CONCRETE SLAB ON GRADE	378.0	m3	15.6	5,897	94,408	69,178	0	0	0	0	163,586
6	RED WARNING TAPE	7,193.0	m	0.0	94	1,758	1,151	0	0	0	0	2,909
6	3" PVC SCH 40 EMBEDDED CONDUIT Underground Cable Marker	989.0	m	1.0	969	18,221	0	6,682	0	0	0	24,903
SUBTOTAL	**010-ZC-001 Civil Earth Work**				**8,872**	**161,195**	**127,026**	**6,682**	**0**	**0**	**0**	**294,904**
010-ZE-001	**Lay Down of 1 x 3 c 350 MCM, Cable**											
6	3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE	10,500.0	m	0.7	6,825	128,310	0	609,000	0	0	0	737,310
SUBTOTAL	**010-ZE-001 Lay Down of 1 x 3 c 350 MCM, Cable**				**6,825**	**128,310**	**0**	**609,000**	**0**	**0**	**0**	**737,310**
010-ZE-002	**Lay Down of Fiber Optic Cable**											
7	OPTIC FIBER, 12 STRINGS, INSTALLATION ONLY, UNDERGROUND	10,000.0	m	0.2	1,840	33,414	0	0	0	0	0	33,414
SUBTOTAL	**010-ZE-002 Lay Down of Fiber Optic Cable**				**1,840**	**33,414**	**0**	**0**	**0**	**0**	**0**	**33,414**
010-ZE-003	**Lay Down of 1/0 AWG Ground Cable**											

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
6	BCW STRANDED, #1/0	10,000.0	m	0.3	2,600	48,880	20,040	0	0	0	0	68,920
SUBTOTAL	**010-ZE-003 Lay Down of 1/0 AWG Ground Cable**				**2,600**	**48,880**	**20,040**	**0**	**0**	**0**	**0**	**68,920**
010-ZE-004	**Installation of 2x7m, 6" PVC Conduit**											
6	6" PVC SCH 40 EMBEDDED CONDUIT	938.0	m	2.5	2,336	43,910	0	10,187	0	0	0	54,096
6	6" PVC SCH 40 CONDUIT ELLBOW	134.0	ea	6.6	884	16,627	0	2,344	0	0	0	18,971
SUBTOTAL	**010-ZE-004 Installation of 2x7m, 6" PVC Conduit**				**3,220**	**60,536**	**0**	**12,531**	**0**	**0**	**0**	**73,068**
010-ZE-005	**Installation of 3x 7m,2" PVC Conduit**											
0	TRENCH BACKFILL	3.6	m3	0.3	1	31	0	0	0	0	0	31
6	2" PVC SCH 40 EMBEDDED CONDUIT	2,168.0	m	0.7	1,561	29,346	0	7,545	0	0	0	36,891
6	2" PVC SCH 40 CONDUIT ELLBOW	268.0	ea	1.0	268	5,038	0	836	0	0	0	5,875
SUBTOTAL	**010-ZE-005 Installation of 3x 7m,2" PVC Conduit**				**1,830**	**34,416**	**0**	**8,381**	**0**	**0**	**0**	**42,796**
010-ZE-006	**15 Kv Power Cable Joint**											
6	CABLE SPLICE 3/C #350MCM (185mm2) 15KV Cu+G	4.0	ea	33.6	134	2,527	0	2,944	0	0	0	5,471
SUBTOTAL	**010-ZE-006 15 Kv Power Cable Joint**				**134**	**2,527**	**0**	**2,944**	**0**	**0**	**0**	**5,471**
010-ZE-007	**15 kV Elbow Cable Connection**											
6	CABLE TERMINATION, 3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE Termination supplied by owner	132.0	ea	16.8	2,218	41,691	0	0	0	0	0	41,691
SUBTOTAL	**010-ZE-007 15 kV Elbow Cable Connection**				**2,218**	**41,691**	**0**	**0**	**0**	**0**	**0**	**41,691**
010-ZE-008	**Elbow Surge Arrester Grd. Connec.**											
6	CABLE TERMINATION, ONLY LABOR, 3/C #350MCM (185mm2) 15KV Cu+G STEEL ARMOURED CABLE	6.0	ea	16.8	101	1,895	0	0	0	0	0	1,895

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 010-ZE-008	**Elbow Surge Arrester Grd. Connec.**				**101**	**1,895**	**0**	**0**	**0**	**0**	**0**	**1,895**
010-ZE-009	**15 kV Stress Cone Connec.at Swgr.**											
6	CABLE TERMINATION, INDOOR 3/C #350MCM (185mm2) 15KV Cu+G	7.0	ea	16.8	118	2,211	0	1,792	0	0	0	4,003
SUBTOTAL 010-ZE-009	**15 kV Stress Cone Connec.at Swgr.**				**118**	**2,211**	**0**	**1,792**	**0**	**0**	**0**	**4,003**
010-ZE-010	**Pad Mounted Transf. Installation**											
6	TRAFO 0,6/13.8 Kv, 750 KVA INSTALLATION ONLY	67.0	ea	220.0	14,740	277,112	0	0	0	0	0	277,112
SUBTOTAL 010-ZE-010	**Pad Mounted Transf. Installation**				**14,740**	**277,112**	**0**	**0**	**0**	**0**	**0**	**277,112**
010-ZE-011	**Power Supply to MET Tower**											
0	TRENCH EXCAVATION	132.0	m3	0.3	42	1,034	0	0	0	0	0	1,034
0	TRENCH BACKFILL	132.0	m3	0.3	46	1,131	0	0	0	0	0	1,131
1	LEAN CONCRETE - 1500 PSI (10MPa)	5.3	m3	3.5	18	294	558	0	0	0	0	852
6	2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6	4/C #12 (2.5mm2) 6OOV CU POWER CABLE TYPE XTMU	300.0	m	0.1	21	395	657	0	0	0	0	1,052
6	BCW STRANDED, #1/0	300.0	m	0.3	78	1,466	601	0	0	0	0	2,068
7	OPTIC FIBER, 12 STRINGS	600.0	m	0.2	110	2,005	0	0	0	0	0	2,005
SUBTOTAL 010-ZE-011	**Power Supply to MET Tower**				**532**	**10,385**	**1,816**	**1,044**	**0**	**0**	**0**	**13,245**
010-ZE-012	**Installation of Service Transf.at MET**											
6	DISTRIBUTION TRANSFORMER 0.5 kVA	3.0	ea	10.0	30	564	0	0	600	0	0	1,164
SUBTOTAL 010-ZE-012	**Installation of Service Transf.at MET**				**30**	**564**	**0**	**0**	**600**	**0**	**0**	**1,164**

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 010 **WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
010-ZE-013	**Power Supply to Oper.& Maint. Bldg.**											
0	TRENCH EXCAVATION	44.0	m3	0.3	14	345	0	0	0	0	0	345
0	TRENCH BACKFILL	44.0	m3	0.3	15	377	0	0	0	0	0	377
1	LEAN CONCRETE - 1500 PSI (10MPa)	15.8	m3	3.5	55	883	1,674	0	0	0	0	2,557
6	2" PVC SCH 40 EMBEDDED CONDUIT	100.0	m	0.7	72	1,354	0	348	0	0	0	1,702
6	4/C #4 (16mm2) 6OOV CU POWER CABLE TYPE TC	100.0	m	0.2	21	395	1,072	0	0	0	0	1,467
6	BCW STRANDED, #1/0	100.0	m	0.3	26	489	200	0	0	0	0	689
6	ADMINISTRATION SUBSTATION DISTRIBUTION PANEL	1.0	ea	27.0	27	508	0	0	2,000	0	0	2,508
7	OPTIC FIBER, 12 STRINGS, INSTALLATION ONLY, UNDERGROUND	200.0	m	0.2	37	668	0	0	0	0	0	668
SUBTOTAL	**010-ZE-013 Power Supply to Oper.& Maint. Bldg.**				**267**	**5,017**	**2,947**	**348**	**2,000**	**0**	**0**	**10,312**
010-ZE-014	**Inst.Service Transf.at Op.& Main Bdg**											
6	DISTRIBUTION TRANSFORMER 50 kVA	1.0	ea	47.0	47	884	0	0	3,488	0	0	4,372
SUBTOTAL	**010-ZE-014 Inst.Service Transf.at Op.& Main Bdg**				**47**	**884**	**0**	**0**	**3,488**	**0**	**0**	**4,372**
SUBTOTAL AREA: 010	**WIND FARM 15 KV UNDERGROUND CABLE LAYDOWN**				43,374	809,037	151,829	642,722	6,088	0	0	1,609,676

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 020 **TURBINE TOWER AND TRANSFORMER FOUNDATIONS**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
020-ZC-001	**Civil Work for Turbines**											
0	STRUCTURAL EXCAVATION, ROCK	8,391.9	m3	1.3	10,909	266,955	0	0	0	0	0	266,955
0	STRUCTURAL EXCAVATION	7,748.4	m3	0.6	4,649	113,762	0	0	0	0	0	113,762
0	STRUCTURAL BACKFILL	8,401.8	m3	0.8	6,721	164,474	0	0	0	0	0	164,474
1	LEAN CONCRETE - 1500 PSI (10MPa)	633.1	m3	3.5	2,216	35,479	67,304	0	0	0	0	102,782
1	CONCRETE FOUNDATIONS	7,386.8	m3	16.1	118,557	1,898,103	1,520,267	0	0	0	0	3,418,370
1	ANCHOR BOLTS	194,166.0	kg	0.2	38,833	621,720	563,081	0	0	0	0	1,184,801
1	ANCHOR BOLTS GROUT - NONSHRINK, NON-METALLIC, 1IN	35.2	m3	100.0	3,518	56,315	47,486	0	0	0	0	103,801
SUBTOTAL	**020-ZC-001 Civil Work for Turbines**				**185,404**	**3,156,807**	**2,198,139**	**0**	**0**	**0**	**0**	**5,354,945**
020-ZC-002	**Civil Work for Transformers**											
0	STRUCTURAL EXCAVATION	539.0	m3	0.6	323	7,914	0	0	0	0	0	7,914
0	STRUCTURAL BACKFILL	229.9	m3	0.8	184	4,501	0	0	0	0	0	4,501
1	LEAN CONCRETE - 1500 PSI (10MPa)	18.2	m3	3.5	64	1,018	1,931	0	0	0	0	2,949
1	CONCRETE FOUNDATIONS	295.1	m3	16.1	4,736	75,816	60,724	0	0	0	0	136,540
SUBTOTAL	**020-ZC-002 Civil Work for Transformers**				**5,306**	**89,248**	**62,655**	**0**	**0**	**0**	**0**	**151,903**
020-ZC-003	**Insert and Embeddeds**											
6	0.5" PVC SCH 40 EMBEDDED CONDUIT	246.0	m	0.3	64	1,202	0	186	0	0	0	1,388
6	2" PVC SCH 40 EMBEDDED CONDUIT	409.0	m	0.7	294	5,536	0	1,423	0	0	0	6,960

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 020 **TURBINE TOWER AND TRANSFORMER FOUNDATIONS**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
6	3" PVC SCH 40 EMBEDDED CONDUIT	409.0	m	1.0	401	7,535	0	2,763	0	0	0	10,299
6	6" PVC SCH 40 EMBEDDED CONDUIT	22.0	m	2.5	55	1,030	0	239	0	0	0	1,269
6	2" PVC SCH 40 CONDUIT ELLBOW	201.0	ea	1.0	201	3,779	0	627	0	0	0	4,406
6	3" PVC SCH 40 CONDUIT ELLBOW	402.0	ea	2.2	884	16,627	0	1,838	0	0	0	18,465
6	6" PVC SCH 40 CONDUIT ELLBOW	8.0	ea	6.6	52	993	0	140	0	0	0	1,133
6	3" PVC SCH 40 END BELLS	268.0	ea	2.2	589	11,084	0	347	0	0	0	11,431
6	BCW STRANDED, #1/0	3,063.0	m	0.3	796	14,972	6,138	0	0	0	0	21,110
6	COPPER GROUND ROD, 5/8" X 10' (15.9mm x 3.05m)	335.0	ea	1.5	502	9,447	10,118	0	0	0	0	19,565
6	1/0 AWG COPPER TO 2 HOLE COMPRESSION LUG	268.0	ea	0.5	134	2,519	1,061	0	0	0	0	3,580
SUBTOTAL	**020-ZC-003** **Insert and Embeddeds**				**3,972**	**74,725**	**17,318**	**7,563**	**0**	**0**	**0**	**99,606**
SUBTOTAL AREA: 020	**TURBINE TOWER AND TRANSFORMER FOUNDATIONS**				194,683	3,320,780	2,278,112	7,563	0	0	0	5,606,454

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 030 LOW VOLTAGE ELECTRICAL WORK

Discipline		Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
030-ZE-001		**Low voltage cable underground installation**											
6		WIRE TERMINATION #350MCM (185mm2) 1/C, CU, 6OOV.XTU, INSTALLATION ONLY	1,206.0	m	3.0	3,618	68,018	0	0	0	0	0	68,018
6		#350MCM (185mm2) 1/C, CU, 6OOV.XTU, INSTALLATION ONLY	6,030.0	m	0.3	1,628	30,608	0	0	0	0	0	30,608
SUBTOTAL	**030-ZE-001**	**Low voltage cable underground installation**				**5,246**	**98,627**	**0**	**0**	**0**	**0**	**0**	**98,627**
SUBTOTAL AREA: 030		**LOW VOLTAGE ELECTRICAL WORK**				5,246	98,627	0	0	0	0	0	98,627

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 040 **WIND TURBINE GENERATOR TOWER INSTALLATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
040-ZM-001	**Wind turbine generator installation**											
4	WIND TURBINE & TOWER ERECTION ONLY	69.0	lot	2,500.0	172,500	3,030,825	0	0	0	0	0	3,030,825
4	180 TON CRANE RENTAL	335.0	Day	0.0	0	0	0	0	0	0	703,500	703,500
4	600 TON CRANE RENTAL	335.0	Day	0.0	0	0	0	0	0	0	1,105,500	1,105,500
SUBTOTAL	**040-ZM-001 Wind turbine generator installation**				**172,500**	**3,030,825**	**0**	**0**	**0**	**0**	**1,809,000**	**4,839,825**
SUBTOTAL AREA: 040	**WIND TURBINE GENERATOR TOWER INSTALLATION**				172,500	3,030,825	0	0	0	0	1,809,000	4,839,825

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 050 SITE GRADING AND ROADS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
050-ZC-001	**Civil Earth Work**											
0	MASSIVE EXCAVATION, COMMON SOIL	49,500.0	m3	0.2	9,900	242,253	0	0	0	0	0	242,253
0	COMMON BACKFILL	28,270.0	m3	0.3	8,481	207,530	0	0	0	0	0	207,530
0	ROAD BASE MATERIAL	8,910.0	m3	0.3	2,228	54,507	81,972	0	0	0	0	136,479
SUBTOTAL	**050-ZC-001 Civil Earth Work**				**20,609**	**504,290**	**81,972**	**0**	**0**	**0**	**0**	**586,262**
050-ZC-002	**Culverts for Road crossings**											
0	STRUCTURAL EXCAVATION, ROCK	339.9	m3	1.3	442	10,813	0	0	0	0	0	10,813
	Road crossing & rainwater diversion											
0	STRUCTURAL EXCAVATION	800.8	m3	0.6	480	11,757	0	0	0	0	0	11,757
	Road crossing & rainwater diversion											
0	STRUCTURAL BACKFILL	805.2	m3	0.8	644	15,763	0	0	0	0	0	15,763
	Road crossing & rainwater diversion											
0	CULVERT GALVANIZED STEEL D = 1.0 m (2 mm THICKNESS)	132.0	m	1.5	198	4,845	10,296	0	0	0	0	15,141
	Road crossing of dry river											
SUBTOTAL	**050-ZC-002 Culverts for Road crossings**				**1,765**	**43,178**	**10,296**	**0**	**0**	**0**	**0**	**53,474**
050-ZC-003	**Concrete Trenches under Roads**											
0	STRUCTURAL EXCAVATION, ROCK	33.0	m3	1.3	43	1,050	0	0	0	0	0	1,050
0	STRUCTURAL EXCAVATION	78.1	m3	0.6	47	1,147	0	0	0	0	0	1,147
0	STRUCTURAL BACKFILL	73.7	m3	0.8	59	1,443	0	0	0	0	0	1,443
1	CONCRETE WALLS	17.9	m3	26.4	471	7,545	4,094	0	0	0	0	11,638
SUBTOTAL	**050-ZC-003 Concrete Trenches under Roads**				**620**	**11,184**	**4,094**	**0**	**0**	**0**	**0**	**15,277**
SUBTOTAL AREA: 050	**SITE GRADING AND ROADS**				22,993	558,651	96,362	0	0	0	0	655,013

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
060-BD-001	**Prefabricated Elect. Building Includg**											
0	STRUCTURAL EXCAVATION	77.0	m3	0.6	46	1,131	0	0	0	0	0	1,131
0	STRUCTURAL BACKFILL	33.0	m3	0.8	26	646	0	0	0	0	0	646
1	CONCRETE FOUNDATIONS	36.8	m3	16.1	590	9,443	7,564	0	0	0	0	17,007
3	AIR CONDITIONING	1.0	ea	120.0	120	0	0	0	0	0	5,500	5,500
3	PREFABRICATED ELECTRICAL ROOM	1.0	lot	140.0	140	2,255	0	0	38,600	0	0	40,855
SUBTOTAL	**060-BD-001 Prefabricated Elect. Building Includg**				**922**	**13,475**	**7,564**	**0**	**38,600**	**0**	**5,500**	**65,139**
060-CB-011	**110 Kv Circuit Breaker**											
6	POWER CIRCUIT BREAKER 138 Kv	1.0	ea	200.0	200	3,760	0	0	0	45,000	0	48,760
SUBTOTAL	**060-CB-011 110 Kv Circuit Breaker**				**200**	**3,760**	**0**	**0**	**0**	**45,000**	**0**	**48,760**
060-SG-002	**Main Switchgear**											
6	MEDIUM VOLTAGE METAL CLAD SWITCHGEAR MAIN SUBSTATION	1.0	ea	600.0	600	11,280	0	0	0	375,000	0	386,280
SUBTOTAL	**060-SG-002 Main Switchgear**				**600**	**11,280**	**0**	**0**	**0**	**375,000**	**0**	**386,280**
060-SW-001	**100 kV Switching Equipment**											
6	DISCONNECT SWITCH 138 KV, 3 POLE & GROUNDING SWITCH	2.0	ea	110.0	220	4,136	0	0	0	22,000	0	26,136
SUBTOTAL	**060-SW-001 100 kV Switching Equipment**				**220**	**4,136**	**0**	**0**	**0**	**22,000**	**0**	**26,136**
060-TR-001	**100 kV Potential Transformers**											
6	138 Kv CLASS POTENTIAL TRANSFORMER 100 KV/120 V RATIO windfarm substation	3.0	ea	176.0	528	9,926	0	0	36,000	0	0	45,926
SUBTOTAL	**060-TR-001 100 kV Potential Transformers**				**528**	**9,926**	**0**	**0**	**36,000**	**0**	**0**	**45,926**

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
060-TR-010	**100 kV Current Transformers**											
6	138 Kv CLASS CURRENT TRANSFORMER 1200 / 5A	3.0	ea	64.0	192	3,610	0	0	27,000	0	0	30,610
SUBTOTAL	**060-TR-010 100 kV Current Transformers**				**192**	**3,610**	**0**	**0**	**27,000**	**0**	**0**	**30,610**
060-TR-020	**50 MVA , 13.8 / 100 kV power Transf.**											
0	STRUCTURAL EXCAVATION, ROCK	165.0	m3	1.3	215	5,249	0	0	0	0	0	5,249
0	STRUCTURAL BACKFILL	77.0	m3	0.8	62	1,507	0	0	0	0	0	1,507
1	CONCRETE FOUNDATIONS	84.0	m3	16.1	1,348	21,585	17,288	0	0	0	0	38,873
6	POWER TRANSFORMER 50 MVA 13.8/100 kV.	1.0	ea	2,900.0	2,900	54,520	0	0	0	600,000	0	654,520
SUBTOTAL	**060-TR-020 50 MVA , 13.8 / 100 kV power Transf.**				**4,524**	**82,861**	**17,288**	**0**	**0**	**600,000**	**0**	**700,149**
060-VL-001	**HV Lightning Arresters**											
6	SURGE ARRESTER CLASS 138 KV- MCOV 67 KV	3.0	ea	48.0	144	2,707	0	0	0	13,500	0	16,207
SUBTOTAL	**060-VL-001 HV Lightning Arresters**				**144**	**2,707**	**0**	**0**	**0**	**13,500**	**0**	**16,207**
060-ZC-002	**Site Preparation**											
0	MASSIVE EXCAVATION, COMMON SOIL	244.2	m3	0.2	49	1,195	0	0	0	0	0	1,195
0	SAND / GRAVEL	70.4	m3	0.3	21	517	2,063	0	0	0	0	2,580
0	CURB AND GUTTER, PRECAST, 150mm x 300mm, STRAIGHT SECTION, 0.9 m LONG Soleras	77.0	ea	1.0	77	1,884	0	385	0	0	0	2,269
0	FENCE, 9 GA(2.9mm), GALV.2.4m HIGH PLUS 3 STRANDS BARBED WIRE	77.0	m	2.3	177	4,334	4,620	0	0	0	0	8,954
SUBTOTAL	**060-ZC-002 Site Preparation**				**324**	**7,930**	**6,683**	**385**	**0**	**0**	**0**	**14,997**
060-ZC-003	**Ground Mesh**											

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 13.8 / 100 KV WIND FARM MAIN SUBSTATION

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
0	TRENCH EXCAVATION	232.1	m3	0.3	74	1,817	0	0	0	0	0	1,817
0	TRENCH BACKFILL	232.1	m3	0.3	81	1,988	0	0	0	0	0	1,988
6	BCW STRANDED, #1/0	640.0	m	0.3	166	3,128	1,283	0	0	0	0	4,411
SUBTOTAL	**060-ZC-003 Ground Mesh**				**322**	**6,934**	**1,283**	**0**	**0**	**0**	**0**	**8,216**
060-ZC-004	**Foundation for Equipment & Structure**											
0	STRUCTURAL EXCAVATION	275.0	m3	0.6	165	4,038	0	0	0	0	0	4,038
0	STRUCTURAL BACKFILL	154.0	m3	0.8	123	3,015	0	0	0	0	0	3,015
1	CONCRETE FOUNDATIONS	117.6	m3	16.1	1,887	30,219	24,203	0	0	0	0	54,422
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER Portal de salida y pararayos	11.7	t	50.0	585	10,998	0	17,550	0	0	0	28,548
SUBTOTAL	**060-ZC-004 Foundation for Equipment & Structure**				**2,761**	**48,269**	**24,203**	**17,550**	**0**	**0**	**0**	**90,022**
060-ZC-005	**Cable Trench**											
0	STRUCTURAL EXCAVATION, ROCK	46.2	m3	1.3	60	1,470	0	0	0	0	0	1,470
0	STRUCTURAL EXCAVATION	106.7	m3	0.6	64	1,567	0	0	0	0	0	1,567
0	STRUCTURAL BACKFILL	88.0	m3	0.8	70	1,723	0	0	0	0	0	1,723
1	CONCRETE WALLS TRENCH 1.5 x 1.5 & 0.6 x 0.6 m	44.2	m3	26.4	1,166	18,675	10,133	0	0	0	0	28,808
SUBTOTAL	**060-ZC-005 Cable Trench**				**1,361**	**23,434**	**10,133**	**0**	**0**	**0**	**0**	**33,567**
060-ZC-201	**Control Panel**											
6	CONTROL PANEL	1.0	ea	350.0	350	6,580	0	0	50,000	0	0	56,580

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 13.8 / 100 KV WIND FARM MAIN SUBSTATION

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 060-ZC-201	**Control Panel**				**350**	**6,580**	**0**	**0**	**50,000**	**0**	**0**	**56,580**
060-ZE-014	**3000 A, 15 kV Cable Duct**											
6	CABLE TERMINATION, 1/C #750MCM (396mm2) 15KV EPR SHIELDED CU CABLE OH INSTALL	36.0	ea	9.8	353	6,633	0	3,060	0	0	0	9,693
6	1/C #750MCM (396mm2) 15KV EPR SHIELDED CU CABLE UG INSTALLATION	216.0	m	0.6	119	2,233	0	3,996	0	0	0	6,229
SUBTOTAL 060-ZE-014	**3000 A, 15 kV Cable Duct**				**472**	**8,866**	**0**	**7,056**	**0**	**0**	**0**	**15,922**
060-ZE-016	**H V Connections**											
6	138 kV CONNECTIONS	1.0	ea	1,215.0	1,215	22,842	7,500	0	0	0	0	30,342
6	GUARD GROUND CABLE	1.0	lot	104.0	104	1,955	1,000	0	0	0	0	2,955
6	TESTING & COMMISSIONING OF SUBSTATION	1.0	lot	900.0	900	16,920	1,500	0	0	0	0	18,420
6	ISOLATOR SUPPORT, 138 KV	6.0	ea	11.4	68	1,286	0	0	22,500	0	0	23,786
SUBTOTAL 060-ZE-016	**H V Connections**				**2,287**	**43,003**	**10,000**	**0**	**22,500**	**0**	**0**	**75,503**
060-ZE-017	**Outdoor Lighting**											
6	BRACKET ARM FOR STEEL LIGHT POLE - 1 ARM	6.0	ea	16.0	96	1,805	864	0	0	0	0	2,669
6	STEEL LIGHTING POLE 18 M	6.0	ea	22.5	135	2,538	5,502	0	0	0	0	8,040
6	2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6	#8 (6mm2) THW 1/C, CU, 6OOV WIRE STRANDED	1,200.0	m	0.0	47	880	864	0	0	0	0	1,744
6	HPS ROADWAY LIGHTING FIXTURE 250W, TYPE PS2A	6.0	ea	7.5	45	846	2,542	0	0	0	0	3,388
6	EMERGENCY LIGHTING EQUIPMENT	2.0	ea	27.0	54	1,015	0	0	3,796	0	0	4,811

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 060 **13.8 / 100 KV WIND FARM MAIN SUBSTATION**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 060-ZE-017	**Outdoor Lighting**				**593**	**11,145**	**9,772**	**1,044**	**3,796**	**0**	**0**	**25,756**
060-ZE-115	**Battery & Battery Charger**											
6	BATTERY RACK FOR EMERGENCY SYSTEM.	1.0	ea	14.0	14	263	0	0	0	2,881	0	3,144
6	BATTERY CHARGER FOR EMERGENCY SYSTEM	1.0	ea	33.0	33	620	0	0	0	6,050	0	6,670
SUBTOTAL 060-ZE-115	**Battery & Battery Charger**				**47**	**884**	**0**	**0**	**0**	**8,931**	**0**	**9,815**
060-ZM-015	**Fire Detection and Extinguishing**											
4	FIRE PROTECTION SYSTEM Allowance	1.0	ea	300.0	300	5,271	0	0	10,000	0	0	15,271
SUBTOTAL 060-ZM-015	**Fire Detection and Extinguishing**				**300**	**5,271**	**0**	**0**	**10,000**	**0**	**0**	**15,271**
SUBTOTAL AREA: 060	**13.8 / 100 KV WIND FARM MAIN SUBSTATION**				16,147	294,070	86,925	26,035	187,896	1,064,431	5,500	1,664,857

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 070 100 KV OVERHEAD TRANSMISSION LINE

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
070-ZC-002	**Topographic Work and Soil Mechanic for overhead line**											
6	TOPOGRAPHY FOR OVERHEAD POWERLINE	10.0	km	0.0	0	0	41,000	0	0	0	0	41,000
SUBTOTAL	**070-ZC-002 Topographic Work and Soil Mechanic for overhead lin**				**0**	**0**	**41,000**	**0**	**0**	**0**	**0**	**41,000**
070-ZC-006	**Construction Road**											
0	SURFACE PREPARATION	44,000.0	m2	0.1	2,200	53,834	0	0	0	0	0	53,834
SUBTOTAL	**070-ZC-006 Construction Road**				**2,200**	**53,834**	**0**	**0**	**0**	**0**	**0**	**53,834**
070-ZE-003	**Galvanized Steel Towers**											
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER 100 Towers	250.0	t	50.0	12,500	235,000	0	375,000	0	0	0	610,000
SUBTOTAL	**070-ZE-003 Galvanized Steel Towers**				**12,500**	**235,000**	**0**	**375,000**	**0**	**0**	**0**	**610,000**
070-ZE-004	**Tower Fundations**											
0	STRUCTURAL EXCAVATION	3,764.2	m3	0.6	2,259	55,266	0	0	0	0	0	55,266
0	STRUCTURAL BACKFILL	3,104.2	m3	0.8	2,483	60,768	0	0	0	0	0	60,768
1	CONCRETE FOUNDATIONS 100 Towers	630.0	m3	16.1	10,112	161,885	129,660	0	0	0	0	291,545
SUBTOTAL	**070-ZE-004 Tower Fundations**				**14,853**	**277,919**	**129,660**	**0**	**0**	**0**	**0**	**407,579**
070-ZE-005	**Tower Grounding**											
0	TRENCH EXCAVATION	330.0	m3	0.3	106	2,584	0	0	0	0	0	2,584
6	BCW STRANDED, #1/0	1,500.0	m	0.3	390	7,332	3,006	0	0	0	0	10,338
6	COPPER GROUND ROD, 5/8" X 10' (15.9mm x 3.05m)	300.0	ea	1.5	450	8,460	9,061	0	0	0	0	17,521
6	CADWELD AVERAGE	600.0	ea	2.0	1,200	22,560	5,760	0	0	0	0	28,320

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 070 **100 KV OVERHEAD TRANSMISSION LINE**

Discipline		Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL	**070-ZE-005**	**Tower Grounding**				**2,146**	**40,936**	**17,827**	**0**	**0**	**0**	**0**	**58,763**
070-ZE-007		**Conductor, Insulators Hardware,Acc.**											
6		SUSPENSION INSULATORS CHAIN 138 KV.	300.0	ea	4.5	1,350	25,380	0	137,400	0	0	0	162,780
6		ALLIANCE AAAC CONDUCTOR, 246,9 MCM	60,000.0	m	0.1	7,200	135,360	0	72,000	0	0	0	207,360
6		OVERHEAD GROUND CABLE	20,000.0	m	0.1	2,200	41,360	12,000	0	0	0	0	53,360
SUBTOTAL	**070-ZE-007**	**Conductor, Insulators Hardware,Acc.**				**10,750**	**202,100**	**12,000**	**209,400**	**0**	**0**	**0**	**423,500**
SUBTOTAL AREA: 070		**100 KV OVERHEAD TRANSMISSION LINE**				42,449	809,789	200,488	584,400	0	0	0	1,594,676

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
080-SW-001	**100 kV Switching Equipment**											
6	DISCONNECT SWITCH 138 KV. 3 POLE & GROUNDING SWITCH	2.0	ea	110.0	220	4,136	0	0	0	22,000	0	26,136
SUBTOTAL	**080-SW-001 100 kV Switching Equipment**				**220**	**4,136**	**0**	**0**	**0**	**22,000**	**0**	**26,136**
080-TR-010	**100 kV Current Transformers**											
6	CURRENT TRANSFORMER 138 KV 1200 / 5A	3.0	ea	64.0	192	3,610	0	0	27,000	0	0	30,610
SUBTOTAL	**080-TR-010 100 kV Current Transformers**				**192**	**3,610**	**0**	**0**	**27,000**	**0**	**0**	**30,610**
080-VL-001	**HV Lightning Arresters**											
6	SURGE ARRESTER CLASS 138 KV- MCOV 67 KV	3.0	ea	48.0	144	2,707	0	0	0	13,500	0	16,207
SUBTOTAL	**080-VL-001 HV Lightning Arresters**				**144**	**2,707**	**0**	**0**	**0**	**13,500**	**0**	**16,207**
080-ZC-002	**Site Preparation**											
0	MASSIVE EXCAVATION, COMMON SOIL	244.2	m3	0.2	49	1,195	0	0	0	0	0	1,195
0	SAND / GRAVEL	70.4	m3	0.3	21	517	2,063	0	0	0	0	2,580
0	CURB AND GUTTER, PRECAST, 150mm x 300mm, STRAIGHT SECTION, 0.9 m LONG	77.0	ea	1.0	77	1,884	0	385	0	0	0	2,269
0	FENCE, 9 GA(2.9mm), GALV.2.4m HIGH PLUS 3 STRANDS BARBED WIRE	77.0	m	2.3	177	4,334	4,620	0	0	0	0	8,954
SUBTOTAL	**080-ZC-002 Site Preparation**				**324**	**7,930**	**6,683**	**385**	**0**	**0**	**0**	**14,997**
080-ZC-003	**Ground Mesh Extension**											
0	TRENCH EXCAVATION	232.1	m3	0.3	74	1,817	0	0	0	0	0	1,817
0	TRENCH BACKFILL	232.1	m3	0.3	81	1,988	0	0	0	0	0	1,988
6	BCW STRANDED, #1/0	640.0	m	0.3	166	3,128	1,283	0	0	0	0	4,411

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 **EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 080-ZC-003	**Ground Mesh Extension**				**322**	**6,934**	**1,283**	**0**	**0**	**0**	**0**	**8,216**
080-ZC-004	**Fundation for Equipment & structure**											
0	STRUCTURAL EXCAVATION	220.0	m3	0.6	132	3,230	0	0	0	0	0	3,230
0	STRUCTURAL BACKFILL	110.0	m3	0.8	88	2,153	0	0	0	0	0	2,153
1	CONCRETE FOUNDATIONS	110.3	m3	16.1	1,770	28,330	22,691	0	0	0	0	51,020
6	GALVANIZED STEEL FOR TRANSMISSION LINE STEEL TOWER Portal de salida y pararayos	11.7	t	50.0	585	10,998	0	17,550	0	0	0	28,548
SUBTOTAL 080-ZC-004	**Fundation for Equipment & structure**				**2,575**	**44,711**	**22,691**	**17,550**	**0**	**0**	**0**	**84,952**
080-ZC-005	**Cable Trench**											
0	STRUCTURAL EXCAVATION, ROCK	46.2	m3	1.3	60	1,470	0	0	0	0	0	1,470
0	STRUCTURAL EXCAVATION	106.7	m3	0.6	64	1,567	0	0	0	0	0	1,567
0	STRUCTURAL BACKFILL	88.0	m3	0.8	70	1,723	0	0	0	0	0	1,723
1	CONCRETE WALLS Canaletas 1.5 x 1.5 & 0.6 x 0.6	44.2	m3	26.4	1,166	18,675	10,133	0	0	0	0	28,808
SUBTOTAL 080-ZC-005	**Cable Trench**				**1,361**	**23,434**	**10,133**	**0**	**0**	**0**	**0**	**33,567**
080-ZE-016	**H V Connections**											
6	OUTDOOR HV CONNECTIONS	1.0	ea	1,215.0	1,215	22,842	7,500	0	0	0	0	30,342
6	GUARD GROUND CABLE	1.0	lot	104.0	104	1,955	1,000	0	0	0	0	2,955
6	TESTING & COMMISSIONING OF SUBSTATION	1.0	lot	900.0	900	16,920	1,500	0	0	0	0	18,420
6	ISOLATOR SUPPORT, 138 KV	6.0	ea	11.4	68	1,286	0	0	22,500	0	0	23,786

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 080 EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 080-ZE-016	**H V Connections**				**2,287**	**43,003**	**10,000**	**0**	**22,500**	**0**	**0**	**75,503**
080-ZE-017	**Outdoor Lighting**											
6	BRACKET ARM FOR STEEL LIGHT POLE - 1 ARM	6.0	ea	16.0	96	1,805	864	0	0	0	0	2,669
6	STEEL LIGHTING POLE 18 M	6.0	ea	22.5	135	2,538	5,502	0	0	0	0	8,040
6	2" PVC SCH 40 EMBEDDED CONDUIT	300.0	m	0.7	216	4,061	0	1,044	0	0	0	5,105
6	#8 (6mm2) THW 1/C, CU, 6OOV WIRE STRANDED	1,200.0	m	0.0	47	880	864	0	0	0	0	1,744
6	HPS ROADWAY LIGHTING FIXTURE 250W, TYPE PS2A	6.0	ea	7.5	45	846	2,542	0	0	0	0	3,388
6	EMERGENCY LIGHTING EQUIPMENT	2.0	ea	27.0	54	1,015	0	0	3,796	0	0	4,811
SUBTOTAL 080-ZE-017	**Outdoor Lighting**				**593**	**11,145**	**9,772**	**1,044**	**3,796**	**0**	**0**	**25,756**
SUBTOTAL AREA: 080	**EXTENSION OF EXISTING SUBSTATION KM 6 (AT CODELCO)**				8,018	147,609	60,561	18,979	53,296	35,500	0	315,945

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 090 FACILITIES AND SERVICES

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
090-BD-001	**Operation & Maintenance Building (Prefabricated)**											
0	STRUCTURAL EXCAVATION	495.0	m3	0.6	297	7,268	0	0	0	0	0	7,268
0	ESTABILIZADO	330.0	m3	0.3	83	2,019	3,036	0	0	0	0	5,055
1	CONCRETE FOUNDATIONS concrete blocks to support buildings	1.2	m3	16.1	19	310	249	0	0	0	0	559
1	CONCRETE SLAB ON GRADE walkway pavement	5.4	m3	15.6	84	1,337	980	0	0	0	0	2,317
3	PREFABRICATED BUILDING	264.0	m2	10.0	2,640	0	0	0	0	0	184,800	184,800
SUBTOTAL	**090-BD-001 Operation & Maintenance Building (Prefabricated)**				**3,122**	**10,934**	**4,265**	**0**	**0**	**0**	**184,800**	**199,999**
090-TK-001	**Potable Water tank, 25 m3**											
0	STRUCTURAL EXCAVATION, ROCK	15.2	m3	1.3	20	483	0	0	0	0	0	483
0	STRUCTURAL BACKFILL	12.1	m3	0.8	10	237	0	0	0	0	0	237
1	CONCRETE WALLS	2.7	m3	26.4	72	1,154	626	0	0	0	0	1,780
4	WATER PUMP	1.0	ea	35.0	35	615	0	0	0	750	0	1,365
4	CARBON STEEL TANK 25 M3	1.0	ea	290.0	290	5,095	0	0	9,460	0	0	14,555
5	PIPING SYSTEM FOR ADMINISTRATION & MAINTENANCE BUILDING	1.0	ea	120.0	120	2,635	2,000	0	0	0	0	4,635
SUBTOTAL	**090-TK-001 Potable Water tank, 25 m3**				**546**	**10,219**	**2,626**	**0**	**9,460**	**750**	**0**	**23,055**
090-ZM-001	**Sewage treatmemt Plant**											
0	STRUCTURAL EXCAVATION	55.0	m3	0.6	33	808	0	0	0	0	0	808
0	SELECT FILL PURCHASED	22.0	m3	0.3	8	188	256	0	0	0	0	444

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 090 FACILITIES AND SERVICES

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
0	STRUCTURAL BACKFILL	33.0	m3	0.8	26	646	0	0	0	0	0	646
4	SEWAGE WATER TREATMENT PLANT	1.0	lot	400.0	400	7,028	0	0	10,000	0	0	17,028
SUBTOTAL	**090-ZM-001 Sewage treatmemt Plant**				**467**	**8,670**	**256**	**0**	**10,000**	**0**	**0**	**18,926**
SUBTOTAL AREA: 090	**FACILITIES AND SERVICES**				4,136	29,823	7,147	0	19,460	750	184,800	241,980

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 INDIRECTS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
100-BA-001	**Engineering Services**											
9	DETAIL ENGINEERING	1.0	lot	0.0	0	0	0	0	0	0	1,211,438	1,211,438
9	CONSTRUCTION MANAGEMENT	1.0	lot	0.0	0	0	0	0	0	0	1,962,713	1,962,713
SUBTOTAL	**100-BA-001 Engineering Services**				**0**	**0**	**0**	**0**	**0**	**0**	**3,174,151**	**3,174,151**
100-DA-009	**Test and Commissioning**											
9	VENDOR REPRESENTATIVES	1.0	lot	816.0	816	0	0	0	0	0	83,300	83,300
9	PRECOMISSIONING ASSISTANCE	1.0	lot	19,800.0	19,800	0	0	0	0	0	466,043	466,043
SUBTOTAL	**100-DA-009 Test and Commissioning**				**20,616**	**0**	**0**	**0**	**0**	**0**	**549,343**	**549,343**
100-DB-001	**Spare Parts**											
9	SPARE PARTS	1.0	lot	0.0	0	0	0	95,000	0	0	0	95,000
SUBTOTAL	**100-DB-001 Spare Parts**				**0**	**0**	**0**	**95,000**	**0**	**0**	**0**	**95,000**
100-DM-001	**Temporary Facilities**											
9	TEMPORARY BUILDINGS	1.0	lot	0.0	0	0	0	0	0	0	396,472	396,472
9	FIELD DISTRIBUTABLE COSTS	1.0	lot	0.0	0	0	0	0	0	0	91,500	91,500
9	CONSTRUCTION UTILITIES	1.0	lot	0.0	0	0	0	0	0	0	179,280	179,280
9	CONSTRUCTION SERVICES	1.0	lot	0.0	0	0	0	0	0	0	724,603	724,603
SUBTOTAL	**100-DM-001 Temporary Facilities**				**0**	**0**	**0**	**0**	**0**	**0**	**1,391,855**	**1,391,855**
100-DM-005	**Topographic Work and Soil Mechanic**											
9	THIRD PARTY SERVICES	1.0	lot	0.0	0	0	0	0	0	0	588,368	588,368

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 INDIRECTS

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
SUBTOTAL 100-DM-005	**Topographic Work and Soil Mechanic**				**0**	**0**	**0**	**0**	**0**	**0**	**588,368**	**588,368**
100-FR-001	**Freight & Duties**											
9	FREIGHT	1.0	lot	0.0	0	0	0	0	0	0	236,741	236,741
9	IMPORT DUTIES	1.0	lot	0.0	0	0	0	0	0	0	150,660	150,660
9	FREIGHT FOR WIND TOWER FROM ANTOFAGASTA TO SITE	1.0	lot	0.0	0	0	0	0	0	0	524,177	524,177
SUBTOTAL 100-FR-001	**Freight & Duties**				**0**	**0**	**0**	**0**	**0**	**0**	**911,578**	**911,578**
100-ZZ-001	**Contingency**											
9	CONTINGENCY	1.0	lot	0.0	0	0	0	0	0	0	3,037,265	3,037,265
SUBTOTAL 100-ZZ-001	**Contingency**				**0**	**0**	**0**	**0**	**0**	**0**	**3,037,265**	**3,037,265**
SUBTOTAL AREA: 100	**INDIRECTS**				20,616	0	0	95,000	0	0	9,652,560	9,747,560

Capital Cost Estimate: Detail Report Sorted by Area, Tag and Discipline

ÁREA 100 **INDIRECTS**

Discipline	Description	Quantity	Unit	U_MHR	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subc	Total
TOTAL PROJECT					530,162	9,099,211	2,881,422	1,374,699	266,740	1,100,681	11,651,860	26,374,613

FLUOR®

CLIENT: SEAWEST

CALAMA WIND PROJECT PRELIMINARY FEASIBILITY STUDY

SCENARIO: 37.2 Mw with 62 turbines rated at 600 kw

Capital Cost Estimate: Summary by Discipline

Code	Disciplina	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subcontract	Total
0	Earthworks & Civil	55,184	1,350,356	160,601	770	0	0	0	1,511,727
1	Concrete	179,605	2,875,473	2,385,912	0	0	0	0	5,261,385
3	Architectural	2,900	2,255	0	0	38,600	0	190,300	231,155
4	Mechanical	156,025	2,741,359	0	0	29,460	750	1,674,000	4,445,569
5	Piping	120	2,635	2,000	0	0	0	0	4,635
6	Electrical	78,427	1,474,453	151,594	1,247,287	198,680	1,099,931	0	4,171,944
7	Instrumentation	1,895	34,417	0	0	0	0	0	34,417
9	Indirects	20,616	0	0	95,000	0	0	8,993,668	9,088,668
Grand Total		**494,772**	**8,480,948**	**2,700,107**	**1,343,057**	**266,740**	**1,100,681**	**10,857,968**	**24,749,501**

FLUOR®

CLIENT: SEAWEST

CALAMA WIND POWER PROJECT PRELIMINARY FEASIBILITY STUDY

SCENARIO: 40.2 Mw with 67 turbines rated at 600 kw each.

Capital Cost Estimate: Summary by Discipline

Code	Disciplina	MHR	Labor	Loc_Matl	Imp_Matl	Loc_Eq	Imp_Eq	Subcontract	Total
0	Earthworks & Civil	57,070	1,396,492	165,623	770	0	0	0	1,562,886
1	Concrete	192,579	3,083,192	2,559,824	0	0	0	0	5,643,017
3	Architectural	2,900	2,255	0	0	38,600	0	190,300	231,155
4	Mechanical	173,525	3,048,834	0	0	29,460	750	1,809,000	4,888,044
5	Piping	120	2,635	2,000	0	0	0	0	4,635
6	Electrical	81,365	1,529,713	153,975	1,278,929	198,680	1,099,931	0	4,261,228
7	Instrumentation	1,987	36,088	0	0	0	0	0	36,088
9	Indirects	20,616	0	0	95,000	0	0	9,652,560	9,747,560
Grand Total		**530,162**	**9,099,211**	**2,881,422**	**1,374,699**	**266,740**	**1,100,681**	**11,651,860**	**26,374,613**

Appendix N

Financial Model Format

APPENDIX N

1 PREPARATION OF DETAILED FINANCIAL TEMPLATES FOR THE FINANCIAL STRUCTURE OF EACH PROJECT

1.1 GENERAL ASPECTS

According to the working programme established by SEAWEST, the following activities were developed in this study.

- Design of financial templates in conjunction with Codelco
- Preparation of the financial templates based on the detailed information of costs of the project, price forecast and analysis of the energy generation.

1.2 WORKING WITH CODELCO IN THE DESIGN OF AN ADEQUATE TEMPLATE

One of the principal aspects of the financial and economical evaluation, is that it must conform to the schemes and practices that are commonly used by the company that will analyse the final results. For this reason, and as part of the development of the activity of this study, several meetings were held with professionals from Codelco, to obtan from them the principal aspects required for the financial and economical evaluation of the project.

Initially, the consultants asked Codelco to submit the project evaluation templates that the company uses to evaluate its own projects. Codelco analysed this request and asked the consultants to develop a financial model according to their expertise, that would later be reviewed by the technical counterpart of Codelco in the study.

Since this was the final agreement, the template of the model is presented as part of the contents of this report. The financial model that was developed is included in electronic format in **Appendix O**.

1.3 PREPARATION OF FINANCIAL TEMPLATES BASED ON DETAILED COSTS, PRICE FORECAST AND ANALYSIS OF ENERGY GENERATION.

1.3.1 Description of the Model

1.3.1.1 General Aspects

- The model contemplates an evaluation horizon of 20 years.
- A discount rate of 10% has been used, since it is the commonly used for the evaluation of projects in the power sector.
- The model has considered the project under the perspective that it is a business that can be developed by any company, not necessarily designed for Codelco, although it considers the possibility of investment in affiliate companies.
- As a result, the model does not consider tax exemptions, oo other type of franchises that could be included in the evaluation.
- The model allows the simulation of the economical evaluation considering the flows of the shareholders and the total flows of the project.
- The model allows the simulation of the Statement of Income of the company that develops the project, facing different financing scenarios, presenting in every case the dividend flows, during the evaluation period.
- This indicates that the project is evaluated as an isolated project, and also as a project that is part of the global functioning of a company as Codelco.

1.3.1.2 Worksheets that compose the Model

The financial model was implemented in MS Excel, and it is composed of 6 basic worksheets:

1. Info Generation Worksheet
2. Info Credits Worksheet
3. Investment Worksheet
4. Revenues Worksheet
5. Costs Worksheet
6. Evaluation Worksheets (With and without VAT)

Each of the numbered Worksheets is described below. All monetary amounts are expressed in Dollars of the United States of America (USD$). Separate worksheets are availabe to consider the evaluation with and without the Value Added Tax (VAT).

Info Generation Worksheet (Generation)

This Worksheet is made up of the generation data of the project and is used as an input to Revenues Worksheet. Basically, it describes the plant generation in terms of energy and power. In this manner, the Worksheet has basic information of the following aspects:

I. Basic Price of the energy: This forecast must be incorporated according to the report "Electricity Prices Forecast in the SING" developed previously as part of this Study (refer to Report N°1). In this way, for this case 4 scenarios are run, generating 4 different evaluations, one for each price scenario.

II. Quarterly Generation: This Worksheet gathers the information of the expected quarterly energy generation of the plant. Generation will specifically depend on the wind speed data that will be obtained and on its generation potential. This part of the Worksheet has been structured with quarterly energy generation, to make it coincident with the quarterly data structure of the electricity prices forecast. To complete the information it must be assumed that the first quarter corresponds to the start of the year, which is january, february and march. The input data for this module correspond to module V.

III. Firm Capacity Considered: This part of the Worksheet has the information of the firm capacity considered for the plant. This will depend on the technical data that will be obtained, on international experience, on the wind data registers, and on the negotiations that will be held with authorities and potential clients regarding the remuneration that will be received for the firm capacity of the plant. Additionally, the selling price of the firm capacity has to be incorporated in this module.

IV. Payment of Tolls Considered: In case the plant is installed and connected to the Northern Interconnected System (SING), the transmission of the energy and power will have to pay tolls determined by the legal framework. In this way basic tolls should be calculated, according to the influence area of the plant, and also the additional tolls if it corresponds. In both cases calculations will depend on the firm capacity of the plant.

Info Credits Worksheet (CERs)

This Worksheet contains data from the potential sell of the carbon credits generated by the operation of the wind farm. This Worksheet is the input to the Revenues Worksheet and basically resumes data of the tons of CO_2 emissions that are replaced by the operation of the plant, and of the selling price of the carbon credits. Additionally, it allows sensitivity analysis in case it is required by the electricity price forecast.

INVESTMENT Worksheet

This Worksheet has all the information of the investment required for the installation and starting-up of the wind farm. The Worksheet gathers information about amounts of investment in:

I. Preliminary studies: Site studies, Permits, installation of meteorological equipment, legal costs, consulting services, engineering costs, geotechnical surveys, interconnection and transmission studies, Environmental Impact Assessments, etc.
II. Land: Investment in the purchasing of the land in case it corresponds
III. Construction: Investment in all the civil works that are required for the installation of the wind farm, including manual labor.
IV. Equipment and machinery: Investment in the purchasing of equipment and machinery of the wind farm, including import duties.
V. Legal and Financial Costs: This item corresponds principally to notarial costs and financial fixed costs for the contracting of credits or other financial mechanisms.
VI. Other: Everything considered investment and not included in the foregoing ítems.

REVENUES Worksheet

This Worksheet has the information related to the revenues due to the sale of energy and power generated by the project, as well as the revenues from the sale of carbon credits. Specifically it reviews information from the Info Generation Worksheet and the Info Credits Worksheet. Additionally, it incorporates sensitivity analyses for the following ítems:

- Energy
- Price of energy
- Firm Capacity
- Price of Capacity

With this information, it is then possible to run the different scenarios required for the evaluation of the project.

COSTS Worksheet

This Worksheet incorporates all the information referred to the costs associated to the project. Specifically the following items are detailed.

- Administration Costs (reflected as management costs of the project in this stage)
- Operation and maintenance Costs
- Costs due to the payment of transmission tolls
- Costs related to the representation of the plant in the CDEC-SING
- Depreciation Costs
- Other Costs
- Administrative and selling Costs

EVALUATION Worksheets (With and without VAT)

This is the principal tool of the model, because it allows the simulation of the project's operation from an integral perspective. In this way, the model produces the following information:

- Cash flow of the project with and without financing
- Short and long term financing requirements
- Optimal structure of debt to equity ratio
- Final Cash Flow of the company

This financial model includes basic sub-modules such as Debt Service, Statement of Income, General Balance Sheets, Cash Flow and the Evaluation of the project.

Debt Service Sub-Module

This sub-module allows simulation of cash flows resulting from the payment of interests and installments of the credits contracted by the company. This possibilitates simulation of several financing scenarios, including different interest rates, debt lifes, etc.

The rates of interest are entered in the module Statement of Incomein the ítem Financial Costs of the company, which affect the Statement of Income. Since the amortizations affect the Cash flow, its result is introduced in the corresponding module.

Besides, following the premise that feasible projects must be profitable, independentrly of the financing, the module allows an economical evaluation of the project without financing. In other words, the evaluation is done assuming that the project is financed integrally with equity.

In case that the project becomes profitable in this conditions, its yield can be improved by simulating different debt to equity ratios, so that the user of the model can adjust this parameter according to the risk profile of the project.

Statement of Income Sub-Module

Two types of revenues are considered in this sub-module, the revenues of the own company independent of the project, and those revenues coming from the project. In the case of a new project, the first type of revenues are set to zero.

For the calculation of the operating income, the projections of revenues and costs of sales of the company come from Revenues and Costs Worksheets described previously. These reflect the calculation of projected sales and expected costs due to the operation of the business.

For the calculation of the Non Operating Results, financial expenses are considered; these are due to the short and long term debt service. Likewise, financial incomes are considered in case that there exist positive cash remnants during the year.

The income tax is calculated considering the credits due to accumulated losses, in case they exist. Additionally, the model can incorporate the effect of an accelerated depreciation, by a modification in the COSTS Worksheet.

This model includes an evaluation that includes the data generated in the Revenues, Costs and Investment Worksheets Costs. The evaluation is based on annual cash flows of the project, in thousands of US dollars.

Cash Flow Sub-Module

This sub-module allows cash flow adjustments to study the effect of the company's Statement of Income over the Balance Sheet.

This sub-module considers all the company's cash flow inputs and outputs, including:

- Payment of dividends
- Amortization of credits
- Depreciations
- Investments
- Equity increases

Each of the cash flow movements are adjusted in the Balance to incorporate changes in the assets, liabilities or equity accounts.

Balance Sub-Module

This sub-module allows long term projections of the balance sheets of the company, during all the evaluation period of the project.

The current assets account considers the entrance of working capital that is supposed to be constant and that does not generate financial interests.

The final cash of the project is driven from the cash flow sub-module and it is considered that it reports an interest rate that is 2% lower than the cost of the credits. The fixed assets account considers the depreciations of every period, as well the company's investments.

This model allows depreciation of the assets with different methods, depending on the life of each asset.

The equity account considers the changes of the equity of the company due to the policy of dividends that has been adopted. In this case, it is considered that there is a provisional payment of dividends corresponding to 30% of the net profits of the year, and the next year the payment is completed as an effective dividend.

Finally the EVALUATION Worksheet calculates the Net Present Value of the cash flows based on the discounted cash flows of yearly dividends.

Appendix O

Financial Model

BASIC INFORMATION

Data for the Economical Evaluation	
Assessment Timeframe (in Years)	20
Private Discount Rate	8.5%
Income Tax Rate	17.0%

Plant Characteristics	
Installed Capacity (MW)	39.9
Capacity Factor (%)	28.5%
Acknowledged Firm Capacity (%)	30%

Taxes and others	
Value Added Tax-VAT	19.0%
Import Duties	0.0%
Income Tax Rate	17.0%
Land Tax	1.425%
Income free of taxes (in %)	0.0%

Financing Data	
Long term interest rate	6.5%
Short term interest rate	7.5%
% of investment with credit	60%
Debt life (in years)	10
Interest rate for deposits	4.5%

Price Sensitivity	
Marginal Energy Costs (%)	100%
Power Node Price (%)	100%
Price of carbon credit per Ton of CO2 (US$/T	4.0

Emission Factor (ton CO2 /MWh)	1.03
O&M Costs (US$/kWh)	0.0075

Costs of Towers and Generators (US$/kW) C	803.8

RESULTS

Economical Evaluation (without VAT)	
Net Present Value	-$31,251
Internal Rate of Return	#DIV/0!

Economical Evaluation (with VAT recovery)	
Net Present Value	-$21,729
Internal Rate of Return	-2.62%

Economical Evaluation (100% devolution of VAT)	
Net Present Value	-$21,729
Internal Rate of Return	-2.62%
IVAN	**-0.47**

Resulting Indicators	
Total Investment (US$/kW)	1,264
Monomical Selling Price (USD$/MWh)	27.7
Investment without import duties (US$ tl	50,416
Investment with import duties (US$ thou	50,416

Economical Evaluation of the Cash Flow of Shareho	
Net Present Value	-$19,094
Internal Rate of Return	#NUM!
Residual Value of the Company	- 53,355

BASIC INFORMATION

Data for the Economical Evaluation	
Assessment Timeframe (in Years)	20
Private Discount Rate	8.5%
Income Tax Rate	17.0%

Plant Characteristics	
Installed Capacity (MW)	41.3
Capacity Factor (%)	35.5%
Acknowledged Firm Capacity (%)	30%

Taxes and others	
Value Added Tax-VAT	19.0%
Import Duties	0.0%
Income Tax Rate	17.0%
Land Tax	1.425%
Income free of taxes (in %)	0.0%

Financing Data	
Long term interest rate	6.5%
Short term interest rate	7.5%
% of investment with credit	60%
Debt life (in years)	10
Interest rate for deposits	4.5%

Price Sensitivity	
Marginal Energy Costs (%)	100%
Power Node Price (%)	100%
Price of carbon credit per Ton of CO2 (US$/T	4.0

Emission Factor (ton CO2 /MWh)	1.03
O&M Costs (US$/kWh)	0.0075

Costs of Towers and Generators (US$/kW) C	1,132.9

RESULTS

Economical Evaluation (without VAT)	
Net Present Value	-$44,396
Internal Rate of Return	#DIV/0!

Economical Evaluation (with VAT recovery)	
Net Present Value	-$34,591
Internal Rate of Return	#DIV/0!

Economical Evaluation (100% devolution of VAT)	
Net Present Value	-$34,591
Internal Rate of Return	#DIV/0!
IVAN	**-0.60**

Resulting Indicators	
Total Investment (US$/kW)	1,510
Monomical Selling Price (USD$/MWh)	25.6
Investment without import duties (US$ th	62,291
Investment with import duties (US$ thou	62,291

Economical Evaluation of the Cash Flow of Sharehol	
Net Present Value	-$24,040
Internal Rate of Return	#NUM!
Residual Value of the Company	- 83,189

SCENARIOS FOR SALE OF GENERATION TO THE SPOT MARKET

Assumptions:
Debt to Equity Ratio of 60/40
Discount Rate= 8.5%
Debt life= 10 years
Scenario Without SIC-SING Interconnection
Marginal Cost of Energy (see Price Forecast in Model)
Marginal Cost of Capacity= 7.29 US$/kW-month
3 scenarios for acknowledged firm capacity: 50%, 40%, 30% (only for sales to spot market, not for PPA)
2 scenarios of taxes (without VAT and 100% VAT devolution)
Without import duties

Case 1. Sales to SPOT Market with Firm Capacity of 50%

Without VAT Firm Capacity = 50%= 20MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$25,090	1.37%	-$25,838	1.22%	-$35,680	0.22%
ScenB: Financing at 5.5% and 10 years	-$22,039	not positive	-$24,278	not positive	-$36,230	not positive
ScenC: Financing at 6.5% and 10 years	-$25,133	not positive	-$27,374	not positive	-$40,078	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$21,265	2.58%	-$22,166	2.29%	-$30,171	1.68%
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$12,903	not positive	-$15,142	not positive	-$27,094	not positive
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$15,997	not positive	-$18,236	not positive	-$30,917	not positive

100% VAT Devolution Firm Capacity = 50%= 20MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$21,959	3.46%	-$23,542	3.05%	-$32,341	2.40%
ScenB: Financing at 5.5% and 10 years	-$10,595	4.04%	-$13,711	2.47%	-$25,143	not positive
ScenC: Financing at 6.5% and 10 years	-$13,126	2.92%	-$16,354	1.18%	-$28,553	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$16,402	4.81%	-$17,936	4.44%	-$26,745	3.55%
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$467	8.32%	-$2,999	7.31%	-$13,104	4.03%
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$2,611	7.48%	-$5,281	6.41%	-$16,238	2.92%

Case 2. Sales to SPOT Market with Firm Capacity of 40%

Without VAT Firm Capacity = 40%= 16MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$28,477	0.35%	-$29,915	not positive	-$40,249	not positive
ScenB: Financing at 5.5% and 10 years	-$28,546	not positive	-$30,780	not positive	-$42,971	not positive
ScenC: Financing at 6.5% and 10 years	-$31,656	not positive	-$33,898	not positive	-$46,823	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$24,059	1.69%	-$24,900	1.41%	-$34,117	0.66%
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$19,410	not positive	-$21,641	not positive	-$33,813	not positive
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$22,504	not positive	-$24,735	not positive	-$37,652	not positive

100% VAT Devolution Firm Capacity = 40%= 16MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$26,075	2.41%	-$27,591	1.99%	-$36,908	1.53%
ScenB: Financing at 5.5% and 10 years	-$19,130	not positive	-$22,584	not positive	-$34,491	not positive
ScenC: Financing at 6.5% and 10 years	-$21,890	not positive	-$25,344	not positive	-$37,901	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$20,382	3.85%	-$21,947	3.45%	-$30,974	2.68%
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$7,519	5.42%	-$10,450	4.08%	-$21,834	0.17%
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$9,949	4.41%	-$12,979	2.97%	-$25,244	not positive

Case 3. Sales to SPOT Market with Firm Capacity of 30%

Without VAT Firm Capacity = 30%= 12MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$32,821	not positive	-$34,378	not positive	-$45,038	not positive
ScenB: Financing at 5.5% and 10 years	-$35,071	not positive	-$37,304	not positive	-$49,716	not positive
ScenC: Financing at 6.5% and 10 years	-$38,188	not positive	-$40,422	not positive	-$53,568	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$26,796	0.93%	-$28,208	0.42%	-$38,577	not positive
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$25,917	not positive	-$28,140	not positive	-$40,544	not positive
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$29,017	not positive	-$31,251	not positive	-$44,396	not positive

100% VAT Devolution Firm Capacity = 30%= 12MW	47X850 kW		42X950 kW		25X1650 kW	
	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %	NPV US$ Thousands	IRR %
ScenA: Without financing, without CERs	-$30,132	1.43%	-$32,340	0.79%	-$43,008	0.09%
ScenB: Financing at 5.5% and 10 years	-$28,183	not positive	-$31,626	not positive	-$43,838	not positive
ScenC: Financing at 6.5% and 10 years	-$30,943	not positive	-$34,386	not positive	-$47,248	not positive
ScenD: Without financing, with CERs @4 US$/ton CO2	-$24,361	2.85%	-$26,031	2.40%	-$34,839	1.97%
ScenE: Financing at 5.5% , with CERs @ 4 US$/ton CO2	-$15,591	1.43%	-$18,969	not positive	-$31,181	not positive
ScenF: Financing at 6.5% , with CERs @ 4 US$/ton CO2	-$18,306	not positive	-$21,729	not positive	-$34,591	not positive

	GENERAL ASSUMPTIONS		
1	Assessment timeframe	20	years
2	Private discount rate	8.5%, 10%	annual
3	Income tax rate	17%	over income
4	Value Added Tax-VAT	19%	Increased to 19% after october 2003
5	Import duties	6%., 0%	Starting in 2003
6	Land tax	1.425%	
	Debt to equity ratio	50 / 50 and 60/40	
	Long term interest rate	5.5%, 6.5%, 7.5%, 9.5%	
7	Debt life (in years)	10	
8	Simulations with turbines from Vestas and NEG Micon	850 ; 950; 1650 kW	
9	Capacity factor (%)	32.2%; 28.5%; 35.5%	depending on turbine used
10	Sale of electricity in spot market	Forecast of Marginal Energy Costs	
11	Acknowledged Firm Capacity in %	30%, 40%, 50%	According to CDEC-SING, similar to run-of-river hidros and sensitivities
12	Carbon credit Price (US$/ ton CO2)	4	According to price offered by PCF to Jepirachi Wind Farm in Colombia
13	Emission Factor of CO2 (Ton CO2/MWh)	0.8 to 1.03	Scenario with mixture of coal-petcoke based on study by Trexler (method1). Other methodology was also used with new forecast of prices (method2)
14	Turbines Cost CIF Mejillones (US$/kW)	764.2 US$/kW; 804 US$/kW; 1133 US$/kW	Quotations from Vestas and NEG Micon of august 18, 2003 (case towers IEC II)
15	O&M Costs of Plant (US$/kWh))	0.0075	Reference value obtained from UNDP and estimates by Seawest
16	Administrative and Sales Expenses (US$/year)	1.5% out of investment on equipm & mach.	As a percentaje over investment in equipment and machinery
17	Cost of Representation before CDEC	3% over sales	% over sales
18	Costs of Tolls	7 US$/kW-month	US$/kW-month
19	Linear Depreciation	20	years
20	Legal Costs	24 ThUS$/year	ThUS$/year fixed
21	Costs in third parties	12 ThUS$/year	ThUS$/year fixed
22	Financial Costs (commissions)	6 ThUS$/year	ThUS$/year fixed
23	VAT recovery	based on credit and debit of the project	

BASIC INFORMATION

Data for the Economical Evaluation	
Assessment Timeframe (in Years)	20
Private Discount Rate	8.5%
Income Tax Rate	17.0%

Plant Characteristics	
Installed Capacity (MW)	39.9
Capacity Factor (%)	28.5%
Acknowledged Firm Capacity (%)	30%

Taxes and others	
Value Added Tax-VAT	19.0%
Import Duties	0.0%
Income Tax Rate	17.0%
Land Tax	1.425%
Income free of taxes (in %)	0.0%

Financing Data	
Long term interest rate	6.5%
Short term interest rate	7.5%
% of investment with credit	60%
Debt life (in years)	10
Interest rate for deposits	4.5%

Price Sensitivity	
Marginal Energy Costs (%)	100%
Power Node Price (%)	100%
Price of carbon credit per Ton of CO2 (US$/T	0.0

Emission Factor (ton CO2 /MWh)	1.03
O&M Costs (US$/kWh)	0.0075

Costs of Towers and Generators (US$/kW) C	803.8

RESULTS

Economical Evaluation (without VAT)	
Net Present Value	-$13,204
Internal Rate of Return	-2.07%

Economical Evaluation (with VAT recovery)	
Net Present Value	-$1,762
Internal Rate of Return	7.73%

Economical Evaluation (100% devolution of VAT)	
Net Present Value	$20
Internal Rate of Return	8.51%
IVAN	**0.00**

Resulting Indicators	
Total Investment (US$/kW)	1,264
Monomical Selling Price (USD$/MWh)	40.2
Investment without import duties (US$ tl	50,416
Investment with import duties (US$ thou	50,416

Economical Evaluation of the Cash Flow of Shareho	
Net Present Value	-$19,094
Internal Rate of Return	#NUM!
Residual Value of the Company	- 8,958

BASIC INFORMATION

Data for the Economical Evaluation	
Assessment Timeframe (in Years)	20
Private Discount Rate	8.5%
Income Tax Rate	17.0%

Plant Characteristics	
Installed Capacity (MW)	41.3
Capacity Factor (%)	35.5%
Acknowledged Firm Capacity (%)	50%

Taxes and others	
Value Added Tax-VAT	19.0%
Import Duties	0.0%
Income Tax Rate	17.0%
Land Tax	1.425%
Income free of taxes (in %)	0.0%

Financing Data	
Long term interest rate	6.5%
Short term interest rate	7.5%
% of investment with credit	60%
Debt life (in years)	10
Interest rate for deposits	4.5%

Price Sensitivity	
Marginal Energy Costs (%)	100%
Power Node Price (%)	100%
Price of carbon credit per Ton of CO2 (US$/T	0.0

Emission Factor (ton CO2 /MWh)	1.03
O&M Costs (US$/kWh)	0.0075

Costs of Towers and Generators (US$/kW) C	1,132.9

RESULTS

Economical Evaluation (without VAT)	
Net Present Value	-$13,556
Internal Rate of Return	0.58%

Economical Evaluation (with VAT recovery)	
Net Present Value	$773
Internal Rate of Return	8.77%

Economical Evaluation (100% devolution of VAT)	
Net Present Value	$3,071
Internal Rate of Return	9.49%
IVAN	**0.05**

Resulting Indicators	
Total Investment (US$/kW)	1,510
Monomical Selling Price (USD$/MWh)	40.2
Investment without import duties (US$ th	62,291
Investment with import duties (US$ thou	62,291

Economical Evaluation of the Cash Flow of Shareho	
Net Present Value	-$24,040
Internal Rate of Return	#NUM!
Residual Value of the Company	- 6,270

SCENARIOS WITH PPA
47 turbines X 850kW

PPA with monomical selling price: 42 USD$/MWh until 2009, afterwards 35.6 USD$/MWh ; Discount Rate=8.5%

Economical Evaluation (without VAT)	*ScenA*	*ScenB*	*ScenC*	*ScenD*	*ScenE*	*ScenF*
Net Present Value	-$18,894	-$5,778	-$8,860	-$15,032	$2,123	-$335
Internal Rate of Return	3.02%	4.52%	2.11%	4.23%	9.78%	8.30%

Economical Evaluation (100% devolution of VAT)						
Net Present Value	-$12,838	$4,884	$3,763	-$7,387	$10,234	$9,221
Internal Rate of Return	5.48%	10.59%	10.09%	6.79%	12.81%	12.34%
IVAN	**-0.28**	**0.11**	**0.08**	**-0.16**	**0.22**	**0.20**

Resulting Indicators						
Total Investment (US$/kW)	1,262	1,262	1,262	1,262	1,262	1,262
Monomical Selling Price (USD$/MWh	37.7	37.7	37.7	37.7	37.7	37.7
Investment without import duties (US$	50,416	50,416	50,416	50,416	50,416	50,416
Investment with import duties (US$ th	52,396	52,396	52,396	52,396	52,396	52,396

PPA with monomical selling price: 35.6 USD$/MWh during all the period; Discount Rate=8.5%

Economical Evaluation (without VAT)	*ScenA*	*ScenB*	*ScenC*	*ScenD*	*ScenE*	*ScenF*
Net Present Value	-$21,979	-$14,150	-$17,244	-$18,118	-$5,143	-$8,126
Internal Rate of Return	2.27%	-3.13%	no positivo	3.47%	5.38%	3.45%

Economical Evaluation (100% devolution of VAT)						
Net Present Value	-$17,334	-$1,559	-$3,830	-$11,790	$5,779	$5,262
Internal Rate of Return	4.53%	7.87%	6.96%	5.85%	10.80%	10.52%
IVAN	**-0.37**	**-0.03**	**-0.08**	**-0.25**	**0.12**	**0.11**

Resulting Indicators						
Total Investment (US$/kW)	1,262	1,262	1,262	1,262	1,262	1,262
Monomical Selling Price (USD$/MWh)	35.6	35.6	35.6	35.6	35.6	35.6
Investment without import duties (US$ th	50,416	50,416	50,416	50,416	50,416	50,416
Investment with import duties (US$ thou	52,396	52,396	52,396	52,396	52,396	52,396

PPA with monomical selling price: 42 USD$/MWh until 2017, afterwards 35.6 USD$/MWh ; Discount Rate=8.5%

Economical Evaluation (without VAT)	*ScenA*	*ScenB*	*ScenC*	*ScenD*	*ScenE*	*ScenF*
Net Present Value	-$17,001	-$2,243	-$5,011	-$13,139	$4,342	$2,331
Internal Rate of Return	3.70%	7.14%	5.44%	4.86%	10.99%	9.81%

Economical Evaluation (100% devolution of VAT)						
Net Present Value	-$10,158	$7,565	$6,393	-$4,807	$12,813	$11,800
Internal Rate of Return	6.17%	11.60%	11.09%	7.41%	13.69%	13.23%
IVAN	**-0.22**	**0.16**	**0.14**	**-0.10**	**0.28**	**0.25**

Resulting Indicators						
Total Investment (US$/kW)	1,262	1,262	1,262	1,262	1,262	1,262
Monomical Selling Price (USD$/MWh	40.2	40.2	40.2	40.2	40.2	40.2
Investment without import duties (US$	50,416	50,416	50,416	50,416	50,416	50,416
Investment with import duties (US$ th	52,396	52,396	52,396	52,396	52,396	52,396

PPA with monomical selling price: 33.0 USD$/MWh during all the period; Discount Rate=8.5%

Economical Evaluation (without VAT)	*ScenA*	*ScenB*	*ScenC*	*ScenD*	*ScenE*	*ScenF*
Net Present Value	-$24,324	-$19,645	-$22,740	-$20,446	-$10,509	-$13,603
Internal Rate of Return	1.50%	#DIV/0!	#DIV/0!	2.75%	1.15%	-1.65%

Economical Evaluation (100% devolution of VAT)						
Net Present Value	-$20,745	-$7,683	-$10,119	-$15,154	$2,100	-$10
Internal Rate of Return	3.68%	5.26%	4.21%	5.05%	9.33%	8.50%
IVAN	**-0.45**	**-0.17**	**-0.22**	**-0.33**	**0.05**	**0.00**

Resulting Indicators						
Total Investment (US$/kW)	1,262	1,262	1,262	1,262	1,262	1,262
Monomical Selling Price (USD$/MWh)	33.0	33.0	33.0	33.0	33.0	33.0
Investment without import duties (US$ th	50,416	50,416	50,416	50,416	50,416	50,416
Investment with import duties (US$ thou	52,396	52,396	52,396	52,396	52,396	52,396

BASIC INFORMATION

Data for the Economical Evaluation	
Assessment Timeframe (in Years)	20
Private Discount Rate	8.5%
Income Tax Rate	17.0%

Plant Characteristics	
Installed Capacity (MW)	40.0
Capacity Factor (%)	32.2%
Acknowledged Firm Capacity (%)	50%

Taxes and others	
Value Added Tax-VAT	19.0%
Import Duties	0.0%
Income Tax Rate	17.0%
Land Tax	1.425%
Income free of taxes (in %)	0.0%

Financing Data	
Long term interest rate	6.5%
Short term interest rate	7.5%
% of investment with credit	60%
Debt life (in years)	10
Interest rate for deposits	4.5%

Price Sensitivity	
Marginal Energy Costs (%)	100%
Power Node Price (%)	100%
Price of carbon credit per Ton of CO2 (US$/T	4.0

Emission Factor (ton CO2 /MWh)	1.03
O&M Costs (US$/kWh)	0.0075

Costs of Towers and Generators (US$/kW) C	764.2

RESULTS

Economical Evaluation (without VAT)	
Net Present Value	$2,331
Internal Rate of Return	9.81%

Economical Evaluation (with VAT recovery)	
Net Present Value	$7,671
Internal Rate of Return	11.97%

Economical Evaluation (100% devolution of VAT)	
Net Present Value	$11,800
Internal Rate of Return	13.23%
IVAN	**0.25**

Resulting Indicators	
Total Investment (US$/kW)	1,262
Monomical Selling Price (USD$/MWh)	40.2
Investment without import duties (US$ thousands)	50,416
Investment with import duties (US$ thousands)	50,416

Economical Evaluation of the Cash Flow of Shareholders withou	
Net Present Value	-$13,509
Internal Rate of Return	1.97%
Residual Value of the Company	18,528

Appendix P

Form of Contract for Power Purchase Agreement and Sale of Carbon Credits

APPENDIX P

POWER PURCHASE AGREEMENT

Celebrated between

CODELCO

and

(Buyer)

Related to:

.....

Dated:

.....

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The ..... hereinafter referred to as the BUYER, represented in this act by....., its ....., and .....a company incorbyated under the laws of ....., having its registered office in the city of ....., hereinafter referred to as the SELLER, represented in this act by .....

The SELLER and the BUYER are referred to individually as Party and collectively as Parties.

The Parties celebrate the present Agreement that will be ruled by the following articles:

ARTICLE 1 - PURPOSE

1 The purpose of this Agreement is the purchase by the BUYER and the delivery by the SELLER as independent power producer, of the electricity generated by a wind farm with a nominal capacity of ...(...) MW (Megawatts). This capacity results from the installation, in the Comuna of ....., in the Region of ..... in Chile, of ..... wind turbine generators with an individual capacity of ..... KW(Kilowatts) each.

1.1 The energy will be available according to the schedule of operation of the wind turbine generators contained in Appendix 3.

1.2 The energy generated by the wind turbine generators shall be registered monthly and purchased totally by the BUYER.

ARTICLE 2 - DEFINITIONS

To clarify the group of documents that compose this Agreement, the following terminology and definitions are adopted:

ENERGY
Electrical Energy, expressed in MWh, that shall be generated by the FACILITY during the term of the AGREEMENT and that is effectively delivered to the BUYER at the point of delivery.

NOMINAL CAPACITY
Maximum generation of the FACILITY, expressed in MW.

FACILITY
Electric generation plant composed by ..... wind turbine generators with an individual nominal capacity of ..... KW, including host land, principal and auxiliary equipment, metering and protection systems.

TOTAL INSTALLED CAPACITY
The resulting sum of the individual capacities of each wind turbine generator, which in their final configuration represent a total of ..... MW.

TECHNICAL SPECIFICATIONS
Document that defines technical conditions and information necessary for the preparation of the proposal by the providers of the equipment of the FACILITY.

POINT OF DELIVERY
The physical point located within the substation ..... of the....., at which the FACILITY is interconnected with the transmission line.

URGENCY
Operating condition or situation of the equipment that can affect the normal delivery of energy and that shall be corrected as soon as possible, through the programming of disconnection of the equipment for its proper repairment.

EMERGENCY
Operating condition or situation of the equipment that can affect the normal delivery of energy and that shall be corrected immediately. In this condition the equipments can be disconnected, to be repaired, although this might produce the interruption of electrical supply.

PARTY (IES)
Shall be understood as SELLER and BUYER when indicated in plural, and each one individually when cited in singular.

(include other definitions, if necessary)

ARTICLE 3 - DOCUMENTS RELATED TO THE AGREEMENT

1 This Agreement shall only be valid after the implementation of the following measures:

- Obtention of permits and authorizations from governmental agencies,
- Signature of the following documents:
  - Of the project;
  - Of the supply of special equipment;
  - Of Construction;
  - Of Operation and Maintenance (O&M);
  - Of Insurance;
  - (Cite other documents, if necessary).

2 This documents shall be valid independently of their transcription, except in the case that eventually they have a conflict with this Agreement. In such case, this Agreement shall supersede all other documents relating to the matters of this Agreement.

3 The sections of the said documents are correlative and complementary and any stipulation that is registered in only one of the documents, shall be interpreted as if it is registered in all the other documents.

ARTICLE 4- MANAGEMENT OF THE OPERATION

1 Within 30 days prior to the commercial operation date of the first wind turbine generator of the FACILITY, both the SELLER and the BUYER shall designate 1 (one) representative, so that they are jointly responsible for the operational activities that relate to the interconnection of the FACILITY to the electrical system of the BUYER.

2 This representantives shall respond for the ellaboration of the procedures and instructions related to the operation of the wind turbine generators during the stages of:

- Starting-upand testing,
- Integration of the FACILITY with the metering and protection systems, and the interconnection line of the BUYER;
- Maintenance;
- Normal, Urgent and Emergency Operations.

3. The procedures cited in item 2 of this ARTICLE shall be based on functional specifications and technical limitations, pursuant to Appendixes 1 and 2.

ARTICLE 5 - STAGES FOR THE COMMERCIAL OPERATION OF THE FACILITY

1. The SELLER shall initiate the implementation works of the FACILITY, according to the execution schedule stipulated in Appendix 3, to fulfill the established timing.

1.1 The availability and the interconnection of the wind turbine generators to the transmission system shall be fulfilled in the following sequence:

PERIOD	Nº of WIND TURBINE GENERATORS	INSTALLED CAPACITY (kw)
From ...to	_	.....
From ...to	_	.....
From ...to	_	.....
From ...to	_	.....
From ...to	_	.....

2. The SELLER shall have the right to prorogue the mounting schedule of the wind turbine generators, in relation to the dates stipulated in Appendix 3, according to the delays provoked by force majeure events, pursuant to ARTICLE 10.

2.1 The SELLER shall notify the BUYER by a written document, about any event that could imply the delay in the availability of the the wind turbine generators .

2.2 Any delay in the delivery of energy motivated exclusively by the BUYER, excepting force majeure events, does not eliminate the SELLER´s right to receive the part of the payment of the energy that corresponds to the sum of the capacities of the available wind turbine generators, multipliplied by the capacity factor of the

available of the wind turbine generators, multiplied by the average operative capacity factor, and by the period of time of the delay .

3. In the ocurrence of the events stipulated in item 2 above, and after evaluating the consecuences of the delays, the BUYER shall establish a new execution schedule, upon mutual agreement with the SELLER.

ARTICLE 6 - STARTING-UP AND OPERATION TESTS

1. During the starting-up and testing periods of the FACILITY, according to Appendix 4, the energy generated by the turbines being tested shall be billed by the SELLER to the BUYER, at the price stipulated in ARTICLE 12.

2. During the period discussed in the preceding item, the synchronism of the wind turbine generators with the transmission system shall be vinculated to the scheduling of tests previously agreed with the agents responsible for the operation of the electrical system.

3. The SELLER shall send the BUYER copies of the results of all the testings executed and of the tests that shall be run to overcome existing failures of the FACILITY. The BUYER shall not use or disclose the results of the testings excepting the case in which they are required for the management and fulfillment of the present Agreement, or in case they are requested by the regulatory and supervision official authorities.

ARTICLE 7- INTERCONNECTION OF THE WIND FARM

1. The SELLER shall be responsible for the project, construction, starting-up, operation and maintenance of the FACILITY, along with its respective protection and metering associated systems.

2. The BUYER shall be responsible for the project, construction, starting-up, operation and maintenance of the interconnection line from the FACILITY to the substation called ....., along with its respective protection and metering associated systems.

3. The projects for the interconnection of the wind turbine generators to the transmission system shall be analysed and implemented by the SELLER in conjunction with the BUYER, with the objective of obtaining the best electrical performance and synchronization of the FACILITY with the transmission system .

ARTICLE 8 - OBLIGATIONS

1. Of the SELLER

1.1 . In addition to the obligations contained in the other articles of this Agreement, the following are obligations of the SELLER:

- Obtainment and renovation of all the species, authorizations, licences and permits from the ministeries and municipallities that refer to the FACILITY, which are necessary for the fulfillment of the obligations originated in this Agreement, which will constitute Appendix 7.

- Payment of all taxes, import duties, contributions and other burdens present or future,

- Guarantee the continuity, security and quality of service of the energy delivered by the wind turbine generators ;

- Guarantee a the BUYER total ausencia de any responsibility en relación al desempeño of the activities of the SELLER related to a this Agreement;

1.2 . Presentation of Documents

The SELLER shall submit to the BUYER, the following documents up to ..... months prior to the date of achieving commercial operation of the first wind turbine generator of the FACILITY;

- Execution schedule of the project, which will constitute Appendix 3;

- Copy of the insurance policies specified in ARTICLE 22, which will constitute Appendix 6;

- Documents and technical data necessary and sufficient for the BUYER to project, construct and operate the interconnection installations of the FACILITY, which will constitute Appendixes 1 and 2;

- Testing and Starting-up programme of the FACILITY, which will constitute Appendix 4;

1.3 . The SELLER shall communicate immediately the BUYER about any changes in the documents described in this item.

2. Of the BUYER

2.1 In addition to the obligations contained in the other articles of this Agreement , the following are also obligations of the BUYER:

- To pay according to ARTICLE 11, the amount of energy effectively available at the point of delivery;

ARTICLE 9 - METERING

1. METERING SYSTEM

1.1 The SELLER shall install electrical metering systems, in both the wind turbine generators and in the interconnection point with the transmission system, for the metering of active and reactive energy, according to the following characteristics:

- Individual meters for each wind turbine generator ,
- Totaling Meter in the point of interconnection with the transmission system ;
- Class 0,2 Metering precission.

1.2. The BUYER can install a backup metering system, at its own criteria and expense,.

2. CONFIRMATION OF THE METERING SYSTEM

2.1 Prior to the commercial operation date, the SELLER shall test and calibrate the accuracy of the metering system according to the parameters established by the responsible agents of the operation and in conformity to Appendix 5.

2.2 The SELLER shall also test and calibrate the metering system in any date, upon justified request from the BUYER. The SELLER shall bear the cost of this request, if it is proved that the metering system was not operating accurately within its precission class limits. On the contrary, the BUYER shall bear such costs.

2.3 The BUYER shall have the right to designate a representative to attend the testing and calibrating procedures, as well as any inspection or adjustment procedures of the metering system. The SELLER shall notify the BUYER, in advance, of the time when any inspections or testings shall take place.

2.4 The representative of the BUYER shall fulfill all the instructions and regulations of the SELLER, and shall compensate and exonerate the BUYER for any losses or damages produced by the omissive or negligent acts of the representative.

2.5 Whenever the metering system is found to be operating outside the acceptable accuracy limits, the SELLER shall adjust it to record properly or substitute it at its own expense, programming such services in conjunction with the BUYER.

3 READINGS OF THE METERS

3.1 Procedures:

The metering system shall integrate its registers of the billing period at 12:00 am of the last day of each month. The BUYER has the right to attend any procedure related to reading the meters. The SELLER shall maintain in its files the register of all the metering measurements.

3.2. Failures in the metering system:

In case that the metering system is out of service or whenever there is an observed variation greater than ..... %, the adjustment of the measurements shall be done using the following procedures:

- Reading the backup meters, if they exist,

- Reading the meters of the wind turbine generators,
- Estimation based on available informations and upon mutual agreement of the Parties,

- In case that the Parties do not reach an agreement upon the estimated measurement, the BUYER shall pay the SELLER based on the estimated readings of the BUYER;

- The difference between prior payments done by the BUYER and the recalculated amount, shall be compensated in the following billings. The adjustment shall not be done for previous periods to the last confirmation of the proper operation of the metering system.

4. SEALS OF THE METERING SYSTEM

The metering system shall comply with the specifications definided by the agents responsible of the operation of the electrical system and shall be sealed. The seals shall only be destroyed by the SELLER. The BUYER will be notified, with a minimum anticipation of twenty-four (24) hours, about the necessity of destroying the seals, excepting emergencies. The notification shall specify the hour at which the seal of a meter will be destroyed. The BUYER can decide to be present at such procedure.

ARTICLE 10 - FORCE MAJEURE

1 Force majeure shall mean any event or combination of events not within the control of the affected Party, that impedes the fulfillment of its obligations. The force majeure events shall include, but is not limited to.

1.1 Political events that occur internally or externally and that affect directly the country, such as:
- Any acto of war (declared or not declared), invasion, armed conflict or act of a foreign enemy, blocade, embargo, revolution, commotions, insurrection, civil riots, acts of terrorism or sabotage;
- Stikes, arrests and restraint operations that ocurr in a general manner affecting the whole country and the FACILITY.

1.2 Other events not within the control of the affected Party, such as:
- Floods, hurricanes or earthquakes,
- Explosions or chemical pollutions (in addition to those resulting from an act of war);
- Epidemics or plague.

2 If due to force majeure events, a Party is rendered unable wholly or partially to fulfill its obligations, this Party shall notify the other, in a maximum term of 48 hours after the event, excepting the stipulations of subitem 2.1 of ARTICLE 5, specifying the nature of the event and its consequences.

2.1 The affected Party shall notify immediately the other Party, when the force majeure event has stopped, and the date when its is capable of resuming the fulfillment of its obligations.

3. The affected Party shall substantiate the force majeure causes and its consequences, and shall take all the necessary actions to remedy the situation and restablish the normal conditions pursuant to this Agreement.

3.1 The suspension of the obligations will only be limited to the ambit and period of time inherent to the force majeure events, taking in account that the affected Party shall take all immediate measures to remedy the cause and its effects.

ARTICLE 11 - PRICE, BILLING AND ADJUSTMENT

1 PRICE
The selling price of the energy delivered by the SELLER, under the purpose of this Agreement, shall be .....(equivalent to US$.....(.....) per MWh (megawatt-hour).

2 BILLING
The bills related to the energy supplied shall be emitted monthly, by the SELLER, and shall be sent to the BUYER, using the selling price stipulated in the preceding item 1.

3 ADJUSTMENT

3.1 The selling price of the energy shall be adjusted annually, and such periodicity can be altered according to regulations in force, and according to formulas and adjustment indexes that shall be defined.

3.2 The SELLER shall submit all price adjustment calculations for the approval of the BUYER, jointly with all the evidence.

3.3 In the event of interruptions or discontinuity of the indexes cited in subitem 3.1 of this ARTICLE, or in caso any other alteration in the adjustment process occurs, the Parties shall agree on the use of another index.

3.4 The prices established in the preceding item 1 of this ARTICLE shall be referred to as prices of the month of .....of the year ....

ARTICLE 12 – PAYMENTS

1. Upon achieving commercial operation, the SELLER shall have the right to receive monthly payments for the energy effectively registered, subtracting the contingent deductions stipulated in this Agreement.

1.2 The BUYER shall pay the monthly bill to the SELLER, corresponding to the value of registered energy at the point of delivery, which shall be equal to the multiplication of the energy price, expressed in US$/MWh, by the energy effectively registered.

2. Within the first five working days of each month, the BUYER shall emit a metering report, which will describe all the events of energy unavailability ocurred during the preceding month, with the consequent calculation of the penalty pursuant to the stipulations of ARTICLE 12, which will allow the SELLER to calculate the value of the bill.

2.1 The corresponding bill shall be sent to the BUYER within 10 (ten) days after the metering report mentioned in item 2 has been emitted.

4 The BUYER shall send the payment within the first five working days of the subsequent month to the month in which the bill has been sent, provided that the SELLER sends the bill no later than the 15th day of the month after the energy has been delivered.

5 Payments shall be deposited in the credit account of the bank that is indicated by the SELLER.

The BUYER shall pay late payment charges from the date the original bill was due through the previous day of the real payment.

5.1 The late payment charges shall be calculated using an interest rate of ..... % per month, calculated in due proportion of the days, for a delay of up to .....(...) days, and an interest rate of ..... % per month, calculated in due proportion of the days, for a delay of more than .....(...) days.

5.2 The late payment charges shall be payed by the BUYER in the bill of the following month.

6 The SELLER shall send simultaneously to the BUYER, the billing documents of the original and the adjusted prices, mentioned in ARTICLE 11, along with the respective calculations of price adjustments and the official published adjusting indexes.

ARTICLE 13- PAYMENT GUARANTEE

1 The BUYER and the SELLER, within thirty (30) days after the firm of this Agreement, shall choose a financial institution that will manage a compensation account intended to exclusively guarantee punctuality and completion of the total payment of the contractual obligations by the BUYER.

2 For the purpose of this Agreement, the compensation account shall be considered as valid only after the BUYER, the SELLER and the financial institution that manages the compensation account, have signed a particular Agreement for the administration of this account.

3 With a maximum of one day after the foreseen date to establish the compensation account, the BUYER is obliged to constitute it with a minimum required amount of two monthly bills, equivalent to the supply of ... MW of registered energy.

4 In case that, for a continuos period of thirty six months upon the commercial operation date of the last wind turbine generator of the FACILITY, there are no withdrawals by the SELLER , the basic value requered for the compensation account shall be reduced in 50% (fifty per cent) of the value stipulated in item 3 of this ARTICLE.

5 The BUYER shall have the right to make a withdrawal of the remnant that exceeds the basic value required in any date.

6 In case that the BUYER pays a lesser value than its monthly obligations, the SELLER shall have the right to withdraw the difference between the integral value of the obligations still indebted and the amount effectively paid.

7 After any withdrawal, the BUYER shall make the deposit to the compensation account, within a maximum of three working days after the referred withdrawal, in order that the remnant in the account returns to the basic vale in force.

8 Upon the termination de this Agreement, the compensation account shall be extinguished automatically in the same termination date.

ARTICLE 14 - LEGAL AND FISCAL OBLIGATIONS

1 All taxes and fiscal contributions, including burdens related to health, social and security payments, or of any nature produced by the execution of this Agreement, shall be payed exclusively by the SELLER, excepting those payments which correspond to exclusive obligations of the BUYER.

ARTICLE 15 - ASSIGNMENT

1 This Agreement shall not be assigned, totally or partially, without previous and express consent of the BUYER.

2 The SELLER can assign its rights foreseen in the monthly billing, according to item 1 of ARTICLE 12, to guarantee eventual financing obtained with financial agents for the construction of the FACILITY.

3 In observance of the regulations of the Electrical Sector, the SELLER has the assured posibility of assigning the FACILITY to third parties that posses the appropriate technical, economical and financial qualifications for accomplishing the integral purpose of this Agreement.

4 The BUYER has the assured preference right in the assignment that is treated in precedent item 3. Non excercising this right does not imply the aniticipated renuncia of the previous and express anulation of the assignment to third parties.

ARTICLE 16 - RESCISSION

1 MOTIVES FOR THE RESCISSION OF THIS AGREEMENT BY THE BUYER:

I. Delay in the dates stipulated in ARTICLE 5 for the availability of the FACILITY, in a term superior to 9 (nine) months, desde que by motivos no imputables a the BUYER and observadas eventuales prorrogas de term concedidas a the SELLER;

II. The unfulfillment, by the SELLER, of the obligations stipulated in this Agreement excepting the unfulfillments motivated by force majeure;

III. The disolution, liquidation or bankruptcy of the SELLER;

IV. The modification of the commercial purpose or of the structure of the SELLER that damages the fulfillment of the purpose of this Agreement;

V. The manifest lack of interest by the SELLER to initiate or continue with the activities for the construction of the FACILITY;

VI. The annulment of the autorization to the SELLER to constitute as an independent power producer, according to stipulations in Art .....of ....

2 MOTIVES FOR THE RESCISSION OF THIS AGREEMENT BY THE SELLER:

I. The disolution, liquidation or bankruptcy of the BUYER;

II. Any unfulfillment by the BUYER to make the payments to the SELLER within three months of the date they were due;

III. Failure by the BUYER to deliver or restablish any credit support or payment guarantee;

3 RESCISSION NOTIFICATION

3.1 Upon the ocurrence of an unfulfillment, that is not corrected within the established period, the damaged Party, can according to its criteria, iniciate the rescission of this Agreement by sending a written notification to the other Party, indicating its intention to rescind this Agreement. The notification of the rescission intention shall specify the event or unfulfillment of the responsible Party.

3.2 After the notification of the rescission intention, the Parties shall discuss about the actions that must be undertaken, during a maximum period of forty five (45) days, if it is the case of an unfulfillment of the Agreement; the Parties shall discuss during a maximum period of ninety (90) days, if it is the case of any other event.

3.3 At the end of the discussion period described in the previous item, and if there has been no agreement about the solution of the unfulfillment, the damaged Party shall send a rescission notification to the other Party, constituting the automatic rescission of this Agreement.

4 OBLIGATIONS AFTER THE RESCISION

4.1 Upon the termination of this Agreement, the Parties shall not have any other obligations excepting those obligations originated before the rescission or termination dates.

ARTICLE 17 – TERM

1 The present Agreement shall commence at the date of its signature and shall continue thereafter for .....(...) years after the commercial operation date of the last wind turbine generator of the FACILITY, taking in account the eventual prorogation conceded pursuant to item 2 of ARTICLE 5.

2 At the end of the fifteenth year, the SELLER and the BUYER agree to start negociations to reevalute and update the conditions stipulated in this Agreement .

3 The BUYER has the option to buy the FACILITY at the termination of this Agreement, in case the SELLER has an interest in selling it.

ARTICLE 18 - NOVATION

Failure of exerting any of the rights guaranteed to the Parties in this Agreement, in the regulation, or failure to apply any foreseen penalty, does not imply novation, and shall not be interpreted as a resignation or desistance of future actions.

ARTICLE 19 - TOTAL VALUE OF THE AGREEMENT

The total estimated value of this Agreement, only for accountant matters, corresponds to US$.....(....).

ARTICLE 20 - COMPENSATIONS

1 During all the period of use of the installations, starting from the beginning of the project and up to the termination of this Agreement, the SELLER shall guarantee the BUYER, its agents and employees, the total absence of responsibility, related to physical injures, death or property damages, ocurred during the performance of its activities, pursuant to this Agreement, provided that such responsibility is not a result of fault or premeditation of the agents and employees of the BUYER.

1.1 The SELLER shall assume the defense of any claim or legal action relative to this Agreement, including those motivated by issues related to the environment originated after the commercial operation date of the FACILITY, that are presented against the BUYER by third parties, protecting it from any responsibility and paying all the legal costs that could result from this procedures, without the possibility of asking for any devolution by the BUYER.

1.2 In any judicial decission related to environmental issues is produced, and if it is proved that it was originated by the acts of the SELLER, this Party shall be responsible for its obligations, pursuant to the mechanisms or agreements reached with the environmental and official state agencies, independent of the fact that such Party was operating directly or indirectly the FACILITY.

1.3 During all the term of use of the installations, the BUYER shall assume total responsibility facing the SELLER derived from damages to civil properties that ocurred as a confirmed consequence of orders, resolutions and acts of its employees, emitted or performed to comply with its contractual obligations.

ARTICLE 21 - INSURANCE

1 The SELLER shall be responsible for the establishment of insurances to protect its personnel, the installations and all the equipment, materials and systems that shall be involved in the execution of the obligations of this Agreement .

2 The SELLER is obliged to maintain insurance coverage against any risk that shall affect all materials, equipments and systems involved in the construction of the project pursuant to this Agreement, starting from the date in which they

rest in the factory of their suppliers, during its storage, and up to the moment they are staffed in the terrains of the FACILITY.

3 During the construction of the project, the SELLER shall be responsible for contracting the transportation insurance of all materials and equipment under its responsibility, by their replacement value.

4 The SELLER shall also be responsible for contracting the engineering risk insurance, covering the risks derivaded from the civil works, mounting, commissioning and operation of the FACILITY, covering, at the very least, the risks of fire, electrical damage, explosions, hurricanes and floods.

5 The SELLER shall not supply any of the services stipulated in this Agreement before presenting the referred insurance policies to the BUYER.

6 The coverage of the foreseen insurances does not exclude or diminish, under any circumstance, the obligations and responsibilities of the SELLER pursuant to this Agreement or to existing law, meaning that the SELLER is totally responsible of any losses and damages not covered by the insurance.

7 The Parties agree that the compensations due to the insurance policies for the covered sinisters, shall principally be destined to the restitution or recovery of the damaged properties, to its original characteristics and without prejudice to the operation of the FACILITY.

8 The SELLER shall be responsible for contracting the crossed civil responsibility insurance policy, covering the risks derived from the construction of the FACILITY and any other stipulated in this Agreement.

9 The compensations for damages involving crossed civil liability insurance, covered in specific insurance policies, according to the preceding item, shall be payed to its due claimants or to the agents proposed directly by the SELLER.

10 Independently of receiving the compensation, the SELLER shall have the total responsibility to restitute the damaged properties or to compensate third parties in actions that involve civil responsibility. There is no possibility that the BUYER shall have participations for insufficiency of insurances or a maximum limit of compensations declared in the policies.

11 All insurance policies shall have an ARTICLE that establishes that such policies shall not be terminated or altered without a previous and express consent from the BUYER.

ARTICLE 22 - NOTIFICATIONS

1 ADDRESS OF THE ADDRESSEE

Except in the cases discussed in this Agreement, all the other notifications or any other communications between the Parties shall be delivered in writing, addressed to the indicated person and shall be either:

- Delivered personally;
- Delivered by first class mail;
- Delivered by postal service with a confirmation receipt;

In the case of the SELLER:
(indicate addressee)

In the case of the BUYER:
(indicate addressee)

2 CHANGE OF ADDRESS

Parties pledge to inform each other immediately and in writing, any chang in their address or modification in the addressee of the notificarions.

ARTICLE 23 - CONFIDENTIALITY

1. Each Party, including their employees, consultants and agents shall maintain the confidentiality of all the documents and every other technical or commercial informations delivered by each other directly or in the name of the other Party, related to the project, the construction, insurance , operation, maintenance, management and financing of the FACILITY.

2. The informations and documents obtained according to the terms of the present Agreement shall not be published, disclosed or used by the Parties, their investors, consultants or employees unless its is required to fulfill their obligations under the present Agreement, or except if required by law or judicial decission.

3. The dispositions of this ARTICLE shall not apply to:

- Any information of public knowledge that has not been disclosed by one of the Parties and that does not constitute a violation of the present ARTICLE;

- Any information that is in the hands of the receiving Party before the disclosure mentioned before and that has not been obtained under any confidentiallity obligation; and

- Any information obtained from third parties that can be disclosed and that has not been obtained under confidentiality obligation.

4. The restrictions to this ARTICLE shall not impede the use of similar confidentiality articles to the ones present in this Agreement or in other Contracts hereby mentioned.

ARTICLE 24 - GENERAL DISPOSITIONS

1.HEADINGS
The headings of the Articles of this Agreement shall only be used as a simple reference, and shall not constitute integral part of it or be used for its interpretation.

2.RELATION BETWEEN THE PARTIES
The present Agreement shall not be interpreted in the sense of creating an association, joint-venture, or collective society between the Parties. Parties shall not celebrate agreements, assume obligations, represent or make bindings in the name of the other Party.

3. PARTIAL NULLITY
The total or partial nullity of any articles of this Agreement shall not affect the rest of the articles.

4. PUBLIC ANNOUNCEMENTS
None of the Parties shall make or emit public announcements or revelations related to this Agreement without the consent of the other Party. Notwithstanding, no consent shall be necessary when one of the Parties is obliged to make any public announcements or revelations due to mandate from legal, governmental, regulatory, supervision or judicial authorities.

5. INTEGRAL AGREEMENT
The present Agreement, and its Appendixes, represent the real declaration of the wills of the Parties and substitutes any previous agreement, written or verbal, any offers or other communications of any nature relative to its purpose.

6.DECLARATION
The Parties declare that none of them has taken or will take any action that can cause the other Party, or its shareholders, any penalty, responsibility or loss of benefits derived from the application of the legislation of the Estados Unidos de América related to the practice of corruption acts abroad.

ARTICLE 25 – ARBITRATION

1. The cases that are omitted and the disputes that originate during the execution of this Agreement shall be initially submitted to be solved by representatives of the Load Dispatch Center or by decission of the Directories of the Parties.

2. Only after all mediation procedures have been exhausted to solve the disputes, including the use of experts, and if there is no impediment in the chilean legislation, the Parties agree to settle their dispute by the use of an arbitration that considers the following stipulations.

3. Any Party, after written notification with a receipt confirmation, can require the initiation of an arbitration. The notification must be presented with a minimum

anticipation of thirty days and shall specify the matters on dispute or the right that has been affected.

4. The Parties, upon agreement, shall designate one or more arbitrators to settle the dispute. Meanwhile, if there is no agreement within thirty days after the arbitration notification, the competent authority for the organization and implementation of such procedure shall be President of the International Chamber of Commerce.

5. The arbitrator shall judge the dispute according to chilean legislation applicable to the matters in dispute. In case of any ambiguity in the legislation, the Civil Code shall be applied.

6. The decission of the arbitrator, formalized in writing, shall be final and its fulfillment shall be obligatory, and the Parties shall have no right to appeal it.

7. The costs of the arbitration procedures, including lawyers´ salaries and other costs, shall be assumed in the way determined by the arbitrator .

8. The Parties shall be vinculated to the decission of the arbitration and shall take all necessary measures for its effective compliance.

ARTICLE 26 -GOVERNING LAW

The present Agreement shall be interpreted according to the legislation of the Republic of Chile.

ARTICLE 27 - LANGUAGE

The present Agreement was written in two copies, in spanish and english.

ARTICLE 28 - DOMICILE

Without prejudice to the stipulations in ARTICLE 25, the Parties fix their domicile in the city of ....., and expressly renounce to any other, for the resolution of their conflicts.

THE SELLER **THE BUYER**

WITNESSES

Appendix Q

Simple Development an Construction Plan for the Wind Farm

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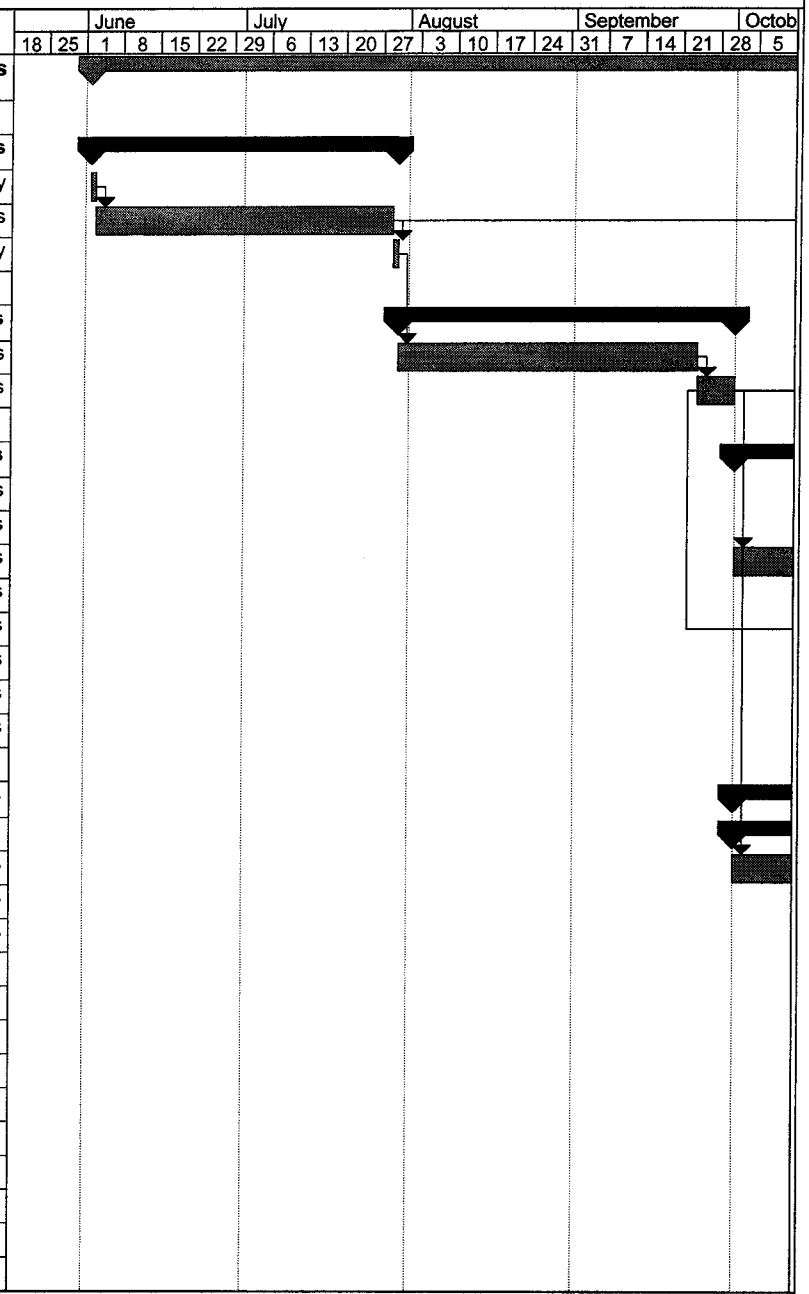
Calama Wind Project

62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
0	**Calama 40 MW Wind Project**	**Mon 6/2/03**	**Fri 4/29/05**	**500 days**
1				
2	**CODELCO ANALYSIS**	**Mon 6/2/03**	**Tue 7/29/03**	**42 days**
3	Receive Final Report	Mon 6/2/03	Mon 6/2/03	1 day
4	Internal Discussion/Meetings	Tue 6/3/03	Mon 7/28/03	40 days
5	Decision on Project Details	Tue 7/29/03	Tue 7/29/03	1 day
6				
7	**DEVELOPMENT PARTNER**	**Wed 7/30/03**	**Tue 9/30/03**	**45 days**
8	Interview/Negotiate with Developer/Manufacturer	Wed 7/30/03	Tue 9/23/03	40 days
9	Finalize terms and agreements	Wed 9/24/03	Tue 9/30/03	5 days
10				
11	**PROJECT AGREEMENTS**	**Wed 10/1/03**	**Wed 10/20/04**	**276 days**
12	Term sheet with Wind Turbine Vendor	Wed 6/9/04	Tue 6/29/04	15 days
13	Construction Loan	Wed 6/9/04	Wed 7/7/04	21 days
14	Power Purchase Agreement	Wed 10/1/03	Tue 2/3/04	90 days
15	General Interconnection Agreement with SING	Wed 3/31/04	Tue 6/8/04	50 days
16	EPC Contract	Wed 11/5/03	Tue 12/30/03	40 days
17	Turbine Warranty	Wed 9/22/04	Wed 10/20/04	21 days
18	Service Agreement with Turbine Manufacturer	Wed 8/25/04	Tue 10/19/04	40 days
19	Maintenance, Operating & Management Agreement	Wed 3/17/04	Tue 5/11/04	40 days
20				
21	**PRE-CONSTRUCTION PHASE**	**Wed 10/1/03**	**Mon 12/27/04**	**324 days**
22	**Permitting**	**Wed 10/1/03**	**Thu 10/21/04**	**277 days**
23	Environmental Impact Studies	Wed 10/1/03	Tue 3/16/04	120 days
24	SEIA Permit	Wed 3/17/04	Tue 6/8/04	60 days
25	Electrical and Civil Works Studies	Wed 11/26/03	Tue 2/17/04	60 days
26	Change of Soil Use Study	Wed 11/26/03	Tue 1/27/04	45 days
27	Provisional Permit Request from SEC	Wed 1/28/04	Tue 3/23/04	40 days
28	Definitive Request from Ministry of Economy	Wed 2/11/04	Tue 4/6/04	40 days
29	Direction of Municipal Works	Fri 8/13/04	Thu 10/7/04	40 days
30	Request for services for interconnection - SING	Wed 10/29/03	Tue 4/13/04	120 days
31	Request for interconnection to transmission CDEC-SI	Wed 10/29/03	Tue 4/13/04	120 days
32	Road crossing permits from Ministry of Public Works	Fri 8/20/04	Thu 10/14/04	40 days
33	Aircraft lighting - Aeronautical General Direction Offic	Wed 2/25/04	Tue 6/8/04	75 days
34	Issuance of Building Permits	Thu 10/21/04	Thu 10/21/04	0 days
35				



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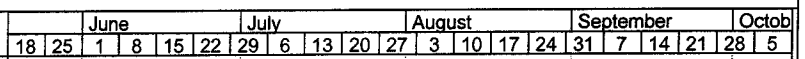
Calama Wind Project

62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
36	**Engineering & Design**	**Wed 10/29/03**	**Thu 8/5/04**	**202 days**
37	**Civil Engineering & Design**	**Wed 10/29/03**	**Thu 8/5/04**	**202 days**
38	Prelim Surveying - Sites	Wed 10/29/03	Tue 11/4/03	5 days
39	Site Road Engineering & Design	Wed 12/31/03	Tue 1/27/04	20 days
40	Foundation Engineering & Design	Fri 7/9/04	Thu 8/5/04	20 days
41	**Electrical Engineering & Design**	**Wed 4/7/04**	**Tue 7/6/04**	**65 days**
42	Site Electrical Engineering & Design	Wed 4/7/04	Tue 5/18/04	30 days
43	CMS Engineering & Design	Wed 6/9/04	Tue 7/6/04	20 days
44	**Turbine Engineering & Design**	**Tue 6/15/04**	**Tue 7/27/04**	**30 days**
45	Receive Approved Foundation Loads from Vend	Tue 7/6/04	Tue 7/6/04	0 days
46	Receive Installation Manual from Vendor	Tue 6/15/04	Tue 6/15/04	0 days
47	Develop Installation Sequencing Plan	Wed 7/14/04	Tue 7/27/04	10 days
48				
49	**Contracts & Material Order**	**Fri 8/6/04**	**Mon 12/27/04**	**102 days**
50	Develop RFP's for Subcontracts	Fri 8/6/04	Thu 8/19/04	10 days
51	**Issue RFP's for Subcontracts**	**Fri 8/20/04**	**Thu 8/26/04**	**5 days**
52	Site Work/ Road Construction	Fri 8/20/04	Thu 8/26/04	5 days
53	Turbine & Transformer Foundations	Fri 8/20/04	Thu 8/26/04	5 days
54	Low & High Voltage Electrical	Fri 8/20/04	Thu 8/26/04	5 days
55	Turbine Installation	Fri 8/20/04	Thu 8/26/04	5 days
56	Major Materials	Fri 8/20/04	Thu 8/26/04	5 days
57	**Receive & Evaluate Bids**	**Fri 9/24/04**	**Thu 10/7/04**	**10 days**
58	Site Work/ Road Construction	Fri 9/24/04	Thu 10/7/04	10 days
59	Turbine & Transformer Foundations	Fri 9/24/04	Thu 10/7/04	10 days
60	Low & High Voltage Electrical	Fri 9/24/04	Thu 10/7/04	10 days
61	Turbine Installation	Fri 9/24/04	Thu 10/7/04	10 days
62	Major Materials	Fri 9/24/04	Thu 10/7/04	10 days
63	**Issue Subcontracts**	**Fri 10/8/04**	**Thu 10/21/04**	**10 days**
64	Site Work/Road Construction	Fri 10/8/04	Thu 10/21/04	10 days
65	Turbine & Transformer Foundations	Fri 10/8/04	Thu 10/21/04	10 days
66	Low & High Voltage Electrical	Fri 10/8/04	Thu 10/21/04	10 days
67	Turbine Installation	Fri 10/8/04	Thu 10/21/04	10 days
68	Major Materials	Fri 10/8/04	Thu 10/21/04	10 days
69	**Major Materials**	**Wed 9/22/04**	**Mon 12/27/04**	**69 days**
70	**Order Major Materials**	**Wed 9/22/04**	**Tue 11/2/04**	**29 days**
71	Foundation Templates	Fri 10/22/04	Fri 10/22/04	0 days



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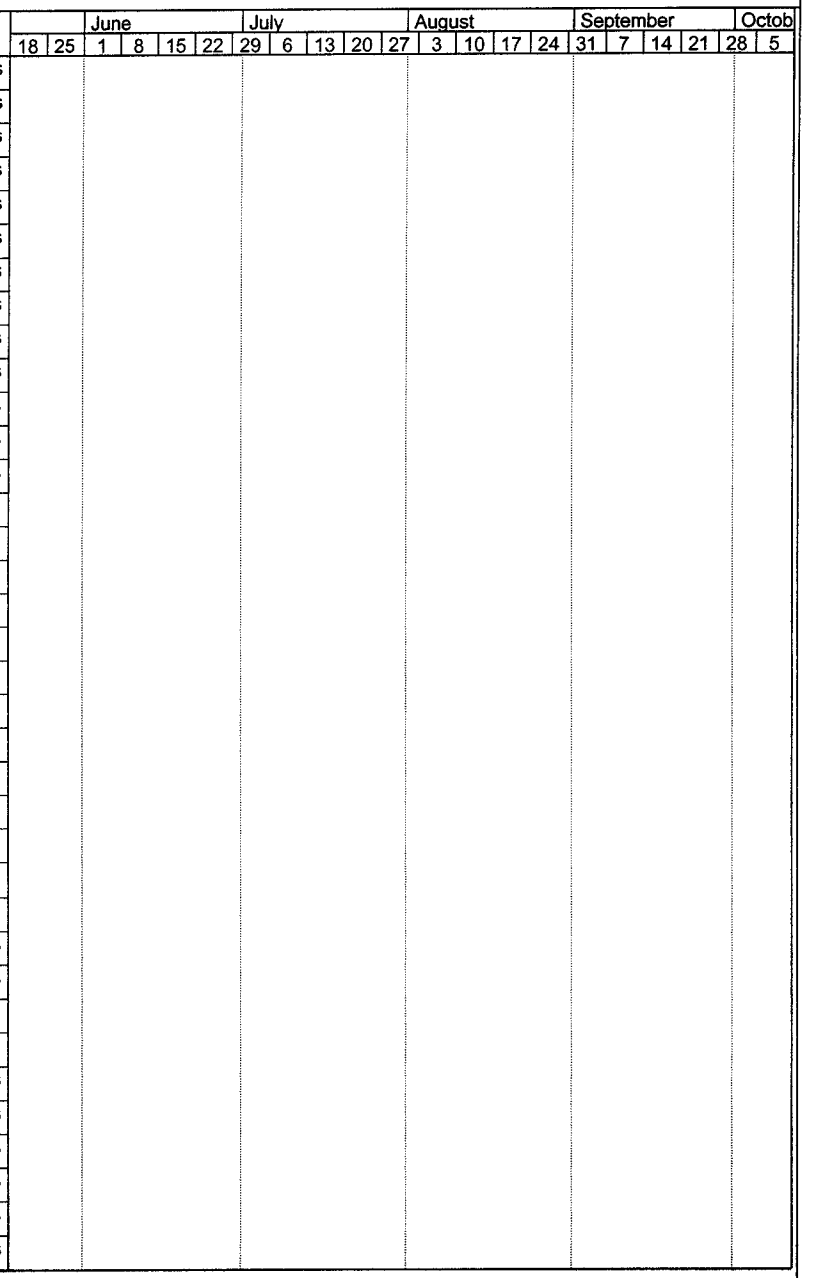
Calama Wind Project

62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
72	Foundation Anchor Bolts & Embedment Rin	Mon 10/18/04	Mon 10/18/04	0 days
73	Foundation CMPs	Mon 10/18/04	Mon 10/18/04	0 days
74	High Voltage Materials	Wed 9/29/04	Wed 9/29/04	0 days
75	High Voltage Cable	Wed 10/6/04	Wed 10/6/04	0 days
76	Turbine Transformers	Wed 9/22/04	Wed 9/22/04	0 days
77	Fiber Optic Cable	Wed 10/6/04	Wed 10/6/04	0 days
78	CMS Hub Building	Fri 10/29/04	Fri 10/29/04	0 days
79	CMS Network Hardware	Fri 10/29/04	Fri 10/29/04	0 days
80	CMS Computer Hardware	Tue 11/2/04	Tue 11/2/04	0 days
81	CMS Software	Tue 10/19/04	Tue 10/19/04	0 days
82	**Manufacture and Ship Major Materials**	**Wed 9/22/04**	**Mon 12/27/04**	**69 days**
83	Foundation Templates	Fri 10/22/04	Thu 12/9/04	7 wks
84	Foundation Anchor Bolts & Embedment Rin	Mon 10/18/04	Fri 12/10/04	8 wks
85	Foundation CMPs	Mon 10/18/04	Fri 12/10/04	8 wks
86	High Voltage Materials	Wed 9/29/04	Tue 12/14/04	11 wks
87	High Voltage Cable	Wed 10/6/04	Tue 12/14/04	10 wks
88	Turbine Transformers	Wed 9/22/04	Tue 12/14/04	12 wks
89	Fiber Optic Cable	Wed 10/6/04	Tue 12/14/04	10 wks
90	CMS Hub Building	Fri 10/29/04	Thu 12/23/04	8 wks
91	CMS Network Hardware	Fri 10/29/04	Thu 12/23/04	8 wks
92	CMS Computer Hardware	Tue 11/2/04	Mon 12/27/04	8 wks
93	CMS Software	Tue 10/19/04	Mon 12/27/04	10 wks
94				
95				
96	**BOP CONSTRUCTION PHASE**	**Fri 10/22/04**	**Wed 4/27/05**	**134 days**
97	**Construction Site Mobilization**	**Fri 10/22/04**	**Tue 10/26/04**	**3 days**
98	CM Site Office Mobilization	Fri 10/22/04	Tue 10/26/04	3 days
99	Temporary Site Utilities & Services	Fri 10/22/04	Tue 10/26/04	3 days
100				
101	**Site Work**	**Wed 10/27/04**	**Wed 4/27/05**	**131 days**
102	Road/Site Work Contractor Mobilization	Wed 10/27/04	Fri 10/29/04	3 days
103	Initial Site Clean-Up	Mon 11/1/04	Tue 11/9/04	7 days
104	Survey Access and Site Road Alignment	Wed 10/27/04	Tue 11/2/04	5 days
105	Road Staking	Wed 10/27/04	Tue 11/2/04	5 days
106	Turbine Pad Staking	Wed 10/27/04	Tue 11/9/04	10 days
107	Preliminary Site Inspection	Tue 11/9/04	Tue 11/9/04	0 days



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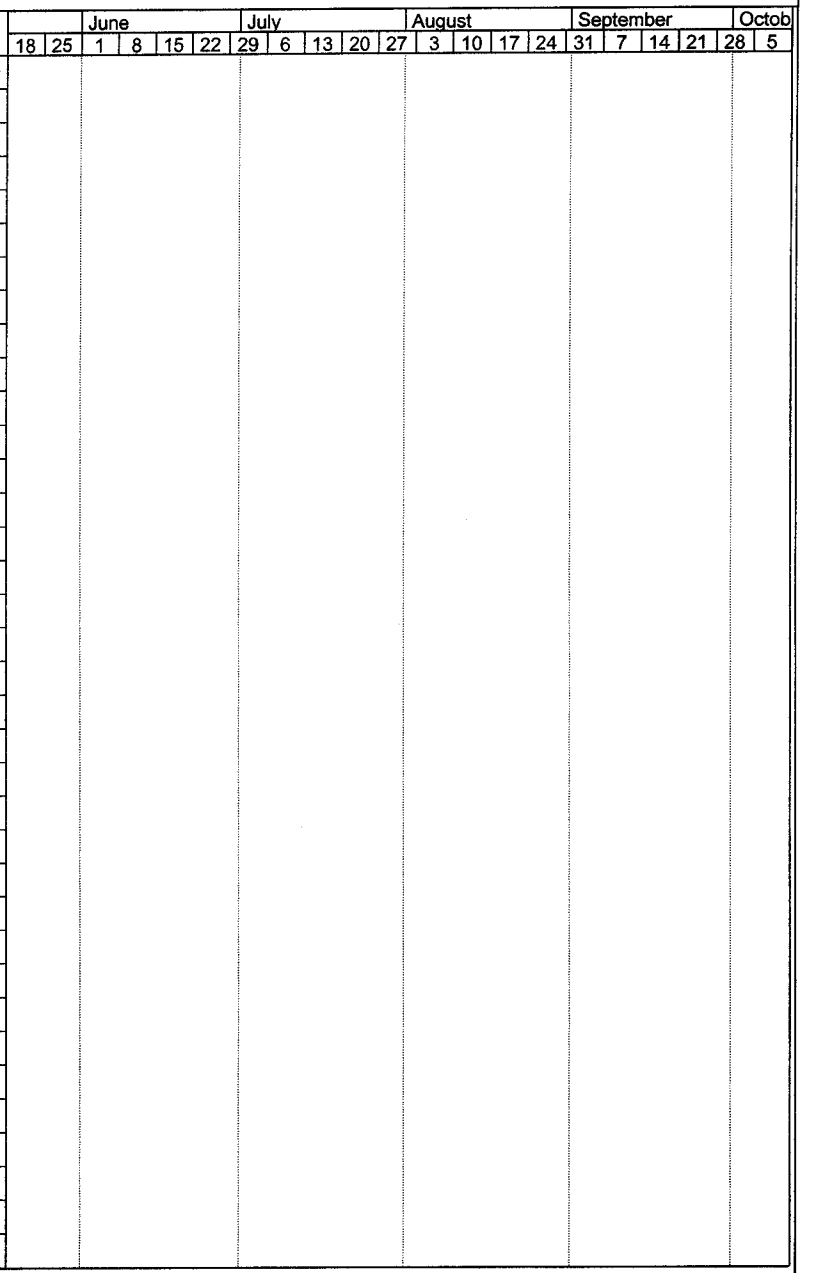
Calama Wind Project

62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
108	Rough-Cut Access/Site Roads	Wed 11/10/04	Tue 11/23/04	10 days
109	Base Access/Site Roads	Wed 11/24/04	Tue 12/7/04	10 days
110	Final Site Roads	Mon 4/11/05	Fri 4/22/05	10 days
111	Final Site Cleanup & Reclamation	Mon 4/11/05	Fri 4/22/05	10 days
112	Road/Site Work Contractor Demobilization	Mon 4/25/05	Wed 4/27/05	3 days
113				
114	**Foundation Installation**	**Wed 12/8/04**	**Tue 2/8/05**	**45 days**
115	Foundation Contractor Mobilization	Wed 12/8/04	Fri 12/10/04	3 days
116	Receive Template Rings	Fri 12/10/04	Fri 12/10/04	1 day
117	Receive Foundation Materials	Mon 12/13/04	Fri 12/31/04	15 days
118	Foundation Excavation	Mon 12/13/04	Fri 1/21/05	30 days
119	Haul Spoils	Tue 12/14/04	Mon 1/24/05	30 days
120	Set Outer Foundation CMPs	Tue 12/14/04	Mon 1/24/05	30 days
121	Backfill/Slurry Outer CMPs	Tue 12/14/04	Mon 1/24/05	30 days
122	Set Inner CMPs & A-Bolts	Wed 12/15/04	Tue 1/25/05	30 days
123	Pour WTG Foundations	Thu 12/16/04	Wed 1/26/05	30 days
124	Pour Transformer Foundations	Thu 12/16/04	Wed 1/26/05	30 days
125	Remove & Relocate Foundation Templates	Fri 12/17/04	Thu 1/27/05	30 days
126	Foundation Cleanup	Mon 12/20/04	Fri 1/28/05	30 days
127	**Foundation Completion**	**Thu 12/23/04**	**Thu 2/3/05**	**30 days**
128	Complete First 11 Foundations	Thu 12/23/04	Thu 12/23/04	0 days
129	Complete Next 11 Foundations	Fri 12/31/04	Fri 12/31/04	0 days
130	Complete Next 11 Foundations	Mon 1/10/05	Mon 1/10/05	0 days
131	Complete Next 11 Foundations	Tue 1/18/05	Tue 1/18/05	0 days
132	Complete Next 11 Foundations	Wed 1/26/05	Wed 1/26/05	0 days
133	Complete Last 7 Foundation	Thu 2/3/05	Thu 2/3/05	0 days
134	Foundation Contractor Demobilization	Fri 2/4/05	Tue 2/8/05	3 days
135				
136	**Electrical System Installation**	**Mon 11/22/04**	**Fri 3/11/05**	**80 days**
137	**Upgrade Substation**	**Mon 11/22/04**	**Fri 3/11/05**	**80 days**
138	Substation Construction	Mon 11/22/04	Fri 3/11/05	80 days
139	**High Voltage Electrical Installation**	**Wed 12/8/04**	**Wed 2/2/05**	**41 days**
140	High Voltage Contractor Mobilization	Wed 12/8/04	Tue 12/14/04	5 days
141	Receive Underground Cable	Wed 12/15/04	Tue 12/21/04	5 days
142	Receive High Voltage Materials	Wed 12/15/04	Tue 12/28/04	10 days
143	Receive Transformers	Wed 12/15/04	Tue 1/4/05	15 days



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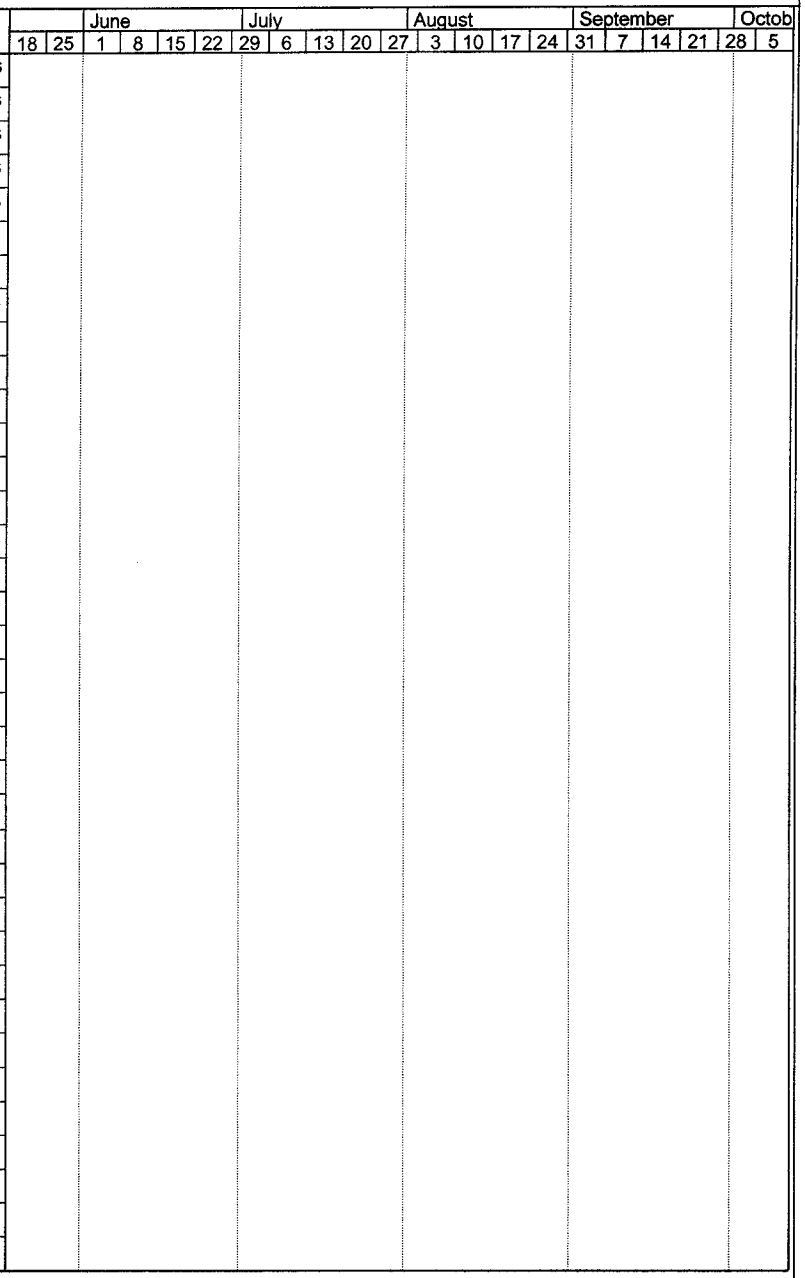
ID	Task Name	Start	Finish	Duration
144	Set Transformers	Mon 1/3/05	Fri 1/21/05	15 days
145	Trench for Underground Cable	Fri 12/24/04	Thu 1/27/05	25 days
146	Install Underground HV Cables	Mon 12/27/04	Fri 1/28/05	25 days
147	Bore Under I-10	Wed 12/15/04	Tue 1/4/05	15 days
148	Transformer Terminations	Thu 1/6/05	Wed 2/2/05	20 days
149				
150	**Communication & Monitoring System**	**Wed 12/15/04**	**Thu 3/3/05**	**57 days**
151	Receive Fiber Optic Cable	Wed 12/15/04	Tue 12/21/04	5 days
152	Build Pad for Hub Building	Wed 12/22/04	Thu 12/23/04	2 days
153	Receive and Set Hub Building	Fri 12/24/04	Mon 12/27/04	2 days
154	Receive CMS Network Hardware	Fri 12/24/04	Thu 1/13/05	15 days
155	Receive CMS Computer Hardware	Tue 12/28/04	Mon 1/10/05	10 days
156	Receive CMS Software	Tue 12/28/04	Tue 12/28/04	1 day
157	Install Fiber Optic Cable	Fri 12/24/04	Thu 1/27/05	25 days
158	Splice & Terminate Fiber Optic Cable	Fri 1/21/05	Thu 2/3/05	10 days
159	Install Network Hardware	Fri 1/28/05	Thu 2/3/05	5 days
160	Install & Configure Computer Systems	Fri 2/4/05	Thu 2/10/05	5 days
161	Test Network	Fri 2/11/05	Thu 2/17/05	5 days
162	Test Installation	Fri 2/18/05	Thu 2/24/05	5 days
163	Test System (incl. BOP Performance Test)	Fri 2/25/05	Thu 3/3/05	5 days
164				
165				
166	**TURBINE INSTALLATION PHASE**	**Mon 12/27/04**	**Fri 4/8/05**	**75 days**
167	**Turbine Delivery, Staging & Prep**	**Mon 12/27/04**	**Fri 2/18/05**	**40 days**
168	Turbine Installation Contractor Mobilization	Mon 12/27/04	Mon 1/3/05	5 days
169	Receive 11 Controllers	Mon 1/3/05	Fri 1/7/05	5 days
170	Receive 11 Controllers	Mon 1/10/05	Fri 1/14/05	5 days
171	Receive 11 Controllers	Mon 1/17/05	Fri 1/21/05	5 days
172	Receive 11 Controllers	Mon 1/24/05	Fri 1/28/05	5 days
173	Receive 11 Controllers	Mon 1/31/05	Fri 2/4/05	5 days
174	Receive 7 Controllers	Mon 2/7/05	Fri 2/11/05	5 days
175	Receive/Stage 9 Bottom Tower Sections	Mon 1/3/05	Fri 1/7/05	5 days
176	Receive/Stage 9 Bottom Tower Sections	Mon 1/10/05	Fri 1/14/05	5 days
177	Receive/Stage 9 Bottom Tower Sections	Mon 1/17/05	Fri 1/21/05	5 days
178	Receive/Stage 9 Bottom Tower Sections	Mon 1/24/05	Fri 1/28/05	5 days
179	Receive/Stage 9 Bottom Tower Sections	Mon 1/31/05	Fri 2/4/05	5 days



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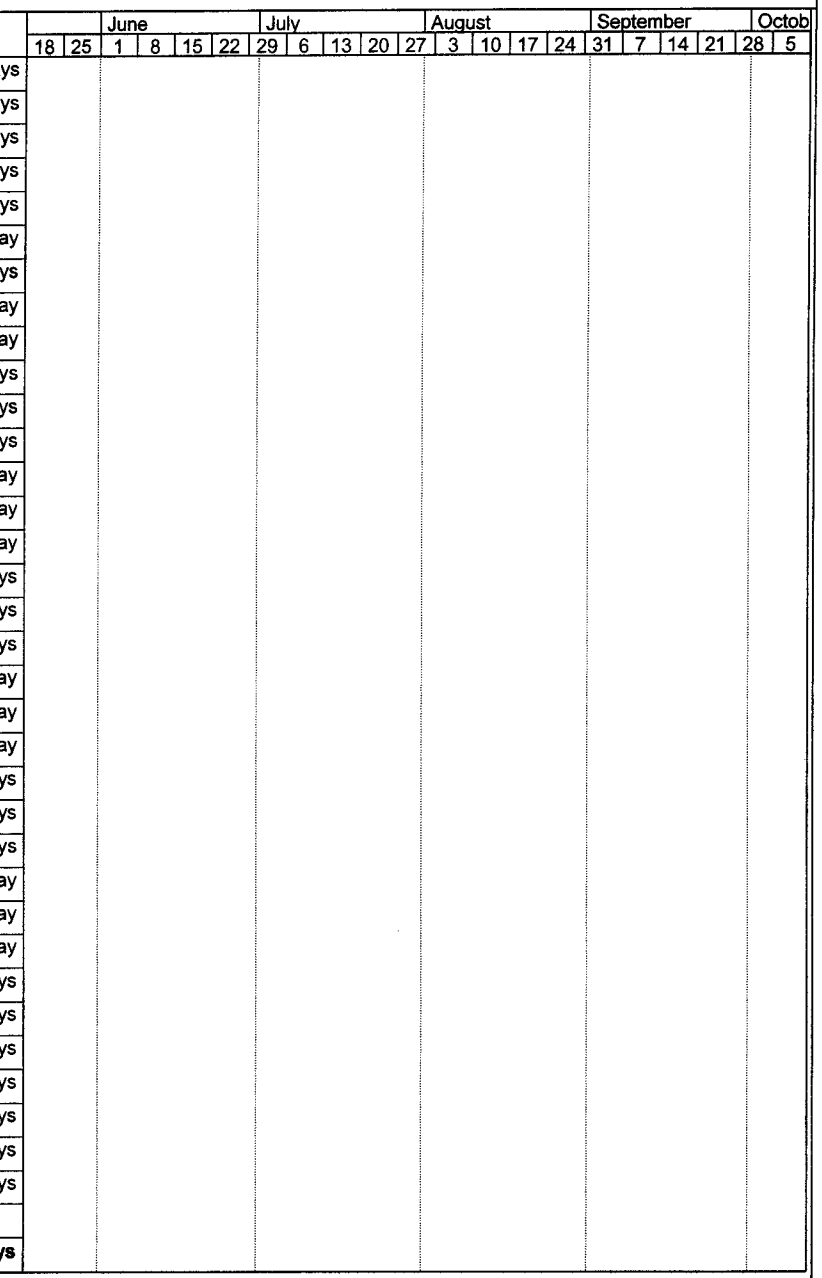
62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
180	Receive/Stage 9 Bottom Tower Sections	Mon 2/7/05	Fri 2/11/05	5 days
181	Receive/Stage 8 Bottom Tower Sections	Mon 2/14/05	Fri 2/18/05	5 days
182	Receive/Stage 9 Mid Tower Sections	Mon 1/3/05	Fri 1/7/05	5 days
183	Receive/Stage 9 Mid Tower Sections	Mon 1/10/05	Fri 1/14/05	5 days
184	Receive/Stage 9 Mid Tower Sections	Mon 1/17/05	Fri 1/21/05	5 days
185	Receive/Stage 9 Mid Tower Sections	Mon 1/24/05	Mon 1/24/05	1 day
186	Receive/Stage 9 Mid Tower Sections	Tue 1/25/05	Mon 1/31/05	5 days
187	Receive/Stage 9 Mid Tower Sections	Tue 2/1/05	Tue 2/1/05	1 day
188	Receive/Stage 8 Mid Tower Sections	Wed 2/2/05	Wed 2/2/05	1 day
189	Receive/Stage 9 Top Tower Sections	Mon 1/3/05	Fri 1/7/05	5 days
190	Receive/Stage 9 Top Tower Sections	Mon 1/10/05	Fri 1/14/05	5 days
191	Receive/Stage 9 Top Tower Sections	Mon 1/17/05	Fri 1/21/05	5 days
192	Receive/Stage 9 Top Tower Sections	Mon 1/24/05	Mon 1/24/05	1 day
193	Receive/Stage 9 Top Tower Sections	Tue 1/25/05	Tue 1/25/05	1 day
194	Receive/Stage 9 Top Tower Sections	Wed 1/26/05	Wed 1/26/05	1 day
195	Receive/Stage 8 Top Tower Sections	Thu 1/27/05	Wed 2/2/05	5 days
196	Receive/Stage 11 Nacelles and Hubs	Mon 1/3/05	Fri 1/7/05	5 days
197	Receive/Stage 11 Nacelles and Hubs	Mon 1/10/05	Fri 1/14/05	5 days
198	Receive/Stage 11 Nacelles and Hubs	Mon 1/17/05	Mon 1/17/05	1 day
199	Receive/Stage 11 Nacelles and Hubs	Tue 1/18/05	Tue 1/18/05	1 day
200	Receive/Stage 11 Nacelles and Hubs	Wed 1/19/05	Wed 1/19/05	1 day
201	Receive/Stage 7 Nacelles and Hubs	Thu 1/20/05	Wed 1/26/05	5 days
202	Receive/Stage 11 Sets of Blades	Mon 1/3/05	Fri 1/7/05	5 days
203	Receive/Stage 11 Sets of Blades	Mon 1/10/05	Fri 1/14/05	5 days
204	Receive/Stage 11 Sets of Blades	Mon 1/17/05	Mon 1/17/05	1 day
205	Receive/Stage 11 Sets of Blades	Tue 1/18/05	Tue 1/18/05	1 day
206	Receive/Stage 11 Sets of Blades	Wed 1/19/05	Wed 1/19/05	1 day
207	Receive/Stage 7 Sets of Blades	Thu 1/20/05	Wed 1/26/05	5 days
208	Prepare Bottom Tower Sections	Tue 1/4/05	Mon 1/31/05	20 days
209	Prepare Mid Tower Sections	Tue 1/4/05	Mon 1/31/05	20 days
210	Prepare Top Tower Sections	Tue 1/4/05	Mon 1/31/05	20 days
211	Inspect Blades	Tue 1/4/05	Mon 1/24/05	15 days
212	Inspect/Prep Nacelles	Tue 1/4/05	Mon 2/7/05	25 days
213	Assemble Rotors	Tue 1/11/05	Mon 2/14/05	25 days
214				
215	**Turbine Installation**	**Thu 1/6/05**	**Fri 4/8/05**	**67 days**



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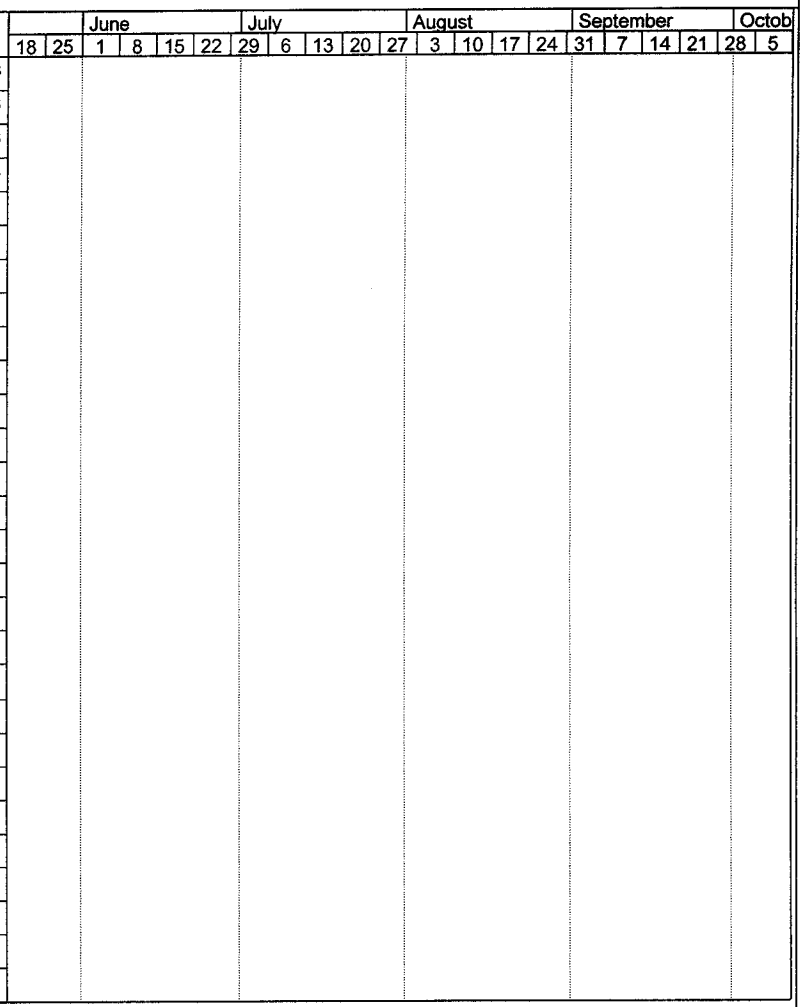
62 - 600kw Turbines

Prelim. Construction Project Schedule

ID	Task Name	Start	Finish	Duration
216	Install WTG Controllers	Thu 1/6/05	Thu 3/3/05	40 days
217	Set & Grout Bottom Tower Sections	Thu 1/6/05	Wed 3/2/05	40 days
218	Set Mid Tower Sections	Mon 1/10/05	Fri 3/4/05	40 days
219	Set Top Tower Sections	Mon 1/10/05	Fri 3/4/05	40 days
220	Set Nacelles	Mon 1/10/05	Fri 3/4/05	40 days
221	Set Rotors	Mon 1/10/05	Fri 3/4/05	40 days
222	Torque Mid-Section, Upper Tower, and Nacelle Bolts	Thu 1/13/05	Wed 3/9/05	40 days
223	Grout Knockouts	Mon 2/21/05	Fri 3/4/05	10 days
224	Stretch Foundation Anchor Bolts	Mon 2/21/05	Fri 3/18/05	20 days
225	Paint Foundation Bolts & Miscellaneous Work	Mon 3/21/05	Fri 4/1/05	10 days
226	Turbine Installation Contractor Demobilization	Mon 4/4/05	Fri 4/8/05	5 days
227				
228	**Turbine Electrical**	**Mon 1/10/05**	**Tue 3/22/05**	**52 days**
229	WTG Controller Terminations	Mon 1/10/05	Fri 3/4/05	40 days
230	WTG Upper & Lower Terminations	Mon 1/17/05	Fri 3/11/05	40 days
231	Pre-Commissioning Work	Mon 1/24/05	Fri 3/18/05	40 days
232	Final Commissioning Work	Wed 1/26/05	Tue 3/22/05	40 days
233				
234	**FINAL ACCEPTANCE PHASE**	**Tue 2/8/05**	**Fri 4/29/05**	**58 days**
235	Turbine Acceptance Test	Tue 2/8/05	Tue 2/22/05	14 edays
236	BOP Performance Tests	Wed 3/23/05	Tue 4/5/05	10 days
237	Project Acceptance Test	Tue 4/5/05	Tue 4/19/05	14 edays
238	Final Construction Punch List	Mon 3/21/05	Fri 3/25/05	5 days
239	Site Acceptance & Sign Off	Mon 3/28/05	Tue 3/29/05	2 days
240	Substantial Completion	Tue 4/5/05	Tue 4/5/05	0 days
241	Construction Turnover to Operations	Tue 4/5/05	Tue 4/5/05	0 days
242	Complete Construction Punch List	Wed 4/6/05	Tue 4/19/05	10 days
243	CM Site Demobilization	Mon 4/25/05	Fri 4/29/05	5 days

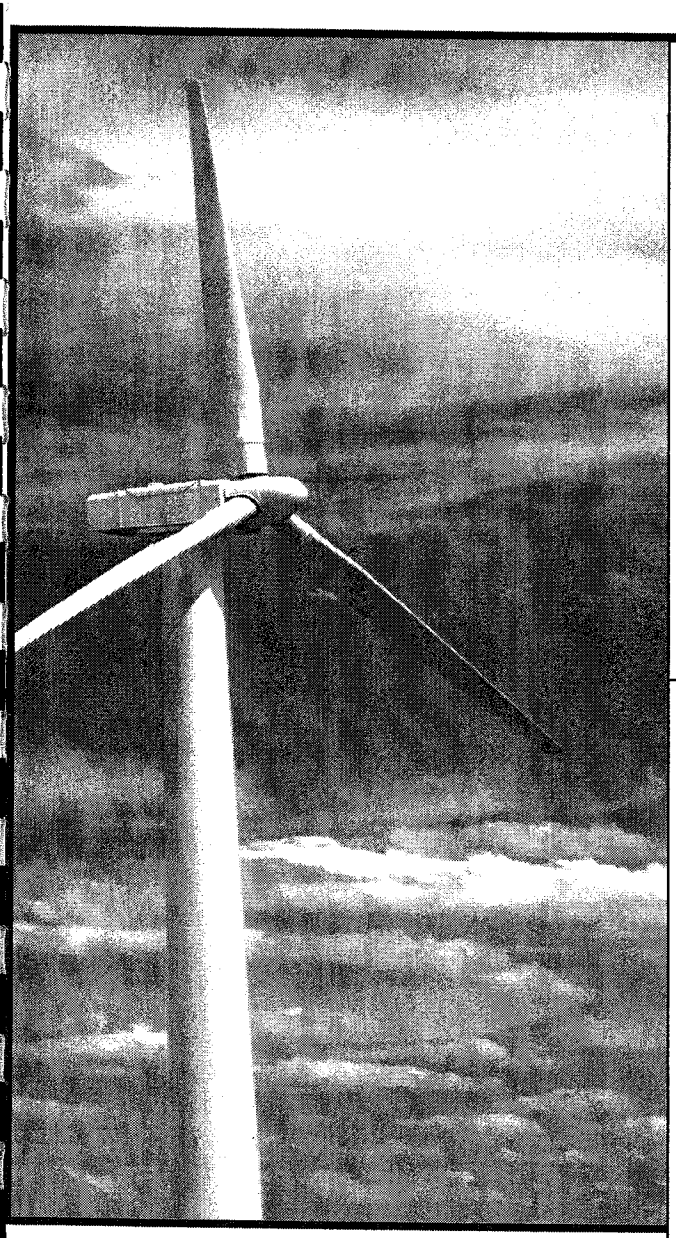


Revision 1 - April 23, 2003

Printed: Wed 5/26/04

Appendix R

Operations and Maintenance Plan for the Wind Farm



CODELCO
Operating Plan

SEAWEST

WindPower for a clean future℠

DEVELOPMENT · CONSTRUCTION · OPERATIONS AND MAINTENANCE · FINANCING

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OPERATING PLAN

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OPERATING PLAN

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Exhibit D	-	Organization Chart - Service Division
Exhibit E	-	Job Descriptions - Service Division
Exhibit F	-	Extended Maintenance Schedule
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Exhibit H	-	Project Budget

1. EXECUTIVE SUMMARY

This document describes a preliminary plan for operation and maintenance of the CODELCO wind power plant. The Operating Plan includes information regarding Plant staffing, maintenance plans, historical information, operating budget, and other information pertinent to the operation of the Plant.

2. DELIVERY OF OPERATING PLAN

The Operating Plan should be prepared and distributed initially prior to the Substantial Completion of the Plant, and thereafter, on or before October 1st of each year.

2.1. Operating Plan Distribution List

The operating plan is typically distributed to the plant owner as well as to all operations and maintenance personnel. In the case of Codelco, the distribution list would be developed in conjunction with Codelco and attached in Exhibit A.

2.2. Operating Plan Revision Notice

If the Operating Plan is revised during the Operating Period, a formal revision must be prepared and sent to all parties on the distribution list using the Operating Plan Revision Notice form, a copy of which is given in Exhibit B.

3. ORGANIZATION, STAFFING AND TRAINING

This section of the Operating Plan provides information about the structure of the Service Division and the staff dedicated to the operation and maintenance of the Plant.

3.1. Organization

3.1.1. Organization Chart – Service Division

An organization chart for the service group responsible for operation and maintenance of the Plant is given in Exhibit D.

3.2. Staffing And Training

This section describes staffing requirements for the Plant, typical personnel job descriptions and training information.

3.2.1. General Wind Plant Staffing

Staffing requirements for field personnel are based on the number of units installed on a commercial project and the expected workload to maintain the units. Initially there should be six technicians to maintain the daily technical tasks required for the Plant. At least four of the technicians will have a Technician C rating or higher. A General Manager, Data Analyst and Administrative Assistant are recommended to provide additional project support on site.

General operating hours for a service division are 7:00AM to 3:30PM, with management staff available from 8:00AM to 5:00PM, Monday through Friday. Additionally, weekend support and 24-hour on-call services are required.

3.2.2. Job Descriptions – Service Division

Typical job descriptions for Services Division field personnel are given in Exhibit E attached.

3.3. Planned Training

Field personnel should be trained in mechanical, electrical, and hydraulic principals. During the early stage of project operation, the focus is on development of turbine-specific parameters (e.g., torque specs, operational parameters, etc.). Typically all turbine technicians are trained at another wind power facility for a period of 4-6 months prior to the mechanical completion and commissioning of the facility. The technicians then participate in the commissioning of the facility and long-term operations and maintenance.

4. GENERAL O&M PROCEDURES

4.1. Summary of Planned Operations

The following summarizes the planned operation activities of the Plant:

- Monitoring and reporting of the Wind Turbine and Plant operation and performance.
- Monitoring and reporting on the service work and warranty repairs on the Wind Turbines performed by the Wind Turbine supplier.
- Monitoring and reporting of local and remote Wind Turbine resets (local at the turbine, remote at the operations center).
- Monitoring, investigation, and reporting on Wind Turbine warranty issues.
- Monitoring forecasting and reporting on actual Plant production.
- Monitoring and reporting on Interconnection Facilities operations including switching, meter reads, scheduled and unscheduled outages.
- Monitoring and reporting on Balance of Plant repairs.

A more exhaustive description of the Plant operations requirements is given in the Outline of Operator's Specific Contractual Responsibilities in Exhibit C attached.

4.2. Outline of Operator's Specific Contractual Responsibilities

Prior to Substantial Completion of the Plant, an Outline of Operator's Specific Contractual Responsibilities will be developed. This document will list all the administrative and operating requirements pertaining to the Plant that are specified in various contract documents. A sample checklist is given in Exhibit C.

4.3. O&M Procedures Manual

An O&M Procedures Manual will be prepared that contains written operations and maintenance procedures for the Plant, largely related to the operations and maintenance of the Balance of Plant

equipment. This manual also contains results of tests conducted on the Plant, and general information about the Plant.

4.4 Wind Turbine Instruction Manual

The Wind Turbine Generator Instruction Manual (the "Turbine Instruction Manual") is provided by the Wind Turbine manufacturer. The Turbine Instruction Manual accurately represents and details the specific maintenance, troubleshooting and operating procedures to be performed on the Wind Turbines. The operating procedures given in the manual include, but are not limited to, the error list, the parameter list, the description of the menu system, a functional description of the Wind Turbines, a description of the data monitoring features of the controller, and a definition of the start-up sequence of the Wind Turbine. All operations and maintenance of the Wind Turbines is performed in accordance with the Turbine Instruction Manual.

4.5 As Built Drawings and Equipment Specifications

The As Built Drawings and Equipment Specifications are prepared by the EPC Contractors or their Subcontractors and provided to the Plant operator. These documents and drawings are intended to accurately and completely represent in detail (a) the physical placement of all Wind Turbines as assembled, erected and installed, (b) the physical placement of all Balance of Plant equipment as assembled, erected and installed, and (c) the specifications for all Balance of Plant equipment installed as part of the Plant.

4.6 Drawing Addendum

The drawing addendum for the Turbine Instruction Manual (the "Drawing Addendum") contains specific drawings necessary to support and explain the procedures to be carried out in the Turbine Instruction Manual. The Drawing Addendum is compiled by the EPC Contractors and provided to the Plant Operator for reference. The Plant operator should be familiar with the contents of the Drawing Addendum, as some procedures for the operations, maintenance and repair of the Wind Turbines that are given in the Wind Turbine Instruction Manual are supplemented by information contained in the Drawing Addendum.

5. SUMMARY RESULTS FROM LAST PERIOD and APPLICATION TO FUTURE PERIODS

5.1. Prior Period(s) Results

This section presents some information and statistics about the performance of the Plant during the prior Operating Period(s). This information is primarily used to assess whether modifications to the Plant operation or maintenance practices are necessary or desirable to improve performance, reduce downtime or minimize future problems and repairs.

5.1.1. Actual Versus Expected Performance

During the first Operating Period, there is no prior period data to present. In subsequent Operating Plans, this section will present summary performance information from the Plant with the idea of highlighting

issues that cause us to evaluate whether modifications to the Plant operation or maintenance practices are necessary or desirable.

5.1.2. Downtime Summary

During the first Operating Period, there is no prior period data to present. In subsequent Operating Plans, this section will present summary information about downtime of the Plant, used to evaluate whether modifications to the Plant operation or maintenance practices are necessary or desirable.

5.1.3. Significant Events

During the first Operating Period, there is no prior period data to present. In subsequent Operating Plans, this section will present information about significant events that occurred at the Plant (such as a gear box failure or a safety accident), used to evaluate whether modifications to the Plant operation or maintenance practices are necessary or desirable.

5.1.4. Manufacture Initiated Wind Turbine Modifications and Retrofits

During the first Operating Period, there is no prior period data to present. In subsequent Operating Plans, this section will present summary information concerning modifications to the wind turbines made by the manufacturer, which may necessitate modifications to the Plant operation or maintenance practices.

5.2. Impact of Prior Results on Future Plans

During the first Operating Period, there is no prior period information to analyze. In subsequent Operating Plans, this section will discuss modifications to the Plant operation or maintenance practices that are necessary or desirable based on Plant performance or events that occurred in prior Operating Period(s). This section will also include any changes to the operations and maintenance practices that were implemented during the prior Operating Period and the basis for such changes.

6. WIND PLANT MAINTENANCE PLANS

6.1. Maintenance Plan

This section describes the suggested maintenance plan for the Plant equipment and infrastructure during the Operating Period.

6.1.1. Wind Turbine Maintenance

Two maintenance cycles should take place during the first Operating Period. The first maintenance performed will be the 500-hour maintenance. The 500-hour maintenance will begin when the wind turbine generators have accumulated 500 hours of operation. Operational hours are hours that the wind turbine generator produces energy. Available hours do not constitute operational hours. The estimated time frame for the 500-hour maintenance is three to four months. Following the 500-hour maintenance is the 1st half-year maintenance that should be completed within two to three months. Both the 500-hour maintenance and the 1st half-year maintenance of the wind turbines will be performed in accordance with procedures set forth in the O&M Procedures Manual and the Wind Turbine Instruction Manual.

6.1.2. Blade Cleaning

Blade cleaning will be performed when needed. Turbine performance is measured to determine the need for blade cleaning. During the first operating period, trends in project efficiency have not been established and, therefore, a schedule for blade cleaning during the first operating period has not been developed. Typically blade cleaning is performed during periods when expected project output is the greatest.

6.1.3. Transformer Maintenance

Transformer maintenance is scheduled on an annual basis. After the first transformer maintenance an annual maintenance cycle will be established. Scheduled power outages are required to perform transformer maintenance. Transformer maintenance should be scheduled during Off Peak periods to avoid lost energy production.

6.1.4. Utility Interconnect Maintenance

Utility interconnect maintenance is scheduled on an annual basis. After the first utility interconnect maintenance is scheduled, an annual maintenance cycle should be established. Establishing a maintenance schedule that coincides with that of the transformer maintenance reduces the number of scheduled power outages required to complete both tasks.

6.1.5. Meteorological Station Maintenance

Meteorological ("met") station maintenance should be scheduled in the first year of Operation.

6.1.6 Communications Network Maintenance

A "Software Maintenance Warranty" from the manufacturer would be effective for the first twelve-months of operations. The warranty includes full version upgrades to software, service pack upgrades, diagnostic white papers, and technical telephone support.

The project SCADA system monitors the performance of the communications network. Additional precautions include cleaning of the communications hub building and computer hardware.

6.1.7 Site Roads & Other Civil Works

Inspections of the site roads and the Plant's boundary fencing should be performed regularly. The date and comments associated with the inspection are recorded in a logbook. The service group promptly addresses maintenance and repair needs identified during the inspections.

6.2. Extended Maintenance Schedule

An extended maintenance schedule showing a proposed maintenance schedule and activities for the next 5 years is given in Exhibit F.

7. PLANNED REPAIRS, RETROFITS, UPGRADES OR REPLACEMENTS

There would be no major repairs, retrofits, upgrades or replacements planned for the Plant equipment during the first Operating Period. The Plant equipment is new and covered under various warranties.

8. INVENTORY STATUS AND EXPECTED PARTS USAGE

This section describes the parts inventory status and parts usage for the Plant.

8.1 Parts Inventory, Cost and Lifetime

An initial inventory of wind turbine spare parts and an initial inventory of the balance of plant spare parts that will be on the Plant site as of the Substantial Completion Date are given in Exhibits G and H, respectively.

8.2 Parts Usage History

During the first Operating Period, there is no prior period information about parts usage to present. In subsequent Operating Plans, this section would present data concerning parts usage at the Plant, with the goal of determining appropriate inventory levels for the current operating period.

8.3 Expected Parts Usage This Period

Since this is the first operating period, data to support expected parts usage is not available. In the first operating period trends will be established allowing assumptions to made on expected parts usage for the subsequent operating period.

9. PROPOSED OPERATING BUDGET

A budget for the Operating Period is given in Exhibit H.

10. TESTING ACTIVITIES

Several tests will be conducted during the first Operating Period on the Plant as a whole or on specific components of the Plant. These tests are discussed in this section.

10.1. Project Acceptance Tests

A Project Acceptance Test will be conducted to evaluate the overall performance capability of the Plant. This test will be conducted in accordance with standard procedures and will commence after Substantial Completion and after all the wind turbine controllers have been programmed with the final correction factors determined from the Wind Turbine Anemometer Correlation Procedure. It is expected that this test will take about 15 days to complete, depending on wind conditions.

10.2 Project Site Calibration

The purpose of the Project Site Calibration is to determine the difference in the wind resource ("Flow Distortion") between a permanent meteorological tower installed approximately 2.5 rotor diameters upwind of a test wind turbine (the "Test WTG") and a temporary meteorological tower installed at the Test WTG location. Concurrent wind speed and wind direction data will be collected from both meteorological towers. A Flow Distortion Correction Factor will be developed from the data collected and used to determine the free stream wind speed ("FSWS") at the Test WTG location after the temporary meteorological mast has been removed. Calculating the hub height FSWS at the Test WTG location can be performed at any time during the life of the project by applying the Flow Distortion Correction Factor to the hub height FSWS at the permanent meteorological mast. The result being the adjusted free stream

wind speed ("AFSWS") from the permanent meteorological mast, which will be considered the best estimation of the FSWS at the Test WTG location.

10.3. Wind Turbine Initial Performance Tests

After erection and commissioning of each wind turbine, the on-site Initial Performance Test of the wind turbines will be completed. Passing the Initial Performance Tests with respect to a fully assembled wind turbine, and the equipment associated therewith, means achieving the following milestones:

- The wind turbine is mechanically complete;
- All equipment associated with such fully assembled wind turbine has been properly assembled, erected, installed and tested in accordance with the technical specifications and other contract requirements, and is mechanically, electrically and structurally sound as set forth in such equipment's technical specifications and the contract requirements, and can be used safely in accordance with the contract documents for the Project (including any warranties), applicable laws and good utility industry practice(s); and
- All items of the work necessary to connect such wind turbine to the interconnection facilities have been completed and the wind turbine generated positive power.

10.4 Wind Turbine Acceptance Test

The Turbine Acceptance Test is a comparison of the measured nominal energy yield (the measured power output from the Test WTG combined with the nominal wind speed distribution for the Project site) to the warranted nominal energy yield (the warranted power curve combined with the nominal wind speed distribution for the Project site). This test is usually performed before the Wind Turbine Anemometer Correlation (see 4. below). The Turbine Acceptance Test will commence after the completion of the Initial Performance Test of the Test WTG.

A permanent meteorological mast will be located 2.5 rotor diameters away from the Test WTG. Sensors on the permanent meteorological mast will include a calibrated anemometer located at hub height, wind direction, temperature and pressure sensors. A wind turbine anemometer (WTA) will be mounted on the Test WTG nacelle. Wind Turbine power will be measured using a set of current transformers and a calibrated watt transducer.

Data consisting of the hub height free stream wind speed (FSWS), wind direction, temperature, and pressure from sensors located on the permanent met tower, and the wind turbine anemometer wind speed (WTAWS) and turbine power output from the Test WTG will be recorded. Correction factors will be applied to the measured wind speeds recorded at the permanent anemometer for topographic effects at the Test WTG locations (Flow Distortion Correction Factor). The correction factors will be calculated during the Project Site Calibration (see 1. above).

A power curve will be generated from this data and integrated with the nominal wind speed distribution for the Project site to calculate the measured nominal energy yield. This will be compared to the warranted nominal energy yield as calculated from the warranted power curve for the wind turbines and the nominal wind speed distribution for the Project site.

The Test WTG will be deemed to have passed the Turbine Acceptance Test if the measured nominal energy yield is equal to or greater than ninety seven per cent (97%) of the warranted nominal energy yield.

10.5 Wind Turbine Anemometer Correlation

The purpose of the Wind Turbine Anemometer Correlation is to subtract the flow distortion effects of the turbine blades, both stationary and operational, and the effects of the turbine nacelle, from the wind turbine Anemometer signal. The result is a correction factor equation that is programmed into the wind turbine controllers and is applied to the wind turbine anemometer wind speed ("WTAWS"). Once the WTAWS has been corrected by the equation, the WTAWS will be considered the best estimation of the free stream wind speed (FSWS) at the each wind turbine location for the purpose of calculating wind turbine performance.

10.6 Balance of Plant Performance Tests

After completing the construction/installation of the balance of plant equipment and improvements, a Balance of Plant Performance Test for the Project will be conducted. The completion of the Balance of Plant Performance Tests verify that all balance of plant items are mechanically, electrically and structurally sound as set forth in the technical specifications, and can be used safely in the accordance with the contract documents, applicable laws and good utility industry practices(s). Additionally, the performance test of the central monitoring system ("CMS") shall be based on a series of three separate performance measurements: a network installation test, a CMS installation test and the data validation test.

10.7 Project Acceptance Test

The purpose of the Project Acceptance Test is to determine whether the wind turbines in the Project, taken as a whole, will perform in accordance with the warranted wind turbine power curve over a range of wind speeds representative of the annual wind speed distribution at the Project site. The Project Acceptance Test shall commence after the Wind Turbine Acceptance Test and after each wind turbine in the Project has been programmed with the Wind Turbine Anemometer Correction Factors. The test requirement shall be that the actual output of the Project during the test period shall be equal to or greater than ninety five per cent (95%) of the total gross projected output of the project.

Exhibit A

OPERATING PLAN
DISTRIBUTION LIST

(List of Appropriate Personnel to be inserted)

Exhibit B

OPERATING PLAN REVISION NOTICE

DATE:

TO: 1) 4)

2) 5)

3)

FROM:

___ Enclosed are hardcopy documents
___ Attached are data files

To make your volumes of the Operating Plan current and complete, please insert the pages as noted below.

Volume:		
Section:		
Comments:		
	Title/Description	Dated
Remove Old:		
Insert New:		

Exhibit C

SAMPLE CHECKLIST OF
OPERATOR'S SPECIFIC RESPONSIBILITIES

Contract Section Reference	SUMMARIZED WORK DESCRIPTION	RESPONSIBILITY *		REQUIRED FREQUENCY	PROCEDURAL REFERENCES	*Completion date & employee #*
		DIVISION	DEPT.			
5.	**MANAGEMENT WORK:**					
5.1.	Supervise/monitor/organize/maintain/report on operation of the Project in strict accordance with O&M Agreement and Project Documents.	Service Org	All	Continuous	• General: All forms, procedures and reports • Operations Plan • Turbine Operation Manuals	
5.2.	Supervise/monitor/organize/maintain/report, on operation of WTG., including liaison w/turbine manufacturer; document/communicate position re conformance/obligation under warranty and service agreements.	Service Org	Operations & Admin	a) As events may occur b) Following scheduled maintenance c) As appropriate	a) Notification of Event form b) Project Event Tracking Summary c) Scheduled Service Summary of Findings Reports d) Other written communication as appropriate.	
5.3.	Monitor, coordinate, report on diagnosis of faults/defects/breakdowns of WTGs and remedial action taken per turbine manufacturer's recommended procedures.	Service Org	Operations	Continuous as events occur	• Service Reports • Notification of Event form • Project Event Tracking Summary • Monthly Reports: WTG Downtime, CMS Detail, Site Statistics	
5.4.	Perform activities in compliance project documents.	Service Org	Operations	Continuous	• Interconnection Facilities Agreement.	
5.5.	Supervise/monitor/organize/report on performance of remote control of WTGs, including directing reset of	Services	Operations	Continuous as events occur	• Service Reports • Mfg's Operations	

Contract Section Reference	SUMMARIZED WORK DESCRIPTION	RESPONSIBILITY *		REQUIRED FREQUENCY	PROCEDURAL REFERENCES	*Completion date & employee #*
		DIVISION	DEPT.			
	remotely re-settable trips during regular business hours. Notify of planned/scheduled outages of the CMS/Power Collection System/Project Interconnection Facilities/ Grid affecting remote control of the WTG's.				Manual – Alarm List	
5.6	Keep real/personal property and equipment free and clear of all liens and encumbrances.	SWC	Proj. Admin.	Continuous	• Periodic check of recorded documents	
5.7.	Supervise/monitor/organize/report on local control of WTGs including directing reset of manual trips and coordinating shutdown/start-up procedures as required for WTG maintenance. Notification of planned/scheduled outages of the CMS/Power Collection System/Project Interconnection Facilities/Grid affecting remote control of the WTG's.	SWC	Operations	Continuous as events occur	• Service Reports • Turbine Manufacturer's Operations Manual - Alarm List	
5.8.1.	Supervise/coordinate scheduled maintenance of power collection system.	SWC	Operations	Annual	Transformer Mtc. Check sheet	

Exhibit D

SITE ORGANIZATION CHART

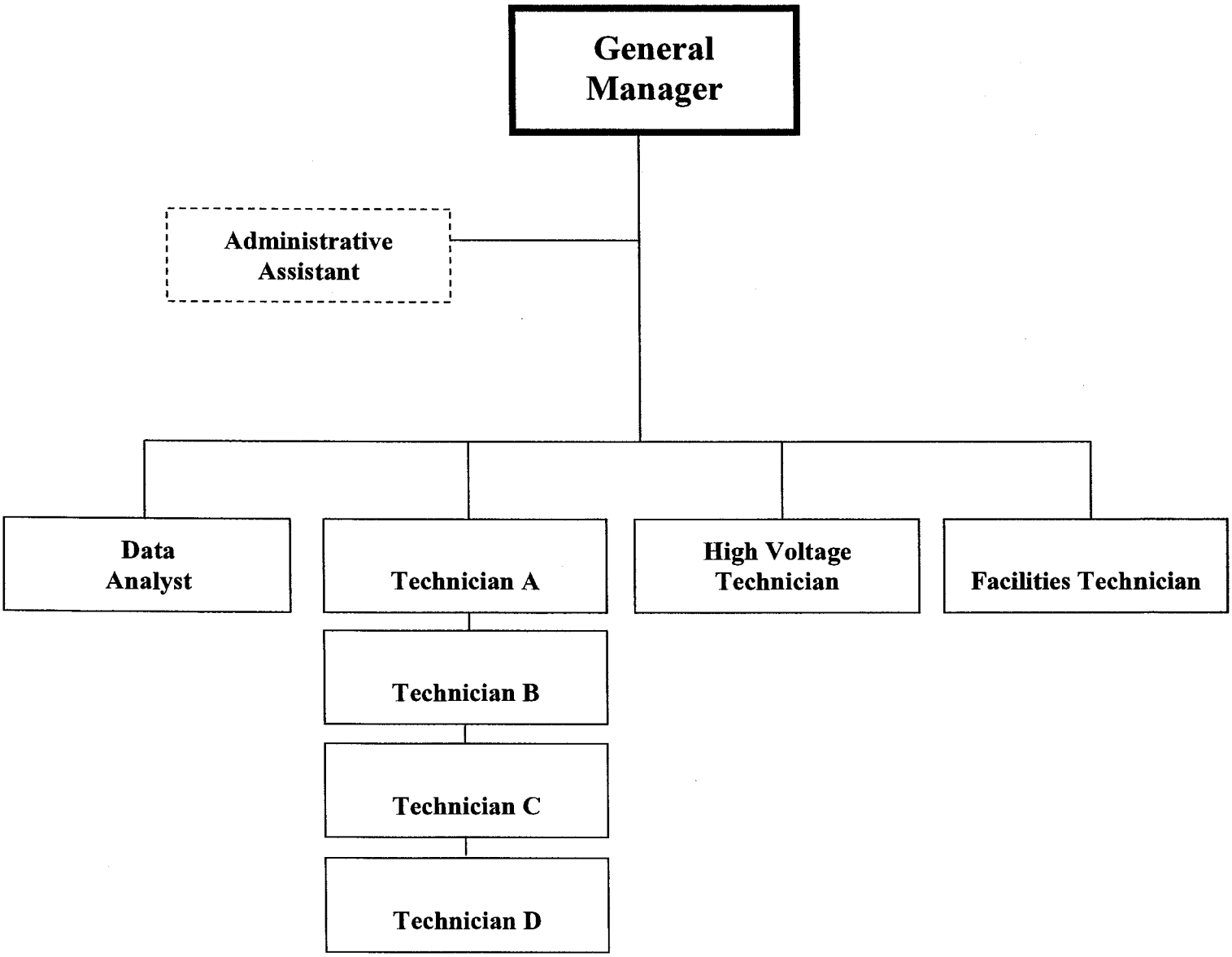

Exhibit E

Job Descriptions

Detailed job descriptions are provided for each of the following positions in the Service Organization:

Project Supervisor
Job Definition: Under the direction of the Operations Manager, supervises the Turbine Technicians and coordinates the activities of the assigned wind turbine project site(s) in an efficient manner for the desired quality and quantity of work

Turbine Technician A
Job Definition: Highly skilled position in the maintenance and repair of wind turbine mechanical and electrical systems.

Turbine Technician B
Job Definition: Skilled position in the maintenance and repair of wind turbine mechanical systems.

Turbine Technician C
Job Definition: Moderately skilled position in the maintenance and repair of wind turbine mechanical systems.

Turbine Technician D
Job Definition: Entry level position in the maintenance and repair of wind turbine mechanical systems.

High Voltage Technician
***Job Definition*:** Skilled position in maintenance and repair of the wind turbine mechanical system as well as the wind plant electrical and high voltage systems. Applies electrical theory and related knowledge to test and modify electrical machinery and electrical control equipment and circuitry.

Facilities Technician
Job Definition: Skilled position that applies varying degrees of knowledge of wind turbine mechanical, electrical, data and communications systems, anemometry and high voltage systems.

Electronics Technician
Job Definition: Skilled position that applies electronics/electrical theory and related knowledge to troubleshoot, bench-test, repair and install the electrical systems and electronics components of a wind turbine.

Fabricator
Job Definition: Skilled position in the fabrication, repair and rebuilding of wind turbine parts.

Heavy Equipment Operator
Job Description: Operates crane and heavy equipment. Note: This title may be held by an employee in a "specialist" capacity, concurrent with another regular job classification (i.e. Technician)

Extended Maintenance Schedule (Example)

Maintenance Type	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year
Turbine Maintenance													**2003**
500 hr. maintenance				xx units					xx units				
1st half year maintenance							xx units					xx units	
Transformer Maint.													
Annual maintenance								xx units					
Interconnect Maint.													
Annual maintenance								xx units					
MET Maintenance													
Annual maint./reevaluation										xx units			
Comms Network Maint.													
Annual maintenance												xx units	
Civil Works Maint.													
Monthly maintenance	Inspect,	repair	as	needed									
Turbine Maintenance													**2004**
Annual Maintenance													
Half Year Maintenance													
Transformer Maint.													
Annual maintenance								xx units					
Interconnect Maint.													
Annual maintenance								xx units					
MET Maintenance													
Annual maint./reevaluation			reeval							xx units			
Comms Network Maint.													
Annual maintenance												xx units	
Civil Works Maint.													
Monthly maintenance	Inspect,	repair	as	needed									

Extended Maintenance Schedule

Maintenance Type	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year
Turbine Maintenance													**2005**
Annual Maintenance													
Half Year Maintenance													
Transformer Maint.													
Annual maintenance								xx units					
Interconnect Maint.													
Annual maintenance								xx units					
MET Maintenance													
Annual maint./reevaluation										xx units			
Comms Network Maint.													
Annual maintenance												xx units	
Civil Works Maint.													
Monthly maintenance	Inspect,	repair	as	needed									
Turbine Maintenance													**2006**
Annual Maintenance													
Half Year Maintenance													
Transformer Maint.													
Annual maintenance								xx units					
Interconnect Maint.													
Annual maintenance								xx units					
MET Maintenance													
Annual maint./reevaluation										xx units			
Comms Network Maint.													
Annual maintenance												xx units	
Civil Works Maint.													
Monthly maintenance	Inspect,	repair	as	needed									

Extended Maintenance Schedule

Maintenance Type	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year
Turbine Maintenance													**2007**
Annual Maintenance													
Half Year Maintenance													
Transformer Maint.													
Annual maintenance								xx units					
Interconnect Maint.													
Annual maintenance								xx units					
MET Maintenance													
Annual maint./reevaluation										xx units			
Comms Network Maint.													
Annual maintenance												xx units	
Civil Works Maint.													
Monthly maintenance	Inspect,	repair	as	needed									

Exhibit G
TURBINE INVENTORY OF SPARE PARTS

A sample inventory is provided for Codelco's reference. An actual turbine spare parts list would be developed during the turbine procurement process and will be based on the final turbine selected.

Spare Parts List

Category	Component
A	**Blade and Blade Assembly**
	- Blade
	- Blade Bearing
	- Blade Bolt
B	**Rotor Head and Rotor Head Assembly**
	- Rotor Head
	-Oil Cylinder
	- Hydraulic Hose & Fitting
	- Pitch Linkage
	- Pitch Angle Signal Sensor Assembly
C	**Hydraulic Station & Pitch Assembly**
	- G.O. Pump Motor Unit
	- Hose
	- Hydraulic Valve
	- Pressure Switch
	- Filters
	- Accumulator
	- Accessory
	- Booster
D	**Slip Ring and Rotary Joint**
	- Slip Ring
	- Rotary Joint
E	**Main Shaft and Low Speed Brake Assembly**
	- Slip Ring
	- Main Shaft Bearing
	- Low Speed Locking Device
F	**Gearbox and Gearbox Assembly Items**
	- Main Gear
G	**Lubricant Oil Transferring**
	- Lubricant Oil pump
	-Oil Cooler
	- Filters
	- Pressure Switch
	- Valves
	- Accessory

H	**High Speed Brake**
	- High Speed Service Brake
	- High Speed Locking Device
I	**Generator Assembly and High Speed Coupling**
	- Generator
	- Generator Mount
	- Coupling
J	**Yaw System**
	- Yaw Gear
	- Yaw Motor
	- Yaw Brake
V	**Electrical Components (Tower Bottom)**
	- Control Panel (Tower Bottom)
W	**Electrical Components (Inside Nacelle)**
	- Inside Nacelle
	- Inside Nacelle

Exhibit H
Proposed Project Budget

A sample budget is provided for Codelco's reference. An actual project budget would need to be developed during the construction phase of the project.

Notes:

1. All values in U.S. dollars.
2. This budget should not be used for estimating or other purposes. This budget is provided solely to show the format and breakdown of a typical budgeting report. It is in no way indicative of actual project costs for the Codelco Project.

Exhibit H
Proposed Project Budget

NEW PROJECT START UP ESTIMATES
PROJECT NAME **CALAMA**

	DESCRIPTION	
	MOBILIZATION	**COSTS**
A.	OPERATIONS BUILDING	$ 175,000.00
B.	SITE STORAGE	$ -
C.	OFFICE EQUIPMENT/FURNITURE	$ 37,500.00
D.	EQUIPMENT	$ 80,000.00
E.	TOOLS	$ 110,000.00
F.	VEHICLES	$ 144,000.00
G.	SHOP EQUIPMENT	$ 21,800.00
J.	RELOCATION COSTS	$ 40,000.00
K.	WAREHOUSE	$ 12,000.00
	SUBTOTAL	$ 620,300.00
	CONTINGENCY 5%	$ 31,015.00
	TOTAL	**$ 651,315.00**

	OPERATION	
A.	STAFF Year 1	$ 248,960.00
	STAFF Year 2	$ 136,640.00
B.	OFFICE EXPENSE	$ 40,200.00
C.	FIELD EXPENSE	$ 25,000.00
	YEARLY TOTAL Year 1	**$ 314,160.00**
	YEARLY TOTAL Year 2-25	**$ 201,840.00**
	W/O FORKLIFT TOTAL Year 1	**$ 329,160.00**

Exhibit H
Proposed Project Budget

MOBILIZATION ASSUMPTIONS

			COSTS	
A.	**OPERATIONS BUILDING:**		$ 175,000.00	$200K TO 280K
	5K TO 7K SQ. FT AT $40 SQ. FT			
A.1	**OPTION #1**			
	OFFICE TRAILER/STORAGE SHED			$ 100,000.00
A.2	**OPTION #2**			
	RENT AN EXISTING FACILITY		UNKNOWN - requires research	
		total	$ 175,000.00	
B.	**SITE STORAGE:**			
	NOT NEEDED			
		total		
C.	**OFFICE EQUIPMENT/FURNITURE**			
	3 OFFICE SET UPS		$ 5,000.00	
	FILE CABINETS		$ 1,500.00	
	BOOK CASE		$ 500.00	
	1 FAX/COPIER PRINTER		$ 7,500.00	
	PHONE SYSTEM		$ 4,500.00	
	2 LAPTOP		$ 6,500.00	
	2 WORK STATION		$ 5,000.00	
	MISC. APPLIANCES		$ 2,000.00	
	BASIC OFFICE SUPPLIES		$ 1,500.00	
	RADIO SYSTEM		$ 3,500.00	
		total	$ 37,500.00	
D.	**VEHICLES:**			
	1 4X4 EXCAB		$ 28,000.00	
	4 4X4 SERVICE TRUCK		$ 84,000.00	
	14x4 crew cab		$ 32,000.00	
		total	$ 144,000.00	
E	**EQUIPMENT:**			
	1 FORK LIFT 10,000 LB		$ 80,000.00	
	OPTION			
	RENT AS NEEDED			
	RAISES OPERATION COST			
		total	$ 80,000.00	
F	**TOOLS:**			
	4 SERVICE SETUP		$ 30,000.00	
	2 OPS SETUP		$ 9,000.00	
	2 COMPRESSOR & TRAILER		$ 7,000.00	
	4 GENERATOR		$ 5,000.00	
	2 AIR/HYD TORQUE WRENCH		$ 32,000.00	
	STEAM CLEANER/TRAILER/TANK		$ 10,000.00	
	2 WINCH		$ 6,000.00	
	MISC		$ 5,000.00	
	SAFETY EQUIP		$ 6,000.00	
		total	$ 110,000.00	

Exhibit H
Proposed Project Budget

G.	**SHOP EQUIPMENT:**			
	TOOL SETUP		$	8,000.00
	HYD RAMS		$	4,000.00
	BENCH TOOLS		$	3,000.00
	TORQUE CALIBRATION		$	1,500.00
	TORCH SETUP		$	1,000.00
	WELDER		$	2,000.00
	COMPRESSOR		$	1,800.00
	BENCHES CARTS		$	500.00
		total	$	21,800.00
H	**WAREHOUSE:**			
	RACKS/SHELVES		$	4,000.00
	OIL CONTAINMENT		$	1,000.00
	SUPPLIES		$	5,000.00
	UNIFORMS		$	1,000.00
	MISC		$	1,000.00
		total	$	12,000.00
I	**RELOCATION:**			
	LIVING STIPEND - GENERAL MANAGER		$	25,000.00
	RELOCATION - GENERAL MANAGER		$	15,000.00
		total	$	40,000.00
	SUBTOTAL		$	620,300.00
	CONTINGENCY 5%		$	31,015.00
	TOTAL		$	651,315.00

Exhibit H
Proposed Project Budget

OPERATIONS COSTS

STAFF		**COSTS YEARLY**
Year 1 -Expat General Manager & Operations Manager training local hires		
1 TEMPORARY GENERAL MANAGER (EXPAT)	$	90,000.00
1 OPERATIONS MGR. (Local Hire in training for GM)	$	22,500.00
2 TECHNICIANS A & B (Local Hire)	$	24,000.00
2 TECHNICIANS C&D (Local Hire)	$	20,000.00
2 TECHNICIANS (High Voltage & Facilities - Local Hires)	$	24,000.00
1 OFFICE SUPPORT (Local Hire)	$	14,000.00
SUBTOTAL	$	194,500.00
BENEFITS AT 28% OF WAGES	$	54,460.00
total	**$**	**248,960.00**
Year 2-25 - Local Hires promoted to General Manager and Operations Manager		
1 GENERAL MANAGER (Promotion of Op Manager Local Hire)	$	24,750.00
2 TECHNICIANS A&B (Local Hire)	$	24,000.00
2 TECHNICIANS C&D (Local Hire)	$	20,000.00
2 TECHNICIANS (High Voltage & Facilities - Local Hires)	$	24,000.00
1 OFFICE SUPPORT (Local Hire)	$	14,000.00
SUBTOTAL	$	106,750.00
BENEFITS AT 28% OF WAGES	$	29,890.00
total	**$**	**136,640.00**
OFFICE EXPENSE		
UTILITIES	$	10,000.00
SUPPLIES	$	3,000.00
NETWORK MAINT	$	5,000.00
BUILDING MAINTENANCE	$	2,000.00
INSURANCE	$	12,000.00
TRAVEL	$	4,500.00
POSTAGE DELIVERY	$	1,200.00
PUBLIC RELATIONS EMPLOYEE EVENT	$	1,500.00
MISCELLANEOUS	$	1,000.00
total	$	40,200.00
FIELD EXPENSE		
TRAINING - Local Hire Ops Manager & Tech A's	$	10,000.00
FUEL	$	8,000.00
VEHICLE MAINT/REPAIR	$	1,500.00
TOOLS	$	2,000.00
HAZARDOUS MATERIALS	$	500.00
RAGS SOLVENTS	$	1,200.00
MISC.	$	1,800.00
total	$	25,000.00
TOTAL	$	314,160.00
ADD FORKLIFT RENTAL IF NOT PURCHASED	$	15,000.00
ADJUSTED TOTAL	$	329,160.00

Exhibit H
Proposed Project Budget

CALAMA CHILE SITE EVALUATION

PURPOSE: To estimate mobilization and operating costs for a 37.2 MW project of unknown turbine type.

SITE CONDITIONS: The site is approximately 5 km to the town of Calama in El Loa. Calama has a population of approximately 138,202. Most services are available in Calama. The next closest city is San Pedro de Atacama with a population of about 5,000 with very little services. Antofagasta is 213 km away with a population of 297,000. The shipping port is in Antofagasta.
Power and phone service would need to be brought in with the transmission line. Water service would need to be provided by tanks or a well. Water is sparse in the Atacama Desert; the average annual rainfall for the entire region is approximately 5mm (0.2in). Title to land does not necessarily carry water rights with it; in this sense water rights are like mineral rights. In the San Pedro region, water comes from 3 sources: the Rio de San Pedro, the Rio de Vilama, and an artesian well known as Pozo Tres3. With the possible exception of Pozo Tres, the water is community property, and its allocation is the prerogative of the local water district. The Calama airport (El Loa) is near to the site and is a civil airport open to public use. Calama is the principal support town for a huge open-pit copper mine at Chuquicamata, and consequently, the Chilean airlines Lanchile and Ladeco operate Boeing 737 airliners between Calama and Santiago, and between Calama and Antofagasta daily
Unskilled labor appears readily available as the unemployment rate in Region 2 is 7.6 to 8.5% per the last Census. Skilled labor in the area at the technician level is expected to also be readily available due to the close proximity to the mine. Chile's GDP per capita/purchasing power parity is $10,000 as compared to the US of $36,300. Labor rates will be estimated based on US prices and factored for the purchasing power parity. Assumptions will need to be verified.

OPERATION FACILITY: WE HAVE THREE OPTIONS FOR THE FACILITY.
1. BUILD A 5 TO 7 THOUSAND SQ.FT BUILDING WITH THREE TO FOUR OFFICES APROX.
1000 SQ.FT 4 TO 6 FOR WAREHOUSE.
BENEFIT: FACILITY ON SITE REDUCED LABOR AND COST WITH COMMUNICATIONS
TO TURBINE SCADA SYSTEM. WILL MEET ALL LONG TERM NEEDS OF PROJECT.
ABILITY TO STORE PARTS, VEHICLES AS WELL AS PERFORM SHOP WORK AS REQUIRED.
WILL ELIMINATE THE NEED OF A SEPARATE SCADA HUB BUILDING AND THE RADIO
INTERFACE.

2. PURCHASE MOBILE OFFICE AND BUILD LOW COST STORAGE: POSSIBLE OPTION DUE TO
BUDGET CONSTRAINTS. MOBILE OFFICES DON'T DO WELL IN BAD WEATHER LOCATIONS
MAY SAVE 150K BUT WILL NOT HAVE ANY LONG TERM VALUE.

3. RENTAL FACILITY: NO BUILDING IN TOWN WITHOUT MAJOR REMODEL. WILL LOOK INTO OLD MILITARY
BASE TO SEE IF ANY OPTIONS EXIST. WILL NEED TO HAVE RADIO LINK FOR PROJECT DATA NO LINE OF
SITE LOCATIONS FOUND.

EQUIPMENT: THE ONLY AREA TO REMOVE COST WOULD BE FORKLIFT. WITH THE LARGER TURBINES MOVING
PARTS REQUIRES A BOOM TRUCK OR FORKLIFT. COULD RENT BUT ONLY SHIFTS THE BURDEN TO OPERATIONS.

STAFF: A MINIMUM OF 4 TECHS AND 1 OPS MANAGER ALSO INCLUDED IS A STAFF MEMBER FOR OFFICE DUTIES AND
DATA REQUIREMENTS. MAY REMOVE OFFICE PERSON BUT NOT RECOMMENDED. DATA AND OFFICE WORK ARE THE
SAME FOR 25MW OR 50MW. TEMP MANAGER WILL BE RELOCATED AFTER FIRST YEAR. COST WILL BE ALLOCATED
TO OVERHEAD SUPPORT.
ALL OTHER REQUIREMENTS ARE BEST ESTIMATES AND NO FURTHER AREAS FOR COST SAVINGS ARE SEEN
THE FOLLOWING BUDGET IS BEST GUESS WITH THE INFORMATION AVAILABLE AT THIS TIME

Appendix S

Project Offering Memorandum

Executive Summary

This information package presents descriptive physical and technical overviews of an approximately 40MW utility-scale wind energy project located near Calama, Chile. A summary of project elements is provided, as summarized below, with further information available as necessary to complete appropriate due diligence and to arrange project capitalization. Information is provided for discussion purposes only and is strictly confidential.

Background

Corporación Nacional del Cobre (Codelco) began exploring the feasibility of a wind farm in the Chuquicamata/Calama region in 1994. In 2000, through a grant funded by the U.S. Trade and Development Association, Codelco commissioned SeaWest WindPower, Inc. (www.seawestwindpower.com) to conduct a feasibility study to determine various scenarios under which a wind power project would be both technically feasible and economically viable. The study is in the final stages and SeaWest is currently exploring different financing scenarios for the project on behalf of Codelco. Pending the outcome of the study, it is expected that Codelco would work with an experienced wind development company and turbine manufacturer to bring the project to fruition.

It is anticipated that the project will be developed through a special purpose corporation or Sociedad anónima of which Codelco would hold some controlling interest. This corporation would be established to own all necessary development rights and entitlements and development assets and to act as the contracting entity for the project. Although this special purpose company would seek non-recourse project financing over the life of the project, it is expected that Codelco would provide some recourse during the construction and start-up phase of the project. Because it is anticipated that this project will be financed with limited-recourse or non-recourse project financing, all development activities will be undertaken with independent engineer review of each critical design element and construction milestone to provide an appropriate level of due diligence for financing institutions.

Project Details

It is currently anticipated that the project will be up to 40 MW in size and up to USD$50 million in capital cost. The project power would be sold to Codelco under a long-term power purchase agreement. As part of the feasibility study, SeaWest is exploring the feasibility of selling the carbon emissions credits to generate an additional revenue stream. The turbine manufacturer would provide operations and maintenance (O&M) of the turbines during the warranty period. Following the warranty period, it is expected that an experienced O&M wind company would provide on-going turbine maintenance and balance of plant maintenance.

Project Site

The project site is located on land controlled by Ministerio de Bienes Nacionales and can easily accommodate more than 40 MW of turbines. Although final agreements are not yet signed, Codelco has substantially negotiated the term and cost of the land leases with Bienes Nacionales. The project site is just south of the city of Calama, approximately 213 km from Antofagasta and is accessible overland from Antofagasta or by airplane to the Calama airport.

Proposed Technology

SeaWest, on behalf of Codelco, is in the process of evaluating the most efficient technology for the project site and is in discussions with many first-tier turbine manufacturers, including Bonus, Nordex, Vestas, MHI, GE Wind, Gamesa, NEG Micon and Enercon. Final selection will be made pending a formal request-for-quotation process and subsequent negotiations with turbine vendors following the signing of a project power purchase agreement.

In addition to the turbines, the major equipment that will be utilized in the Project includes wind turbines, wind turbine towers, wind turbine and transformer foundations, padmount transformers, a power collection system, a substation, interconnection facilities, and a Supervisory Control and Data Acquisition ("SCADA") system.

Wind Resource Assessment

On site wind energy assessment began in February 2002, and was expanded in December of 2002. There are currently 2 met towers on the project site and one additional tower north of the site. A third party wind energy assessment is currently in the process and will utilize both the site specific data and long-term data collected in the area to determine the project capacity factor. Additional third party wind energy assessments will be completed as appropriate to meet forecasting and financing requirements.

Interconnection

It is proposed that the project be interconnected at the SING Norte Grande Interconnection System. A technical feasibility analysis performed by Fluor Daniel Chile confirmed capacity and has indicated that a wind farm up to 50 MW would cause no interference with normal power systems operations.

Permits and Land Use Approvals

As a part of the feasibility study, Deuman Ingeniieros, a local Chilean engineering company under subcontract to SeaWest, has been working with CONAMA to develop a draft term of reference for permitting the wind project. The study specifically is targeting permitting the plant through an Environmental Impact Declaration instead of an Environmental Impact Study due to the low environmental impact of the facility. Furthermore, Deuman has been working to gain support from other agencies such as Comisión de Nacional de Energìa (CNE).