Costa Rica

Tejona Wind Power Project

The Costa Rica Tejona Wind Power Project is the result of a collaborative relationship between the World Bank as GEF Implementing Agency and the Inter-American Development Bank as Executing Agency.

COSTA RICA

TEJONA WIND POWER PROJECT

PROJECT REPORT AND SUPPORTING DOCUMENT

Recipient: The Government of Costa Rica
Instituto Costarricense de Electricidad (ICE)

Co-financing: Inter-American Development Bank (IDB)

GEF Amount: Approximately US$3.3 million

Terms: Grant

Objectives: To co-finance a 20 MW wind power plant in the Guanacaste Province of Costa Rica which will demonstrate commercialization of utility-scale wind energy technology to the region, and eliminate use of a significant amount of fossil fuel, thereby reducing CO_2 emissions from thermal power plants.

Financing Plan:

	Local	Foreign	Total
		($ millions)	
GEF	0.0	3.3	3.3
IDB Financing	0.0	24.1	24.1
ICE	3.9	0.0	3.9
Total	3.9	27.4	31.3

Economic Rate of Return: 15.21% with GEF financing
13.25% without GEF financing

GLOBAL ENVIRONMENT FACILITY/INTER-AMERICAN DEVELOPMENT BANK

COSTA RICA. TEJONA WIND POWER PROJECT

PROJECT REPORT AND SUPPORTING DOCUMENT

1. <u>Background</u>. The Instituto Costarricense de Electricidad (ICE) is the national Costa Rican utility. In the past, electrical generating expansion has emphasized the use of hydroelectric and thermal power plants. However, during the past decade ICE has been researching the potential for generating power from wind, geothermal, and biomass energy sources.

2. In the mid-1970s, ICE began a wind measurement program. In later years, a more extensive measurement program was implemented which estimated the geographic distribution of the wind resource in Costa Rica. These wind resource measurement programs have shown that Costa Rica has an extensive wind resource and have identified an exceptionally good site for development of a wind project. The Tejona site is near Lake Arenal in the Guanacaste Province and has a potential of at least 60 MW of generating capacity. The resource analyses that have been conducted indicate that the resource at the Tejona site is superior even to extensively developed sites in the California passes.

3. A proposal for private development of the wind resource at the Tejona site was made to ICE in 1989 by a private U.S. wind power developer. At the time, Costa Rica was still formulating its private power regulations and contract terms. Although the project was technically feasible, there was a gap between the power purchase price schedule offered by ICE and the purchase rate required to service the debt and provide adequate after-tax return of equity. Consequently, the project was not pursued, although ICE remained highly interested in the potential for wind power development and continued to conduct a detailed resource monitoring program at the Tejona site.

4. In 1990, the Global Environment Facility (GEF) was established. In March 1992, the Government of Costa Rica, through the Ministry of National Planning and Economic Policy, submitted a proposal to the GEF administered by the World Bank as trustee for support in developing a utility-scale, grid-connected wind electric power plant. In 1992, the U.S. Agency for International Development (USAID) funded a prefeasibility study of the project. The study was completed in August 1992 and published in December 1992. As a result of this study, the GEF earmarked approximately $3.3 million in support for the project. In May 1993, the Inter-American Development Bank (IDB) contracted with an independent consultant to complete a feasibility study for the project. In the feasibility study, the consultants followed up on issues that were identified in the prefeasibility study as needing more detailed investigation. The particular emphasis of the feasibility study was to further refine the cost estimates for the project and provide a refined assessment of the technical, economic, and environmental feasibility of the proposed power plant.

5. The IDB and the Government of Costa Rica have negotiated a major power sector loan (Electric Power Development Loan III-Loan 796/OC-CR) from the IDB to support ICE's expansion plan through the year 2000. A component of this loan will provide financing for the 20 MW wind electric power plant at the Tejona site.

6. <u>GEF Funding Justification</u>. Key GEF considerations that are to be accounted for when considering a project for funding include sustainability, readiness, implementability, replicability, project economics, and reduction of global warming. This wind power plant in Costa Rica is characterized by a high degree of readiness and implementability, and the extensive wind resource facilitates a sustainable and replicable project. The prefeasibility and feasibility studies that have been conducted have demonstrated project economics. However, the project economics are marginal without grant assistance from the GEF. At the conclusion of the prefeasibility study, without the GEF commitment, the project would not have been evaluated in detail or considered as a viable option for ICE.

7. The GEF grant facilitates the inclusion of this project in the generation least-cost expansion program and made the project eligible for a loan from an international lending institution. This financing will help to create the confidence necessary for sustainable use of wind power in this region of the world. The development of the project will demonstrate the technical, economic, financial, institutional, and environmental feasibility of grid-connected, utility-scale wind electric power plants in the context of the Costa Rican national grid. The infrastructure costs which will be covered by the GEF grant will support the economic viability of project expansion in the future. With the knowledge and experience gained, the risks and associated costs of subsequent wind power plant development in the region will be reduced. The project will facilitate growth in wind electric generation through conventional utility financing and possibly through private power financing as well. These factors will provide support for further development of the region's exceptional wind resource.

8. Although the majority of ICE's 930 MWe of capacity is hydroelectric and geothermal generation, significant amounts of thermal generation are in ICE's expansion plan. A study to quantify the environmental benefits of wind power was conducted by ICE and USAID. The study concluded that a 20 MW wind power plant would reduce CO_2 emissions from thermal power plants by approximately 60,000 metric tons per year.

9. The Tejona wind project does not directly displace a fossil-based project; however, it does displace fossil fuel usage through the economic dispatch of the various system facilities. In addition, the Tejona wind project results in a start-up delay for several other projects. Table 1 summarizes the annual displacement of thermal energy and the total energy benefit of the 20-year life of the project.

Table 1. Energy Balance of the Project
Tejona Wind Power Project: 20 MW

Year	Project Total (GWh) A	Final Consumption (GWh) B	Thermal Substitute (GWh) C	Hydro Substitution Dams (GWh) D	Hydro Substitution Misc. (GWh) E	Total B+C+D+E (GWh) F
1993						
1994						
1995						
1996						
1997	93.70	0.00	68.22	20.24	5.24	93.70
1998	93.53	0.08	66.91	17.95	8.59	93.53
1999	93.67	0.96	65.47	15.26	11.98	93.67
2000	94.07	0.13	68.22	11.84	13.88	94.07
2001	93.44	0.18	76.33	0.00	16.93	93.44
2002	92.93	1.68	71.69	0.00	19.56	92.93
2003	92.87	1.87	91.00	0.00	0.00	92.87
2004	93.59	2.04	72.63	15.50	3.42	93.59
2005	92.87	0.05	71.95	4.68	16.19	92.87
2006	93.47	0.52	92.94	0.00	0.01	93.47
2007	93.62	0.66	36.52	42.27	14.17	93.62
2008	93.61	0.00	49.74	0.00	43.87	93.61
2009	93.24	0.18	40.05	0.00	53.01	93.24
2010	93.18	0.42	62.60	0.00	30.16	93.18
2011	93.31	0.00	84.02	0.00	9.29	93.31
2012	94.26	0.86	79.17	0.00	14.23	94.26
2013	93.46	0.60	68.59	7.98	16.28	93.45
2014	93.46	0.60	68.59	7.98	16.28	93.45
2015	93.46	0.60	68.59	7.98	16.28	93.45
2016	93.46	0.60	68.59	7.98	16.28	93.45
2017	93.46	0.60	68.59	7.98	16.28	93.45

Key:
A: Total energy production
B: Incremental increase in consumption
C: Displacement of internal energy
D: Energy stored in Arenal
F = B + C + D + E = Total Benefit

10. <u>Project Objectives</u>. The overall objective of this project is to improve the environment by reducing the consumption of fossil fuels for energy production. This objective will be achieved through realization of several additional objectives, including:

1. Demonstration of wind energy technology in the high-wind and heavy-precipitation environment experienced in Costa Rica and other Central American sites.

2. Familiarization of a major regional utility with how wind energy will integrate into their generation system.

3. Familiarization of a major regional utility with the operation and maintenance of a wind power plant.

Achieving these objectives will support further development of wind energy technology in the region, and thus reduce emission from fossil-fuel-fired power plants.

11. <u>Project Site Description</u>. The project site is located in the Guanacaste Province on two parallel ridges to the northwest of Lake Arenal and near the village of Tejona. Montecristo and Altamira Ridges are shown in Figures 1 and 2, respectively. Project layouts were developed for two potential scenarios: one using 300 kW wind turbines and one using 400 kW wind turbines. As shown in Figures 3 and 4, these layouts place the turbines on Montecristo Ridge and Altamira Ridge, which is immediately east of Montecristo Ridge. The project will consist of between 40 and 100 wind turbines, depending on the size of the turbine proposed by the winning bidder. A topographical survey was conducted for the feasibility study and maps were developed for each ridge with contour lines at every meter. These contour maps and several site visits facilitated the siting of the turbines for the project layouts. Where appropriate, provisions have been made to facilitate future expansion of the project.

12. The vegetation at the proposed site is primarily grass, with a few patches of trees in the lower valleys between the ridges. The land in the project area is used for cattle grazing, which is compatible with wind power development. It is anticipated that this activity will continue after installation of the project.

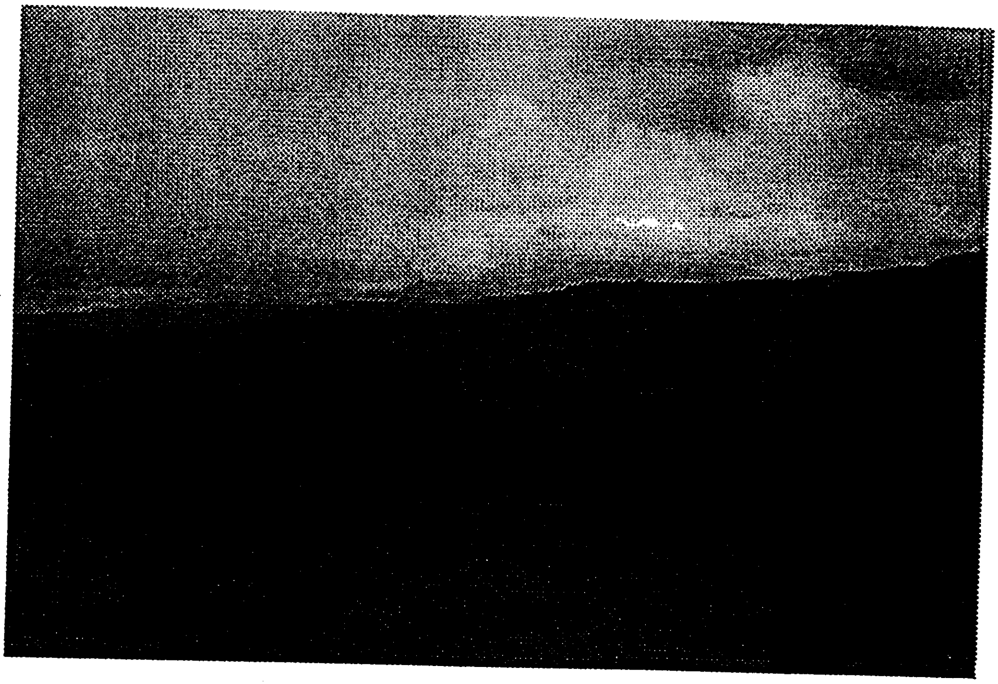


Figure 1. Montecristo Ridge

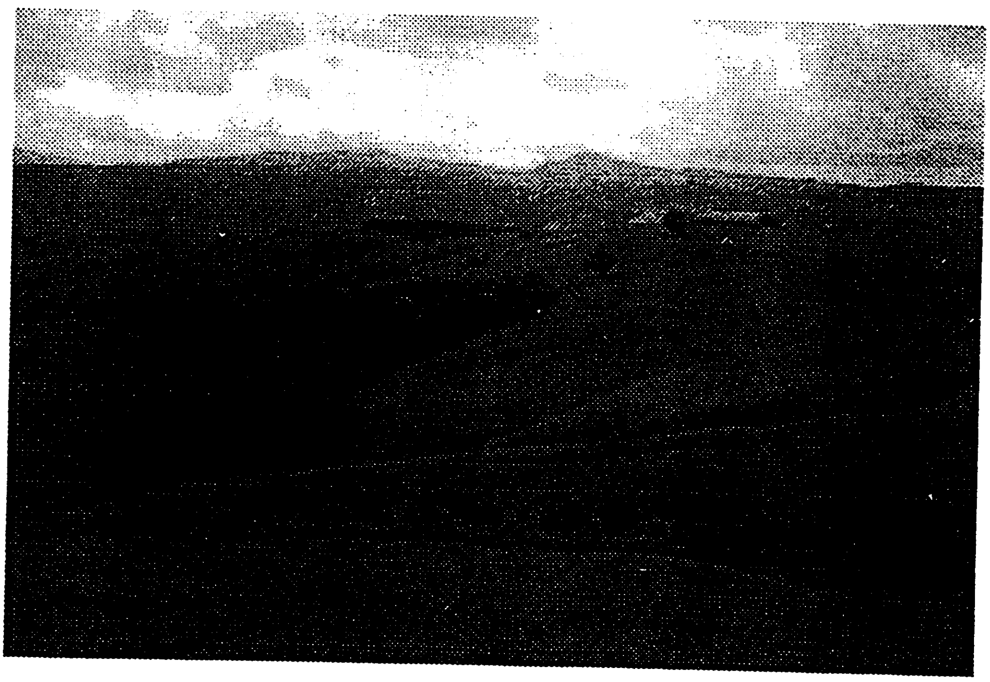


Figure 2. Altamira Ridge

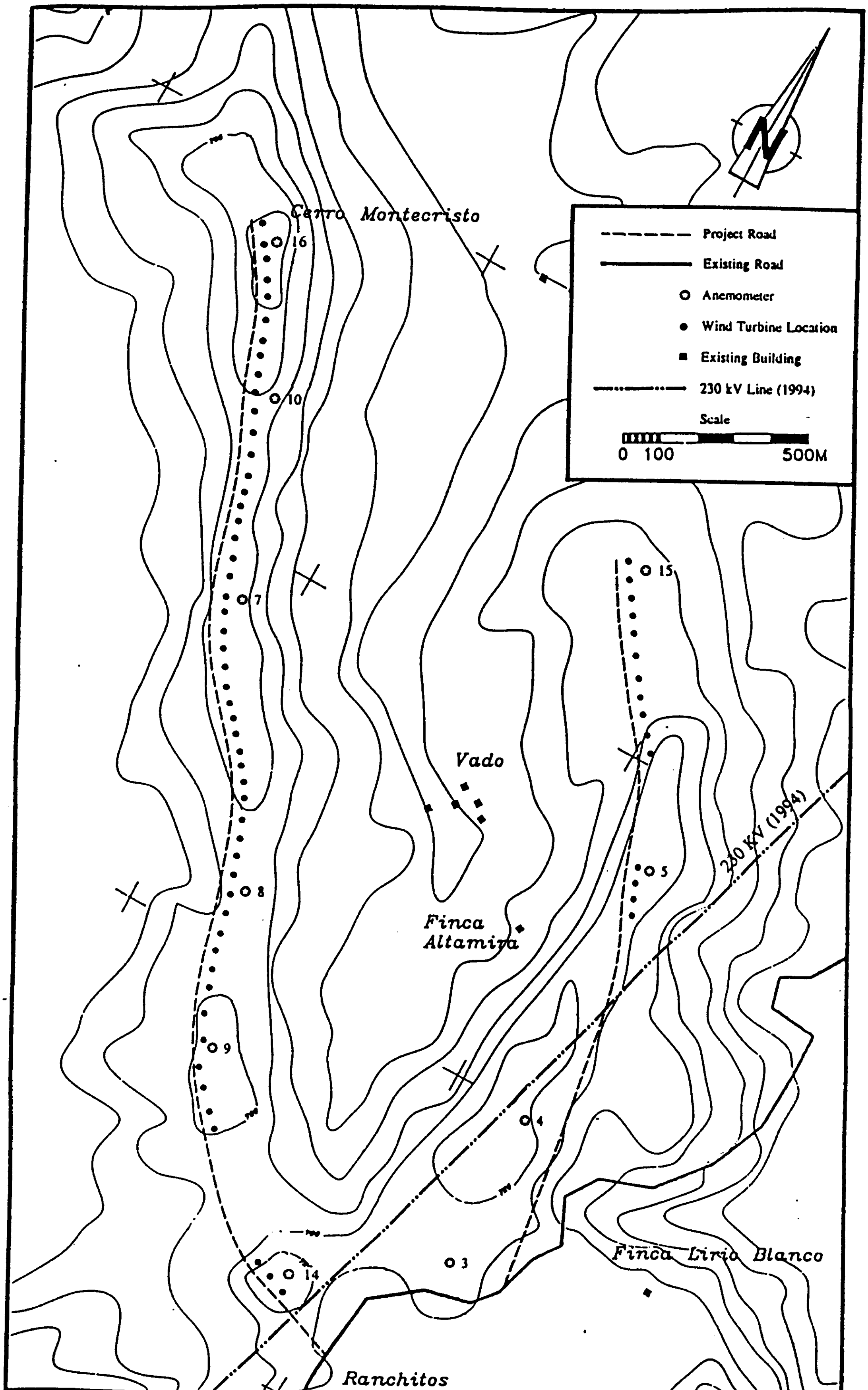


Figure 3. 300 kW Project Layout

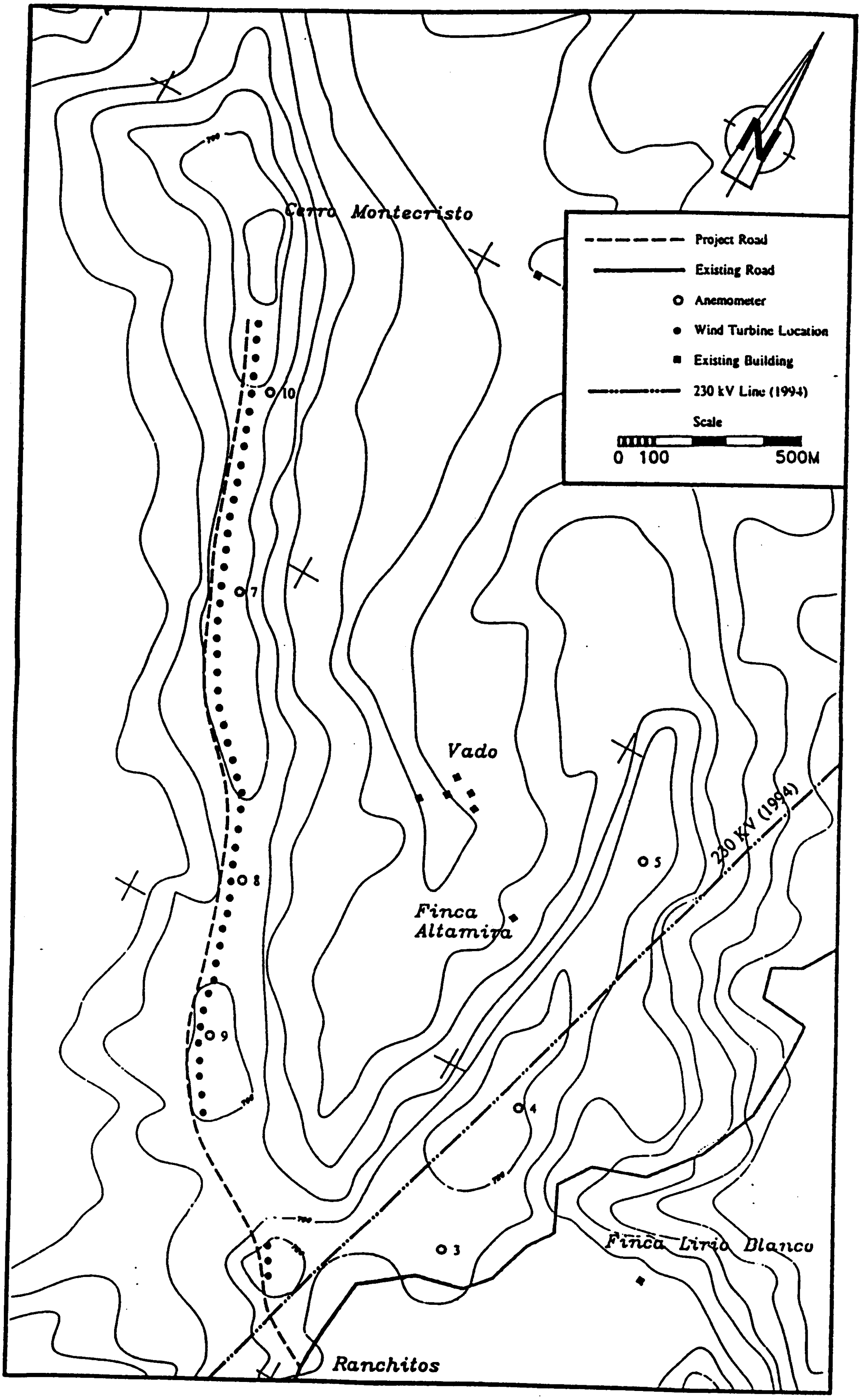


Figure 4. 400 kW Project Layout

13. As part of the feasibility study, a geotechnical survey of the project was conducted in March 1993. Based on the observation at the site and on the laboratory results, it appears that the soil is basically homogeneous and is unlikely to exhibit significant erosion or drainage problems.

14. A new 230 kV transmission line will pass directly through the project area and connect to the Arenal substation located approximately 7.5 km to the south. The new line is scheduled for completion in 1994-95. The project transmission line (34.5 kV) will run approximately parallel to this line and connect to the grid at the existing Arenal substation.

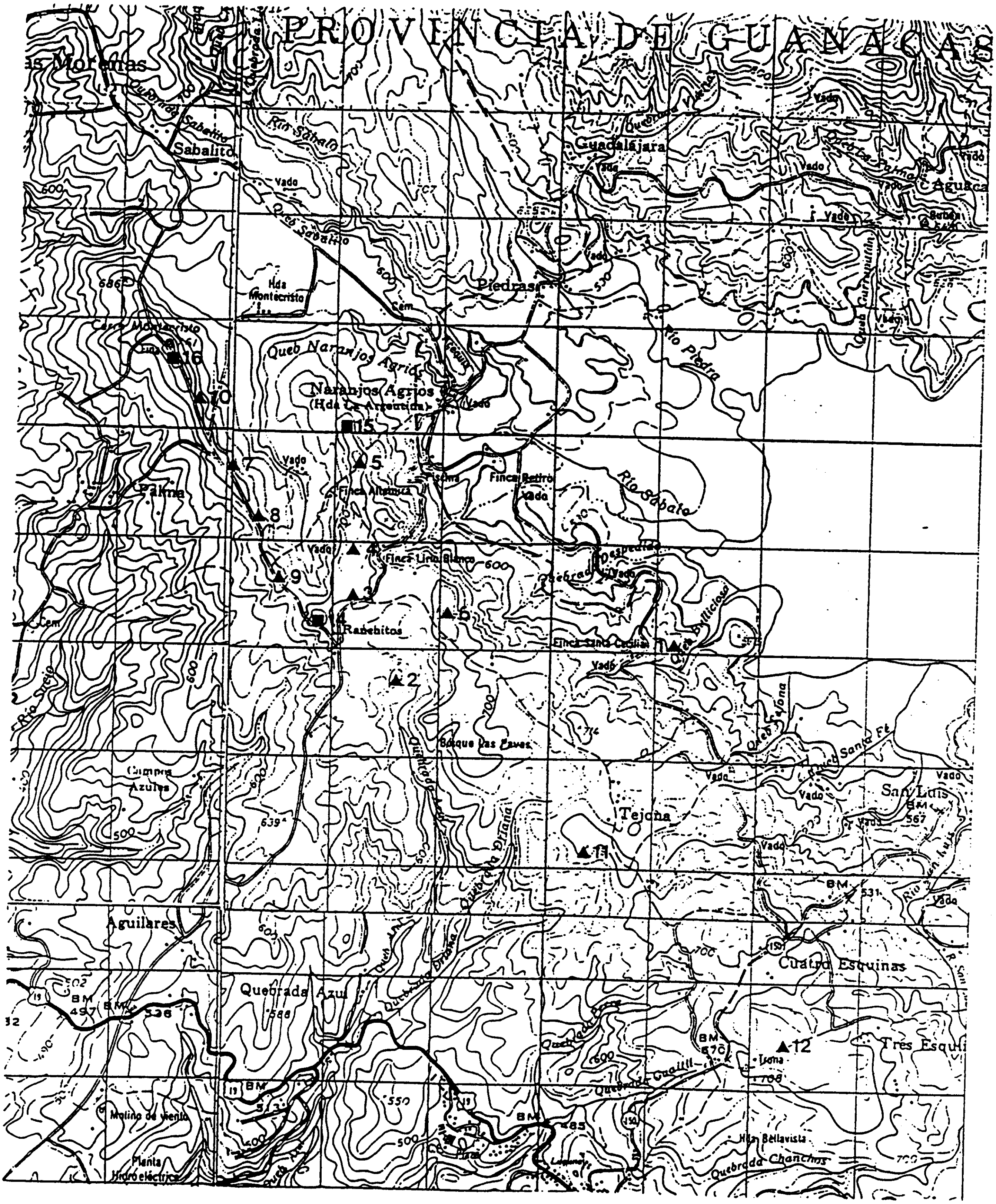
15. Wind Resource Description. A long-term wind station has been located on the shore of Lake Arenal since 1976. In January 1990, 14 additional anemometers were installed at 12 locations along ridges to the west of the lake and operated approximately 2 years. As recommended by the prefeasibility study, additional monitoring sites were installed in early 1993. These additional sites were installed to obtain data at the end of the ridgelines and to obtain data at multiple heights to calculate the wind shear. Figure 5 shows the location of all of the wind monitoring stations used in the feasibility study.

16. Due to the importance of the wind resource in making energy projections, a significant emphasis was placed on accurate measurement of the winds in the prefeasibility and feasibility studies. Because the power of the wind is proportional to the cube of the wind speed, small variations in speed result in significantly larger variations in power production. To account for the diurnal and seasonal variation in wind speed, the energy production estimates and all subsequent analyses are based on hourly wind speed values. Figures 6 and 7 show the diurnal and seasonal variance for three of the monitoring sites.

17. The quality of wind resource data for the Tejona site is fairly high, and reasonable correlations were made between stations to permit estimation of missing data and the development of a complete set of data for 1991. The long-term station at Lake Arenal was used to determine the representativeness of the 1991 winds. The hourly wind speeds were adjusted accordingly so as to be representative of the long-term resource. Table 2 provides a summary of the estimated long-term monthly wind speeds for 14 monitoring stations. The annual average wind speeds for anemometers on the site is over 11.2 m/s, one anemometer on the site shows an annual average of 13.8 m/s.

18. According to the long-term data from the Lake Arenal station, the average annual wind speed varies by a maximum of 7% from the long term. As a result, it is expected that the maximum year-to-year variation in energy production will generally not exceed 14%.

19. Projected Performance. As previously indicated, two project layouts were developed for estimating energy projections. Calculations of estimated gross and net energy were made for each scenario. In order to calculate the gross (or theoretical) energy production for the project, each turbine was assigned an anemometer that was believed to be representative of the wind speeds that would be experienced by that turbine.



▲ Anemometer Location ■ New Anemometers (1993)

Figure 5. Location of Wind Monitoring Sites

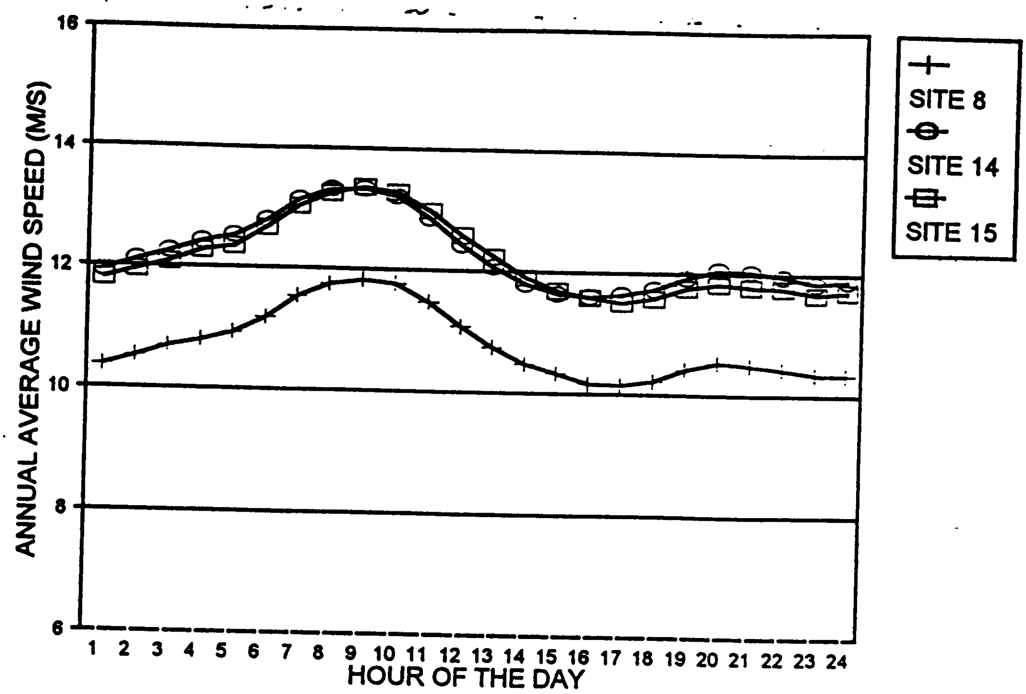


Figure 6. Long-Term Diurnal Wind Speed

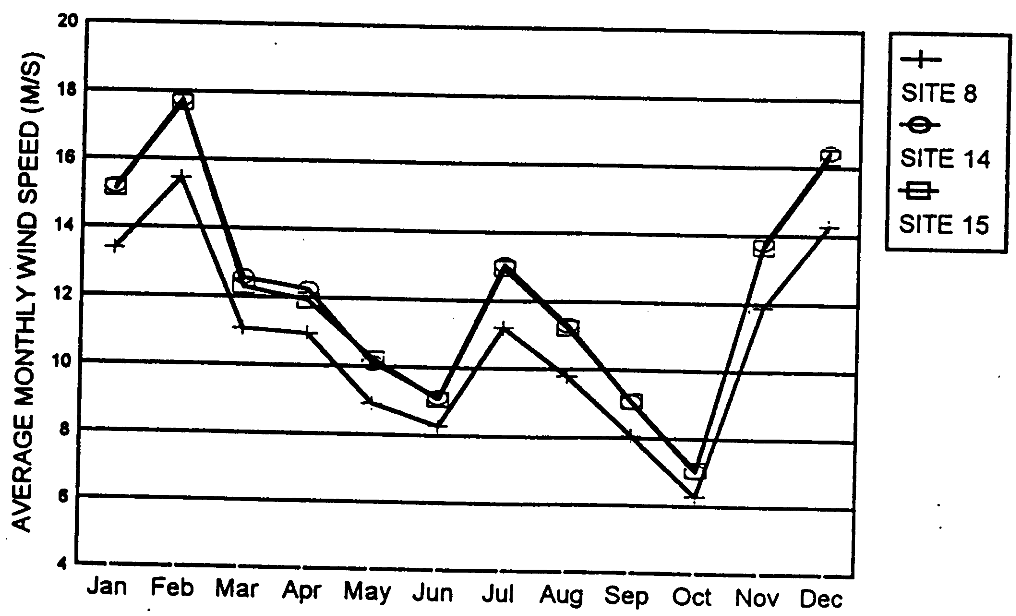


Figure 7. Long-Term Monthly Wind Speed

Table 2. Long-Term Monthly Wind Speed Summary (m/s)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	9.2	10.9	7.5	7.2	5.9	5.3	8.3	7.2	5.6	4.3	8.7	10.4	7.6
2	12.5	14.9	10.5	9.1	8.6	7.8	10.9	9.5	7.7	5.9	11.5	13.5	10.2
3	10.7	12.6	8.7	8.5	7.4	6.5	9.3	8.0	6.5	5.1	9.8	11.6	8.7
4	11.7	13.6	9.4	9.2	7.8	6.8	10.1	8.8	6.8	5.3	10.5	12.5	9.4
5	13.5	15.7	11.0	10.6	9.1	8.1	11.5	10.0	8.1	6.3	12.1	14.5	10.9
6A	14.4	17.1	11.8	11.5	9.9	8.6	12.8	11.1	8.9	6.8	13.2	15.8	11.8
6B	14.6	17.4	11.9	11.7	10.1	8.7	13.0	11.3	9.0	7.0	13.4	16.0	12.0
7	16.5	19.3	13.5	13.2	10.9	10.0	14.1	12.2	9.9	7.6	14.9	18.0	13.3
8	13.4	15.5	11.1	11.0	8.9	8.3	11.2	9.8	8.1	6.3	11.9	14.3	10.8
9	15.1	17.6	12.5	12.1	10.1	9.1	12.9	11.2	9.0	7.0	13.7	16.3	12.2
10	17.4	20.2	14.2	14.0	11.2	10.2	14.6	12.6	10.1	7.6	15.3	18.8	13.8
11	8.7	10.3	7.4	7.2	6.4	5.5	7.4	6.5	5.5	4.3	8.1	9.3	7.2
12	11.3	13.4	9.5	9.2	8.1	7.0	9.9	8.7	7.1	5.6	10.5	12.4	9.4
14 [1]	15.2	17.8	12.6	12.2	10.1	9.1	13.0	11.3	9.1	7.0	13.8	16.4	12.3
15 [2]	15.1	17.7	12.3	11.9	10.2	9.1	13.0	11.2	9.1	7.1	13.7	16.3	12.2
Average	13.3	15.6	10.9	10.6	9.0	8.0	11.5	10.0	8.0	6.2	12.1	14.4	10.8

Note: Site 6A and 6B are at a height of 14M and 27M, respectively.
[1] Values are based on the correlation to site 9 using data available from March through May 1993.
[2] Values are based on the correlation to site 5 using data available from March through May 1993.

20. The gross energy production of each turbine was then established using the turbine power curve and the estimated long-term hourly wind data from the anemometer to which it was assigned. In order to determine net energy projections, all appropriate energy losses were applied to the gross energy estimates. Assuming 300 kW wind turbines are used, the total annual energy production from the project is approximately 93 GWh, for a capacity factor of 53%. Tables 3 and 4 summarize the gross and net energy production on a per-turbine and project basis for a 20 MW project using the 300 kW and 400 kW wind turbine, respectively.

21. The range of annual energy production due to interannual wind variations is given below for the two representative turbine sizes evaluated for this project.

Expected Variation in Annual Energy Output

Wind Speed	Annual Energy for 300 kW turbine (kWh)	Percent Change (compared to average)
Average	93,481,153	
Low	80,140,907	-14%
High	97,882,527	+5%

Wind Speed	Annual Energy for 400 kW turbine (kWh)	Percent Change (compared to average)
Average	90,055,015	
Low	78,558,395	-13%
High	95,619,478	+6%

22. <u>Economic Analysis</u>. During the feasibility study, ICE developed representative construction drawings, schedules, and estimated costs involved with each task, based on their experience with similar work and the labor rates of their personnel. Equipment costs were based on recent quotes whenever possible. The capital requirements and operating cost estimates which were completed for the feasibility study are based on a 20 MW project that uses 67 turbines rated at 300 kW each.

23. For economic analysis, ICE utilizes a production costing model, LOGOS, which simulates a least-cost dispatch of utility power plants, given demand. The results of the simulation show, for a given period under given operating constraints, how often each power plant will run and what the resulting fuel cost will be.

Table 3. Gross and Net Energy Production Estimates for 300 kW Turbines

SITE#	PRODUCTION PER TURBINE GROSS kWh	300 KW LOSSES kWh	NET kWh	#WT 300 KW	TOTAL PRODUCTION 300 KW GROSS kWh	LOSSES kWh
10	2,099,373	28%	1,511,549	15	31,490,595	22,673,228
7	2,062,005	32%	1,402,163	19	39,178,095	26,641,105
8	1,724,629	28%	1,241,733	8	13,797,032	9,933,863
9	1,941,880	28%	1,398,154	7	13,593,160	9,787,075
5	1,709,051	28%	1,230,517	4	6,836,204	4,922,067
14	1,951,595	28%	1,405,148	3	5,854,785	4,215,445
15	1,932,875	28%	1,391,670	11	21,261,625	15,308,370
TOTAL	13,421,408		9,580,934	67	132,011,496	93,481,153

Table 4. Gross and Net Energy Production Estimates for 400 kW Turbines

SITE#	PRODUCTION PER TURBINE GROSS kWh	400 KW LOSSES kWh	NET kWh	#WT 300 KW	TOTAL PRODUCTION 400 KW GROSS kWh	LOSSES kWh
10	2,662,215	28%	1,916,795	9	23,959,935	17,251,153
7	2,607,715	28%	1,877,555	19	49,546,585	35,673,541
8	2,245,362	28%	1,616,661	11	24,698,982	17,783,267
9	2,468,874	28%	1,777,589	8	19,750,992	14,220,714
14	2,419,055	28%	1,741,720	3	7,257,165	5,225,159
TOTAL	12,403,221		8,930,319	50	125,213,659	90,153,834

24. The present values of the net benefits and the internal rate of return were used as the main criteria for the economic evaluation. The useful life of the Tejona project was assumed to be 20 years, and a 12% discount rate was used. Generation expansion plans with and without the Tejona wind power project were simulated for each year to quantify the project incremental costs and benefits for the Interconnected National System (SNI) during the 1993-2012 period.

25. As illustrated in Tables 5 and 6, a present value analysis was used to determine the economic rate of return of the Tejona project with and without the GEF grant financing (respectively). The Internal Rate of Return is the effective discount rate that equalizes the present values of the stream of costs and benefits. The results of the economic analysis indicate the following internal rates of return:

IRR with the GEF grant	15.21%
IRR without the GEF grant	13.25%

26. ICE's current least-cost expansion plan for the period 1993 through 2012 is shown in Table 7. The present expansion plan consists of hydroelectric and geothermal electrical generating facilities. The LOGOS program was used to simulate the system and determine the actual sequence of all future projects, including the Tejona project. The Tejona wind power project was picked up by the LOGOS least-cost scheduling algorithm with a startup time of January 1997. Although the Tejona wind power project does not replace any fossil-fuel based projects, it does displace fossil fuel usage through economic dispatch of various systems facilities, thereby reducing emissions. A present-value analysis of the expansion plan with and without the Tejona project indicates that the incremental cost of the Tejona project (the difference between the present values) is approximately $3.7 million. This analysis provides further economic justification for the GEF involvement. The modified least-cost expansion plan which includes the Tejona project, both with and without the GEF grant, is shown in Tables 8 and 9, respectively.

27. <u>Project Cost and Financial Scheme</u>. Table 10 summarizes the estimated equipment, engineering, and facility costs for the project. Average turbine equipment costs are US$900/kW, with an estimated installed cost of US$1,401/kW. The total estimated cost of the 20 MW wind power plant is approximately US$28 million. Table 11 shows the financial costs and the investment program for the Tejona project from 1994-1999. Table 11 specifies the cost allocations among the IDB, ICE, and the GEF. The detailed breakdown of the GEF grant expenditures is provided in Table 12.

28. <u>Project Implementation</u>. The portion of project financed by IDB will be purchased by ICE on a turnkey basis based on the results of an international competitive bid. The turnkey package will include all components of the project with the exception of the GEF expenditures which were shown in Table 12. The purchases made with the GEF grant will follow the procurement procedures of the Trustee of the GEF (the World Bank). By arrangement between IBRD, acting as Trustee of the Global Environment Trust Fund, and the IDB, the project will be administered by the IDB.

Table 5. Economic Evaluation (with GEF Grant)

	Energy Demand	Costs				Benefits														Total Benefit	Total Costs	Net Benefit	
		Invest-ment	O&M	Distri-bution	Total	Incremental Increase in Energy Consumption			Consumer Surplus		Increased Reliability			Thermal Substitution			Energy Storage						
Year	(GWh)	($ MILL)	($ MILL)	($ MILL)	($ MILL)	(GWh)	($/kWh)	($ MILL)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	($ MILL)	($ MILL)	($ MILL)	Year
1993	4,345																						1993
1994	4,592	0.318			0.318															0.000	0.316	-0.32	1994
1995	4,850	0.805			0.805															0.000	0.805	-0.81	1995
1996	5,123	19.433			19.433															0.000	19.433	-19.43	1996
1997	5,403	4.136	0.652	0.000	4.788	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	66.2	0.058	3.820	20.24	0.056	1.133	4.954	4.788	0.17	1997
1998	5,692	0.021	0.651	0.000	0.672	0.07	0.084	0.006	0.000	0.000	0.00	1.200	0.000	68.9	0.054	3.813	17.95	0.054	0.969	4.588	0.672	3.92	1998
1999	6,002		0.652	0.005	0.657	0.85	0.084	0.072	0.000	0.000	0.00	1.200	0.000	65.6	0.053	3.470	15.28	0.053	0.809	4.350	0.657	3.69	1999
2000	6,327		0.655	0.001	0.655	0.12	0.084	0.010	0.000	0.000	0.00	1.200	0.000	68.2	0.054	3.684	11.84	0.054	0.639	4.333	0.656	3.68	2000
2001	6,687		0.650	0.001	0.651	0.16	0.084	0.013	0.000	0.000	0.00	1.200	0.000	76.3	0.053	4.045	0.00	0.053	0.000	4.059	0.651	3.41	2001
2002	7,021		0.647	0.009	0.656	1.49	0.084	0.125	0.000	0.000	0.00	1.200	0.000	71.7	0.058	4.159	0.00	0.058	0.000	4.283	0.656	3.63	2002
2003	7,388		0.647	0.010	0.657	1.66	0.084	0.139	0.000	0.000	0.00	1.200	0.000	91.0	0.065	5.915	0.00	0.065	0.000	6.054	0.657	5.40	2003
2004	7,784		0.651	0.011	0.663	1.81	0.084	0.152	0.000	0.000	0.00	1.200	0.000	72.6	0.064	4.648	15.50	0.064	0.992	5.792	0.663	5.13	2004
2005	8,122		0.647	0.000	0.647	0.04	0.084	0.004	0.000	0.000	0.00	1.200	0.000	72.0	0.053	3.813	4.68	0.053	0.248	4.065	0.647	3.42	2005
2006	8,496		0.651	0.003	0.653	0.46	0.084	0.039	0.000	0.000	0.00	1.200	0.000	92.9	0.058	5.391	0.00	0.058	0.000	5.429	0.653	4.78	2006
2007	8,877		0.652	0.004	0.655	0.59	0.084	0.049	0.000	0.000	0.00	1.200	0.000	36.5	0.040	1.461	42.27	0.040	1.691	3.201	0.655	2.55	2007
2008	9,276		0.652	0.000	0.652	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	49.7	0.048	2.388	0.00	0.048	0.000	2.388	0.652	1.74	2008
2009	9,703		0.649	0.001	0.650	0.16	0.084	0.013	0.000	0.000	0.00	1.200	0.000	40.1	0.059	2.363	0.00	0.059	0.000	2.376	0.650	1.73	2009
2010	10,151		0.649	0.002	0.651	0.37	0.084	0.031	0.000	0.000	0.00	1.200	0.000	62.6	0.057	3.568	0.00	0.057	0.000	3.600	0.651	2.95	2010
2011	10,615		0.650	0.000	0.650	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	84.0	0.058	4.873	0.00	0.058	0.000	4.873	0.650	4.22	2011
2012	11,100		0.656	0.005	0.661	0.76	0.084	0.064	0.000	0.000	0.00	1.200	0.000	79.2	0.063	4.988	0.00	0.063	0.000	5.052	0.661	4.39	2012
2013	11,807		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2013
2014	12,136		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2014
2015	12,692		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2015
2016	13,272		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2016
2017	13,879		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2017
VAN 12%		15.392	3.127	0.015	18.535	VAN 12% >		0.211		0.000			0.000			18.89			2.587	21.66	18.536	3.13	

IRR (%) = 15.21

Notes:

CMLPO = 0.0062 $/kWh (Includes only distribution costs, Dec. 1992)
CMLP = 0.0773 $/kWh (Includes generation, transmission and distribution costs, Dec. 1992)
Note: Investments include $3.3 million donation in 1996. (3.118 million not counted)

Column 1: Year
Column 2: Energy Demand (GWh)
Column 3: Investment Cost
Column 4: Operation and Maintenance Costs
Column 5: Distribution
Column 6: Total Cost = Column 3 + Column 4
Column 7: Incremental Increase in Consumption (GWh)
Column 8: Price of Electricity ($/kWh)
Column 9: Value of Increased Consumption = Column 7 x Column 8
Column 10: Consumer Surplus ($/kWh)
Column 11: Value of Consumer Surplus = Column 10 x Column 8
Column 12: Increase in Reliability (Reduced unserved demand)
Column 13: Value of Unserved Energy
Column 14: Value of Increased Reliability = Column 12 x Column 13
Column 15: Thermal Substitution (GWh)
Column 16: Cost of Thermal Energy ($/kWh)
Column 17: Value of Thermal Substitution = Column 15 x Column 16
Column 18: Energy Storage (stored and spilled)
Column 19: Price of Stored Energy ($/kWh)
Column 20: Value of Stored Energy = Column 18 x Column 19
Column 21: Total Benefit = Sum of Columns 9, 11, 14, 17, and 20
Column 22: Total Costs = Column 6
Column 23: Net Benefit = Column 21 - Column 22

Table 6. Economic Evaluation
(without GEF Grant)

Year	Energy Demand	Costs: Investment	Costs: O&M	Costs: Distribution	Costs: Total	Benefits: Incremental Increase in Energy Consumption			Consumer Surplus		Increased Reliability			Thermal Substitution			Energy Storage			Total Benefit	Total Costs	Net Benefit	Year
	(GWh)	($ MILL)	($ MILL)	($ MILL)	($ MILL)	(GWh)	($/kWh)	($ MILL)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	(GWh)	($/kWh)	($ MILL)	($ MILL)	($ MILL)	($ MILL)	
1993	4345																						1993
1994	4592	0.319			0.319															0.000	0.319	-0.32	1994
1995	4850	0.805			0.805															0.000	0.805	-0.81	1995
1996	5123	21.947			21.947															0.000	21.947	-21.95	1996
1997	5403	4.480	0.652	0.000	5.112	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	66.2	0.058	3.820	20.24	0.058	1.133	4.954	5.112	-0.16	1997
1998	5692	0.021	0.651	0.000	0.672	0.07	0.084	0.006	0.000	0.000	0.00	1.200	0.000	66.9	0.054	3.613	17.95	0.054	0.969	4.588	0.672	3.92	1998
1999	6002		0.652	0.005	0.657	0.85	0.084	0.072	0.000	0.000	0.00	1.200	0.000	65.5	0.053	3.470	15.26	0.053	0.809	4.350	0.657	3.69	1999
2000	6327		0.655	0.001	0.658	0.12	0.084	0.010	0.000	0.000	0.00	1.200	0.000	68.2	0.054	3.684	11.84	0.054	0.639	4.333	0.658	3.68	2000
2001	6667		0.650	0.001	0.661	0.16	0.084	0.013	0.000	0.000	0.00	1.200	0.000	76.3	0.053	4.046	0.00	0.053	0.000	4.069	0.661	3.41	2001
2002	7021		0.647	0.009	0.658	1.49	0.084	0.125	0.000	0.000	0.00	1.200	0.000	71.7	0.058	4.158	0.00	0.058	0.000	4.283	0.658	3.63	2002
2003	7388		0.647	0.010	0.657	1.66	0.084	0.139	0.000	0.000	0.00	1.200	0.000	91.0	0.065	5.915	0.00	0.065	0.000	6.054	0.657	5.40	2003
2004	7764		0.651	0.011	0.683	1.81	0.084	0.152	0.000	0.000	0.00	1.200	0.000	72.6	0.064	4.648	15.50	0.064	0.992	5.792	0.683	5.13	2004
2005	8122		0.647	0.000	0.647	0.04	0.084	0.004	0.000	0.000	0.00	1.200	0.000	72.0	0.053	3.813	4.68	0.053	0.248	4.065	0.647	3.42	2005
2006	8496		0.651	0.003	0.653	0.46	0.084	0.039	0.000	0.000	0.00	1.200	0.000	92.9	0.058	5.391	0.00	0.058	0.000	5.429	0.653	4.78	2006
2007	8877		0.652	0.004	0.656	0.59	0.084	0.049	0.000	0.000	0.00	1.200	0.000	36.5	0.040	1.461	42.27	0.040	1.691	3.201	0.655	2.55	2007
2008	9278		0.652	0.000	0.652	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	49.7	0.048	2.388	0.00	0.048	0.000	2.388	0.652	1.74	2008
2009	9703		0.649	0.001	0.650	0.16	0.084	0.013	0.000	0.000	0.00	1.200	0.000	40.1	0.059	2.363	0.00	0.059	0.000	2.378	0.650	1.73	2009
2010	10151		0.649	0.002	0.651	0.37	0.084	0.031	0.000	0.000	0.00	1.200	0.000	62.6	0.067	3.568	0.00	0.067	0.000	3.800	0.651	2.95	2010
2011	10615		0.650	0.000	0.650	0.00	0.084	0.000	0.000	0.000	0.00	1.200	0.000	84.0	0.058	4.873	0.00	0.058	0.000	4.873	0.650	4.22	2011
2012	11100		0.658	0.005	0.661	0.76	0.084	0.064	0.000	0.000	0.00	1.200	0.000	79.2	0.063	4.988	0.00	0.063	0.000	5.052	0.661	4.39	2012
2013	11607		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2013
2014	12138		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2014
2015	12692		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2015
2016	13272		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2016
2017	13879		0.651	0.003	0.654	0.53	0.084	0.045	0.000	0.000	0.00	1.200	0.000	68.6	0.063	4.321	7.98	0.063	0.503	4.869	0.654	4.22	2017
VAN 12%		17.174	3.127	0.015	20.317	VAN 12% >		0.211		0.000			0.000			18.89			2.587	21.66	20.317	1.36	

IRR (%) = 13.26

Notes:

CMLPO = 0.0062 $/kWh (Includes only distribution costs, Dec. 1992)
CMLP = 0.0773 $/kWh (Includes generation, transmission and distribution costs, Dec. 1992)

Column 1: Year
Column 2: Energy Demand (GWh)
Column 3: Investment Cost
Column 4: Operation and Maintenance Costs
Column 5: Distribution
Column 6: Total Cost = Column 3 + Column 4
Column 7: Incremental Increase in Consumption (GWh)
Column 8: Price of Electricity ($/kWh)
Column 9: Value of Increased Consumption = Column 7 x Column 8
Column 10: Consumer Surplus ($/kWh)
Column 11: Value of Consumer Surplus = Column 10 x Column 8
Column 12: Increase in Reliability (Reduced unserved demand)
Column 13: Value of Unserved Energy
Column 14: Value of Increased Reliability = Column 12 x Column 13
Column 15: Thermal Substitution (GWh)
Column 16: Cost of Thermal Energy ($/kWh)
Column 17: Value of Thermal Substitution = Column 15 x Column 16
Column 18: Energy Storage (stored and spilled)
Column 19: Price of Stored Energy ($/kWh)
Column 20: Value of Stored Energy = Column 18 x Column 19
Column 21: Total Benefit = Sum of Columns 9, 11, 14, 17, and 20
Column 22: Total Costs = Column 6
Column 23: Net Benefit = Column 21 - Column 22

Table 7. ICE Generation Expansion Plan without Tejona Project

Year	Energy (GWh)	Increase (%)	Peak (MW)	Increase (%)	Generation Plants	Year	Months
1987	3246					1987	
1988	3324	2.4	613			1988	
1989	3493	5.1	658	7.3		1989	
1990	3707	6.1	682	3.6		1990	
1991	3828	3.3	718	5.3		1991	
1992	4082	6.6	763	6.3		1992	
1993	4345	6.4	837	9.7		1993	
1994	4592	5.7	884	5.6	P.G. Miravalles I (55 MW)	1994	4
1995	4850	5.6	933	5.5	P.H. Generacion Privada (8 MW)	1995	1
					P.H. Toro I (24 MW)		6
					P.H. Toro II (66 MW)		6
1996	5123	5.6	985	5.6	P.H. Daniel Gutierrez (20 MW)	1996	1
					P.G. Miravalles II (55 MW)		3
1997	5403	5.5	1037	5.3	------	1997	
					P.H. Generacion Privada (30 MW)		1
1998	5692	5.3	1092	5.3	------	1998	
1999	6002	5.4	1150	5.3	P.H. Angostura (177 MW)	1999	7
2000	6327	5.4	1211	5.3	------	2000	
2001	6667	5.4	1275	5.3	P.H. Generacion Privada (35 MW)	2001	1
					P.G. Miravalles III (1 x 55 MW)		1
2002	7021	5.3	1342	5.3	P.T. Gas (1 x 36 MW)	2002	
2003	7388	5.2	1410	5.1	P.T. Gas (2 x 36 MW)	2003	1
2004	7764	5.1	1481	5.0	P.T. Gas (1 x 36 MW)	2004	1
2005	8123	4.6	1547	4.5	P.H. Guayabo (245 MW)	2005	1
2006	8496	4.6	1616	4.5	------	2006	
2007	8877	4.5	1687	4.4	P.G. Tenorio (1 x 55 MW)	2007	1
2008	9276	4.5	1760	4.3	P.H. Siquirres I (206 MW)	2008	1
2009	9703	4.6	1839	4.5	------	2009	
2010	10151	4.6	1922	4.5	P.H. Pirris (128 MW)	2010	1
2011	10615	4.6	2008	4.5	------	2011	
2012	11100	4.6	2098	4.5	P.T. Gas (2 x 36 MW)	2012	1

Period:	1993 - 2012
Present Value of Expansion: (Millions of Dollars)	1145.61
Long-term Marginal Cost:	57.64
Price Level:	December 1992
Current Values:	December 1992
Date:	July 1993

Table 8. ICE Generation Expansion Plan with Tejona Project with GEF Grant

Year	Energy (GWh)	Increase (%)	Peak (MW)	Increase (%)	Generation Plants	Year	Months
1987	3246					1987	
1988	3324	2.4	613			1988	
1989	3493	5.1	658	7.3		1989	
1990	3707	6.1	682	3.6		1990	
1991	3828	3.3	718	5.3		1991	
1992	4082	6.6	763	6.3		1992	
1993	4345	6.4	837	9.7		1993	
1994	4592	5.7	884	5.6	P.G. Miravalles I (55 MW)	1994	4
1995	4850	5.6	933	5.5	P.H. Generacion Privada (8 MW)	1995	1
					P.H. Toro I (24 MW)		6
					P.H. Toro II (66 MW)		6
1996	5123	5.6	985	5.6	P.H. Daniel Gutierrez (20 MW)	1996	1
					P.G. Miravalles II (55 MW)		3
1997	5403	5.5	1037	5.3	P.E. Tejona (1 x 20 MW)	1997	7
					P.H. Generacion Privada (30 MW)		1
1998	5692	5.3	1092	5.3	-----	1998	
1999	6002	5.4	1150	5.3	P.H. Angostura (177 MW)	1999	7
2000	6327	5.4	1211	5.3	-----	2000	
2001	6667	5.4	1275	5.3	P.H. Generacion Privada (35 MW)	2001	1
					P.G. Miravalles III (1 x 55 MW)		1
2002	7021	5.3	1342	5.3	-----	2002	
2003	7388	5.2	1410	5.1	P.T. Gas (2 x 36 MW)	2003	1
2004	7764	5.1	1481	5.0	P.T. Gas (2 x 36 MW)	2004	1
2005	8123	4.6	1547	4.5	P.H. Guayabo (245 MW)	2005	1
2006	8496	4.6	1616	4.5	-----	2006	
2007	8877	4.5	1687	4.4	P.G. Tenorio (1 x 55 MW)	2007	1
2008	9276	4.5	1760	4.3	P.H. Siquirres I (206 MW)	2008	1
2009	9703	4.6	1839	4.5	-----	2009	
2010	10151	4.6	1922	4.5	P.H. Pirris (128 MW)	2010	1
2011	10615	4.6	2008	4.5	-----	2011	
2012	11100	4.6	2098	4.5	P.T. Gas (2 x 36 MW)	2012	1

Period:	1993 - 2012
Present Value of Expansion: (Millions of Dollars)	1137.73
Long-term Marginal Cost:	57.24
Price Level:	December 1992
Current Values:	December 1992
Date:	July 1993

Table 9. ICE Generation Expansion Plan with Tejona Project without GEF Grant

Year	Energy (GWh)	Increase (%)	Peak (MW)	Increase (%)	Generation Plants	Year	Months
1987	3246					1987	
1988	3324	2.4	613			1988	
1989	3493	5.1	658	7.3		1989	
1990	3707	6.1	682	3.6		1990	
1991	3828	3.3	718	5.3		1991	
1992	4082	6.6	763	6.3		1992	
1993	4345	6.4	837	9.7		1993	
1994	4592	5.7	884	5.6	P.G. Miravalles I (55 MW)	1994	4
1995	4850	5.6	933	5.5	P.H. Generacion Privada (8 MW)	1995	1
					P.H. Toro I (24 MW)		6
					P.H. Toro II (66 MW)		6
1996	5123	5.6	985	5.6	P.H. Daniel Gutierrez (20 MW)	1996	1
					P.G. Miravalles II (55 MW)		3
1997	5403	5.5	1037	5.3	P.E. Tejona (1 x 20 MW)	1997	7
					P.H. Generacion Privada (30 MW)		1
1998	5692	5.3	1092	5.3	——	1998	
1999	6002	5.4	1150	5.3	P.H. Angostura (177 MW)	1999	7
2000	6327	5.4	1211	5.3	——	2000	
2001	6667	5.4	1275	5.3	P.H. Generacion Privada (35 MW)	2001	1
					P.G. Miravalles III (1 x 55 MW)		1
2002	7021	5.3	1342	5.3	——	2002	
2003	7388	5.2	1410	5.1	P.T. Gas (2 x 36 MW)	2003	1
2004	7764	5.1	1481	5.0	P.T. Gas (2 x 36 MW)	2004	1
2005	8123	4.6	1547	4.5	P.H. Guayabo (245 MW)	2005	1
2006	8496	4.6	1616	4.5	——	2006	
2007	8877	4.5	1687	4.4	P.G. Tenorio (1 x 55 MW)	2007	1
2008	9276	4.5	1760	4.3	P.H. Siquirres I (206 MW)	2008	1
2009	9703	4.6	1839	4.5	——	2009	
2010	10151	4.6	1922	4.5	P.H. Pirris (128 MW)	2010	1
2011	10615	4.6	2008	4.5	——	2011	
2012	11100	4.6	2098	4.5	P.T. Gas (2 x 36 MW)	2012	1

Period: 1993 - 2012
Present Value of Expansion: 1139.79
(Millions of Dollars)
Long-term Marginal Cost: 57.34
Price Level: December 1992
Current Values: December 1992
Date: July 1993

Table 10. Tejona Project Costs (Per Turbine and Project Total)

Tejona Wind Project

	Per Turbine Cost			Project Costs		
	Local	External	Totals	Local	External	Totals
Facilities	$957	$0	$957	$64,100	$0	$64,100
Land	$3,985	$0	$3,985	$267,000	$0	$267,000
Land Acquisition	$3,896	$0	$3,896	$261,000	$0	$261,000
Right-of-Way	$57	$0	$57	$3,800	$0	$3,800
Land Rental	$33	$0	$33	$2,200	$0	$2,200
Roads and Grading	$4,149	$1,367	$5,516	$278,000	$91,600	$369,600
Roads & Tower Access	$3,312	$1,040	$4,352	$221,900	$69,700	$291,600
Grading	$837	$327	$1,164	$56,100	$21,900	$78,000
Foundations	$11,918	$10,687	$22,604	$798,500	$716,000	$1,514,500
Preparation & Installation	$9,872	$9,391	$19,263	$661,400	$629,200	$1,290,600
Support Activities	$2,046	$1,296	$3,342	$137,100	$86,800	$223,900
Wiring and Underground Cables	$1,360	$706	$2,066	$91,100	$47,300	$138,400
Annexed Buildings and Storerooms	$1,540	$0	$1,540	$103,200	$0	$103,200
Installation	$11,046	$2,603	$13,649	$740,100	$174,400	$914,500
Turbine Tower	$4,606	$2,603	$7,209	$308,600	$174,400	$483,000
Tejona Substation (switchyard)	$3,021	$0	$3,021	$202,400	$0	$202,400
Arenal Substation	$3,042	$0	$3,042	$203,800	$0	$203,800
Land Transport	$378	$0	$378	$25,300	$0	$25,300
Transmission Line	$1,536	$2,121	$3,657	$102,900	$142,100	$245,000
Electromechanical Equipment	$0	$312,667	$312,667	$0	$20,948,700	$20,948,700
Turbines and Towers	$0	$270,000	$270,000	$0	$18,090,000	$18,090,000
Transformers	$0	$16,000	$16,000	$0	$1,072,000	$1,072,000
Arenal Substation	$0	$14,810	$14,810	$0	$992,300	$992,300
Switchyard	$0	$3,745	$3,745	$0	$250,900	$250,900
Other Electrical Materials	$0	$8,112	$8,112	$0	$543,500	$543,500
Maintenance Equipment & Spare Parts	$0	$6,269	$6,269	$0	$420,000	$420,000
O&M Training	$276	$2,813	$3,090	$18,500	$188,500	$207,000
Direct Costs	$36,767	$339,233	$376,000	$2,463,400	$22,728,600	$25,192,000
Engineering Supervision	$8,796	$2,970	$11,766	$589,300	$199,000	$788,300
Design & Construction	$8,796	$0	$8,796	$589,300	$0	$589,300
Consulting	$0	$2,970	$2,970	$0	$199,000	$199,000
General & Administrative Expenses	$8,000	$0	$8,000	$536,000	$0	$536,000
Contingency	$5,358	$17,104	$22,463	$359,000	$1,146,000	$1,505,000
Indirect Costs	$22,154	$20,075	$42,228	$1,484,300	$1,345,000	$2,829,300
Total Cost	$58,921	$359,307	$418,228	$3,947,700	$24,073,600	$28,021,300

Notes:

Local currency values include the following indirect costs: 15% of direct cost for local management; 10% of direct costs for engineering; 43.5% of direct labor costs for social security; and 5.5% of subtotal for institutional costs. Foreign currency includes 5.5% of subtotal for institutional costs.

Table 11. Financial Cost Summary and Investment Program

	Total External IDB	Total Local GEF	Total Local ICE	Total Total	1994 External IDB	1994 Local GEF	1994 Local ICE	1994 Total	1995 External IDB	1995 Local GEF	1995 Local ICE	1995 Total
1. Engineering and Administration	199	0	1125	1324	0	0	80	80	20	0	288	308
1.1 Construction Eng. Supervision	199	0	589	788	0	0	0	0	20	0	208	228
1.2 Admin. and General Costs	0	0	536	536	0	0	80	80	0	0	80	80
2. Direct Construction Cost	20026	2702	2464	25192	0	0	268	268	69	0	274	343
2.1 Generation	18275	1710	2138	23123	0	0	268	268	69	0	274	343
2.1.1 Roadways	92	0	609	701	0	0	268	268	69	0	274	343
2.1.2 Civil Work	763	0	993	1756	0	0	0	0	0	0	0	0
2.1.3 Electromech. Equipment	18246	1710	0	19956	0	0	0	0	0	0	0	0
2.1.4 Turbine Installation	174	0	536	710	0	0	0	0	0	0	0	0
2.2 Transmission Work	142	992	307	1441	0	0	0	0	0	0	0	0
2.2.1 Arenal Substation	0	992	204	1196	0	0	0	0	0	0	0	0
2.2.2 Transmission Line	142	0	103	245	0	0	0	0	0	0	0	0
2.3 Other Costs	809	0	19	828	0	0	0	0	0	0	0	0
2.3.1 Maintenance Vehicles	120	0	0	120	0	0	0	0	0	0	0	0
2.3.2 Spares Parts	300	0	0	300	0	0	0	0	0	0	0	0
2.3.3 O&M Training	189	0	19	208	0	0	0	0	0	0	0	0
3. Miscellaneous Costs	4519	598	512	5629	0	0	36	36	14	0	71	85
3.1 Contingency	1011	135	359	1505	0	0	35	35	4	0	56	60
3.2 Escalation	3508	463	153	4124	0	0	1	1	10	0	15	25
4. Construction Financing Costs	8145	0	644	8789	52	0	192	244	61	0	231	292
4.1 Interest	5839	0	0	5839	1	0	0	1	10	0	0	10
4.2 Commissions	0	0	644	644	0	0	192	192	0	0	231	231
4.3 Inspections	306	0	0	306	51	0	0	51	51	0	0	51
Total General	30889	3300	4745	38934	52	0	576	628	164	0	864	1028
Percentages	79.3	8.5	12.2	100.0				1.6				2.6

	1996 External IDB	1996 Local GEF	1996 Local ICE	1996 Total	1997 External IDB	1997 Local GEF	1997 Local ICE	1997 Total
1. Engineering and Administration	80	0	509	589	80	0	249	329
1.1 Construction Eng. Supervision	80	0	295	375	80	0	88	168
1.2 Admin. and General Costs	0	0	214	214	0	0	161	161
2. Direct Construction Cost	16478	2394	1737	20609	3480	308	186	3974
2.1 Generation	15835	1402	1430	18667	3371	308	166	3845
2.1.1 Roadways	23	0	67	90	0	0	0	0
2.1.2 Civil Work	763	0	993	1756	0	0	0	0
2.1.3 Electromech. Equipment	14962	1402	0	16364	3284	308	0	3592
2.1.4 Turbine Installation	87	0	370	457	87	0	166	253
2.2 Transmission Work	128	992	297	1417	14	0	10	24
2.2.1 Arenal Substation	0	992	204	1196	0	0	0	0
2.2.2 Transmission Line	128	0	93	221	14	0	10	24
2.3 Other Costs	515	0	10	525	95	0	10	105
2.3.1 Maintenance Vehicles	120	0	0	120	0	0	0	0
2.3.2 Spares Parts	300	0	0	300	0	0	0	0
2.3.3 O&M Training	95	0	10	105	95	0	10	105
3. Miscellaneous Costs	3589	519	324	4432	910	78	81	1069
3.1 Contingency	828	120	224	1172	178	15	44	237
3.2 Escalation	2761	399	100	3260	732	63	37	832
4. Construction Financing Costs	835	0	151	986	1849	0	49	1898
4.1 Interest	784	0	0	784	1798	0	0	1798
4.2 Commissions	0	0	151	151	0	0	49	49
4.3 Inspections	51	0	0	51	51	0	0	51
Total General	20982	2913	2721	26616	6319	386	565	7270
Percentages				68.4				18.7

	1998 External IDB	1998 Local GEF	1998 Local ICE	1998 Total	1999 External IDB	1999 Local GEF	1999 Local ICE	1999 Total
1. Engineering and Administration	20	0	0	20	0	0	0	0
1.1 Construction Eng. Supervision	20	0	0	20	0	0	0	0
1.2 Admin. and General Costs	0	0	0	0	0	0	0	0
2. Direct Construction Cost	0	0	0	0	0	0	0	0
2.1 Generation	0	0	0	0	0	0	0	0
2.1.1 Roadways	0	0	0	0	0	0	0	0
2.1.2 Civil Work	0	0	0	0	0	0	0	0
2.1.3 Electromech. Equipment	0	0	0	0	0	0	0	0
2.1.4 Turbine Installation	0	0	0	0	0	0	0	0
2.2 Transmission Work	0	0	0	0	0	0	0	0
2.2.1 Arenal Substation	0	0	0	0	0	0	0	0
2.2.2 Transmission Line	0	0	0	0	0	0	0	0
2.3 Other Costs	0	0	0	0	0	0	0	0
2.3.1 Maintenance Vehicles	0	0	0	0	0	0	0	0
2.3.2 Spares Parts	0	0	0	0	0	0	0	0
2.3.3 O&M Training	0	0	0	0	0	0	0	0
3. Miscellaneous Costs	6	0	0	6	0	0	0	0
3.1 Contingency	1	0	0	1	0	0	0	0
3.2 Escalation	5	0	0	5	0	0	0	0
4. Construction Financing Costs	2165	0	17	2182	1183	0	4	1187
4.1 Interest	2114	0	0	2114	1132	0	0	1132
4.2 Commissions	0	0	17	17	0	0	4	4
4.3 Inspections	51	0	0	51	51	0	0	51
Total General	2191	0	17	2208	1183	0	4	1187
Percentages				5.7				3.0

Note: Values in thousands of dollars. (December 1992 dollars)

US $1.00 = 138.07 Colones

Table 12. GEF Grant Expenditures

	Cost $,000
Electromechanical Equipment	$1,710
Pad-Mounted Transformers	$1,072
Switchyard Structures	$16
Switchyard Line Sections	$155
Switchyard Switches	$20
Reactive Compensation	$60
Monitoring System	$107
Control & Power Cable	$280
Arenal Substation	$992
Structures	$16
Transformation Section	$203
Line Sections	$155
Transformer	$618
Contingency	$135
Escalation	$463
Total	$3,300

29. The IDB has financed the preparation of bidding documents for the project. ICE and independent consultants are developing the bidding documents with the objective of ensuring only fully qualified suppliers and equipment suitable for the Tejona wind resource are selected for the project. This will be accomplished through a two-stage bidding process.

30. In the first phase, only the qualification and experience of the organization and equipment will be considered relative to a predetermined evaluation criteria. Evaluation criteria will include international construction experience on wind turbine projects and on-schedule civil and electrical construction experience in Central America similar to the work required for the Tejona project. The bidder will provide details of the operational experience of the proposed wind turbine including availability history, performance data, and retrofit information. The design basis will be reviewed to ensure the turbine's adequacy for the Tejona environment. The proposed turbine will carry a multi-year warranty against defects in design, materials, and workmanship. The manufacturer will be responsible for O&M during the warranty period, with assistance by ICE personnel to gain experience. Only those organizations that satisfy all of the criteria will move to the second evaluation stage.

31. The second evaluation stage will compare the proposals based on cost, schedule, and other factors to establish the overall winner. Bidders will be required to submit turbine cost data, operation and maintenance costs, and detailed turbine performance projections. Independent consultants will be

used to support ICE in evaluation of the bids and project construction oversight. This will help ensure that the project is awarded to a qualified firm, and that IDB and GEF interests are considered.

32. A warranty, which covers any defects in the design and manufacture of the turbine, will be required with the wind turbines. The turbine manufacturer will provide the necessary parts and labor to repair any failures that are covered by the warranty. The power curve of the turbines will also be warranted.

33. Following construction of the project, a series of project acceptance tests will be conducted to verify that the performance, electrical, and noise characteristics of the project are within specified limits.

34. The development of the project schedule, which is presented in Figure 8, includes consideration of the constraints imposed on the site due to climate and weather. Consideration was also given to equipment availability. Preliminary procurement activities began in the Fall of 1993. Site preparation is scheduled to begin in September 1995 and turbine installation is to begin in August 1996. Turbine checkout will take place in the Spring of 1997, with commercial operation scheduled to commence in June 1997.

35. <u>Operation and Maintenance</u>. ICE's operation of the Tejona project ensures effective integration of the facility into their existing system. Because this will be the first wind power plant owned by ICE, a comprehensive training program will be necessary in order for ICE personnel to independently operate and maintain the project. The specifications of the training program will include a combination of training at the turbine manufacturer's facility and field experience on installed turbines. After the training with the manufacturer, the ICE personnel will participate in the site installation work.

36. <u>Environmental Aspects</u>. An environmental impact study was conducted by ICE for the Tejona project and reviewed by consultants in June 1993. The study concluded that although the environment would be affected during the construction phase of the project, none of the effects were considered to be severe or unmitigable. During the operating stage of the project, the primary impact identified was the visual impact of the turbines and towers.

37. The Instituto Nacional de Biodiversidad (INBio) prepared a list of all species of flora believed to be in the area. The list categorizes the species based on the elevation at which they can be found and identifies various levels of potential endangerment. The site is classified as a semi-deciduous, low, tropical forest. There are several species of plants and none are considered to be in danger of extinction.

38. There is a low diversity of fauna in this region because of the alteration of the forest to support dairy cattle. As a result, the majority of mammals from the region have been displaced to other areas, where they have permanently adapted. Existing mammals in the vicinity are not in danger of extinction.

INSTITUTO COSTARRICENSE DE ELECTRICIDAD
ELECTRICAL DEVELOPMENT PROGRAM III
TEJONA WIND PLANT

ID	Task Name	Start	Finish	Predecessor
1	Financing	2/15/94	9/24/94	
2	Signing the Loan Contract	2/15/94	2/15/94	
3	Legislative Approval	9/24/94	9/24/94	
4	Consulting	8/3/93	6/25/97	
5	Designs & Specifications	8/3/93	2/14/94	
6	Execution Phase	1/1/94	6/25/97	
7	Negotiation	1/1/94	3/31/95	
8	Short List	1/1/94	5/31/94	
9	Qualifications	6/1/94	3/31/95	8
10	Consulting Services	4/7/95	6/25/97	
11	Technical Review	4/7/95	4/28/95	
12	Assistance During Assembly	8/23/96	9/6/96	
13	Assistance During Operation	6/11/97	6/25/97	
14	Land Acquisition	8/2/93	6/27/94	
15	Topographic Surveying	8/2/93	9/2/93	
16	Assessment	9/3/93	12/7/93	15
17	Jurisdiction Analysis	12/8/93	4/26/94	16
18	Purchase of Land Lease	4/27/94	6/27/94	17
19	Solicitation for Wind Turbines	9/3/93	5/8/97	
20	Specification Preparation	9/3/93	6/22/94	
21	ICE/IDB Approval	6/22/94	9/26/94	20
22	Publication of Documents	9/26/94	10/26/94	21
23	Critique of Documents	10/27/94	11/25/94	22
24	Receiving of Bids	11/28/94	3/7/95	23
25	Bid Evaluation	3/8/95	6/15/95	24
26	ICE Award Approval	6/16/95	7/18/95	25
27	IDB Award Approval	6/16/95	7/18/95	25
28	Award Appeal Period	7/19/95	10/25/95	26:27
29	Issue of Purchase Order/First Payment	10/26/95	1/4/96	28
30	Wind Equipment Manufacture	1/5/96	11/21/96	29
31	Wind Equipment Delivery	8/23/96	5/8/97	30SS+165d
32	Solicitation for Control System	9/3/93	6/18/96	
33	Specification Preparation	9/3/93	6/22/94	
34	ICE/IDB Approval	6/22/94	9/26/94	33

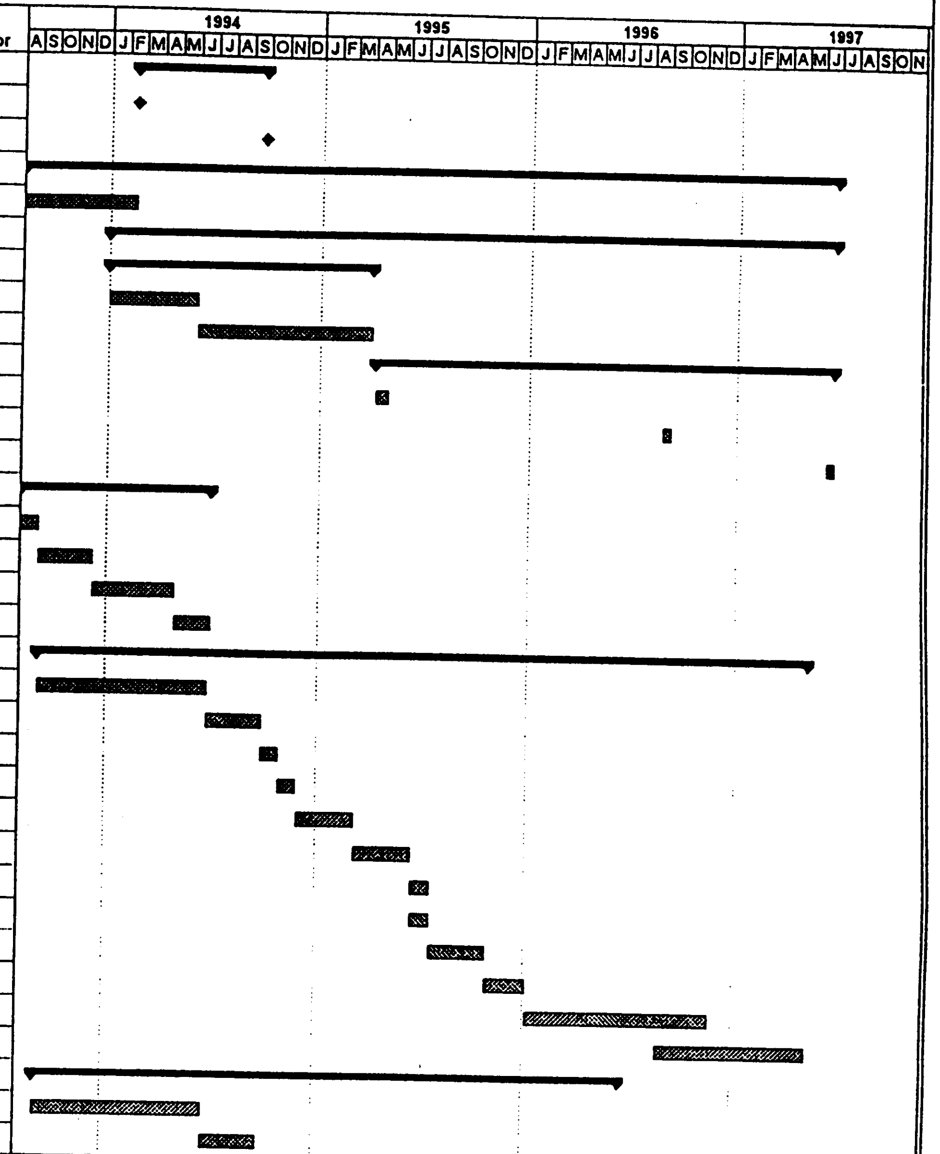


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Figure 8. Tejona Wind Farm Project Schedule

INSTITUTO COSTARRICENSE DE ELECTRICIDAD
ELECTRICAL DEVELOPMENT PROGRAM III
TEJONA WIND PLANT

ID	Task Name	Start	Finish	Predecessor
35	Publication of Documents	9/26/94	10/26/94	34
36	Critique of Documents	10/27/94	11/25/94	35
37	Receiving of Bids	11/28/94	3/7/95	36
38	Bid Evaluation	3/8/95	6/15/95	37
39	ICE Award Approval	6/16/95	7/18/95	38
40	IDB Award Approval	6/16/95	7/18/95	38
41	Award Appeal Period	7/19/95	10/25/95	39:40
42	Issue of Purchase Order/First Payment	10/26/95	1/4/96	41
43	Control Equipment Manufacture	1/8/96	5/17/96	42
44	Control Equipment Delivery	4/17/96	6/18/96	43SS+73d
45	**Solicitation for Transformer/Substation Equipment**	9/3/93	6/18/96	
46	Specification Preparation	9/3/93	6/22/94	
47	ICE/IDB Approval	6/22/94	9/26/94	46
48	Publication of Documents	9/26/94	10/26/94	47
49	Critique of Documents	10/27/94	11/25/94	48
50	Receiving of Bids	11/28/94	3/7/95	49
51	Bid Evaluation	3/8/95	6/15/95	50
52	ICE Award Approval	6/16/95	7/18/95	51
53	IDB Award Approval	6/16/95	7/18/95	51
54	Award Appeal Period	7/19/95	10/25/95	52:53
55	Issue of Purchase Order/First Payment	10/26/95	1/4/96	54
56	Transformer/Substation Equipment	1/5/96	5/16/96	55
57	Transformer/Substation Equipment Delivery	4/17/96	6/18/96	56SS+73d
58	**Solicitation for Electrical Cable**	9/3/93	6/18/96	
59	Specification Preparation	9/3/93	6/22/94	
60	ICE/IDB Approval	6/22/94	9/26/94	59
61	Publication of Documents	9/26/94	10/26/94	60
62	Critique of Documents	10/27/94	11/25/94	61
63	Receiving of Bids	11/28/94	3/7/95	62
64	Bid Evaluation	3/8/95	6/15/95	63
65	ICE Award Approval	6/16/95	7/18/95	64
66	IDB Award Approval	6/16/95	7/18/95	64
67	Award Appeal Period	7/19/95	10/25/95	65:66
68	Issue of Purchase Order/First Payment	10/26/95	1/4/96	67

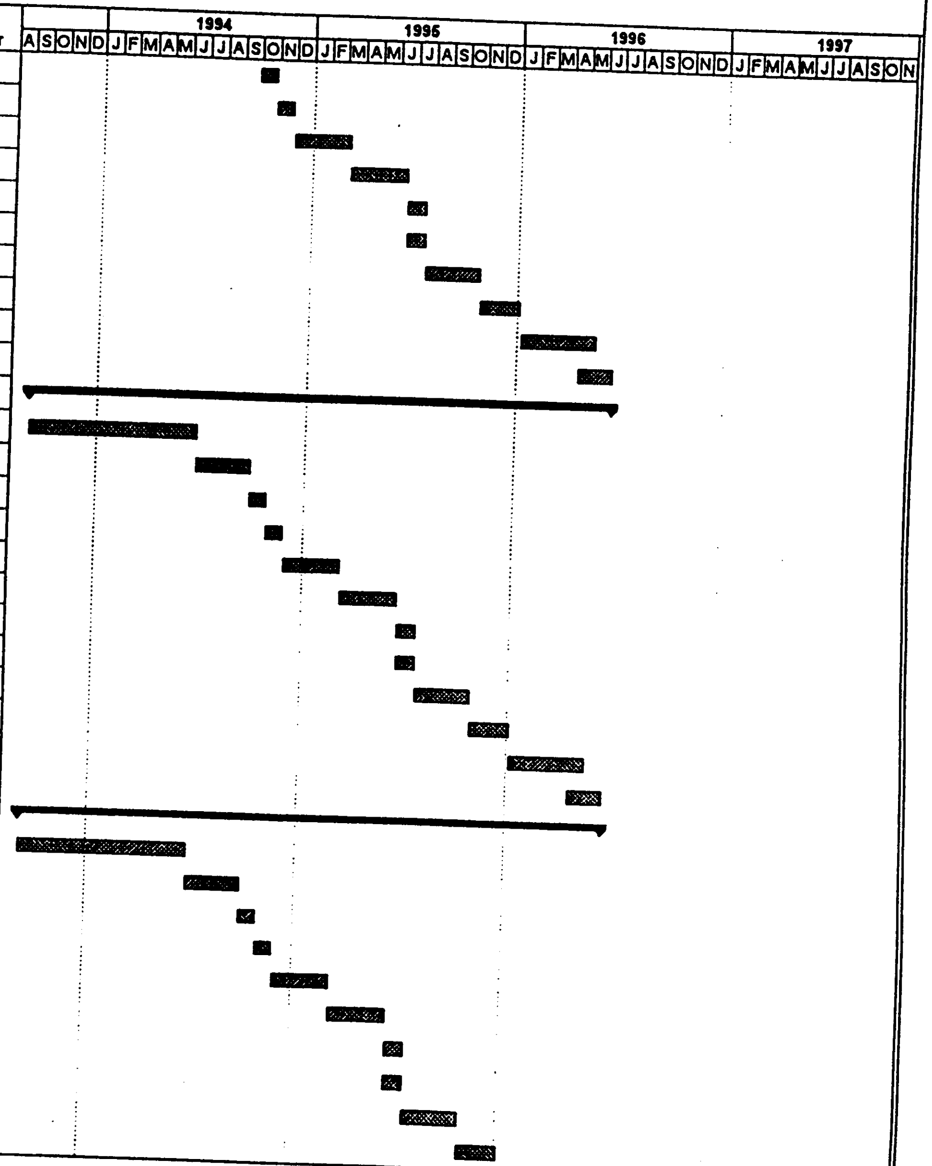

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Figure 8. Tejona Wind Farm Project Schedule (continued)

INSTITUTO COSTARRICENSE DE ELECTRICIDAD
ELECTRICAL DEVELOPMENT PROGRAM III
TEJONA WIND PLANT

ID	Task Name	Start	Finish	Predecessor
69	Electrical Cable Manufacture	1/5/96	5/16/96	68
70	Electrical Cable Delivery	4/17/96	6/18/96	69SS+73d
71	Solicitation for Transmission Line	10/12/96	1/13/97	
72	Delivery of Materials	10/12/96	10/12/96	
73	Construction	10/14/96	1/13/97	
74	Construction	9/26/95	6/10/97	
75	Roads	9/26/95	2/5/96	
76	Housing	10/26/95	1/19/96	
77	Crane Pads	11/28/95	2/5/96	
78	Foundations	1/8/96	10/23/96	
79	Excavations	1/8/96	8/22/96	
80	Concrete Foundations	2/6/96	10/23/96	
81	Trenching	6/18/96	10/28/96	70
82	Electrical Equipment Installation	8/23/96	6/10/97	
83	Towers and Turbines Installation	6/19/96	10/24/96	44
84	Switchyard	5/1/96	9/11/96	57FS-35d
85	Arenal Substation Expansion	6/4/96	10/8/96	
86	Buildings	1/21/96	9/6/96	
87	Wind Turbine Testing	3/10/97	6/10/97	
88	Begin Commercial Operation	6/11/97	6/11/97	
89	Wind Project Testing	6/11/97	7/11/97	

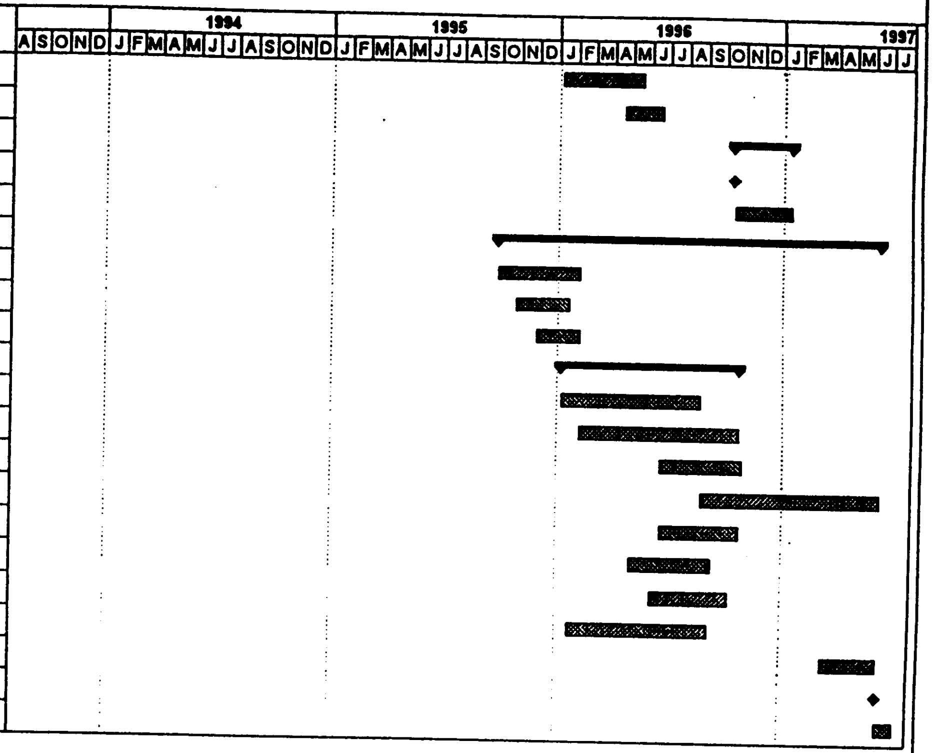

Figure 8. Tejona Wind Farm Project Schedule (continued)

39. There are various species of birds in the vicinity and none are in danger of extinction. According to INBio, the project is not on any migratory bird route.

40. Consideration has been given to the possibility of archeological remains existing at the project site. No cultural remains were found during an exploration made by Museo Nacional de Costa Rica. In comparing the project site with existing data, the only area where archeological remains might be is near the east of the Montecristo Ridge. In order to verify that no cultural remains exist, the feasibility study recommends that an archeologist be present when land movement begins.

41. Project Benefits. The primary benefits of the project are: (a) demonstration of a grid-connected, utility-scale renewable energy project that can be replicated in other areas of Costa Rica and the region; (b) demonstration of turnkey project development to ICE; (c) provide support for additional investment in the power sector; (d) reduced emission of greenhouse gases and reduced reliance on fossil fuels resulting from the displacement of thermal energy; (e) improved SNI grid reliability; (f) possible surplus potential energy stored in the Arenal reservoir; (g) seasonal export potential of hydroelectric energy, and (h) positive impact on tourism (ICE is considering a visitor's center at the site).

42. Risks. Some risk is associated with a first-time project and with operating wind turbines in such a high-wind regime. These risks are being minimized through development of a detailed equipment specification and project-specific supplier quotation criteria. The risks related to economic and wind resource factors have been largely reduced through the extensive research and analysis provided by the feasibility studies. Additional risks associated with wind turbine performance can be minimized during the bid evaluation and procurement stages of the project development.