CHAPTER 8 PROJECT JUSTIFICATION

8.1 Economic and Financial Evaluation

8.1.1 Economic Evaluation

The economic viability of the three wind power projects is examined by computing the Economic Internal Rate of Return (EIRR), which is calculated based on the following assumptions.

(1) Basic Assumptions

Economic evaluation of the proposed project is examined based on the following assumptions.

1) Project Life

The life of the proposed project is assumed to be 20 years including six month construction period, taking into account the economic life of the wind turbine, the main facility of the projects.

2) Price Level and Price Escalation

All the costs and benefits are estimated at the price level of June 2001. Price escalation is not included in the evaluation in order to derive the EIRR net of price escalation impact.

3) Exchange Rate

The applied exchange rates are:

US$1=120.5 Yen = 6.53 Bolivianos

The analysis is made and shown in US dollar.

4) Economic Cost

Economic costs are derived by taking the domestic taxes and subsidies from the financial costs.

<u>Economic Project Cost</u>

Economic project costs are summarized as follows.

Economic Project Costs of the Wind Power Projects (US$)

	Unit	Unit Cost	Charana		Caripe		Chachacomani (W-M)	
			Units	Cost	Units	Cost	Units	Cost
Wind Turbine	kW	2,700	80	216,000	10	27,000	20	54,000
PV System	kW	7,000	16	112,000	4	28,000	0	0
MHP	kW	34,250	0	0	0	0	3	102,749
Inverter	kVA	500	64	32,000	8	4,000	14	7,000
Converter	kVA	180	20	3,600	0	0	10	1,800
Battery	kAh	500	44	22,000	8	4,000	4	2,000
Control House	(1/village)	10,000	1	10,000	1	10,000	1	10,000
Installation Materials	kW	690	96	66,207	14	9,655	20	13,793
Installation Work	kW	603	96	57,931	14	8,448	20	12,069
Transportation	kg	8	11,200	92,946	1,800	14,938	2,000	16,598
Secondary Distribution Line	km	3,409	-	29,904	-	9,200	-	12,500
Administration (8.8%)	-	-	-	56,548	-	10,141	-	20,461
Total Investment Cost	-	-	-	699,136	-	125,382	-	252,969

Source: JICA Study Team

Economic life of the Wind Power

Economic life of the main facilities is estimated as follows.

Economic Life of Major Equipment

Wind Turbine	20 Years
PV/MHP	20 Years
Inverter	10 Years
Converter	10 Years
Battery	6 Years
Control House	20 Years
Secondary Distribution Lines	20 Years

Residual value is assumed to be zero as all the equipment is to be used up to their economic life.

Economic OM Cost

Annual operation and maintenance costs of the project facilities are estimated as follows.

Wind PV/MHP Power: 2% of the investment
Distribution Lines: 2.5% of the investment

5) Economic Benefit

Economic benefits are derived by taking the domestic taxes and subsidies from the financial costs.

The costs of the least-cost alternative system, i.e., a diesel engine powered generation system with the capacity to generate the same amount of electricity as the proposed wind power project, is considered to be the economic benefit.

Investment Cost of the Diesel Generation System

Investment cost of the alternative diesel generation system is estimated as follows.

Investment Cost of the Diesel Generation System

	Unit	Unit Cost	Charana		Caripe		Chachacomani	
			Units	Cost	Units	Cost	Units	Cost
Capacity of the Diesel Generator	kW	750	65	48,750	10	7,500	20	15,000
Automatic Transfer Switch	-	1,910	1	1,910	1	1,910	1	1,910
Protection Box	-	917	1	917	1	917	1	917
Building	-	1,500	1	1,500	1	1,500	1	1,500
Secondary Distribution Lines	km	-	-	29,904	-	9,200	-	12,500
Total	-	-	-	82,981	-	21,027	-	31,827

Source: JICA Study Team

OM Cost

Annual operation and maintenance costs of the alternative diesel generation system are estimated as follows.

Diesel Generation System: 5% of the investment
Distribution Lines: 2.5% of the investment

Diesel Oil Cost

Economic cost of diesel oil in Charaña, Caripe and Chachacomani are summarized as follows.

Economic Cost of Diesel Oil (Bs./Litter)

Charaña	Caripe	Chachacomani
3.19	3.28	3.28

Annual diesel oil costs of the three sites are calculated based on the estimated power generation.

Annual Power Generation and Diesel Oil Cost

	Charaña	Caripe	Chachacomani
Power Generation (kWh/Y)	122,560	22,643	42,671
Fuel Consumption (L/Y)	53,420	13,032	20,405
Diesel Oil Cost (US$/Y)	26,096	6,546	10,250

Economic Life of the Diesel Generation System

Economic life of the main facilities is estimated as follows.

Economic Life of Major Equipment

Diesel Generator	10 Years
Automatic Transfer Switch	10 Years
Protection Box	10 Years
Building	10 Years
Secondary Distribution Lines	20 Years

Residual value is assumed to be zero as all the equipment is to be used up to their respective economic life.

(2) Results of Economic Analysis

The EIRRs of the three projects on the basis of the above assumptions are computed as in Tables 8.1 to 8.3, using the economic cost and benefit stream shown above.

EIRR of the Wind Power Projects

Charaña	Caripe	Chachacomani
-2.6%	1.0%	-0.9%

The EIRRs of the projects in Charaña and Chachacomani are slightly negative through that of the projects in Caripe is positive. The costs of the wind turbine, inverter, converter and PV systems, however, are expected to decline in the future. Should the demand for the wind power generation systems increases in the future, the unit price will likely to fall further. It is calculated that the investment cost of the projects in Charaña and Chachacomani has to come down by 22% and 8% respectively in order to achieve zero EIRR, ie., the opportunity cost of the projects.

In the light of the possible price reduction of the wind power generation systems as well as the environmental consideration of the diesel power, the proposed three wind power projects should be considered as a viable option to be chosen in the respective three areas.

8.1.2 Financial Evaluation

The financial viability of the three wind power projects is examined by computing the power tariff to cover and OM cost of the projects.

(1) Basic Assumptions

Financial evaluation of the proposed project is examined based on the following assumptions. Assumptions such as project life, price level and escalation, exchange rate, economic life of equipment and O&M costs are the same as in the case of the economic evaluation.

1) Financial Project Cost

Financial project costs are assumed to be as follows.

Financial Project Costs of the Wind Power Projects

	Unit	Unit Cost	Charana		Caripe		Chachacomani (W-M)	
			Units	Cost	Units	Cost	Units	Cost
Wind Turbine	kW	3,238	80	259,070	10	32,384	20	64,768
PV System	kW	8,746	16	139,933	4	34,983	0	0
MHP	kW	40,000	0	0	0	0	3	120,000
Inverter	kVA	600	64	38,381	8	4,798	14	8,396
Converter	kVA	216	20	4,318	0	0	10	2,159
Battery	kAh	580	44	25,520	8	4,640	4	2,320
Control House	(1/villag	11,600	1	11,600	1	11,600	1	11,600
Installation Materials	kW	800	96	76,800	14	11,200	20	16,000
Installation Work	kW	700	96	67,200	14	9,800	20	14,000
Transportation	kg	8	11,200	92,946	1,800	14,938	2,000	16,598
Secondary Distribution Line	km	4,091	-	35,885	-	11,040	-	15,000
Administration (8.8%)	-	-	-	66,145	-	11,914	-	23,834
Total Investment Cost	-	-	-	817,798	-	147,296	-	294,674

Source: JICA Study Team

The tax rates included in the financial costs are summarized below.

Taxes for Domestic Products

VAT (Value Added Tax):	13% for all the categories of products
Transaction tax:	3% for all the categories of products

Taxes for Imported Products

Effective VAT:	14.94% for all the categories of products
Import tax:	5% (wind turbine, MHP, inverter, converter)
	10% (PV system)
	20%* (distribution lines)

* Adjusted rate in consideration of the different products used to produce distribution lines

2) Power Demand

Total annual power demand are summarized in the following table.

Power Demand

	Charaña	Caripe	Chachacomani
Estimated HH Users	150	30	70
Average HH Demand (kWh/Y)	265	252	258
Total HH Demand (kWh/Y)	39,750	7,560	18,060
Total Industrial Demand (kWh/Y)	25,928	2,391	2,380
Total Annual Demand (kWh/Y)	65,678	9,951	20,440

3) Calculation of Power Tariff to Cover the OM Costs

Minimum power tariff of the residential sector to cover the OM cost is calculated. The power tariff from the industrial sector is assumed to be 50% higher than that of the residential sector.

The minimum power tariff is calculated by dividing the annual OM cost by annual power demand.

From the financial project costs, financial OM cost is estimated at US$9,731 in Charaña, US$1,719 in Caripe and US$4,708 in Chachacomani per year. The following table shows the minimum power tariff to cover OM cost of the projects.

Minimum Power Tariff to Cover OM Costs (US$)

	Charaña	Caripe	Chachacomani
Residential per kWh	0.12	0.15	0.22
Residential per Month	2.65	3.15	4.73

(2) Results of Financial Analysis

1) Charaña

At present, residential users of the diesel generation system pay on average Bs.30, or US$4.59 per month for three-hour service a day in Charaña. Since each residential user of the wind power project in Charaña is estimated to use 265kWh per year, the monthly payment would be US$2.65 (US$0.12/kWh x 265 kWh / 12 months), which is lower than the amount they pay at present. The wind power project in Charaña will be able to recover 100% O&M cost and a part of the investment cost through power tariff. Under such condition, the wind power project in Charaña would be financially sustainable.

2) Caripe

At present, residential users pay on average Bs.34.1, or US$5.22 per month for kerosine oil and/or candles in Caripe. Since each residential user of the wind power project in Caripe is estimated to use 252kWh per year, the monthly payment would be US$3.15 (US$0.15/kWh x 252 kWh / 12 months), which is lower than the amount they pay at present. The wind power project in Caripe will be able to recover 100% O&M cost and a part of the investment cost through power tariff. Under such condition, the wind power project in Caripe would be financially sustainable.

3) Chachacomani

At present, residential users pay on average Bs.30, or US$4.59 per month for kerosine oil in Chachacomani. Since each residential user of the wind power project in Chachacomani is estimated to use 258kWh per year, the monthly payment would be US$4.73 (US$0.22/kWh x 258 kWh / 12 months), which is slightly higher than the amount they pay at present. However, the service and the benefit they get from 24 hour-a-day operational wind power generation would be no comparison to that of using a kerosine lamp. It could well be said that the wind power project in Chachacomani is sustainable if OM cost is to be covered by the power tariff.

8.2 Initial Environmental Evaluation

8.2.1 IEE for Charaña Wind Power Project

The study on Initial Environmental Evaluation (IEE) was conducted during the fifth field survey in May 2001. The results of survey indicate no negative impact on natural environment as well as social environment is foreseen in implementing this wind power project. The table below shows anticipated environmental impacts in/around the project sites. The expected positive impacts are as follows:

- to provide local farmers with irrigated agriculture with water pumping system in place of rain-fed agriculture,
- to develop cottage industry for job opportunity,
- to improve public services including education and public health in public facilities, and
- to improve public piece and order at night.

Anticipated problems of noise and obstacle of landscape will give a negligible impact on the social environment because the power plant is to be installed in the outskirts of the town.

IEE Matrix for Charañ Wind Power Project, La Paz

		Item	Evaluation	Remarks
Social Environment	1	Resettlement	-	
	2	Economic activities	○	Irrigated agriculture with water pumping system and cottage industry will be promoted.
	3	Traffic and public facilities	○	Public facilities including schools and hospitals will be electrified.
	4	Split of communities	-	
	5	Cultural property	-	
	6	Water rights/Right of common	-	
	7	Public health condition	○	Clean water will be provided by water pumping system.
	8	Waste	-	
	9	Hazards	○	Lighting will enhance safety at night for rural life.
Natural Environment	10	Topography and geology	-	
	11	Soil erosion	-	
	12	Groundwater	-	
	13	Hydrological situation	-	
	14	Coastal zone	-	
	15	Flora and fauna	-	
	16	Climate	-	
	17	Landscape	-	
Pollution	18	Air pollution	-	
	19	Water pollution	-	
	20	Soil contamination	-	
	21	Noise and vibration	-	
	22	Land subsidence	-	
	23	Offensive odor	-	

Notes: ○= Positive impact, - = Negligible impact, △= Minor impact, □= Moderate impact, × = Serious impact, ? = Not clear
This IEE study was implemented by an environmental consultant registered by the Ministry of Sustainable Development and Planification in May, 2001.
The study report of this IEE was submitted to the the Ministry of Sustainable Development and Planification through the Vice Ministry of Energy and Hydrocarbons.
Source: JICA Study Team

8.2.2 IEE for Caripe Wind Power Project

The Initial Environmental Evaluation (IEE) was studied during the fifth field survey in May 2001. According to the results of survey, limited negative impact on the project site is foreseen through the implementation of this wind power project. Expected positive impacts on social environment in the target area are presented in the table below. Local people will receive not only rural electrification but also socioeconomic benefits as follows:

- to promote irrigated agriculture with water pumping system for local farmers,
- to develop cottage industry for income generation in rural area,
- to improve the function of public facilities including municipality office, school and hospital, and
- to enhance safety at night by means of public lighting in the target area.

Since the wind power plant is to be installed in the outskirts of the town, anticipated problems of noise and obstacle of landscape will be negligible on the social environment in Caripe.

IEE Matrix for Caripe Wind Power Project, Oruro

Item			Evaluation	Remarks
Social Environment	1	Resettlement	-	
	2	Economic activities	○	Irrigated agriculture with water pumping system and cottage industry will be promoted.
	3	Traffic and public facilities	○	Public facilities including schools and hospitals will be electrified.
	4	Split of communities	-	
	5	Cultural property	-	
	6	Water rights/Right of common	-	
	7	Public health condition	○	Clean water will be provided by water pumping system.
	8	Waste	-	
	9	Hazards	○	Lighting will enhance safety at night for rural life.
Natural Environment	10	Topography and geology	-	
	11	Soil erosion	-	
	12	Groundwater	-	
	13	Hydrological situation	-	
	14	Coastal zone	-	
	15	Flora and fauna	-	
	16	Climate	-	
	17	Landscape	-	
Pollution	18	Air pollution	-	
	19	Water pollution	-	
	20	Soil contamination	-	
	21	Noise and vibration	-	
	22	Land subsidence	-	
	23	Offensive odor	-	

Notes: ○ = Positive impact, - = Negligible impact, △ = Minor impact, □ = Moderate impact, × = Serious impact, ? = Not clear
This IEE study was implemented by an environmental consultant registered by the Ministry of Sustainable Development and Planification in May, 2001.
The study report of this IEE was submitted to the the Ministry of Sustainable Development and Planification through the Vice Ministry of Energy and Hydrocarbons.
Source: JICA Study Team

8.2.3 IEE for Chachacomani Wind Power Project

The study on Initial Environmental Evaluation (IEE) was carried out during the fifth field survey in May 2001. The results of survey show this wind power project will give no negative impact in/around the project site. Expected positive impacts on social environment are summarized in the table below. The project will contribute to the following socioeconomic benefits as well as rural electrification in the target area:

- to introduce irrigated agriculture with water pumping system for developing horticulture,
- to develop cottage industry for job opportunity in rural area,
- to provide local people with more qualified services for improving social environment and social welfare, and
- to maintain safety and order at night.

Anticipated noise and obstacle of landscape will give a negligible impact on the social environment because the system plans to build on the outskirts of the town.

IEE Matrix for Chachacomani Wind Power Project, Oruro

		Item	Evaluation	Remarks
Social Environment	1	Resettlement	-	
	2	Economic activities	○	Irrigated agriculture with water pumping system and cottage industry will be promoted.
	3	Traffic and public facilities	○	Public facilities including schools and hospitals will be electrified.
	4	Split of communities	-	
	5	Cultural property	-	
	6	Water rights/Right of common	-	
	7	Public health condition	○	Clean water will be provided by water pumping system.
	8	Waste	-	
	9	Hazards	○	Lighting will enhance safety at night for rural life.
Natural Environment	10	Topography and geology	-	
	11	Soil erosion	-	
	12	Groundwater	-	
	13	Hydrological situation	-	
	14	Coastal zone	-	
	15	Flora and fauna	-	
	16	Climate	-	
	17	Landscape	-	
Pollution	18	Air pollution	-	
	19	Water pollution	-	
	20	Soil contamination	-	
	21	Noise and vibration	-	
	22	Land subsidence	-	
	23	Offensive odor	-	

Notes: ○= Positive impact, - = Negligible impact, △= Minor impact, □= Moderate impact, × = Serious impact, ? = Not clear
This IEE study was implemented by an environmental consultant registered by the Ministry of Sustainable Development and Planification in May, 2001.
The study report of this IEE was submitted to the the Ministry of Sustainable Development and Planification through the Vice Ministry of Energy and Hydrocarbons.
Source: JICA Study Team

TABLES

Table 1.1 Monthly Average Wind Speed in La Paz

1 Lapaz Ingavi Tiawanacu UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
87	0	4	3	4	4	3	3	2	4	4	3	4	3.2
88	3	3	0	0	0	0	0	0	4	0	0	4	1.2
89	4	4	3	3	3	2	2	2	3	4	3	4	3.1
90	4	3	3	2	3	3	2	2	3	4	3	3	2.9
91	3	3	3	-	-	-	-	-	-	-	-	-	3.0
92	-	-	-	-	-	-	-	-	-	-	-	-	0.0
93	5	6	4	3	6	5	6	5	4	6	4	5	4.9
94	2	3	2	2	0	0	2	2	2	2	2	2	1.8
95	6	5	5	4	4	4	4	5	6	5	6	6	5.0
96	6	5	6	0	3	0	2	6	7	6	6	7	4.5
97	6	6	6	6	5	6	4	4	5	5	5	5	5.3
98	4	5	6	5	4	4	4	7	6	6	6		4.8
ave.	3.9	4.2	3.7	2.9	3.2	2.7	2.9	3.5	4.4	4.2	3.8	4.4	3.7

(Source : SENAMHI)

2 Lapaz Aroma Collana UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
86	0	0	0	0	0	0	0	0	0	0	0	0	0.0
87	0	0	0	0	0	0	0	0	0	0	0	0	0.0
88	0	0	0	0	0	0	0	0	0	0	0	0	0.0
89	3	2	2	2	2	2	5	3	4	3	4	2	2.8
90	0	0	0	0	0	0	0	0	0	0	0	0	0.0
91	3	3	0	0	0	4	0	4	0	0	4	0	1.5
92	0	0	0	0	4	4	4	4	6	3	0	4	2.4
93	0	0	0	0	0	0	4	3	3	0	0	0	0.8
94	4	3	2	3	2	3	4	4	4	3	3	3	3.2
95	0	2	2	0	2	0	2	2	3	2	3	3	1.8
ave.	1.0	1.0	0.6	0.5	1.0	1.3	1.9	2.0	2.0	1.1	1.4	1.2	1.3

(Source : SENAMHI)

3 Lapaz Los Ar Hichucota UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
86	5	4	3	3	3	5	4	5	4	10	6	8	5.0
87	5	9	10	6	7	8	3	4	5	6	5	7	6.3
88	9	6	7	5	6	3	3	3	4	4	4	4	4.8
89	2	3	4	3	3	2	3	3	3	4	4	3	3.1
90	2	2	3	0	0	0	2	3	3	5	3	7	2.5
91	6	5	0	3	0	2	3	5	8	10	6	2	4.2
92	0	0	1	0	0	0	0	0	0	0	0	0	0.1
93	2	4	4	0	0	0	3	0	5	7	0	0	2.1
94	4	2	7	2	1	3	3	7	9	8	3	4	4.4
95	2	4	7	0	0	3	3	7	6	7	5	6	4.2
ave.	3.7	3.9	4.6	2.2	2.0	2.6	2.7	3.7	4.7	6.1	3.6	4.1	3.7

(Source : SENAMHI)

4 Lapaz Aroma Ayo Ayo UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
88	10	9	9	8	9	8	8	9	12	8	10	9	9.1
89	10	9	10	11	9	7	10	7	13	11	10	10	9.8
90	8	7	9	9	7	8	8	8	9	11	11	10	8.8
91	9	10	8	9	8	9	9	13	12	14	12	12	10.4
92	10	10	9	12	10	11	11	11	15	12	10	10	10.9
93	9	10	12	10	8	11	11	14	12	12	13	12	11.2
94	11	9	10	10	10	12	12	11	11	11	10	10	10.6
95	8	8	8	9	10	7	7	11	13	12	11	10	9.5
96	10	11	11	8	7	8	9	9	10	9	9	8	9.1
97	7	9	8	8	8	9	10	11	11	9	7	8	8.8
ave.	9.2	9.2	9.4	9.4	8.6	9.0	9.5	10.4	11.8	10.9	10.3	9.9	9.8

(Source : SENAMHI)

5 Lapaz Aroma Patacamaya UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
88	7	8	7	6	7	7	8	7	11	15	10	8	8.4
89	7	8	7	9	6	5	6	6	10	10	6	8	7.3
90	9	8	9	7	6	5	5	8	8	11	10	9	7.9
91	8	9	8	8	5	6	5	9	8	10	8	8	7.7
92	6	6	6	8	6	6	9	9	8	8	5	7	7.0
93	4	4	5	4	4	5	7	4	6	7	4	7	5.1
94	6	6	5	5	4	4	6	7	7	6	6	6	5.7
95	5	4	6	5	0	4	5	6	6	6	6	5	4.8
96	5	5	5	6	4	6	7	5	7	6	5	5	5.5
97	4	4	4	4	5	5	5	6	5	6	4	3	4.6
ave.	6.1	6.2	6.2	6.2	4.7	5.3	6.3	6.7	7.6	8.5	6.4	6.6	6.4

(Source : SENAMHI)

6 Lapaz Murillo El Alto UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
89	3	3	3	3	3	2	2	3	4	4	4	3	3.1
90	3	3	4	4	4	4	4	4	5	5	5	5	4.2
91	5	5	4	4	3	4	4	5	5	6	5	5	4.6
92	4	4	4	5	4	4	4	5	6	5	4	5	4.5
93	4	4	4	3	3	2	4	4	4	5	4	4	3.8
94	4	4	5	4	3	3	4	4	5	5	5	5	4.3
95	4	4	4	3	3	3	4	4	5	5	6	6	4.3
96	4	4	4	3	3	4	4	4	6	6	6	4	4.3
97	7	6	7	7	8	8	8	5	8	5	7	8	7.0
98	7	6	7	7	8	8	7	8	9	8	6	8	7.4
ave.	4.5	4.3	4.6	4.3	4.2	4.2	4.5	4.6	5.7	5.4	5.2	5.3	4.7

(Source : SENAMHI)

7 Lapaz Pacaje Carana UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
89	6	5	6	0	4	4	5	7	8	7	6	8	5.5
90	6	10	5	4	5	4	4	5	7	9	6	5	5.8
91	4	5	5	6	8	5	3	4	7	7	7	8	5.8
92	6	6	5	4	4	5	5	4	4	4	5	5	4.8
93	4	6	5	4	4	3	4	5	8	6	7	6	5.2
94	4	5	5	4	4	4	4	5	5	5	5	5	4.6
95	4	5	4	4	3	3	2	4	5	5	5	5	4.1
96	4	5	5	4	6	5	6	7	7	6	8	6	5.8
97	5	6	5	4	5	4	6	3	5	4	5	5	4.8
98	4	4	4	4	4	4	5	4	5	5	5	5	4.4
ave.	4.7	5.7	4.9	3.8	4.7	4.1	4.4	4.8	6.1	5.8	5.9	5.8	5.1

8 Lapaz camac puerto acosta UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
86	4	7	6	9	6	7	8	10	13	13	10	9	8.5
87	8	10	8	9	7	6	8	8	7	10	9	8	8.2
88	7	8	7	6	6	7	7	7	14	8	8	7	7.7
89	-	-	-	-	-	-	-	-	-	-	-	-	0.0
90	6	6	5	4	4	3	5	0	0	0	4	7	3.7
91	6	5	4	5	4	0	3	6	5	4	5	3	4.2
92	3	2	2	3	3	4	3	4	5	3	4	3	3.3
93	3	3	4	3	2	2	2	4	4	5	5	5	3.5
94	4	4	5	5	4	4	4	5	5	5	4	3	4.3
95	3	4	3	3	3	2	3	-	-	-	-	-	3.0
96	-	-	4	4	3	-	-	5	6	4	4	4	4.3
98	4	4	4	3	4	2	4	4	5	4	4	4	3.8
ave.	4.8	5.3	4.7	4.9	4.1	3.7	4.7	5.3	6.4	5.6	5.7	5.3	5.0

9 Lapaz omasu huarina UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
84	4	10	10	9	8	11	10	10	12	12	11	10	9.8
85	9	9	8	9	9	10	11	12	12	9	10	9	9.8
86	10	9	8	8	6	7	8	10	12	12	12	11	9.4
87	11	10	11	11	10	10	9	8	11	12	12	11	10.5
88	13	13	10	9	9	7	10	9	15	12	13	11	10.9
89	10	10	9	12	8	8	8	9	11	12	12	11	10.0
90	9	8	8	9	8	7	8	9	10	12	10	8	8.8
91	7	9	8	7	6	6	7	10	10	10	6	8	7.8
94	7	8	7	7	5	5	7	3	11	9	10	8	7.3
95	7	8	6	3	6	5	6	8	13	11	9	8	7.5
ave.	9.2	9.3	8.3	8.2	7.2	6.8	7.8	8.2	11.6	11.2	10.5	9.5	9.0

10 Lapaz Achiri pacajaes UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
93	6	5	4	3	6	4	6	9	5	5	5	4	5.2
94	4	4	4	3	3	2	2	3	3	4	4	3	3.3
95													0.0
96	4	3	2	0	0	0	2	2	3	3	3	4	2.2
97	5	5	6	7	5	5	4	4	5	6	6	7	5.4
98	3	4	3	3	3	3	0						1.6
ave.	4.4	4.2	3.8	3.2	3.4	2.8	2.8	4.5	4.0	4.5	4.5	4.5	3.9

Table 1.2 Monthly Average Wind Speed in Oruro

1 Oruro cercado oruro											UNIT : Knot		
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
88	7	5	5	2	8	2	3	3	7	5	7	7	5.1
89	7	8	6	6	3	2	3	3	6	7	6	6	5.3
90	7	4	6	5	3	4	4	4	4	6	6	7	5.0
91	6	6	6	4	2	3	0	4	6	7	5	6	18.3
92	4	4	0	0	0	0	0	0	4	3	3	0	1.5
93	3	0	0	0	0	0	0	0	0	3	4	4	1.2
94	4	2	4	4	1	2	3	4	4	4	4	4	3.3
95	3	2	2	2	2	2	2	3	4	5	7	6	3.3
96	4	6	5	5	2	2	2	3	6	5	6	5	4.3
97	4	4	3	3	2	2	3	4	4	3	3	5	3.3
ave.	4.9	4.1	3.7	3.1	2.3	1.9	2.0	2.8	4.5	4.8	5.1	5.0	3.7

(Source : SENAMHI)

2 Oruro cercado caracollo											UNIT : Knot		
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
75	7	7	7	8	8	10	7	8	10	6	7	7	7.7
76	4	3	4	4	5	4	4	6	6	3	4	4	4.3
77	4	4	3	3	3	2	3	5	4	3	3	3	3.3
78	3	3	2	3	3	3	3	4	3	4	4	4	13.0
79	3	2	3	2	2	3	3	2	3	3	3	3	2.7
80	2	5	3	4	4	4	5	5	5	4	4	4	4.1
81	4	3	3	4	4	5	4	5	5	4	5	5	4.3
82	4	4	4	4	4	4	4	5	4	5	5	5	4.3
83	4	4	4	5	5	6	6	5	6	4	5	5	4.9
ave.	3.8	3.8	3.6	4.1	4.2	4.5	4.3	5.0	5.1	4.0	4.4	4.4	4.3

(Source : SENAMHI)

3 Oruro carangas corque											UNIT : Knot		
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
78	5	6	5	5	6	5	6	7	5	6	5	6	22.3
79	4	5	5	4	4	6	7	4	8	6	8	9	5.8
80	6	6	6	6	7	5	5	7	6	7	7	4	6.0
81	7	6	6	6	7	6	8	7	7	6	6	6	6.5
ave.	5.5	5.7	5.5	5.2	6.0	5.5	6.5	6.2	6.5	6.2	6.5	6.2	6.0

(Source : SENAMHI)

4 Oruro cercac caracollo UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
75	-	-	-	-	-	-	-	40	40	16	16	12	-
76	16	40	8	12	28	22	22	40	40	22	16	16	23.5
77	16	40	28	22	40	40	40	40	28	28	40	22	32.0
78	22	22	22	40	40	40	28	40	40	40	40	12	128.7
79	12	16	16	22	22	40	40	12	40	28	40	22	25.8
80	16	40	40	40	40	40	40	40	40	20	40	40	36.3
81	22	22	16	16	22	16	28	40	22	12	12	8	19.7
82	4	-	8	-	-	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-	-	-	-	-	-
84	-	-	-	8	4	40	16	40	40	8	-	-16	-
85	-	-	-	-	-	40	40	40	-	-	-	-	-
ave.	15.4	30.0	19.7	22.8	28.0	34.7	31.7	36.8	36.2	21.7	29.1	14.5	26.7

(Source : SENAMHI)

5 Oruro cercac Aasana UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
78	5	6	5	5	6	5	6	7	5	6	5	6	22.3
79	4	5	5	4	4	6	7	4	8	6	8	9	5.8
80	6	6	6	6	7	5	5	7	6	7	7	4	6.0
81	7	6	6	6	7	6	8	7	7	6	6	6	6.5
ave.	5.5	5.7	5.5	5.2	6.0	5.5	6.5	6.2	6.5	6.2	6.5	6.2	6.0

(Source : SENAMHI)

6 Oruro Salinas de Garci Mendosa UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
75								0	0	0	0	4	0.3
76	0	3	0	0	0	0	0	8	0	5	5	0	1.8
77	4	0	0	0	0	0	0	0	0	0	4	0	0.7
78	2	2	0	0	0	3	0	4	0	0		2	4.3
79	0	0		0	0	0	0	0	0	0	4	5	0.8
80	0	4	0	0	0	0	3						0.6
81	0	0	0	0	0	0	0	0	0	6	0	0	0.5
82	0	0	0	0	0	5	0	0	3	4	0	0	
83	3	0	3	0	0	10	7	0	6	0	0	0	2.4
84	0	0	0	0	0	0	0	0	0	0	0	0	0.0
ave.	1.0	1.0	0.3	0.0	0.0	2.0	1.1	1.3	1.0	1.6	1.6	1.2	1.0

(Source : SENAMHI)

7 Oruro Coipasa UNIT : Knot

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ave.
88				7	8	7	7	8	9	7	10	11	6.2
89	12	9	9	9	7	7	9	10	8			8	7.3
90	9			4	8	8	3	3	3	3	3	3	3.9
91	3	3	3	3	3	3	3	3	3	3	3	3	12.0
92	2	3	2	3	5	5	9	2	6	3	3	4	3.9
93	2	3	2	2	3	3	3	3	3	2	3	3	2.7
ave.	5.6	4.5	4.0	4.6	5.6	5.5	5.6	4.8	5.3	3.6	4.4	5.3	4.9

(Source : SENAMHI)

Table 3.1 Collected Data of Wind Monitoring (1)

Site Name :		**Achiri / La Paz Prefecture,**							
Monitoring Period :		**4 Feb., 2000 - 3 Feb., 2001**							
		Latitude :	**S 17 ° 12'55"**						
		Lognitute:	**W 69 ° 00'02"**						
		Altitude :	**3870 m**						
Year		Wind Speed (20m)	Wind Speed (10m)	Wind Direction	Wind Direction	Solar radiation	Temperature	Humidity	Baromatic Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.0	2.5			234.9	9.0	72.2	-
2	Max	10.9	9.8	N	SEE	1097.9	17.5	99.9	-
	Min.	0.0	0.0			0.0	0.6	29.1	-
	Ave.	2.6	2.2			274.3	9.1	68.7	-
3	Max	13.0	11.6	N	SWW	1230.1	18.9	99.9	-
	Min.	0.0	0.0			0.0	-0.3	19.7	-
	Ave.	2.3	2.0			280.9	8.6	47.0	-
4	Max	13.0	11.6	N	W	1196.3	19.0	99.9	-
	Min.	0.0	0.0			0.0	-3.7	12.7	-
	Ave.	2.5	2.1			256.0	7.0	34.5	-
5	Max	13.9	12.4	N	NNE	1011.3	17.5	98.6	-
	Min.	0.0	0.0			0.0	-7.3	12.8	-
	Ave.	2.7	2.3			244.3	4.2	27.9	793.6
6	Max	12.9	11.5	N	W	940.1	15.4	87.9	798.4
	Min.	0.0	0.0			0.0	-11.4	12.8	789.6
	Ave.	3.1	2.7			267.0	3.6	23.6	792.9
7	Max	16.5	14.8	N	SWW	1083.4	15.5	79.0	798.4
	Min.	0.0	0.0			0.0	-12.7	12.9	788.6
	Ave.	3.0	2.6			277.2	5.8	29.5	793.1
8	Max	15.0	13.5	N	W	1085.1	17.8	98.5	797.7
	Min.	0.0	0.0			0.0	-9.3	12.6	788.9
	Ave.	3.3	2.9			324.3	7.7	24.1	792.8
9	Max	15.0	13.6	N	SWW	1188.7	19.0	89.8	797.1
	Min.	0.0	0.0			0.0	-9.6	12.4	788.3
	Ave.	3.2	2.8			304.6	8.4	39.2	793.3
10	Max	12.9	11.4	N	SWW	1210.6	19.2	99.9	797.4
	Min.	0.0	0.0			0.0	-3.6	12.3	790.0
	Ave.	3.7	3.3			366.4	9.7	24.2	792.2
11	Max	15.6	14.0	N	SWW	1223.7	20.6	90.5	797.1
	Min.	0.0	0.0			0.0	-5.8	12.2	788.6
	Ave.	3.4	2.5			4708.8	9.3	46.3	793.0
12	Max	14.7	13.2	N	SWW	106761.0	20.3	99.8	797.1
	Min.	0.0	0.0			0.0	-1.4	12.3	789.6
2001	Ave.	2.8	2.4			206.2	7.5	74.7	793.1
1	Max	11.2	10.1	N	SEE	1176.9	15.3	99.9	797.1
	Min.	0.0	0.0			0.0	-0.2	21.8	769.3

Table 3.1 Collected Data of Wind Monitoring (2)

Site Name : Charana									
Monitoring Period : 3 Feb., 2000 - 2 Feb., 2001									
Monitoring Period : 4 Feb., 2000 - 2 Feb., 2001									
Latitude : S 17 ° 35'48"									
Lognitute: W 69 ° 26'56"									
Altitude : 4054 m									
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	4.1	3.5			225.6	7.7	71.1	-
2	Max	15.2	13.7	SWW	SWW	1236.0	17.2	99.9	-
	Min.	0.0	0.0			0.0	-1.2	18.2	-
	Ave.	4.0	3.3			284.3	7.3	68.3	-
3	Max	14.8	13.1	SW	SWW	1288.7	18.1	99.9	-
	Min.	0.0	0.0			0.0	-2.6	13.4	-
	Ave.	3.5	2.9			280.9	6.2	47.3	-
4	Max	14.7	12.8	SWW	W	1143.6	17.5	99.9	-
	Min.	0.0	0.0			0.0	-10.2	12.4	-
	Ave.	3.6	3.0			249.8	4.2	37.4	-
5	Max	14.7	13.2	W	SW	1059.4	17.1	97.6	-
	Min.	0.0	0.0			0.0	-12.7	12.4	-
	Ave.	4.1	3.4			240.5	1.2	33.8	779.1
6	Max	15.0	13.2	SWW	W	913.6	14.9	88.4	787.2
	Min.	0.0	0.0			0.0	-16.9	12.6	648.8
	Ave.	4.3	3.6			255.4	0.3	30.8	783.9
7	Max	16.2	13.8	SWW	SWW	966.0	14.2	86.2	787.2
	Min.	0.0	0.0			0.0	-18.4	12.7	780.5
	Ave.	4.3	3.6			272.9	3.0	31.3	784.0
8	Max	16.5	14.4	SW	SW	1128.3	15.0	76.0	787.2
	Min.	0.0	0.0			0.0	-14.6	12.5	780.8
	Ave.	4.8	4.1			266.3	4.6	22.3	783.5
9	Max	15.5	13.7	SW	SW	957.4	18.1	79.1	786.2
	Min.	0.0	0.0			0.0	-12.9	12.2	780.5
	Ave.	4.9	4.2			290.4	6.4	33.5	783.6
10	Max	17.1	15.0	SW	SW	1218.8	17.9	98.9	786.9
	Min.	0.0	0.0			0.0	-11.5	12.2	780.5
	Ave.	5.7	5.0			363.9	6.6	22.6	782.3
11	Max	17.2	15.4	SW	SW	1191.1	20.1	74.6	785.6
	Min.	0.0	0.0			0.0	-10.7	12.0	779.5
	Ave.	5.2	4.5			295.0	7.4	45.9	783.1
12	Max	17.4	15.6	SW	SW	1276.1	19.5	99.9	786.6
	Min.	0.0	0.0			0.0	-7.8	12.0	780.1
2001	Ave.	3.5	3.0			228.7	6.4	78.6	783.2
1	Max	14.3	13.0	SW	SW	1224.3	16.0	99.9	785.9
	Min.	0.0	0.0			0.0	-0.3	20.3	729.3

Table 3.1 Collected Data of Wind Monitoring (3)

Site Name :		**Gonzales**							
Monitoring Period :		**2 Feb., 2000 - 30 Jan., 2001**							
		Latitude :	**S 15 ° 11'56"**						
		Lognitute:	**W 69 ° 00'12"**						
		Altitude :	**3576**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	1.7	1.0			212.5	8.6	83.5	-
2	Max	6.5	4.4	NE	NE	1214.3	16.2	99.9	-
	Min.	0.0	0.0			0.0	2.1	39.5	-
	Ave.	1.4	0.8			221.0	9.2	83.1	-
3	Max	6.0	4.5	NE	NE	1236.8	16.3	99.9	-
	Min.	0.0	0.0			0.0	5.0	45.4	-
	Ave.	1.7	1.1			243.0	8.9	76.4	-
4	Max	6.6	5.2	NE	NE	1133.4	16.1	99.9	-
	Min.	0.0	0.0			0.0	3.9	36.1	-
	Ave.	1.9	1.2			220.6	9.4	65.2	-
5	Max	9.6	7.9	NE	NE	955.9	17.4	99.9	-
	Min.	0.0	0.0			0.0	4.3	13.6	-
	Ave.	2.5	1.7			192.9	8.6	58.4	812.4
6	Max	11.7	9.6	SW	SW	893.4	18.6	99.9	816.4
	Min.	0.0	0.0			0.0	3.5	12.2	810.3
	Ave.	2.6	1.8			214.3	7.6	55.9	812.0
7	Max	11.6	9.7	SW	SW	918.5	16.5	99.9	817.0
	Min.	0.0	0.0			0.0	0.7	12.4	808.6
	Ave.	2.2	1.5			219.9	8.2	70.8	812.7
8	Max	9.4	7.8	NE	NE	1026.4	17.4	99.9	817.0
	Min.	0.0	0.0			0.0	2.8	12.2	809.3
	Ave.	2.2	1.4			241.6	8.7	68.7	812.5
9	Max	10.1	7.8	NE	NE	1145.1	17.2	99.9	816.7
	Min.	0.0	0.0			0.0	3.0	16.3	808.9
	Ave.	1.8	1.2			222.0	8.3	77.1	812.8
10	Max	8.7	6.9	NE	NE	1176.1	16.4	99.9	817.0
	Min.	0.0	0.0			0.0	2.5	30.8	809.3
	Ave.	2.2	1.4			257.6	9.6	74.1	739.0
11	Max	10.3	8.3	NE	NEE	1215.3	17.4	99.9	815.0
	Min.	0.0	0.0			0.0	4.2	17.4	648.4
	Ave.	1.7	1.1			206.4	9.2	74.7	746.6
12	Max	9.7	8.0	NE	NE	1176.6	16.4	99.9	865.5
	Min.	0.0	0.0			0.0	3.0	15.9	648.4
2001	Ave.	1.1	0.6			166.4	8.1	74.2	755.4
1	Max	8.4	6.6	NE	NE	1221.1	14.1	99.9	861.7
	Min.	0.0	0.0			0.0	4.3	47.9	648.4

Table 3.1 Collected Data of Wind Monitoring (4)

Site Name :		**Is. Taquiri**							
Monitoring Period :		**31Jan., 2000 - 29 Jan., 2001**							
		Latitude :	**S 16 ° 17'36"**						
		Lognitute:	**W 68 ° 48'19"**						
		Altitude :	**3919**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.2	2.3			242.0	10.0	74.1	-
2	Max	10.9	8.4	NE	NE	1196.3	16.2	99.8	-
	Min.	0.0	0.0			0.0	4.6	42.6	-
	Ave.	2.7	1.9			265.9	10.4	72.5	-
3	Max	10.8	8.8	NE	NE	1226.8	16.5	99.9	-
	Min.	0.0	0.0			0.0	5.6	32.7	-
	Ave.	2.7	1.8			285.3	10.2	66.1	-
4	Max	8.0	6.5	NE	NE	1127.2	16.9	99.2	-
	Min.	0.0	0.0			0.0	4.8	29.4	-
	Ave.	2.5	1.6			265.7	9.7	56.3	-
5	Max	8.2	6.9	NE	NE	1009.1	16.9	99.8	-
	Min.	0.0	0.0			0.0	2.9	15.3	-
	Ave.	2.5	1.4			228.8	7.0	58.7	804.0
6	Max	7.7	5.8	SW	SW	901.8	14.2	99.9	806.2
	Min.	0.0	0.0			0.0	1.1	25.0	801.5
	Ave.	2.7	1.6			254.1	6.5	51.3	803.9
7	Max	8.4	6.6	SW	SW	958.1	14.0	99.8	807.2
	Min.	0.0	0.0			0.0	-0.9	13.8	799.4
	Ave.	2.9	1.8			279.0	8.3	59.8	804.3
8	Max	9.3	8.5	NE	NE	1131.1	15.6	99.9	807.2
	Min.	0.0	0.0			0.0	0.7	17.1	800.8
	Ave.	2.8	1.6			294.6	9.5	39.8	802.7
9	Max	6.2	4.6	NE	NE	1115.9	15.9	90.8	805.5
	Min.	0.2	0.0			0.0	2.4	17.4	800.1
	Ave.	3.3	2.2			309.8	9.7	64.8	803.3
10	Max	11.8	9.4	NE	NE	1219.2	18.2	99.9	807.2
	Min.	0.0	0.0			0.0	2.2	12.2	702.3
	Ave.	3.3	2.2			349.5	11.6	48.9	705.1
11	Max	10.0	7.7	NE	NEE	1199.0	19.0	97.5	805.5
	Min.	0.0	0.0			0.0	4.8	11.5	648.4
	Ave.	3.4	2.2	0.0	184.9	270.9	10.3	64.5	719.5
12	Max	11.2	9.2	0.3	359.8	1249.2	18.3	97.2	850.6
	Min.	0.0	0.0	0.0	0.0	0.0	3.7	12.9	648.4
2001	Ave.	3.2	2.2	13.1	171.5	210.2	9.3	74.5	731.8
1	Max	10.6	8.4	341.4	359.2	1196.5	15.6	98.6	848.9
	Min.	0.0	0.0	0.0	0.7	0.0	5.4	13.6	648.1

Table 3.1 Collected Data of Wind Monitoring (5)

Site Name :		**Santiago de Llallagua**							
Monitoring Period :		**21 Jan., 2000 - 31 Jan., 2001**							
		Latitude :	**S 17 ° 01'44"**						
		Lognitute:	**W 68 ° 12'27"**						
		Altitude :	**4010**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.3	2.9			213.1	8.4	79.1	-
2	Max	13.4	11.5	NE	NE	1106.1	15.8	99.9	-
	Min.	0.0	0.0			0.0	2.5	43.1	-
	Ave.	2.4	2.1			228.9	8.5	75.2	-
3	Max	11.5	10.0	NE	NE	1182.9	17.2	99.9	-
	Min.	0.0	0.0			0.0	1.6	28.0	-
	Ave.	2.5	2.2			249.6	8.3	61.1	-
4	Max	10.7	9.3	NE	NE	1069.0	16.8	99.9	-
	Min.	0.0	0.0			0.0	0.3	15.4	-
	Ave.	3.0	2.7			232.2	7.8	44.9	-
5	Max	10.9	9.8	NE	NE	943.5	17.1	99.9	-
	Min.	0.0	0.0			0.0	-1.2	13.5	-
	Ave.	3.6	3.2			213.0	5.2	37.0	774.6
6	Max	10.8	9.1	SW	SW	851.6	14.9	99.9	788.3
	Min.	0.0	0.0			0.0	-3.6	13.2	648.8
	Ave.	3.9	3.5			236.6	4.4	29.9	785.7
7	Max	17.4	15.7	SW	SW	910.4	14.3	90.1	789.3
	Min.	0.0	0.0			0.0	-6.7	13.4	781.2
	Ave.	3.5	3.1			241.7	6.3	31.6	708.9
8	Max	12.7	11.0	NE	NE	1103.7	16.1	99.8	788.6
	Min.	0.0	0.0			0.0	-3.8	10.6	648.4
	Ave.	4.3	3.2			291.2	7.9	12.1	648.6
9	Max	11.8	11.3	NE	NE	1101.4	18.1	79.0	678.6
	Min.	0.0	0.0			0.0	-1.6	10.2	648.4
	Ave.	-	2.9			262.4	7.7	5.3	-
10	Max	-	11.1	NE	NE	1124.6	17.2	11.4	-
	Min.	-	0.0			0.0	-0.2	0.5	-
	Ave.	-	3.0			316.7	9.7	0.5	-
11	Max	-	10.3	NE	NEE	1182.3	19.1	4.9	-
	Min.	-	0.0			0.0	-0.5	0.1	-
	Ave.	-	3.0			234.8	8.5	0.3	-
12	Max	-	10.2	NNE	N	1122.2	18.7	7.0	-
	Min.	-	0.0			0.0	0.7	0.1	-
2001	Ave.	-	2.6			173.7	7.4	0.3	-
1	Max	-	9.6	SWW	SEE	1127.9	14.5	2.4	-
	Min.	-	0.0			0.0	3.7	0.1	-

Table 3.1 Collected Data of Wind Monitoring (6)

Site Name :		**Comjo and Coipasa**							
Monitoring Period :		**28 Jan., 2000 - 7 Feb., 2001**							
		Latitude :	**S 19 ° 12'59"**						
		Lognitute:	**W 68 ° 23'24"**						
		Altitude :	**3670**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	5.2	4.5			295.6	11.4	54.7	-
2	Max	16.9	15.0	W	W	1202.5	20.4	99.8	-
	Min.	0.0	0.0			0.0	2.4	12.3	-
	Ave.	5.0	4.2			291.8	11.1	46.5	-
3	Max	15.7	14.1	W	W	1099.7	20.0	98.5	-
	Min.	0.0	0.0			0.0	2.3	12.6	-
	Ave.	4.6	3.9			265.2	9.4	32.1	-
4	Max	15.2	13.6	W	W	986.1	19.2	87.3	-
	Min.	0.1	0.0			0.0	-3.9	12.7	-
	Ave.	4.6	3.8			224.6	6.1	28.6	-
5	Max	20.1	17.9	W	W	904.7	18.1	80.7	-
	Min.	0.0	0.0			0.0	-6.1	13.0	-
	Ave.	5.0	4.1			206.7	2.9	29.9	752.4
6	Max	17.7	15.7	W	W	834.0	13.8	78.3	807.2
	Min.	0.0	0.0			0.0	-9.9	13.4	648.8
	Ave.	5.6	4.6			222.8	1.7	27.0	802.6
7	Max	24.2	21.5	W	W	864.8	13.4	76.1	807.2
	Min.	0.0	0.0			0.0	-11.1	13.4	798.4
	Ave.	5.4	4.5			248.0	4.6	25.2	803.9
8	Max	21.1	18.8	W	W	1003.2	15.6	57.9	808.9
	Min.	0.0	0.0			0.0	-9.5	12.9	800.5
	Ave.	5.6	4.7			308.0	6.7	18.0	804.5
9	Max	18.0	16.2	W	W	1074.6	18.4	37.3	808.6
	Min.	0.0	0.0			0.0	-7.3	12.4	801.1
	Ave.	5.8	4.9			321.4	9.8	22.0	805.4
10	Max	15.7	14.0	W	W	1155.0	19.5	76.9	809.3
	Min.	0.0	0.0			0.0	-3.8	12.5	802.5
	Ave.	6.3	5.4			359.2	9.7	21.1	781.8
11	Max	18.2	16.3	W	W	1146.1	21.5	75.9	808.2
	Min.	0.1	0.0			0.0	-4.6	12.3	648.4
	Ave.	5.8	5.1	211.0	203.6	316.7	11.5	40.1	763.5
12	Max	16.9	15.0	352.5	353.5	1148.0	22.0	99.8	907.4
	Min.	0.0	0.0	2.8	1.6	0.0	0.1	12.2	652.5
2001	Ave.	5.0	4.3	198.0	189.0	271.3	9.7	72.3	762.8
1	Max	15.6	14.0	354.7	359.0	1155.4	18.9	99.8	898.3
	Min.	0.0	0.0	1.5	2.1	0.0	0.6	20.9	652.5

Table 3.1 Collected Data of Wind Monitoring (7)

Site Name :		**Caripe**							
Monitoring Period :		**23 Jan., 2000 - 31 Jan., 2001**							
		Latitude :	**S 18 ° 00'46"**						
		Lognitute:	**W 68 ° 50'37"**						
		Altitude :	**3670**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.8	3.1			245.0	7.1	71.5	-
2	Max	13.3	11.7	W	W	1243.8	15.5	99.9	-
	Min.	0.0	0.0			0.0	0.2	13.5	-
	Ave.	3.6	3.0			251.7	7.3	65.7	-
3	Max	13.7	11.9	W	NWW	1292.3	16.6	99.9	-
	Min.	0.0	0.0			0.0	-1.4	21.1	-
	Ave.	3.3	2.8			262.3	7.0	42.1	-
4	Max	13.3	10.9	W	NWW	1200.0	16.6	95.3	-
	Min.	0.0	0.0			0.0	-5.9	12.7	-
	Ave.	4.3	3.6			242.4	5.5	30.3	-
5	Max	12.6	10.9	NWW	NWW	1039.1	15.8	98.0	-
	Min.	0.0	0.0			0.0	-7.3	12.7	-
	Ave.	5.5	4.6			233.6	3.2	25.0	732.5
6	Max	12.5	10.9	NWW	NWW	954.8	13.0	90.1	784.5
	Min.	0.0	0.0			0.0	-9.3	12.7	648.8
	Ave.	5.5	4.4			253.2	1.8	26.2	780.4
7	Max	17.9	14.8	W	NWW	968.2	13.1	98.8	785.2
	Min.	0.0	0.0			0.0	-12.0	12.9	776.4
	Ave.	5.2	4.3			263.7	4.4	27.2	781.1
8	Max	17.5	14.4	NWW	NWW	1124.9	14.1	88.9	785.2
	Min.	0.0	0.0			0.0	-9.1	12.7	778.1
	Ave.	5.5	4.5			321.4	6.4	20.3	780.9
9	Max	13.8	11.6	NWW	NWW	1192.1	17.0	92.6	785.2
	Min.	0.0	0.0			0.0	-7.2	12.3	778.4
	Ave.	5.0	4.2			0.0	7.2	34.8	781.1
10	Max	13.9	11.4	W	NWW	0.0	16.6	99.9	785.2
	Min.	0.4	0.4			0.0	-6.9	12.2	778.1
	Ave.	5.6	4.8			0.0	8.2	27.4	745.7
11	Max	16.1	12.5	W	NWW	0.0	18.4	92.7	865.5
	Min.	0.4	0.4			0.0	-6.3	12.2	648.4
	Ave.	4.8	4.1			276.2	8.0	51.6	752.3
12	Max	14.6	12.5	W	NWW	1230.2	18.2	99.9	903.7
	Min.	0.0	0.0			0.0	-2.9	12.1	652.5
2001	Ave.	3.2	2.7			0.0	5.6	75.1	768.0
1	Max	12.2	10.4	W	W	1223.5	14.6	99.9	902.0
	Min.	0.0	0.0			0.0	-0.1	32.1	652.8

Table 3.1 Collected Data of Wind Monitoring (8)

Site Name :		**Chachacomani**							
Monitoring Period :		**24 Jan., 2000 - 24 Jan., 2001**							
		Latitude :	**S 18 ° 21'33"**						
		Lognitute:	**W 68 ° 56'56"**						
		Altitude :	**4220 m**						
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.5	3.2			-	7.1	71.1	-
2	Max	13.3	12.3	SE	SE	-	16.0	99.9	-
	Min.	0.4	0.4			-	0.1	15.6	-
	Ave.	2.9	2.7			260.7	7.7	63.9	-
3	Max	13.4	12.4	SE	W	1259.5	16.5	99.9	-
	Min.	0.0	0.0			0.0	-0.1	14.2	-
	Ave.	3.4	3.3			243.4	7.5	42.1	-
4	Max	14.8	13.4	W	W	1091.6	15.8	96.7	-
	Min.	0.1	0.2			0.0	-2.1	13.8	-
	Ave.	4.2	3.9			260.4	6.3	31.2	-
5	Max	17.5	15.9	W	W	946.9	15.8	87.0	-
	Min.	0.0	0.0			0.0	-3.1	14.1	-
	Ave.	5.0	4.6			246.9	3.4	29.1	726.6
6	Max	16.6	14.9	NWW	W	951.7	12.3	75.6	775.1
	Min.	0.1	0.1			0.0	-4.1	15.2	648.8
	Ave.	6.5	6.0			267.1	2.4	29.8	772.2
7	Max	27.1	24.3	NWW	W	1095.6	11.6	96.5	776.4
	Min.	0.1	0.1			0.0	-7.4	16.2	766.9
	Ave.	6.0	5.4			278.2	4.6	29.8	772.6
8	Max	23.2	21.0	NWW	W	1197.0	13.1	77.4	776.4
	Min.	0.1	0.1			0.0	-4.5	14.9	767.9
	Ave.	4.6	4.3			345.0	6.5	22.0	772.6
9	Max	18.3	16.3	W	SWW	1328.9	16.1	79.9	775.4
	Min.	0.0	0.1			0.0	-4.1	13.4	770.0
	Ave.	3.7	3.5			320.3	7.5	32.8	772.7
10	Max	14.1	12.5	SWW	SWW	1279.3	16.3	99.9	775.7
	Min.	0.0	0.0			0.0	-3.9	13.4	769.6
	Ave.	4.7	4.4			383.4	8.1	27.3	767.8
11	Max	18.4	16.7	W	SWW	1293.1	18.4	86.9	775.1
	Min.	0.0	0.1			0.0	-3.3	13.0	648.4
	Ave.	3.5	3.3			300.3	7.9	50.8	743.8
12	Max	13.5	12.3	SWW	SWW	1283.4	17.7	99.9	848.2
	Min.	0.0	0.0			0.0	-1.6	13.1	648.4
2001	Ave.	2.5	2.3			203.4	5.5	77.7	737.9
1	Max	10.9	10.0	SE	SE	1296.3	14.5	99.9	847.5
	Min.	0.0	0.0			0.0	-0.4	29.7	648.4

Table 3.1 Collected Data of Wind Monitoring (9)

Site Name :		**Salinas**							
Monitoring Period :		**14 Jan., 2000 - 14 Dec., 2001**							
		Latitude :	**S 19 ° 21'59"**						
		Lognitute:	**W 66 ° 51'57"**						
		Altitude :	**3652**	**m**					
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.6	461.9			133.1	-69.1	0.4	-
2	Max	10.4	756.6	N	SSE	142.9	-16.6	1.3	-
	Min.	0.4	15.0			0.0	-86.3	0.0	-
	Ave.	3.5	3.3			-	11.2	46.4	-
3	Max	12.5	11.7	NNW	NNW	-	20.5	99.3	-
	Min.	0.4	0.4			-	0.6	12.0	-
	Ave.	3.2	2.9			-	9.8	29.6	-
4	Max	8.7	7.8	NNW	NNW	-	19.9	85.4	-
	Min.	0.4	0.4			-	-2.7	12.1	-
	Ave.	3.5	3.2			236.6	6.6	25.2	-
5	Max	16.7	15.7	NW	NW	855.7	17.4	90.3	-
	Min.	0.0	0.0			0.0	-4.8	12.4	-
	Ave.	4.5	4.5			226.5	3.8	25.2	760.7
6	Max	15.2	14.9	NW	NW	876.3	13.0	67.0	808.6
	Min.	0.0	0.4			0.0	-6.8	13.1	648.8
	Ave.	4.8	4.9			240.5	2.4	24.1	804.3
7	Max	22.3	21.6	NW	NW	927.8	13.3	73.1	808.6
	Min.	0.0	0.4			0.0	-8.4	13.1	798.4
	Ave.	4.0	4.1			271.4	5.3	22.5	804.7
8	Max	16.7	16.2	NW	NW	1030.4	15.6	66.6	808.6
	Min.	0.0	0.4			0.0	-7.7	12.5	800.8
	Ave.	3.5	3.7			329.6	7.6	17.8	804.5
9	Max	11.8	11.6	NW	NW	1122.7	18.6	77.2	808.2
	Min.	0.0	0.4			0.0	-6.8	12.0	801.8
	Ave.	3.5	3.5			333.0	10.4	23.5	804.7
10	Max	12.0	11.3	NNW	NNW	1170.7	20.0	99.8	808.6
	Min.	0.0	0.4			0.0	-1.8	11.9	801.1
	Ave.	3.7	3.8			377.7	10.5	18.3	803.6
11	Max	12.6	12.1	NNW	NNW	1230.3	21.9	62.8	807.2
	Min.	0.0	0.4			0.0	-4.1	11.6	800.5
	Ave.	3.9	3.6			317.0	10.8	35.1	830.6
12	Max	10.5	9.7	NNW	NNW	1191.0	19.3	99.9	835.7
	Min.	0.1	0.0			0.0	0.9	11.9	827.2
2001	Ave.								
1	Max								
	Min.								

Table 3.1 Collected Data of Wind Monitoring (10)

Site Name :		**Sevaruyo**							
Monitoring Period :		**14 Jan., 2000 - 6 Feb., 2001**							
		Latitude :	**S 19 ° 21'58"**						
		Lognitute:	**W 66 ° 51'45"**						
		Altitude :	**3690 m**						
		Wind Speed	Wind Speed	Wind	Wind	Solar			Baromatic
Year		(20m)	(10m)	Direction	Direction	radiation	Temperature	Humidity	Pressure
Month		(m/s)	(m/s)	(20m)	(10m)	(W/m2)	(°C)	(%)	(hPa)
2000	Ave.	3.1	399.2			133.3	-75.9	0.4	-
2	Max	8.2	775.3	NE	NE	142.9	-51.5	1.1	-
	Min.	0.4	4.3			0.0	-86.1	0.0	-
	Ave.	3.1	2.5			-	10.5	59.4	-
3	Max	15.1	12.2	NE	NE	-	21.9	99.9	-
	Min.	0.4	0.4			-	-1.3	12.2	-
	Ave.	3.1	2.6			-	8.4	42.2	-
4	Max	12.5	12.5	NE	NE	-	22.7	98.3	-
	Min.	0.4	0.4			-	-8.7	12.0	-
	Ave.	3.2	2.5			-	4.6	38.2	-
5	Max	11.7	10.1	NE	NE	-	19.1	99.9	-
	Min.	0.1	0.0			-	-11.8	12.1	-
	Ave.	2.9	2.6			219.4	0.9	35.0	761.7
6	Max	10.1	8.8	SW	SW	839.0	14.5	82.3	810.3
	Min.	0.0	0.4			0.0	-15.1	12.7	648.8
	Ave.	3.6	3.1			230.2	0.3	32.3	804.5
7	Max	15.3	13.3	SW	SW	903.5	14.6	89.8	810.3
	Min.	0.0	0.4			0.0	-16.3	12.4	799.4
	Ave.	3.4	3.0			263.6	3.7	31.7	804.5
8	Max	13.8	12.1	NE	NE	1006.8	16.8	99.8	809.9
	Min.	0.0	0.4			0.0	-15.0	12.2	799.4
	Ave.	3.2	2.9			314.4	5.9	27.0	803.5
9	Max	10.3	8.3	NE	NE	1107.3	21.9	99.9	808.2
	Min.	0.0	0.4			0.0	-12.1	11.7	799.8
	Ave.	3.4	3.1			310.9	9.4	33.5	802.9
10	Max	11.4	10.3	NE	NE	1157.9	21.3	99.9	808.2
	Min.	0.0	0.4			0.0	-7.6	11.7	798.4
	Ave.	3.9	3.6			358.9	9.5	23.4	801.1
11	Max	10.8	10.5	NE	NEE	1155.0	24.2	79.6	806.2
	Min.	0.0	0.4			0.0	-10.0	11.4	797.1
	Ave.	3.5	3.3			297.0	10.9	47.8	801.2
12	Max	12.7	11.0	N	N	1228.8	23.5	99.9	807.2
	Min.	0.0	0.4			0.0	-6.1	11.5	797.7
2001	Ave.	2.9	2.7			210.2	9.2	78.1	801.7
1	Max	10.7	9.3	N	N	1200.2	20.0	99.9	805.9
	Min.	0.0	0.4			0.0	2.8	19.7	798.1

Table 5.1 Socio-economic Condition of the Charana

Items for Survey on the Selected Candidate Sites (~~PV~~, ~~MHP~~, Wind)

1. Name of Village / Canton Municipio
Charana (Prefecture: La Paz / Province: Pacajes / Municipality: Charana / Canton: Charana)
2. Location and Access: --km from Road--(earth road)
233 km from La Paz
3. Nos. of HH and Population: per Village / Canton
Population: 1016 Households: 331
4. Rural Economy
4.1 Major economic activity: agriculture, livestock breeding, others (---)

4.2 Industrial Facory (wood and mber, wool, others)
wool
4.2.1 Number of Factories
1
4.2.2 Energy Sources (diesel or other)
n.a.
4.2.3 Capacity of generator (kW) and annual electricity consumption (kWh)
n.a.

4.2.4 Future expansion plan
n.a.

5. Economic Infrastructure

5.1 Access to Major town (---km by paved or earth road)
La Paz 233 km to La Paz, 38km are paved
5.2 Electricity (existing energy sources diesel nicrohydro, or kerossene)
Diesel
5.2.1 OM Organization (Cooperative or Company) and number of staff including
Operator 1 Administration 4
5.2.2 OM cost per year
n.a.
5.2.3 Electricity tariff (Bs/kWh or Bs per month) and annual revenue
30 Bs/Mo
5.2.4 Number of served HH
60
5.3 Water supply (piped water or from well /river)

5.3.1 Organization for water supply system
Canton
5.3.2 Water charge (Bs/month)
5 Bs/Mo
6 Social Infrastructure: for estimating demand for electricity

6.1 Existing schools (number of students)
Elemental school 350 High school 175 Private School 70
6.2 Existing clinic (scale)
3 rooms
6.3 Village office
2 rooms

Table 5.2 Diurnal Power Demand of Charana

DEMAND (kW)													
Time	HHs(L)	HHs(S)	Cafe (L)	Cafe (S)	Store (L)	Store (S)	Office(L)	Office(S)	Small Business	Community (L)	School(L)	Health Clinic (L)	Total
0	1.0	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.1
1	0.6	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.6
2	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8
3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
6	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6
7	0.4	0.2	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.9
8	0.5	0.4	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.0	1.8	0.2	3.8
9	0.5	0.4	0.0	0.0	0.1	0.0	1.6	0.4	0.2	0.1	2.4	0.2	6.2
10	0.5	0.5	0.0	0.0	0.1	0.0	3.0	0.5	0.2	0.1	2.4	0.3	8.0
11	0.5	0.5	0.0	0.0	0.1	0.0	3.0	0.5	0.2	0.1	2.4	0.3	8.0
12	0.7	0.8	0.0	0.0	0.1	0.0	2.0	0.5	0.2	0.1	1.6	0.2	6.6
13	0.7	0.8	0.1	0.1	0.1	0.0	0.6	0.2	0.0	0.1	1.6	0.2	4.7
14	0.7	0.7	0.1	0.1	0.1	0.0	0.6	0.2	0.0	0.1	1.6	0.2	4.5
15	0.9	0.6	0.1	0.0	0.1	0.0	2.0	0.5	0.3	0.1	2.7	0.3	8.0
16	1.5	1.2	0.1	0.0	0.1	0.1	3.0	0.5	0.3	0.1	2.7	0.3	10.3
17	1.8	2.8	0.2	0.2	0.3	0.1	3.0	0.5	0.6	0.1	2.7	0.3	13.2
18	3.8	4.8	0.3	0.4	0.4	0.2	0.1	0.0	0.6	0.3	1.2	0.2	12.8
19	3.6	8.5	0.3	0.4	0.4	0.2	0.1	0.0	0.0	0.3	0.4	0.2	15.1
20	7.5	15.8	0.3	0.3	0.2	0.2	0.0	0.0	0.0	0.3	0.1	0.1	26.0
21	7.5	15.3	0.3	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1	25.2
22	3.0	8.4	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	12.8
23	1.5	6.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	8.1
Total kwh/day	38.3	71.1	2.4	2.0	2.6	1.2	19.6	3.6	2.5	1.8	23.7	3.6	181.5

Table 5.3 Monthly Wind Speed Directional Frequency Distribution

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0<V<0.5	21.9	12.6	16.0	7.4	16.3	22.7	26.1	21.1	19.8	8.7	3.4	5.3	7.4	11.6	14.5	16.8
0.5<=V<1	16.9	17.4	14.4	12.1	21.5	21.1	15.1	12.7	12.5	6.1	3.1	5.4	9.9	12.5	16.5	11.1
1<=V<2	16.9	24.6	23.1	26.9	26.5	27.7	23.1	25.0	19.4	11.8	6.3	11.9	21.5	24.6	31.3	23.2
2<=V<3	20.0	19.3	18.4	19.1	17.8	14.9	16.6	15.2	16.4	8.0	5.0	10.9	21.0	22.4	12.9	22.6
3<=V<4	9.4	10.1	12.6	13.5	5.5	6.2	8.0	4.4	9.5	7.7	4.2	9.6	11.2	12.1	11.3	10.5
4<=V<5	3.1	4.8	6.0	11.5	7.1	5.4	5.0	5.4	7.3	6.1	4.0	11.6	8.7	6.9	6.1	9.5
5<=V<6	5.0	4.8	2.9	6.0	3.7	1.2	1.0	4.9	3.9	5.2	4.9	9.3	4.4	3.2	2.6	2.1
6<=V<7	2.5	2.4	3.4	2.5	1.2	0.8	2.0	2.9	4.7	7.7	5.6	9.2	4.3	2.8	1.6	0.5
7<=V<8	2.5	2.9	1.8	0.0	0.3	0.0	1.0	2.9	2.2	6.8	7.2	5.4	3.2	0.9	1.3	1.1
8<=V<9	1.9	1.0	1.0	0.8	0.0	0.0	1.0	2.5	3.4	6.8	8.4	5.2	1.7	0.7	0.3	0.5
9<=V<10	0.0	0.0	0.3	0.0	0.0	0.0	0.5	0.5	0.4	6.8	9.9	5.6	1.9	0.4	0.6	1.6
10<=V<11	0.0	0.0	0.0	0.2	0.0	0.0	0.5	0.5	0.4	5.9	8.4	4.4	1.2	0.2	0.0	0.0
11<=V<12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	4.3	7.7	2.5	0.3	0.4	0.3	0.0
12<=V<13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	7.0	2.2	0.9	0.4	0.6	0.5
13<=V<14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	3.0	5.6	0.6	0.9	0.4	0.0	0.0
14<=V<15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	5.2	0.3	0.5	0.4	0.0	0.0
15<=V<16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.5	0.2	0.3	0.2	0.0	0.0
16<=V<17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.2	0.4	0.0	0.0	0.0
17<=V<18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.2	0.0	0.0	0.0
18<=V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5.4 Wind Energy Density

Charana	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	6.4	7.7	7.3	6.2	4.2	1.2	0.3	3.0	4.6	6.4	6.6	7.4
Barometric Pressue (hPa)	783	782.8	782.8	782.8	782.8	779.1	783.9	784	783.5	783.6	782.3	783.1
Air Density (kg/m^3)	0.98	0.972	0.973	0.977	0.984	0.99	0.999	0.99	0.983	0.977	0.975	0.973
Average Wind Speed (m/s)	3.5	4.1	4.0	3.5	3.6	4.1	4.3	4.3	4.8	4.9	5.7	5.2
Wind Energy Density (W/m^2)	39.8	63.6	59.2	39.8	43.6	64.8	75.5	74.7	103.3	109.2	171.5	130.0

*Barometric pressures from February to May are the average of the other months

Table 5.5 Turbulence intensity

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Charana	0.22	0.24	0.25	0.29	0.26	0.28	0.23	0.23	0.23	0.18	0.14	0.15	0.14	0.18	0.21	0.21

Table 5.6 Construction Cost of Charana Wind Power Project

Unit : US$.

Item	Cost	Note
1. Installation Works	**200,906**	
1.1 Installation Work	90,424	
1.2 Installation Materials	110,481	
2. Wind generator, PV system, etc.	**511,625**	
2.1 Wind generator	275,053	80kW
2.2 PV system	142,413	16kWp
2.3 Inverter	43,761	60kVA
2.4 Converter	5,294	20kVA
2.5 Battery	31,648	44kAh
2.6 Control house	13,456	
3. Distribution Line	**43,019**	
4. Transportation	**125,068**	
5.Direct Cost Total	**880,618**	1.+2.+3.+4.
6. Administration and Engineering Servi	**77,494**	8.80%
Total Construction Cost	**958,112**	5. + 6.

Table 6.1 Socio-economic Condition of Caripe

Items for Survey on the Selected Candidate Sites (PV, MHP, Wind)

1. Name of Village / Canton Municipio
Caripe (Prefecture: Oruro / Province: Sajama /
Municipality: C.de Carangas / Canton: Caripe)

2. Location and Access: --km from Road--(earth road)
272 km from Oruro

3. Nos. of HH and Population: per Village / Canton
Population: 206 Household: 93

4. Rural Economy

4.1 Major economic activity: agriculture, livestock breeding, others (---)
Agriculture (kinua) Livestock

4.2 Industrial Facory (wood and mber, wool, others)
Non

4.2.1 Number of Factories
0

4.2.2 Energy Sources (diesel or other)
0

4.2.3 Capacity of generator (kW) and annual electricity consumption (kWh)
n.a.

4.2.4 Future expansion plan
n.a.

5. Economic Infrastructure

5.1 Access to Major town (---km by paved or earth road)
Oruro 272 km to La Paz, 257km paved

5.2 Electricity (existing energy sources diesel microhydro, or kerosene)
kerosene

5.2.1 OM Organization (Cooperative or Company) and number of staff including
n.a.

5.2.2 OM cost per year
n.a.

5.2.3 Electricity tariff (Bs/kWh or Bs per month) and annual revenue
n.a.

5.2.4 Number of served HH
n.a.

5.3 Water supply (piped water or from well /river)
piped water (NGO Germany)

5.3.1 Organization for water supply system
Canton

5.3.2 Water charge (Bs/month)
0

6 Social Infrastructure: for estimating demand for electricity

6.1 Existing schools (number of students)
1 elemantal school 35 students

6.2 Existing clinic (scale)
1

6.3 Village office
1

Table 6.2 Estimated Daily Power Demand of Caripe

DEMAND(kW)								
Time	HHs(L)	HHs(S)	Cafe (S)	Store (S)	Community (S)	School(S)	Health Clinic (S)	Total
0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.3
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2
7	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.3
8	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.3
9	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.6
10	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.7
11	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.7
12	0.1	0.5	0.1	0.0	0.0	0.1	0.1	1.0
13	0.2	0.6	0.1	0.1	0.0	0.1	0.1	1.2
14	0.2	0.6	0.1	0.1	0.0	0.1	0.1	1.1
15	0.1	0.5	0.1	0.1	0.0	0.1	0.1	1.0
16	0.2	0.5	0.1	0.1	0.0	0.1	0.1	1.1
17	0.2	0.7	0.1	0.1	0.1	0.2	0.1	1.5
18	0.2	0.8	0.1	0.1	0.1	0.2	0.1	1.7
19	0.3	1.5	0.1	0.2	0.1	0.2	0.1	2.6
20	0.8	3.5	0.1	0.2	0.1	0.1	0.0	4.9
21	0.8	3.5	0.0	0.2	0.0	0.0	0.0	4.6
22	0.4	1.8	0.0	0.0	0.0	0.0	0.0	2.3
23	0.2	0.8	0.0	0.0	0.0	0.0	0.0	1.0
Total (kWh/day)	4.0	16.7	1.1	1.1	0.4	1.3	1.3	27.3

Table 6.3 Monthly Wind Speed Directional Frequency Distribution

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0<V<0.5	18.1	16.5	10.4	13.0	24.2	30.2	25.8	37.3	45.4	50.3	26.3	10.4	2.1	3.2	8.0	14.1
0.5<=V<1	9.5	7.5	6.6	8.7	11.2	11.4	6.5	8.5	12.0	8.7	10.3	3.5	1.6	1.3	7.3	9.7
1<=V<2	19.6	12.4	7.9	7.0	11.4	13.9	12.5	11.2	6.6	8.7	13.2	7.6	4.1	2.3	10.5	11.9
2<=V<3	13.1	6.4	8.6	8.6	14.7	21.1	16.4	11.2	7.7	9.3	9.6	6.7	3.3	2.9	10.5	13.0
3<=V<4	9.0	11.6	9.9	15.4	18.2	12.5	16.6	9.2	6.6	7.1	10.0	7.3	4.9	3.6	8.6	14.6
4<=V<5	10.1	10.1	13.0	17.0	13.3	6.8	9.9	10.8	9.8	8.2	9.6	8.3	5.5	5.2	11.2	16.8
5<=V<6	8.0	10.1	13.0	16.3	4.7	3.0	7.0	6.5	6.0	1.6	6.4	9.4	8.1	6.3	15.3	8.1
6<=V<7	6.0	12.0	12.8	9.6	1.6	0.7	3.4	2.7	3.8	3.8	2.8	7.4	9.4	10.2	11.5	5.4
7<=V<8	2.5	6.7	11.5	3.4	0.7	0.5	1.0	1.2	2.2	0.5	5.0	6.0	10.7	13.2	7.0	2.7
8<=V<9	2.5	3.0	4.8	0.5	0.0	0.0	1.0	0.8	0.0	1.1	1.4	6.5	13.1	13.0	3.5	2.2
9<=V<10	1.5	1.1	1.3	0.2	0.0	0.0	0.0	0.8	0.0	0.5	3.9	9.0	12.6	13.7	2.6	1.6
10<=V<11	0.0	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	6.0	11.1	8.1	0.6	0.0
11<=V<12	0.0	0.7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.1	6.4	6.5	0.6	0.0
12<=V<13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	4.1	3.9	3.5	0.0	0.0
13<=V<14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.8	2.0	1.0	0.0
14<=V<15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.7	1.0	0.0
15<=V<16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.2	0.0	0.0
16<=V<17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.3	0.0
17<=V<18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
18<=V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.0
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 6.4 Wind Energy Density

Caripe	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	5.0	7.1	7.3	7.0	5.5	3.2	1.8	4.4	6.4	7.2	8.2	8.0
Barometric Pressue (hPa)	768	765.3	765.3	765.3	765.3	732.5	780.4	781.1	780.9	781.1	745.7	752.3
Air Density (kg/m^3)	0.96	0.952	0.951	0.952	0.957	0.924	0.989	0.981	0.974	0.971	0.924	0.933
Average Wind Speed (m/s)	3.2	3.8	3.6	3.3	4.3	5.5	5.5	5.2	5.5	5.0	5.6	4.8
Wind Energy Density (W/m^2)	30.0	49.6	42.2	32.5	72.3	146.0	156.4	131.0	153.9	115.3	154.1	98.0

* Barometric pressures from February to May are the average of the other months

Table 6.5 Turbulence intensity

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Caripe	0.23	0.21	0.23	0.25	0.29	0.28	0.26	0.29	0.28	0.29	0.26	0.19	0.14	0.14	0.21	0.25

Table 6.6 Construction Cost of Caripe Wind Power Project

Unit : US$.

Item	Cost	Note
1. Installation Works	**29,299**	
1.1 Installation Work	13,187	
1.2 Installation Materials	16,112	
2. Wind generator, PV system, etc.	**95,030**	
2.1 Wind generator	34,382	10kW
2.2 PV system	35,603	4kWp
2.3 Inverter	5,835	8kVA
2.4 Battery	5,754	8kAh
2.5 Control house	13,456	
3. Distribution Line	**13,235**	
4. Transportation	**20,100**	
5.Direct Cost Total	**157,664**	1.+2.+3.+4.
6. Administration and Engineering Servi	**13,874**	8.80%
Total Construction Cost	**171,538**	5. + 6.

Table 7.1 Socio-economic Condition of Chachacomani

Items for Survey on the Selected Candidate Sites (PV, MHP, Wind)

1. Name of Village / Canton Municipio
Chachacomani (Prefecture: Oruro / Province: Sajama /
Municipality: Turco/ Canton: Chachacomani)

2. Location and Access: --km from Road--(earth road)
350 km from Oruro

3. Nos. of HH and Population: per Village / Canton
Population: 470 Households: 232

4. Rural Economy

4.1 Major economic activity: agriculture, livestock breeding, others (---)
Agriculture (kinua) Livestock

4.2 Industrial Facory (wood and mber, wool, others)
0

4.2.1 Number of Factories
0

4.2.2 Energy Sources (diesel or other)
n.a.

4.2.3 Capacity of generator (kW) and annual electricity consumption (kWh)
n.a.

4.2.4 Future expansion plan
No

5. Economic Infrastructure

5.1 Access to Major town (---km by paved or earth road)
La Paz 350 km to La Paz, 335km paved

5.2 Electricity (existing energy sources diesel microhydro, or kerosene)
kerosene

5.2.1 OM Organization (Cooperative or Company) and number of staff including
n.a.

5.2.2 OM cost per year
n.a.

5.2.3 Electricity tariff (Bs/kWh or Bs per month) and annual revenue
n.a.

5.2.4 Number of served HH
n.a.

5.3 Water supply (piped water or from well /river)
piped water 40 families

5.3.1 Organization for water supply system
Canton

5.3.2 Water charge (Bs/month)
12 Bs/Mo

6 Social Infrastructure: for estimating demand for electricity

6.1 Existing schools (number of students)
1 elemantal school 75 student

6.2 Existing clinic (scale)
1 small

6.3 Village office
1

Table 7.2 Estimated Daily Power Demand of Chachacomani

DEMAND								
Time	HHs(L)	HHs(S)	Cafe (S)	Store (S)	Community (L)	School(L)	Health Clinic (L)	Demand
0	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.9
1	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.5
2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.3
3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
6	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.3
7	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.6
8	0.3	0.5	0.0	0.0	0.0	0.1	0.1	0.9
9	0.3	0.5	0.1	0.1	0.0	0.1	0.1	1.1
10	0.3	0.5	0.1	0.1	0.0	0.1	0.1	1.2
11	0.3	0.5	0.1	0.1	0.0	0.1	0.1	1.2
12	0.4	0.8	0.1	0.1	0.0	0.1	0.1	1.6
13	0.6	0.8	0.1	0.2	0.0	0.1	0.1	1.8
14	0.6	0.7	0.1	0.2	0.0	0.1	0.1	1.7
15	0.3	0.6	0.1	0.2	0.0	0.1	0.1	1.4
16	0.3	0.6	0.2	0.2	0.0	0.1	0.1	1.4
17	0.6	1.1	0.2	0.2	0.0	0.2	0.1	2.3
18	0.8	2.0	0.2	0.1	0.1	0.2	0.1	3.5
19	1.4	3.5	0.2	0.1	0.1	0.2	0.1	5.5
20	2.4	6.8	0.2	0.1	0.1	0.2	0.0	9.7
21	2.4	6.8	0.2	0.0	0.0	0.0	0.0	9.4
22	1.6	4.8	0.2	0.0	0.0	0.0	0.0	6.6
23	0.8	3.0	0.0	0.0	0.0	0.0	0.0	3.8
	14.0	35.5	2.0	1.4	0.3	1.5	1.3	56.0

Table 7.3 Monthly Wind Speed Directional Frequency Distribution

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0<V<0.5	8.3	8.8	5.6	7.6	8.4	4.5	2.4	5.9	5.1	5.5	4.7	2.4	2.4	4.8	6.3	6.1
0.5<=V<1	8.9	5.8	5.6	6.8	8.4	5.7	4.2	5.1	8.1	8.5	6.3	6.3	5.7	7.5	14.1	10.4
1<=V<2	20.1	13.9	16.7	19.9	21.0	21.5	11.8	12.5	23.3	22.2	19.0	15.8	15.1	13.3	28.8	20.6
2<=V<3	13.5	17.7	22.3	24.6	26.2	22.7	24.1	20.0	19.2	23.8	24.3	21.3	12.4	9.1	15.2	14.3
3<=V<4	10.3	16.7	21.9	17.4	18.7	20.6	26.5	27.6	17.6	12.3	13.6	17.4	7.5	4.3	7.5	14.3
4<=V<5	12.6	15.3	13.5	12.3	7.9	13.1	17.5	17.8	13.8	9.9	7.8	9.5	6.0	3.8	8.3	11.1
5<=V<6	10.1	8.8	6.0	6.4	4.7	6.3	7.2	7.0	6.8	6.6	5.6	6.5	4.3	4.7	5.0	10.2
6<=V<7	6.9	7.1	5.6	3.0	3.3	4.5	4.6	1.9	3.3	4.4	4.7	4.2	6.4	5.1	5.0	4.4
7<=V<8	4.9	1.7	1.2	0.4	0.5	0.9	1.5	1.8	1.1	2.2	4.0	3.2	6.7	5.2	2.8	2.7
8<=V<9	0.6	1.4	0.4	1.3	0.9	0.3	0.0	0.1	1.1	2.7	2.0	4.4	7.6	5.1	2.6	2.9
9<=V<10	1.4	0.7	0.8	0.0	0.0	0.0	0.1	0.3	0.5	1.4	1.8	3.3	5.6	5.6	1.2	1.7
10<=V<11	1.1	1.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.5	2.9	3.1	5.2	3.9	1.2	1.0
11<=V<12	1.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	1.1	4.7	3.4	0.2	0.0
12<=V<13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	2.9	3.4	0.7	0.0
13<=V<14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	2.2	3.6	0.0	0.2
14<=V<15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.9	0.0	0.2
15<=V<16	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.6	0.7	0.0
16<=V<17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.4	0.3	0.0
17<=V<18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	0.3	0.0
18<=V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	7.9	0.0	0.0
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 7.4 Wind Energy Density

Chachacomani	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	5.5	7.1	7.7	7.5	6.3	3.4	2.4	4.6	6.5	7.5	8.1	7.9
Barometric Pressue (hPa)	738	758.3	758.3	758.3	758.3	726.6	772.2	772.6	772.6	772.7	767.8	743.8
Air Density (kg/m^3)	0.92	0.943	0.941	0.942	0.946	0.916	0.977	0.97	0.963	0.96	0.952	0.922
Average Wind Speed (m/s)	2.5	3.5	2.9	3.4	4.2	5.0	6.5	6.0	4.6	3.7	4.7	3.5
Wind Energy Density (W/m^2)	13.7	38.41	21.8	35.16	66.57	108.7	254.8	199	89.04	46.18	93.85	37.57

* Barometric pressures from February to May are the average of the other months

Table 7.5 Turbulence intensity

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Chachacomani	0.22	0.25	0.28	0.28	0.3	0.32	0.32	0.29	0.28	0.25	0.22	0.2	0.2	0.19	0.25	0.23

Table 7.6 Construction Cost of Chachacomani Wind Power Project

Unit : US$.

Item	Cost	Note
1. Installation Works	**41,855**	
1.1 Installation Work	18,838	
1.2 Installation Materials	23,017	
2. Wind generator, PV system, etc.	**217,954**	
2.1 Wind generator	68,763	20kW
2.2 MHP	120,000	3kW
2.3 Inverter	10,211	14kVA
2.4 Converter	2,647	10kVA
2.4 Battery	2,877	4kAh
2.5 Control house	13,456	
3. Distribution Line	**17,982**	
4. Transportation	**22,334**	
5.Direct Cost Total	**300,125**	1.+2.+3.+4.
6. Administration and Engineering Servi	**26,411**	8.80%
Total Construction Cost	**326,536**	5. + 6.

Table 8.1 Calculation of EIRR (Economic Internal Rate of Return) of the Wind Project in Charana (La Paz)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Benefit																				
Investment																				
Diesel Generator	48,750										48,750									
Automatic Transfer Switch	1,910										1,910									
Protection Box	917										917									
Building	1,500										1,500									
Secondary Distribution Line	92,946																			
OM Cost																				
OM Cost of the Diesel Generator, et	1,289	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579	2,579
OM Cost of the Distribution Lines	1,162	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324	2,324
Fuel cost	13,048	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096	26,096
Total Benefit	161,522	30,999	30,999	30,999	30,999	30,999	30,999	30,999	30,999	30,999	84,076	30,999	30,999	30,999	30,999	30,999	30,999	30,999	30,999	30,999
Cost																				
Investment																				
Wind Turbine	216,000																			
PV System	112,000																			
MHP	0																			
Inverter	32,000										32,000									
Converter	3,600										3,600									
Battery	22,000						22,000						22,000							
Control House	10,000																			
Installation Materials	66,207																			
Installation Work	57,931																			
Transportation	92,946																			
Secondary Distribution Lines	29,904																			
Administration Cost	56,548																			
OM Cost																				
Wind PV Hybrid System	3,636	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272	7,272
Secondary Distribution lines	374	748	748	748	748	748	748	748	748	748	748	748	748	748	748	748	748	748	748	748
Total Cost	703,146	8,020	8,020	8,020	8,020	8,020	30,020	8,020	8,020	8,020	43,620	8,020	30,020	8,020	8,020	8,020	8,020	8,020	8,020	8,020
Balance	-541,623	22,979	22,979	22,979	22,979	22,979	979	22,979	22,979	22,979	40,456	22,979	979	22,979	22,979	22,979	22,979	22,979	22,979	22,979

EIRR	-2.6%

Table 8.2 Calculation of EIRR (Economic Internal Rate of Return) of the Wind Project in Caripe (Oruro)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Benefit																				
Investment																				
Diesel Generator	7,500										7,500									
Automatic Transfer Switch	1,910										1,910									
Protection Box	917										917									
Building	1,500										1,500									
Secondary Distribution Line	9,200																			
OM Cost																				
OM Cost of the Diesel Generator, et	258	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516
OM Cost of the Distribution Lines	115	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230
Fuel cost	3,273	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546	6,546
Total Benefit	24,673	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292	19,119	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292
Cost																				
Investment																				
Wind Turbine	27,000																			
PV System	28,000																			
MHP	0																			
Inverter	4,000										4,000									
Converter	0																			
Battery	4,000						4,000						4,000							
Control House	10,000																			
Installation Materials	9,655																			
Installation Work	8,448																			
Transportation	14,938																			
Secondary Distribution Line	9,200																			
Administration Cost	10,141																			
OM Cost																				
Wind PV Hybrid System	590	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180
Secondary Distribution lines	115	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230	230
Total Cost	126,087	1,410	1,410	1,410	1,410	1,410	5,410	1,410	1,410	1,410	5,410	1,410	5,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410
Balance	-101,414	5,882	5,882	5,882	5,882	5,882	1,882	5,882	5,882	5,882	13,709	5,882	1,882	5,882	5,882	5,882	5,882	5,882	5,882	5,882

EIRR	1.0%

Table 8.3 Calculation of EIRR (Economic Internal Rate of Return) of the Wind Project in Chachacomani (Oruro)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Benefit																				
Investment																				
Diesel Generator	15,000										15,000									
Automatic Transfer Switch	1,910										1,910									
Protection Box	917										917									
Building	1,500										1,500									
Secondary Distribution Line	12,500																			
OM Cost																				
OM Cost of the Diesel Generator, etc	446	891	891	891	891	891	891	891	891	891	891	891	891	891	891	891	891	891	891	891
OM Cost of the Distribution Lines	156	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313
Fuel cost	6,222	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444	12,444
Total Benefit	38,651	13,648	13,648	13,648	13,648	13,648	13,648	13,648	13,648	13,648	32,975	13,648	13,648	13,648	13,648	13,648	13,648	13,648	13,648	13,648
Cost																				
Investment																				
Wind Turbine	54,000																			
PV System	0																			
MHP	102,749																			
Inverter	7,000										7,000									
Converter	1,800										1,800									
Battery	2,000						2,000						2,000							
Control House	10,000																			
Installation Materials	13,793																			
Installation Work	12,069																			
Transportation	16,598																			
Secondary Distribution Lines	12,500																			
Administration Cost	20,461																			
OM Cost																				
Wind PV Hybrid System	1,655	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311	3,311
Secondary Distribution lines	156	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313
Total Cost	254,781	3,623	3,623	3,623	3,623	3,623	5,623	3,623	3,623	3,623	12,423	3,623	5,623	3,623	3,623	3,623	3,623	3,623	3,623	3,623
Balance	-216,130	10,024	10,024	10,024	10,024	10,024	8,024	10,024	10,024	10,024	20,551	10,024	8,024	10,024	10,024	10,024	10,024	10,024	10,024	10,024

EIRR	-0.9%

FIGURES

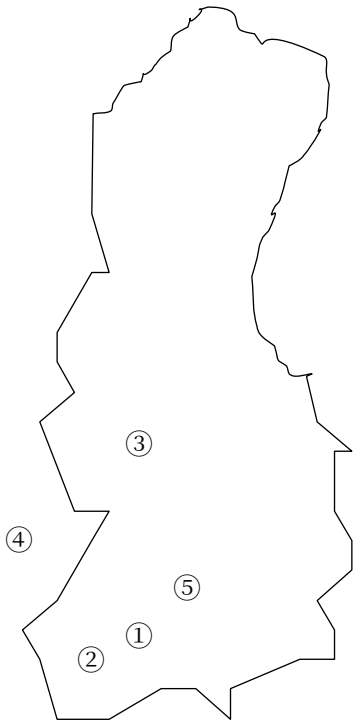


Figure 3.1. Location of wind monitoring sites in La Paz

ID. No.	Site Name
1	Achiri
2	Charana
3	Ramon Gonzales
4	Isla Taquiri
5	SanTiago de Llallagua

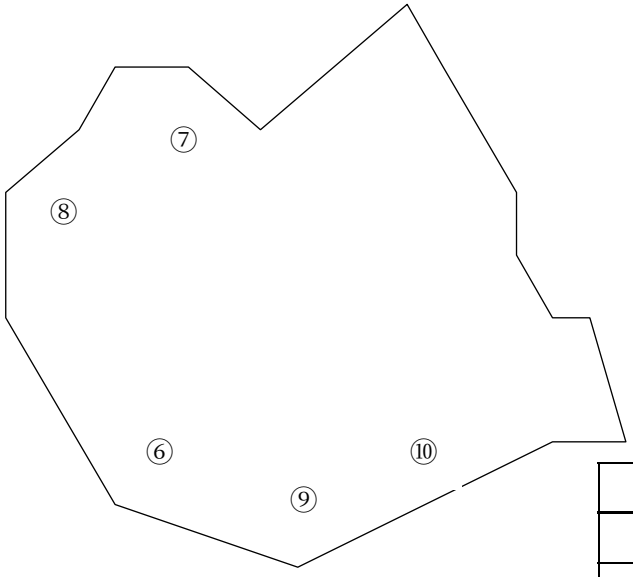
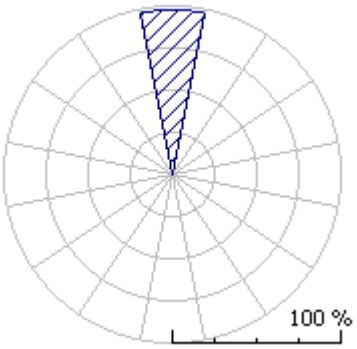
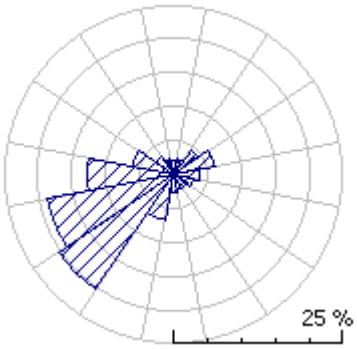


Figure 3.2. Location of wind monitoring sites in Oruro

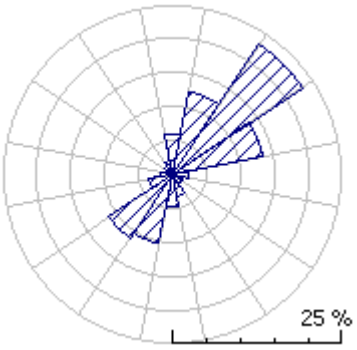
ID. No.	Site Name
6	Comjo / Coipasa
7	Caripe
8	Chachacomani
9	Salinas de Garci Mendosa
10	Sevaruyo



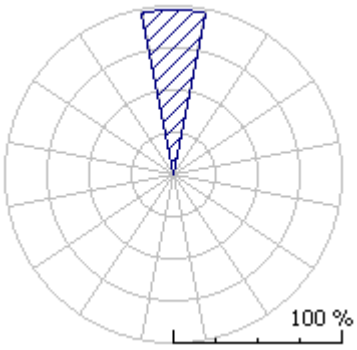
01 Achiri



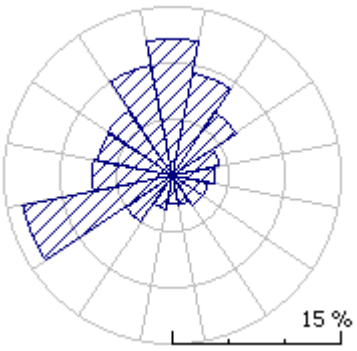
02 Charana



03 Ramon Gonzales

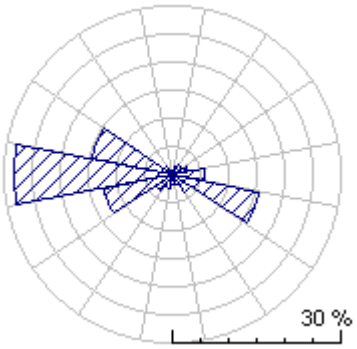


04 Isla Taquiri

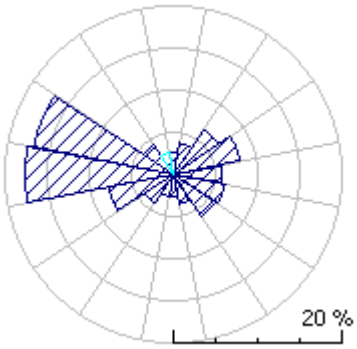


05 Santiago de Llallagua

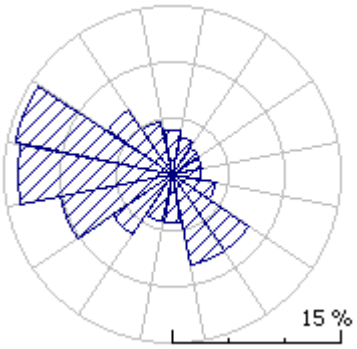
Figure 3.3
Wind Direction (20m), La Paz
February 2000 to January 2001



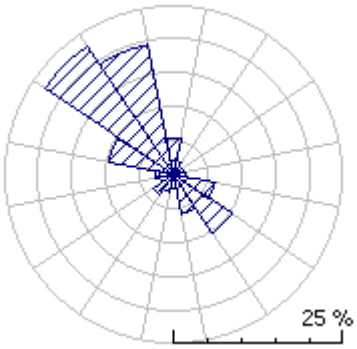
06 Between Comjo and Coipasa



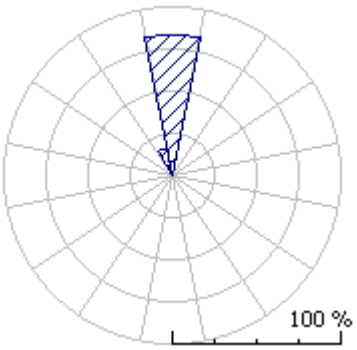
07 Caripe



08 Chachacomani

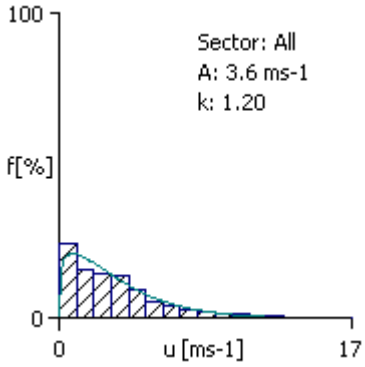


09 Salinas

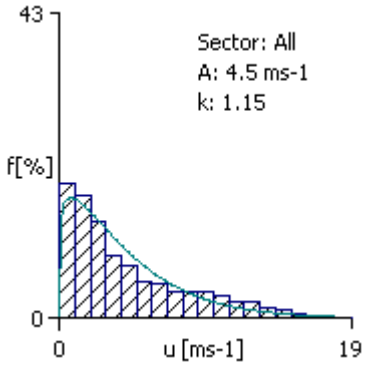


10 Sevaruyo

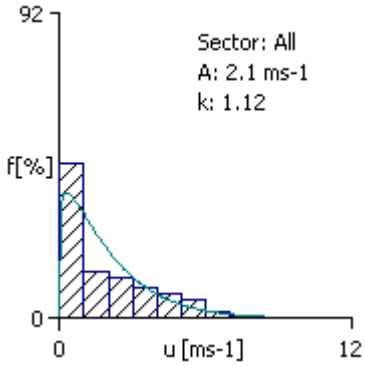
Figure 3.4
Wind Direction (20m), Oruro
February 2000 to January 2001



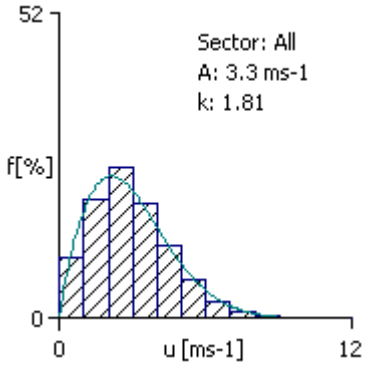
01 Achiri



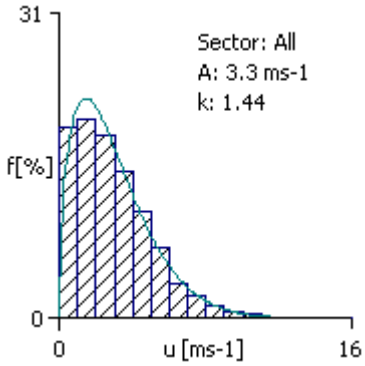
02 Charana



03 Ramon Gonzales

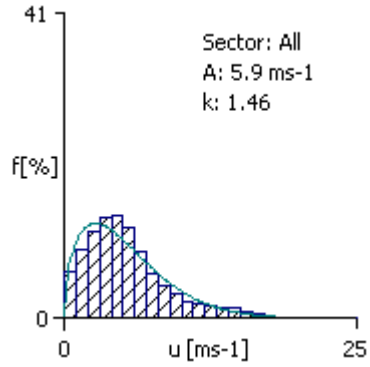


04 Isla Taquiri

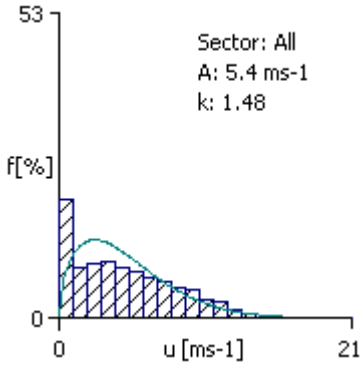


05 Santiago de Llallagua

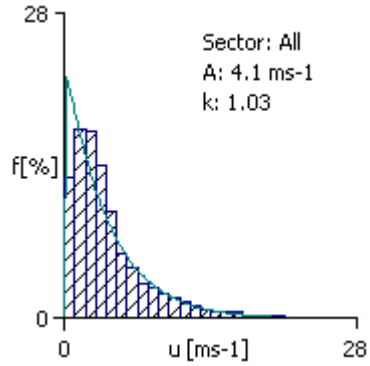
Figure 3.5
Wind Speed Frequency (20m), La Paz
February 2000 to January 2001



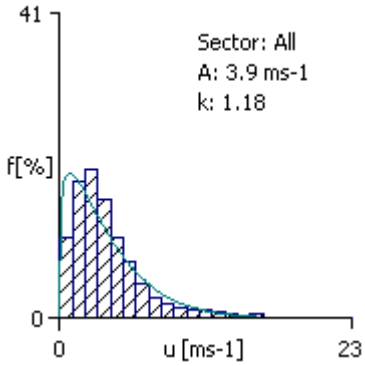
06 Between Comjo and Coipasa



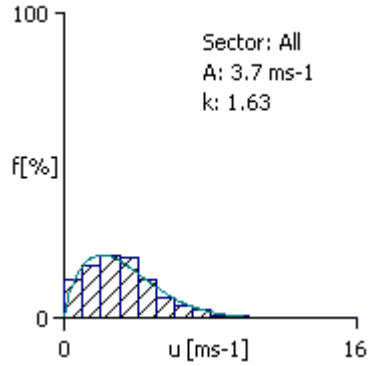
07 Caripe



08 Chachacomani



09 Salinas



10 Sevaruyo

Figure 3.6
Wind Speed Frequency (20m), Oruro
February 2000 to January 2001

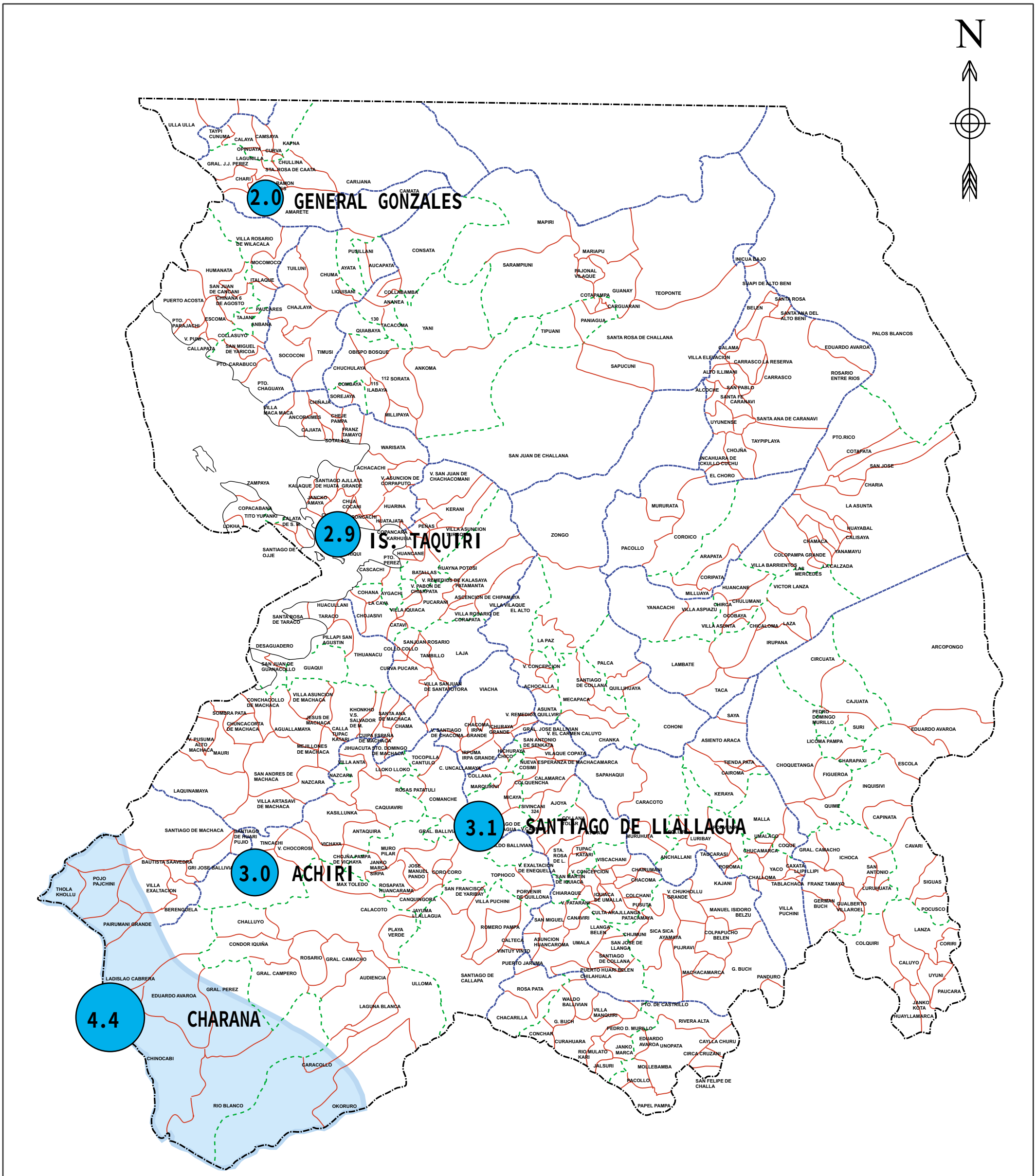


Figure 4.1 Wind Potential Map
La Paz

JICA Study Team

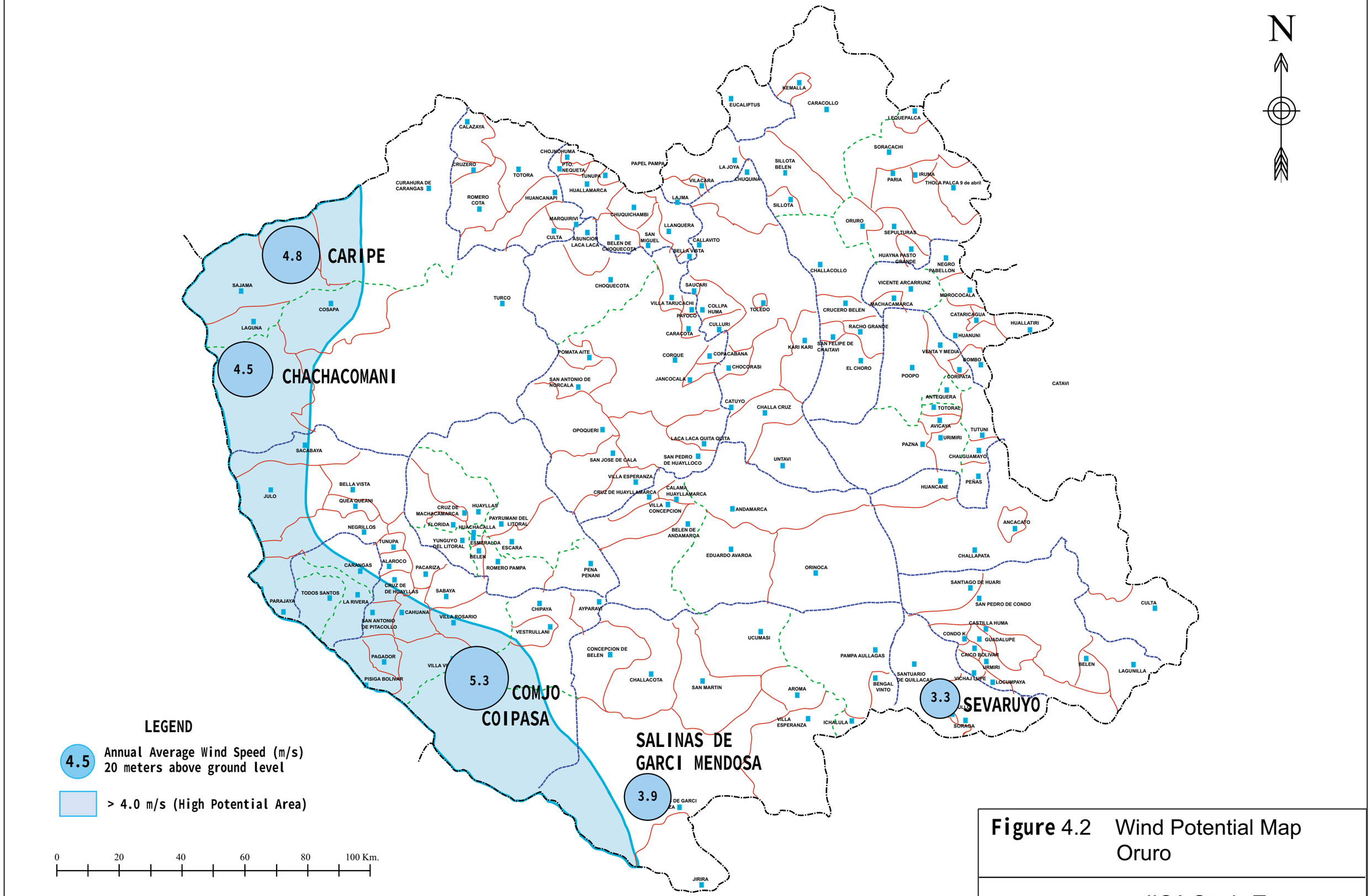
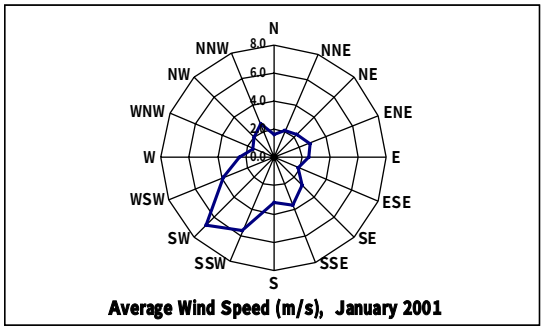
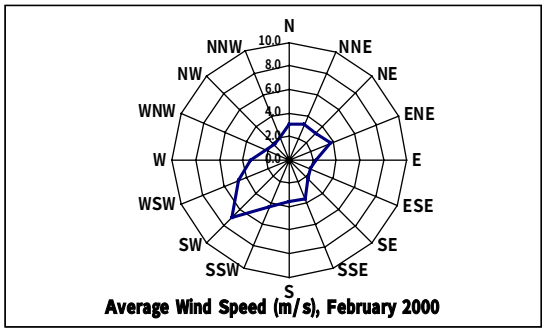


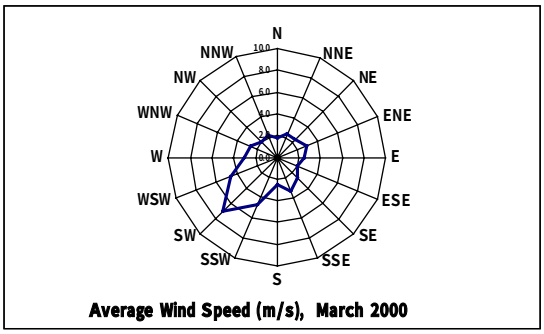
Figure 4.2 Wind Potential Map Oruro

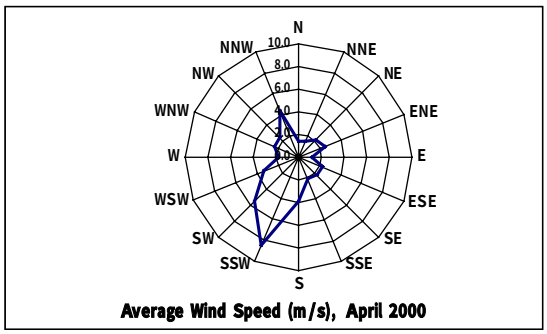
JICA Study Team

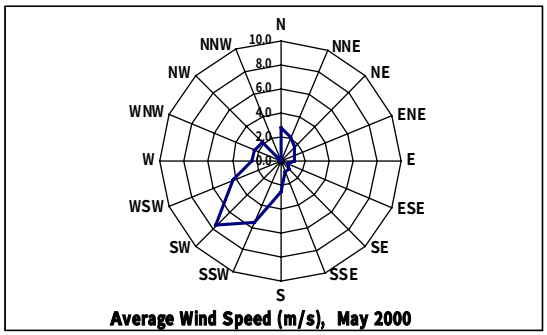
Figure 5.1 Directional Average Wind Speed (m/s) in Charana, La Paz

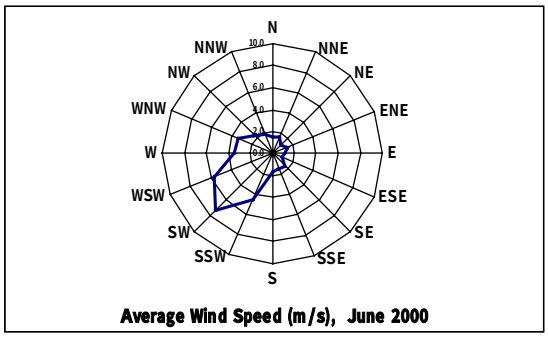


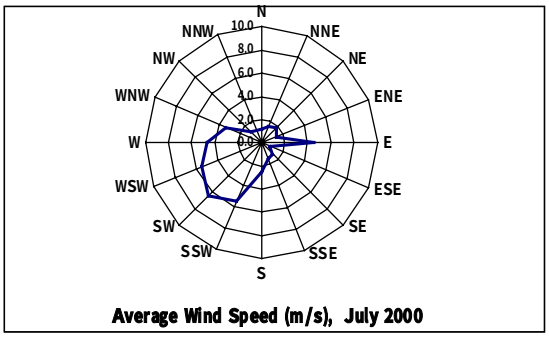


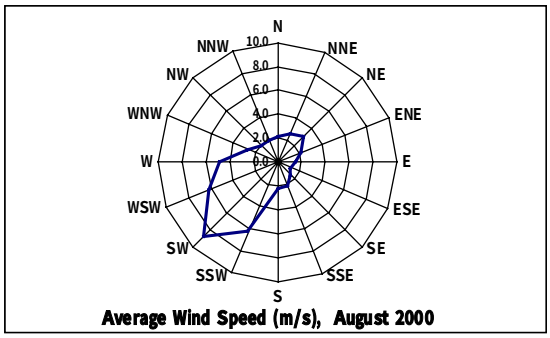


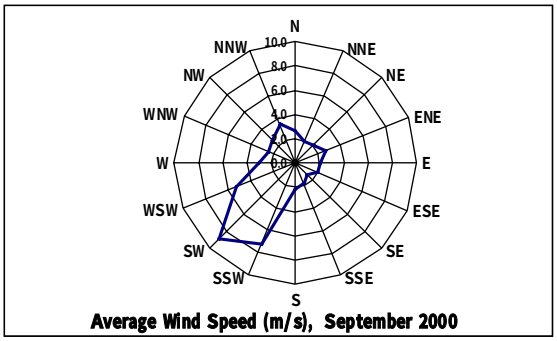




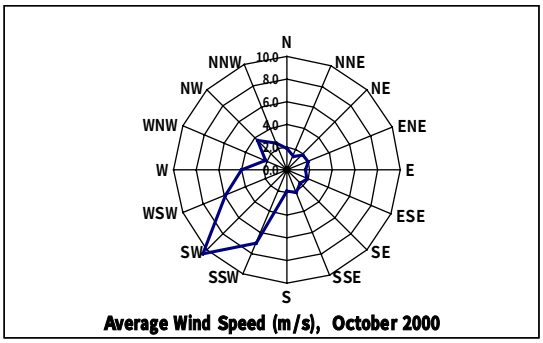




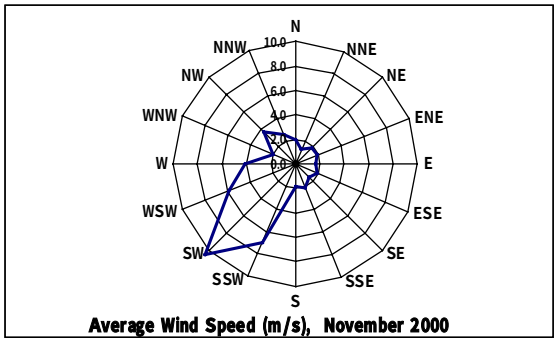




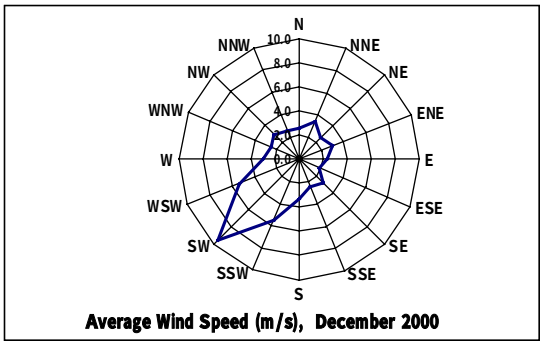
Average Wind Speed (m/s), September 2000



Average Wind Speed (m/s), October 2000

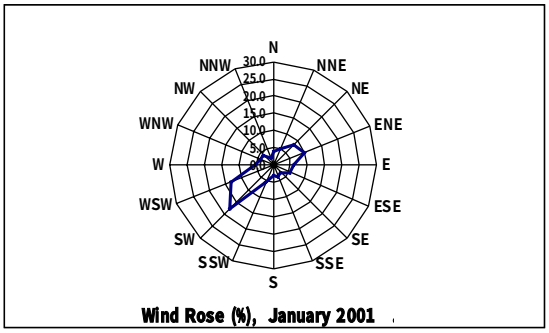


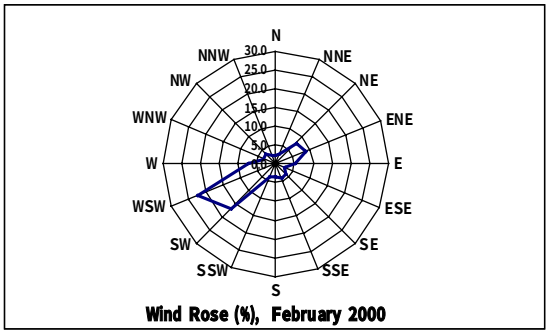
Average Wind Speed (m/s), November 2000

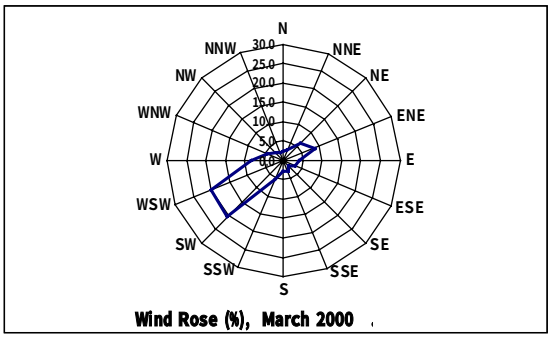


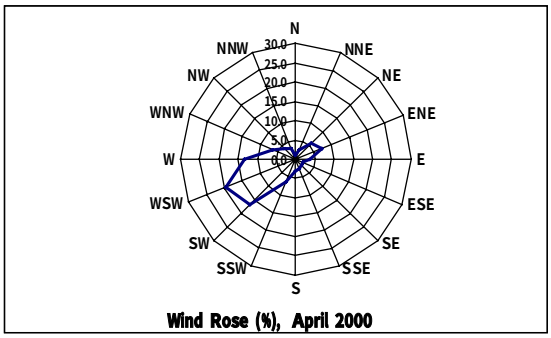
Average Wind Speed (m/s), December 2000

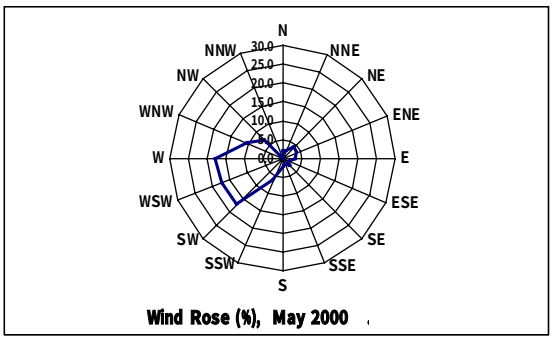
Figure 5.2 Frequency Distribution of Wind Direction in Charana La Paz

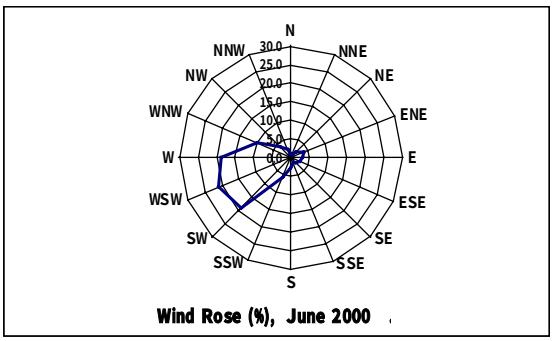


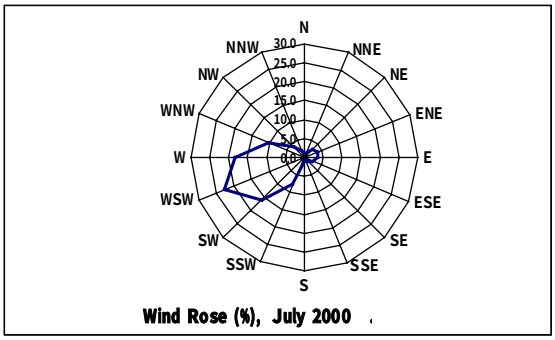


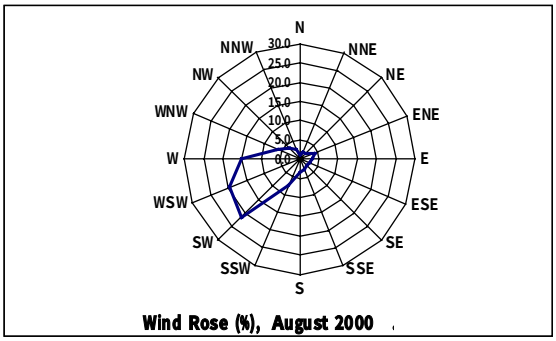


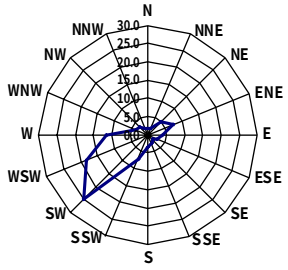




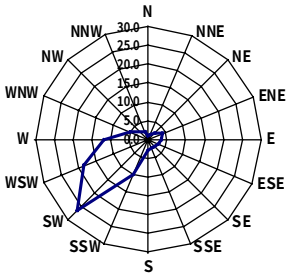




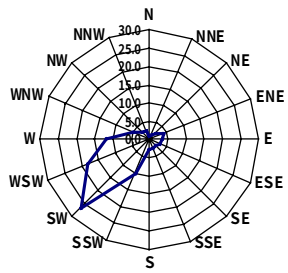




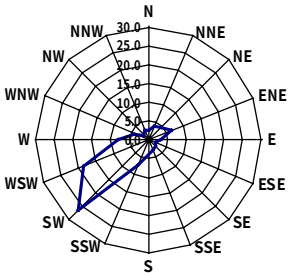
Wind Rose (%), September 2000



Wind Rose (%), October 2000

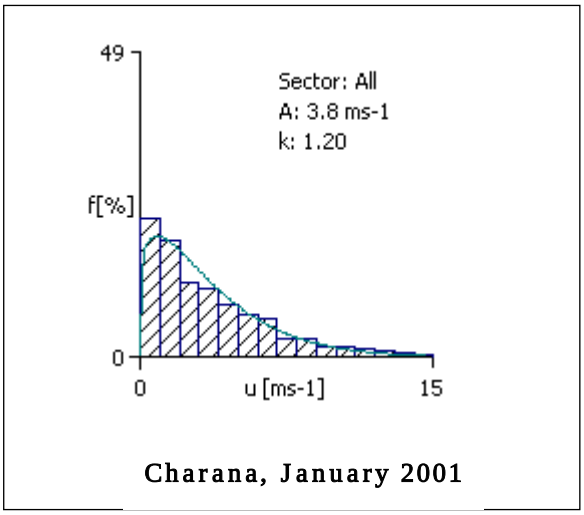


Wind Rose (%), November 2000

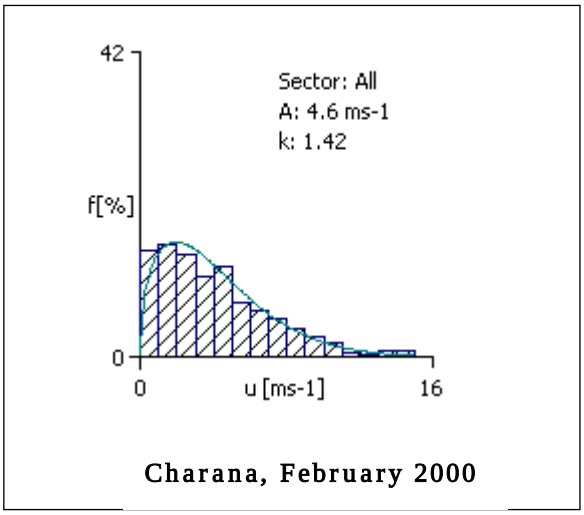


Wind Rose (%), December 2000

Figure 5.3 Weibull Distribution in Charana La Paz



Charana, January 2001



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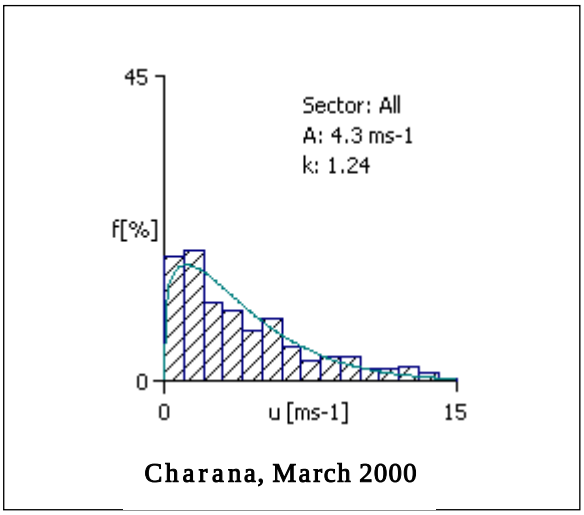
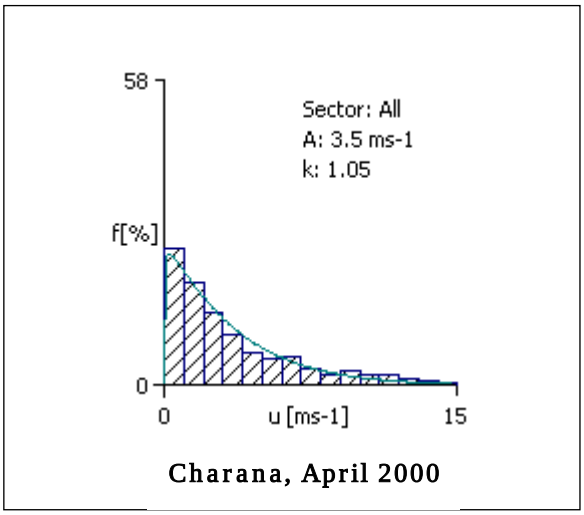
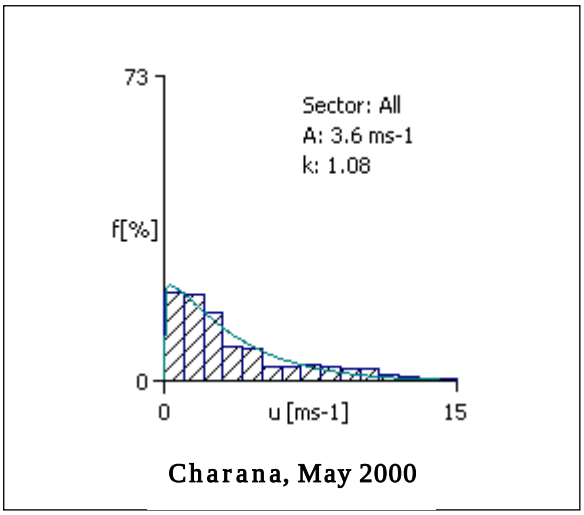


Charana, March 2000



Charana, April 2000



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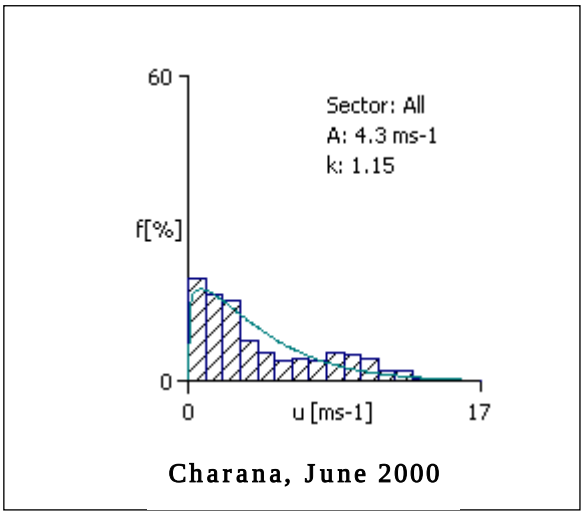
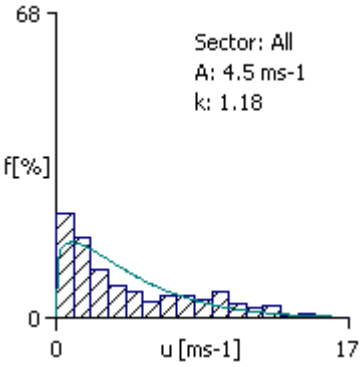
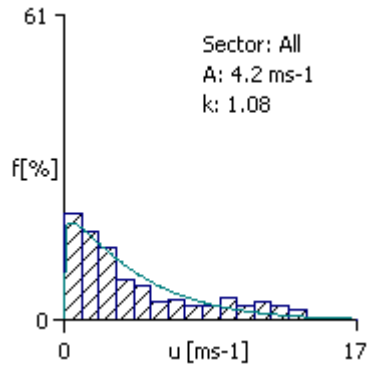


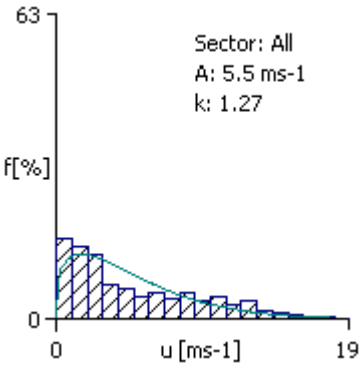
Charana, June 2000



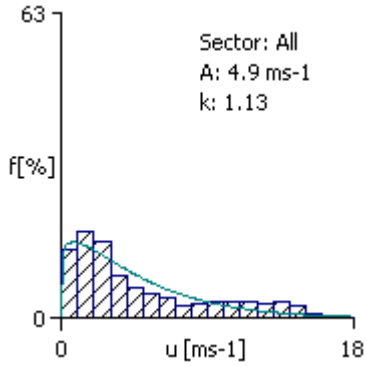
Charana, July 2000



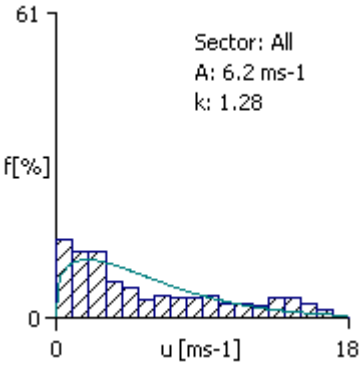
Charana, August 2000



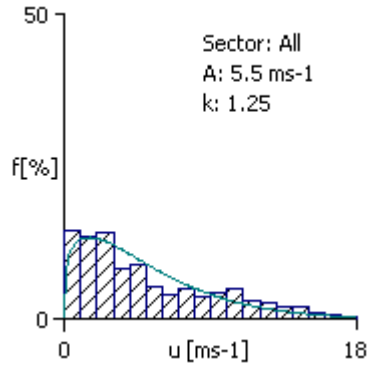
Charana, September 2000



Charana, October 2000



Charana, November 2000



Charana, December 2000

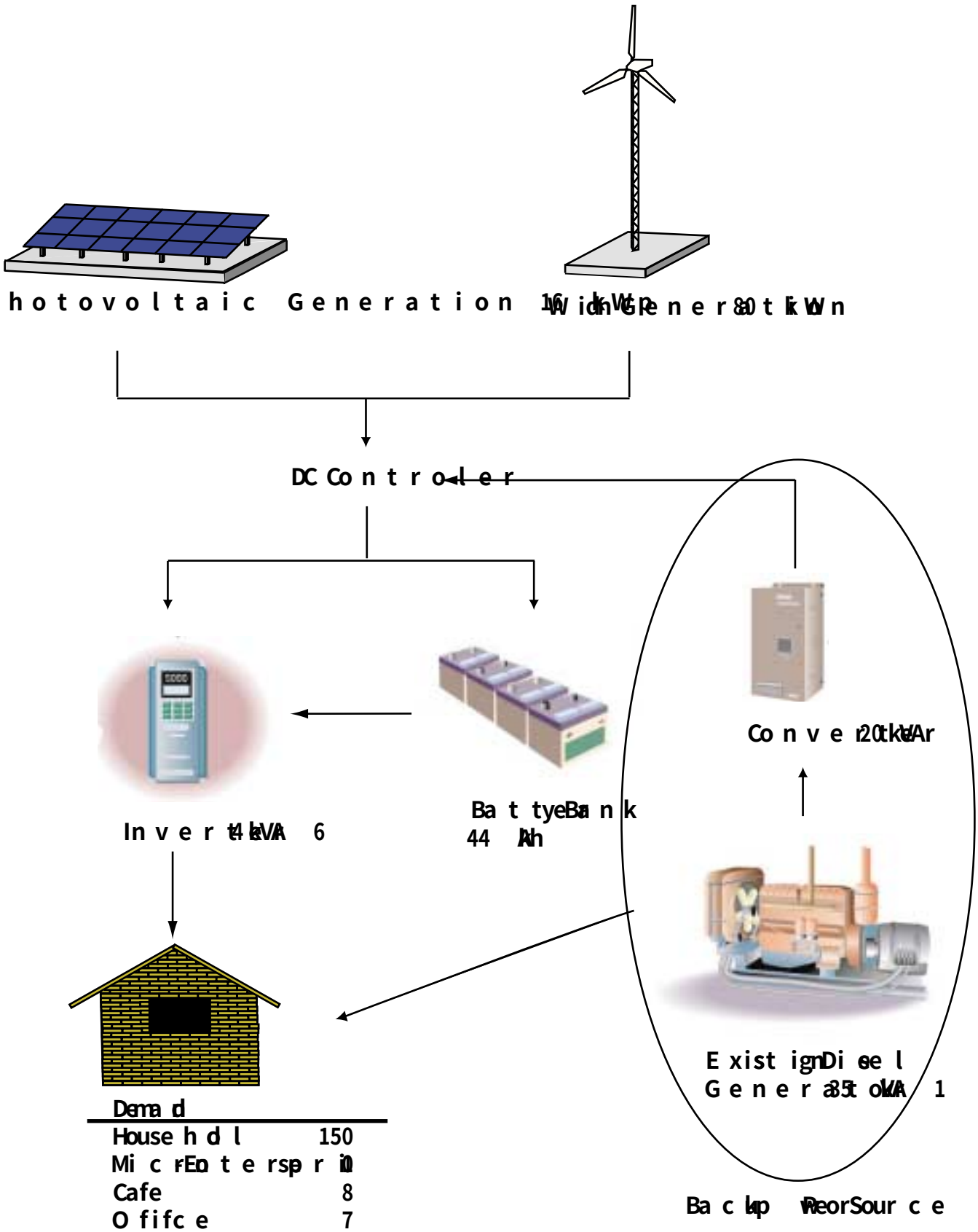


Figure 5.4 Wind-PV Hybrid System in Charaha Development

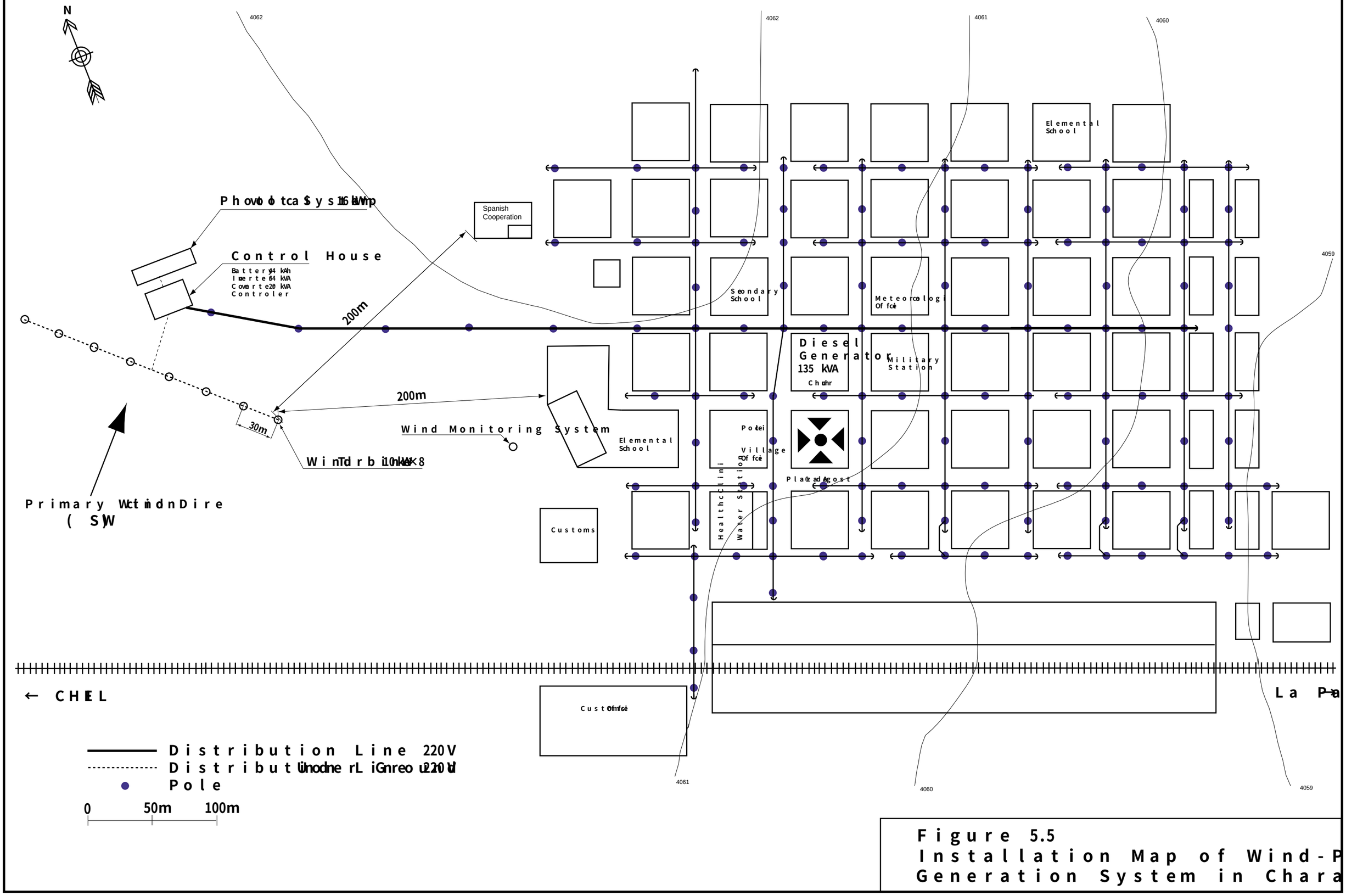
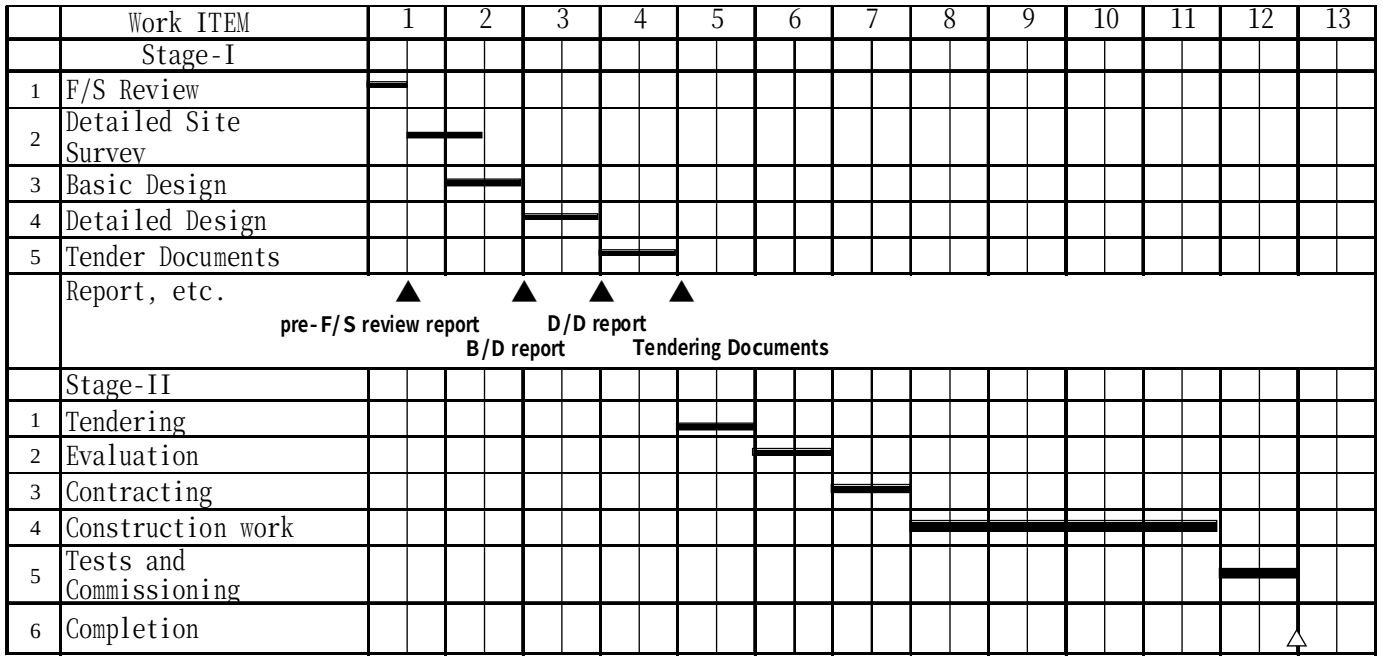


Figure 5.5
Installation Map of Wind-PV Generation System in Charana

Figure 5.6 Construction Schedule of Charana Wind Power Project



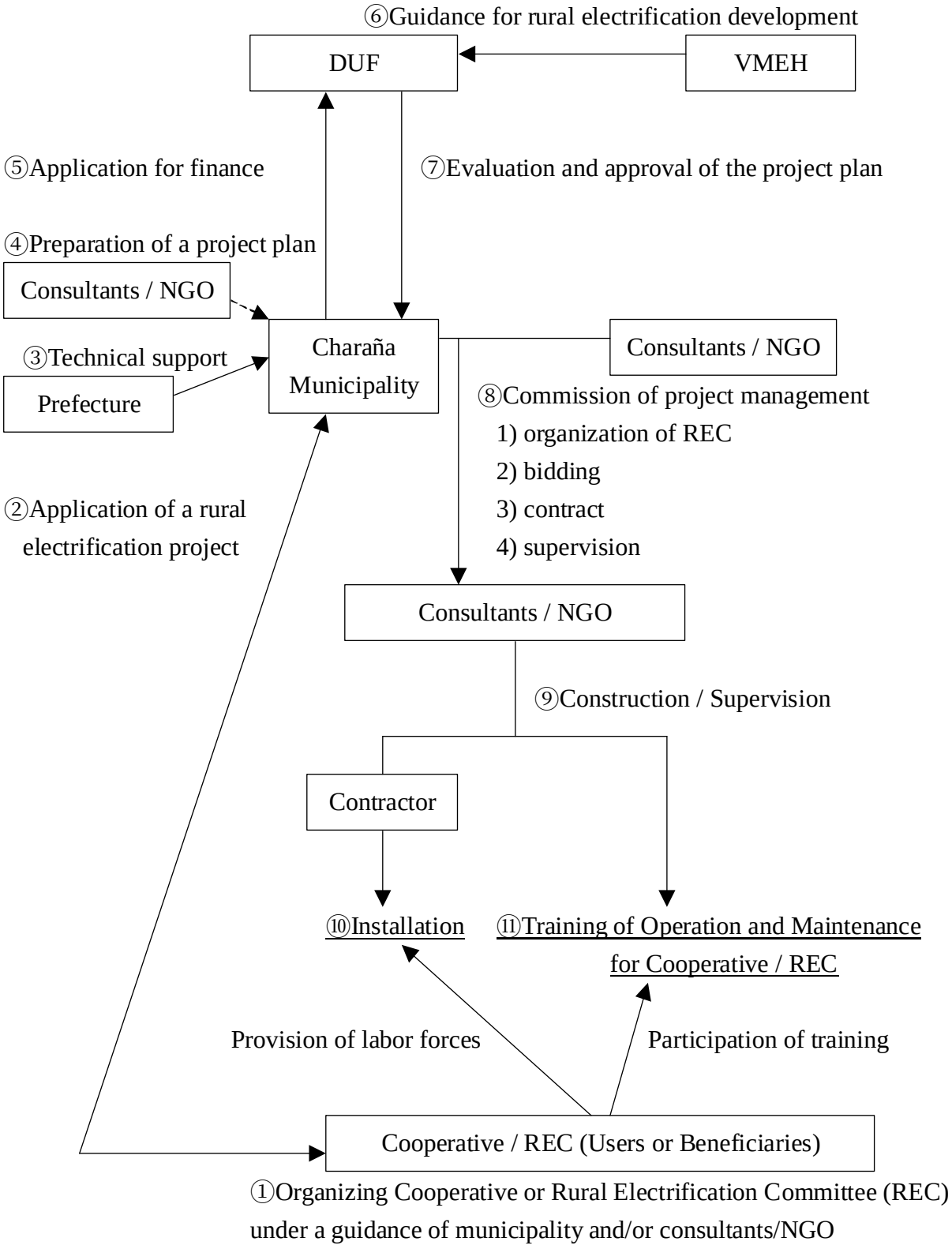
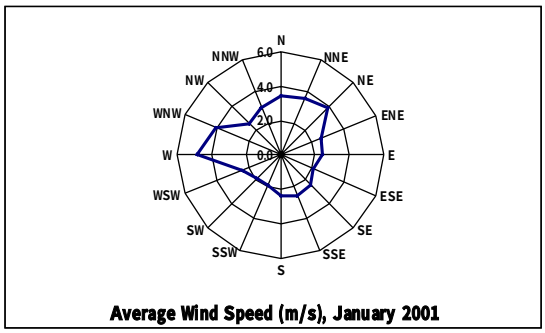


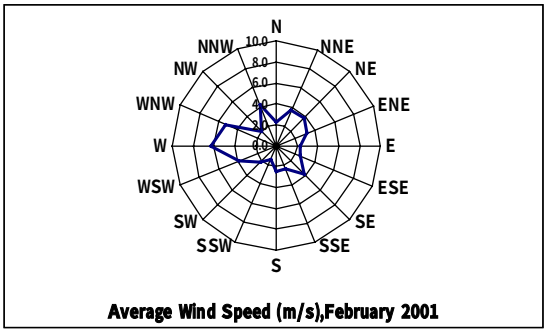
Figure 5.7 Proposed Project Implementation for Charaña Wind Power Project

Source: JICA Study Team

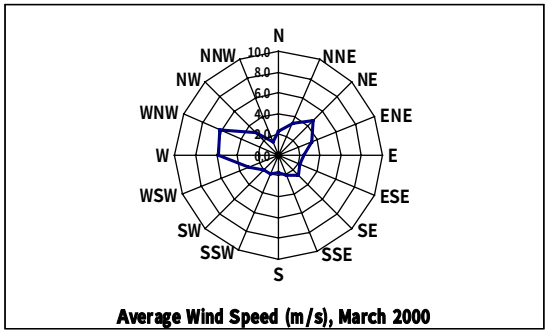
6.1 Directional Average Wind Speed (m/s) in Caripe, Oruro



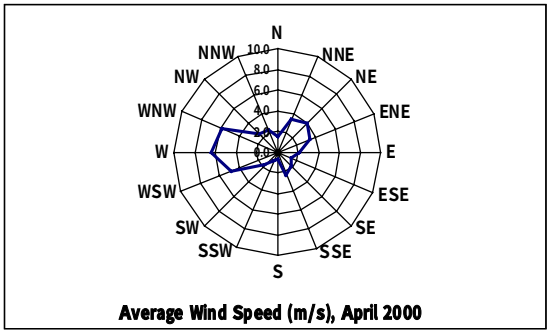
Average Wind Speed (m/s), January 2001



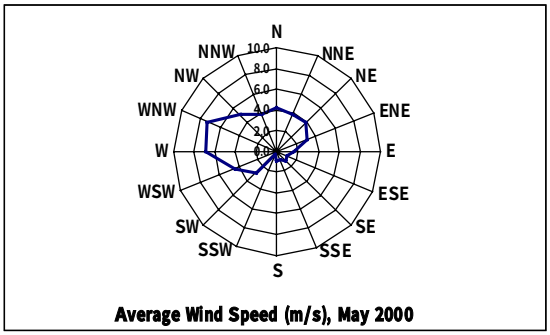
Average Wind Speed (m/s),February 2001



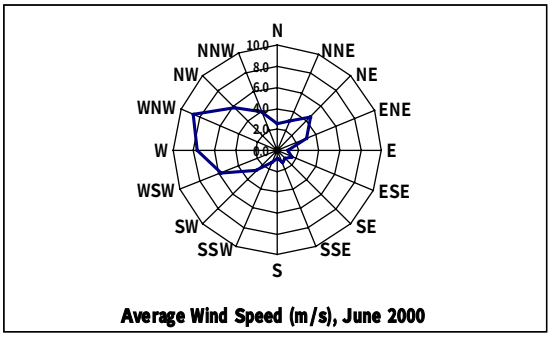
Average Wind Speed (m/s), March 2000



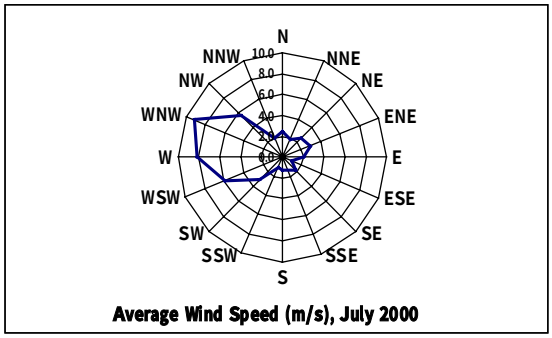
Average Wind Speed (m/s), April 2000



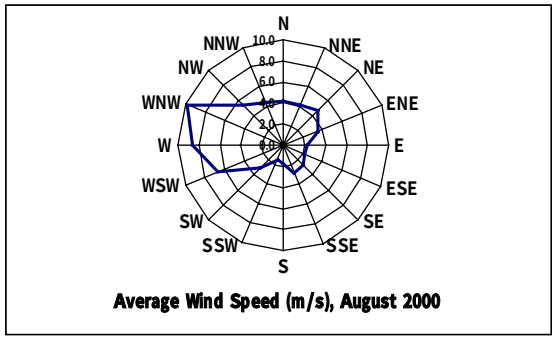
Average Wind Speed (m/s), May 2000



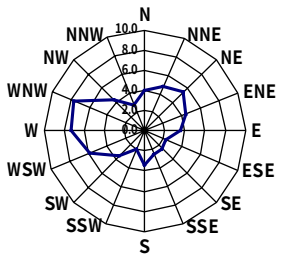
Average Wind Speed (m/s), June 2000



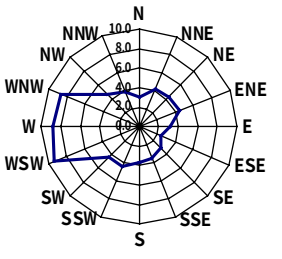
Average Wind Speed (m/s), July 2000



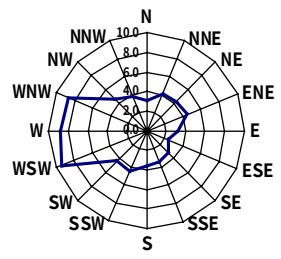
Average Wind Speed (m/s), August 2000



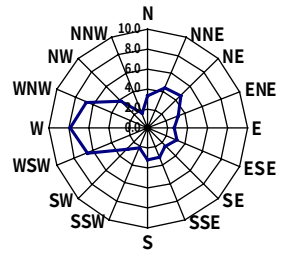
Average Wind Speed (m/s) September 2000



Average Wind Speed (m/s) October 2000

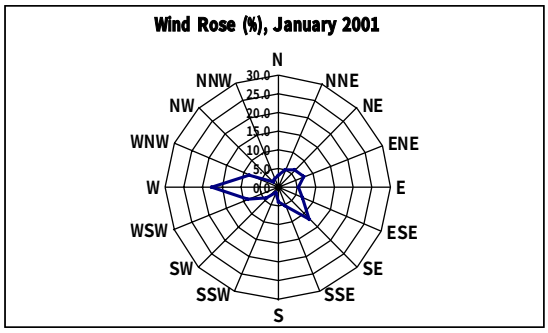


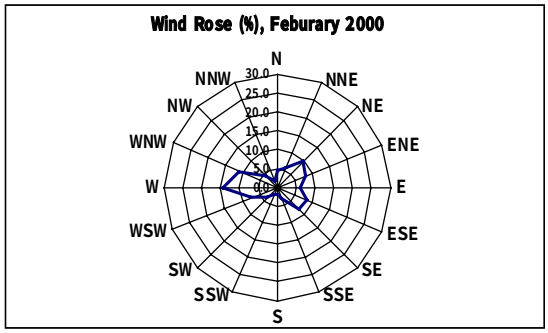
Average Wind Speed (m/s) November 2000

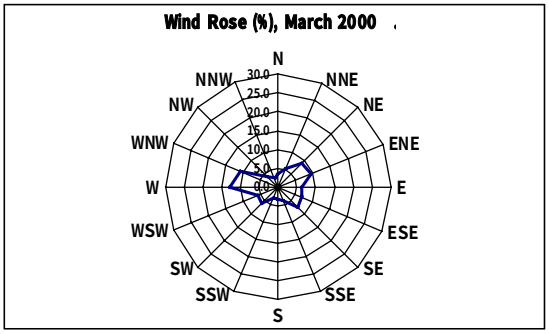


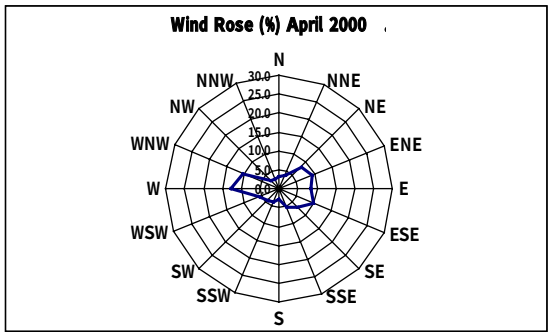
Average Wind Speed (m/s) December 2000

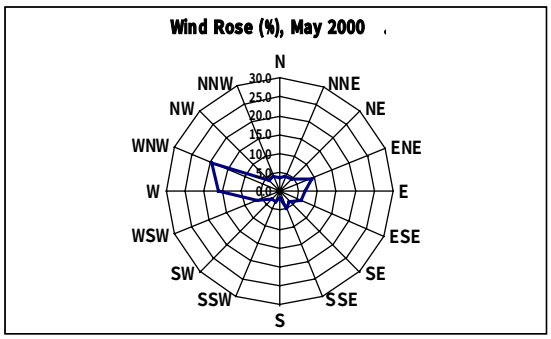
6.2 Frequency Distribution of Wind Direction in Caripe, Oruro

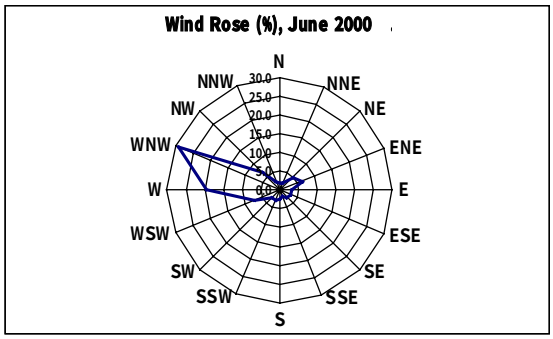


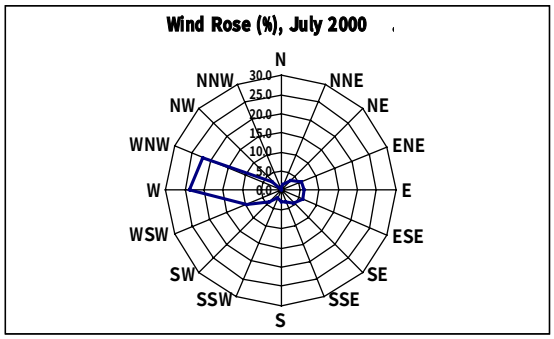


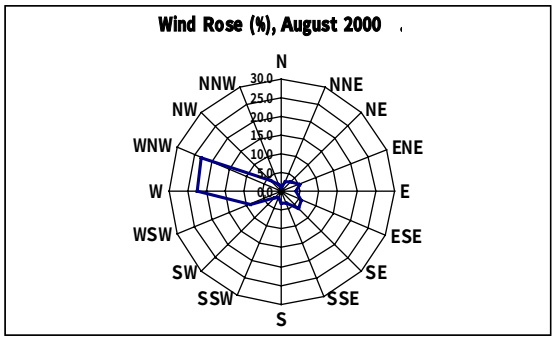


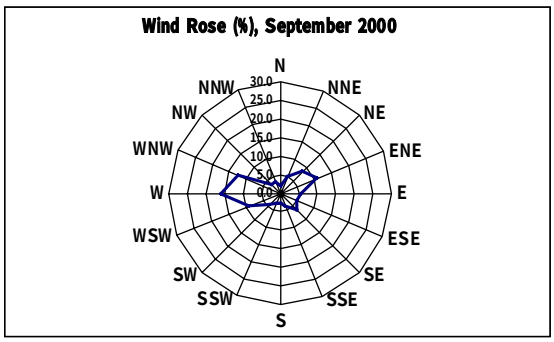


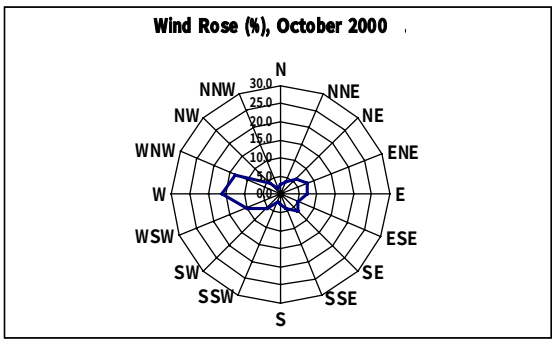


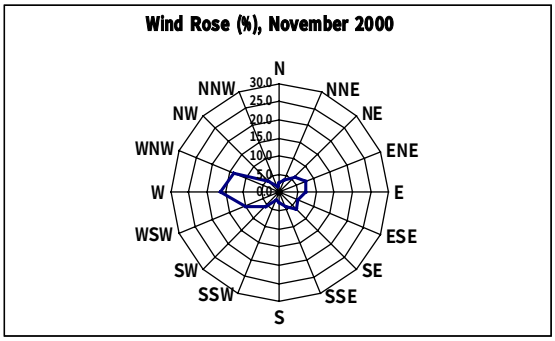







Wind Rose (%), September 2000
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30.0
25.0
20.0
15.0
10.0
5.0
0.0


Wind Rose (%), October 2000
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30.0
25.0
20.0
15.0
10.0
5.0
0.0


Wind Rose (%), November 2000
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30.0
25.0
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15.0
10.0
5.0
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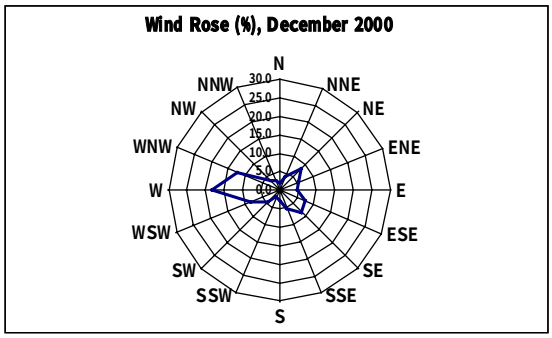
Wind Rose (%), December 2000
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
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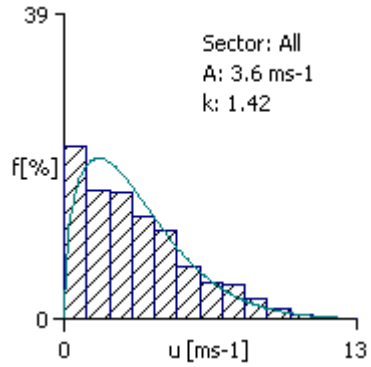
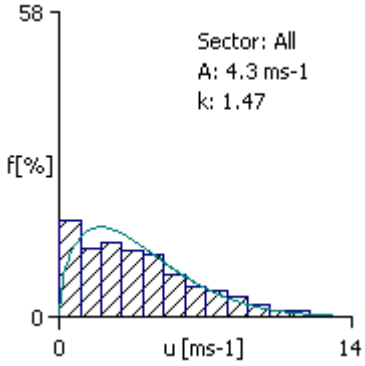
NW
NNW
30.0
25.0
20.0
15.0
10.0
5.0
0.0

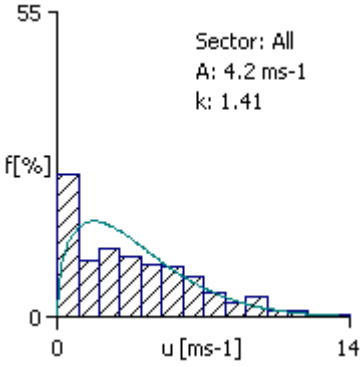
6.3 Weibull Distribution in Caripe Oruro



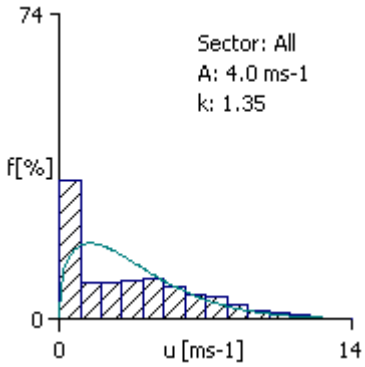
Caripe, January 2001



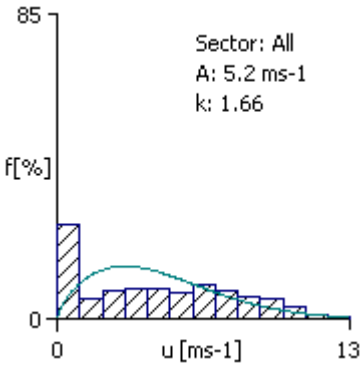
Caripe, February 2000



Caripe, March 2000



Caripe, April 2000



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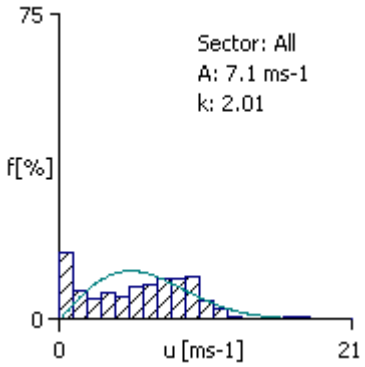
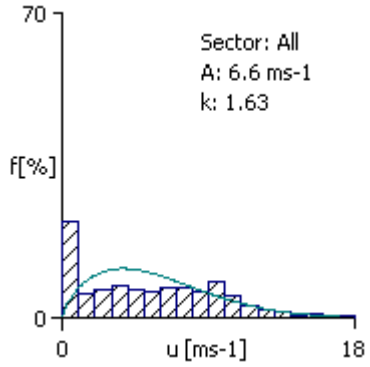
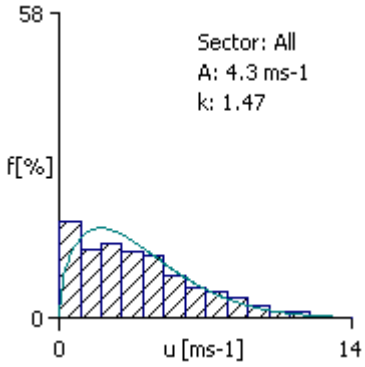


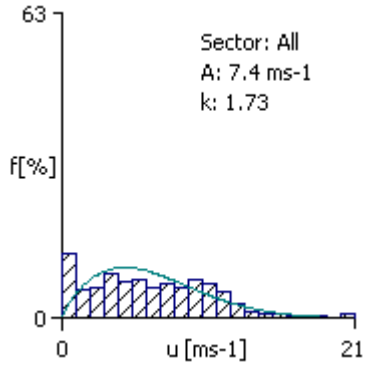
Caripe, June 2000



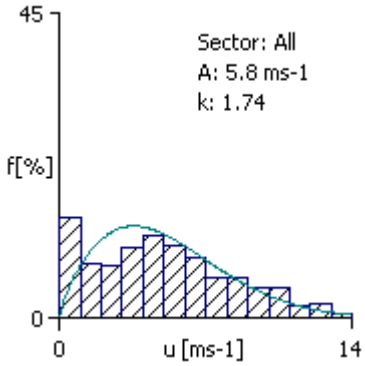
Caripe, July 2000



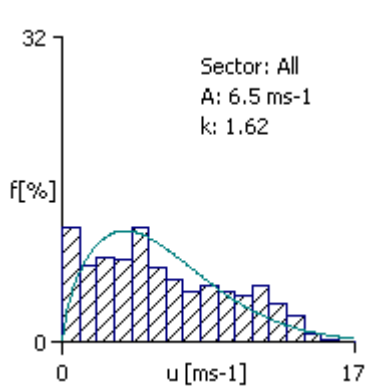
Caripe, August 2000



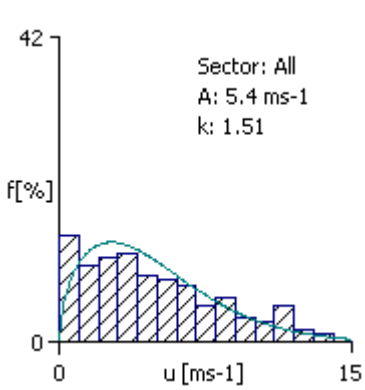
Caripe, September 2000



Caripe, October 2000



Caripe, November 2000



Caripe, December 2000

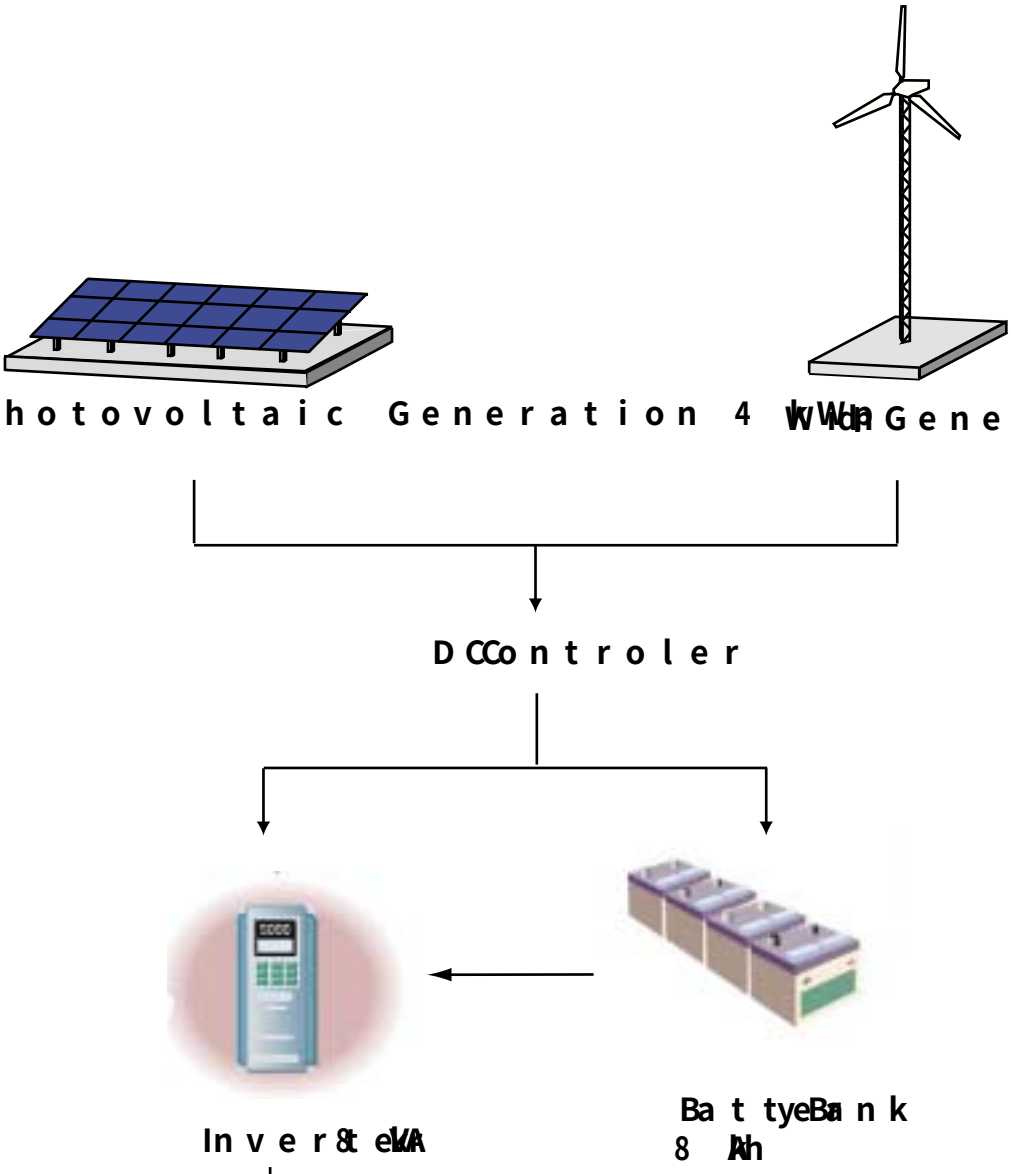


Figure 6.4
Wind-PV Hybrid System
in Caripito Department

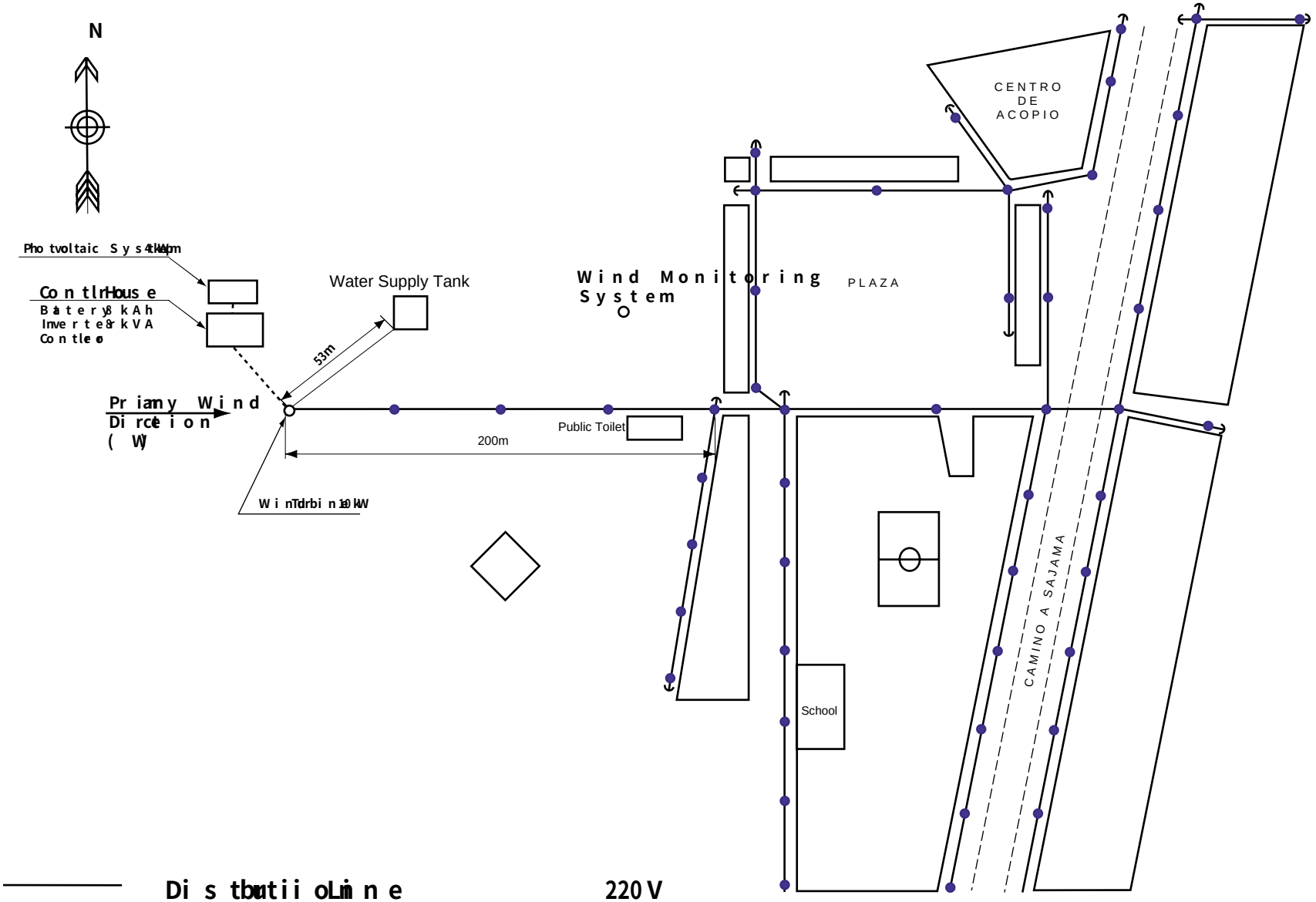
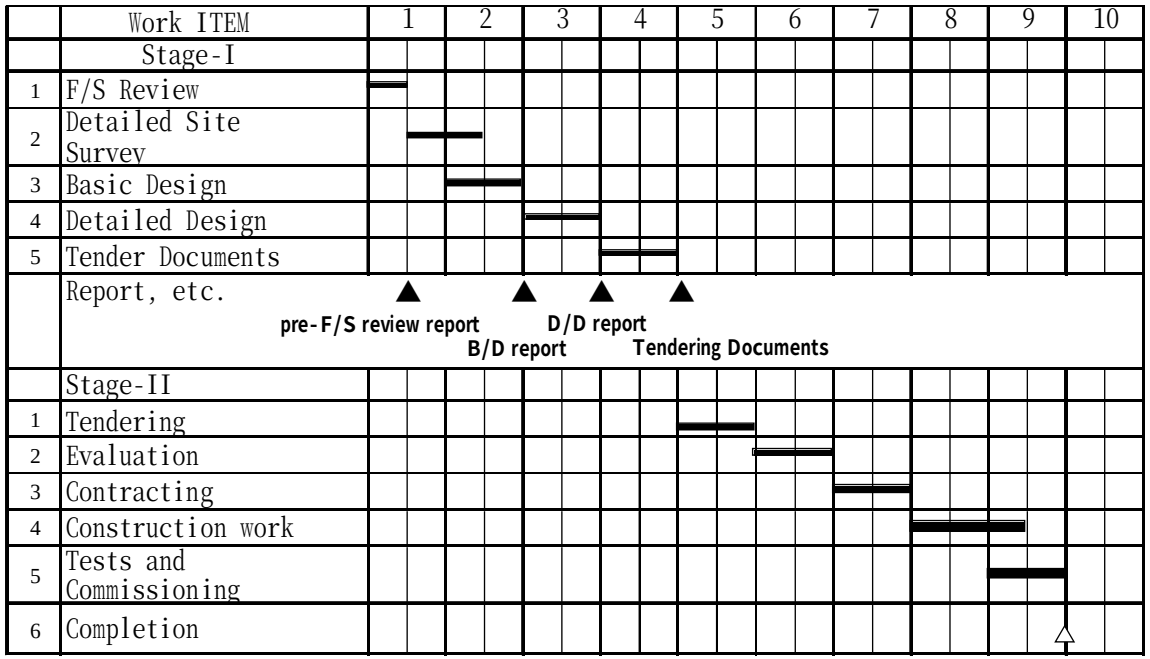


Figure 6.5
Installation map of Wind-PV Hybrid Generation System, Caripe, Oruro Department

Figure 6.6 Construction Schedule of Caripe Wind Power Project



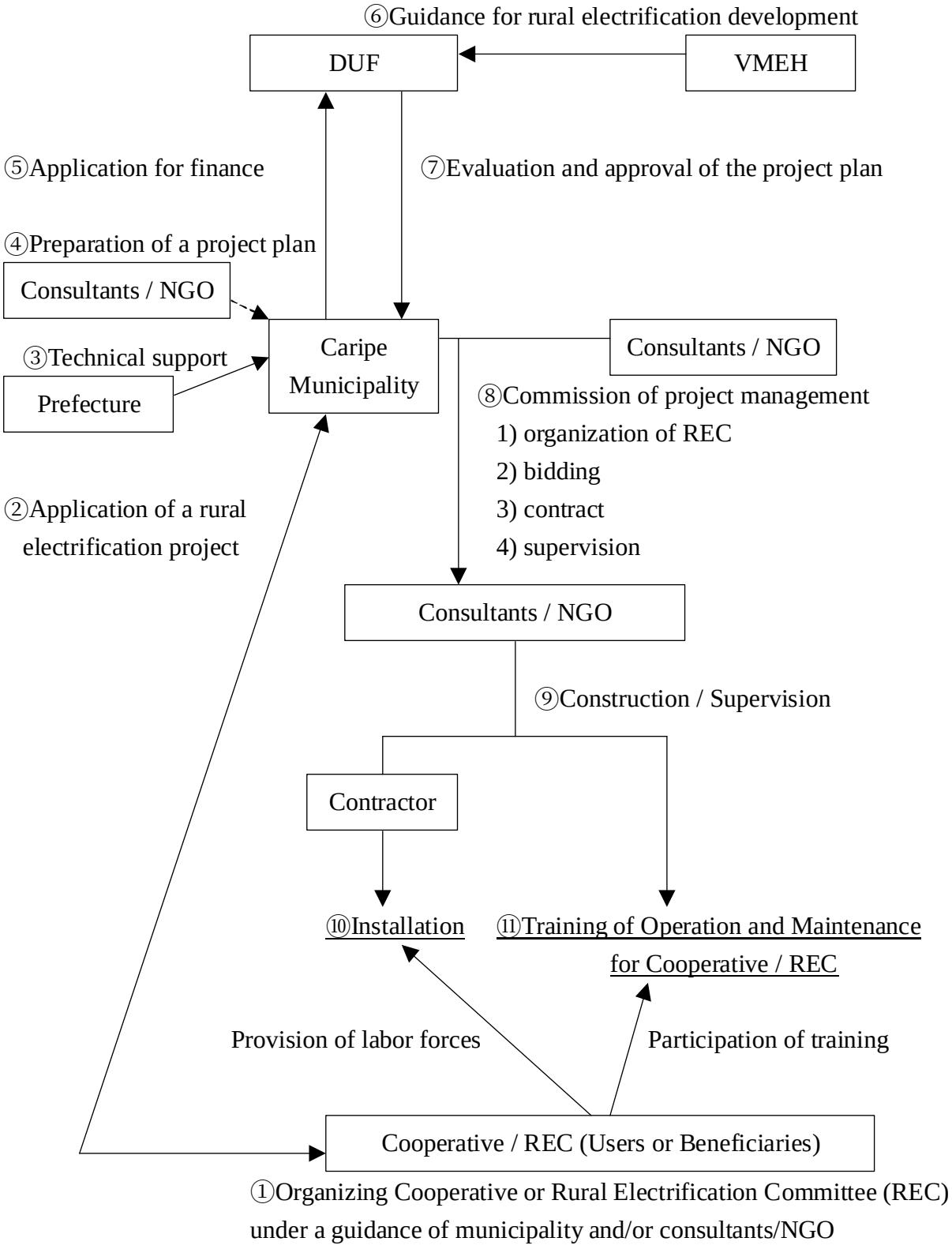
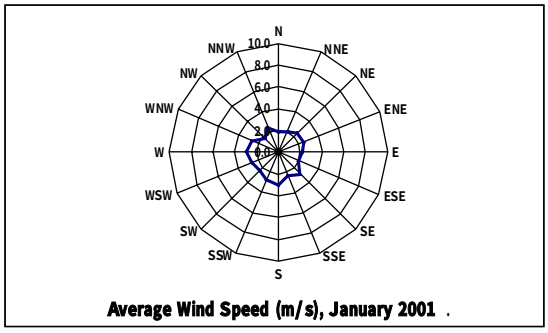


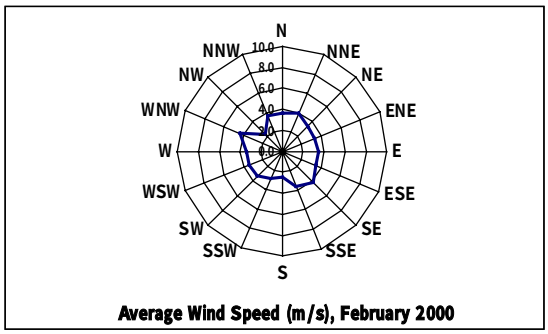
Figure 6.7 Proposed Project Implementation for Caripe Wind Power Project

Source: JICA Study Team

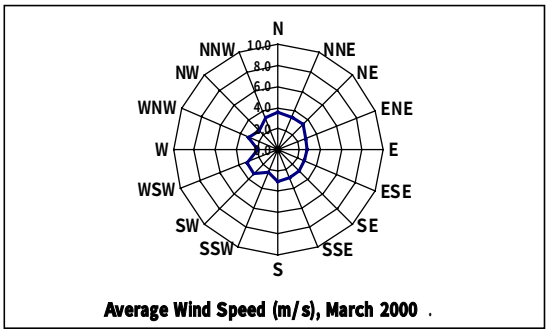
7.1 Directional Average Wind Speed (m/s) in Chachacomani, Oruro



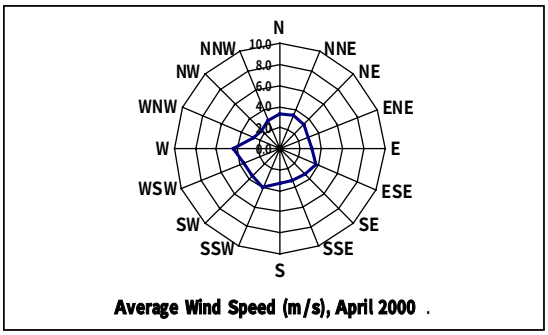
Average Wind Speed (m/s), January 2001 .



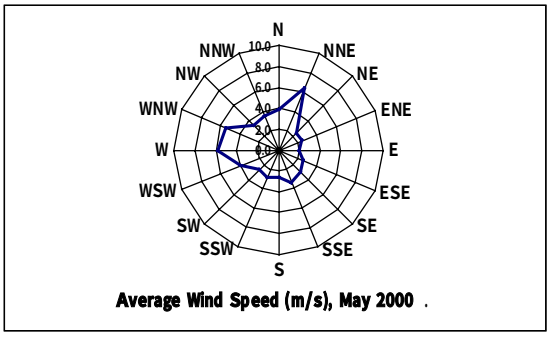
Average Wind Speed (m/s), February 2000



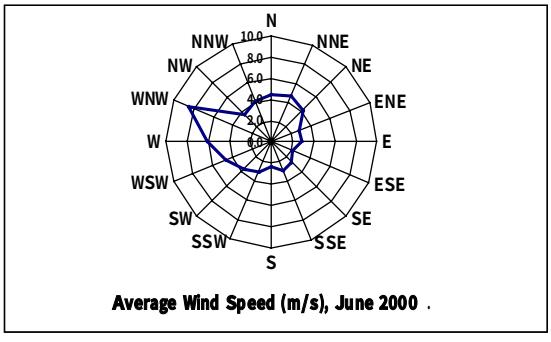
Average Wind Speed (m/s), March 2000 .



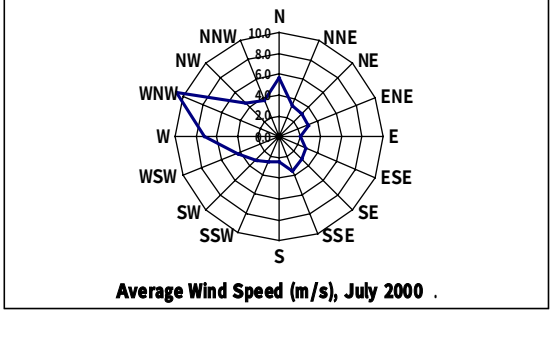
Average Wind Speed (m/s), April 2000 .



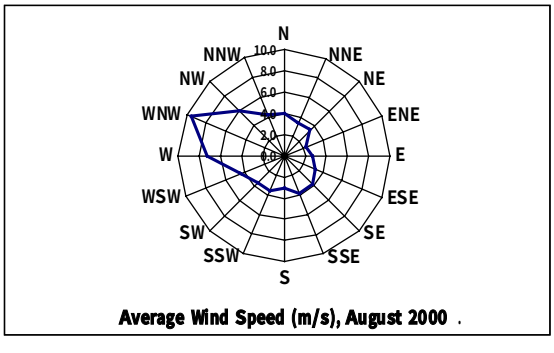
Average Wind Speed (m/s), May 2000 .



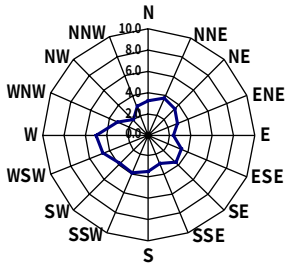
Average Wind Speed (m/s), June 2000 .



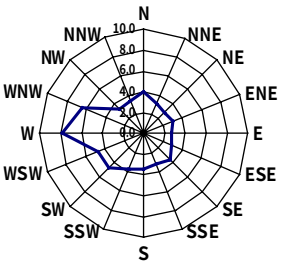
Average Wind Speed (m/s), July 2000 .



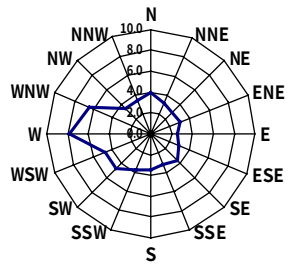
Average Wind Speed (m/s), August 2000 .



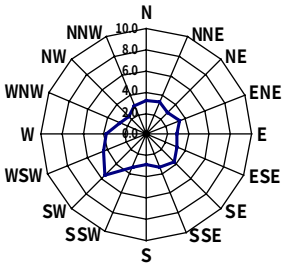
Average Wind Speed (m/s), September 2000



Average Wind Speed (m/s), October 2000

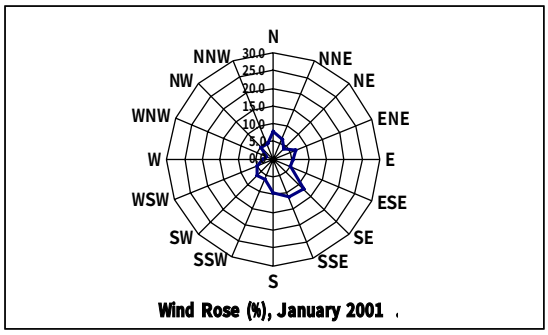


Average Wind Speed (m/s), November 2000 .

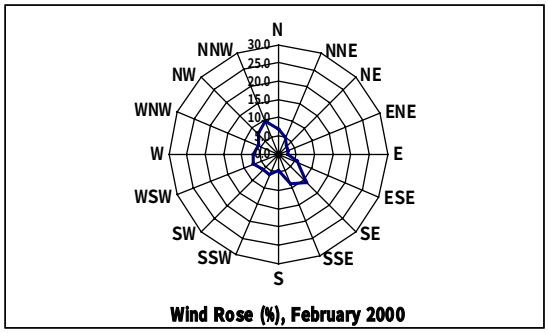


Average Wind Speed (m/s), December 2000 .

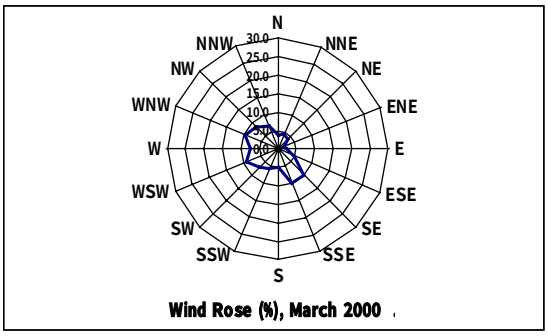
7.2 Frequency Distribution of Wind Direction in Chachacomani, Oruro



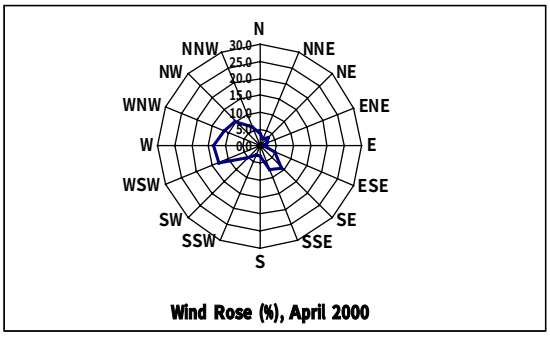
Wind Rose (%), January 2001



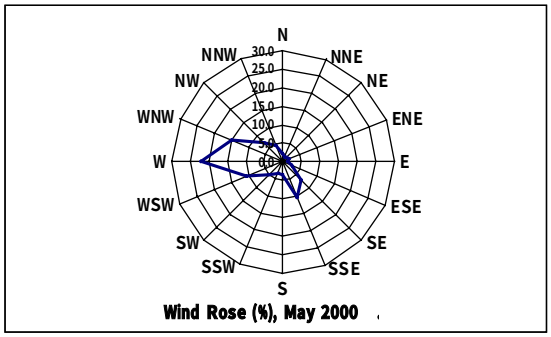
Wind Rose (%), February 2000



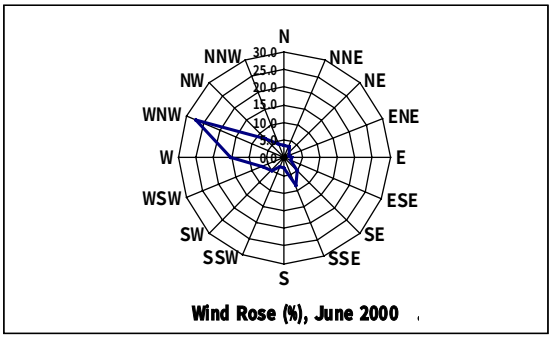
Wind Rose (%), March 2000



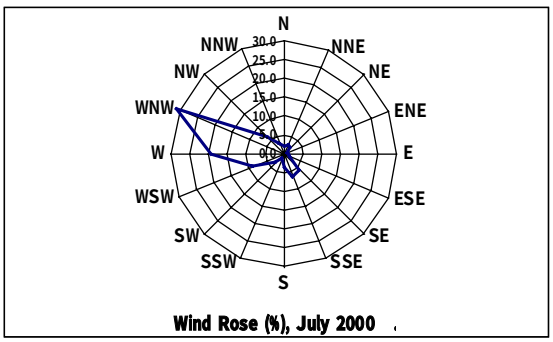
Wind Rose (%), April 2000



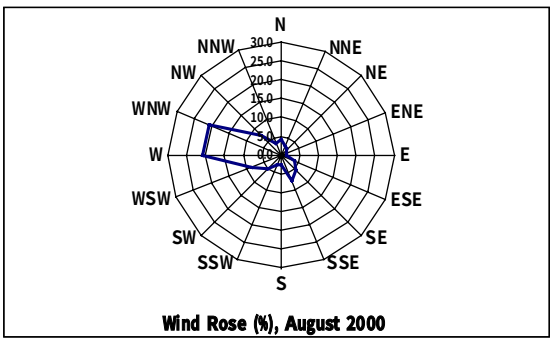
Wind Rose (%), May 2000



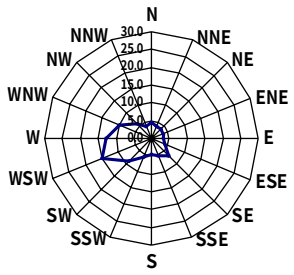
Wind Rose (%), June 2000



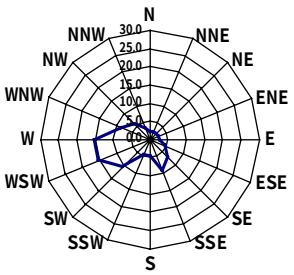
Wind Rose (%), July 2000



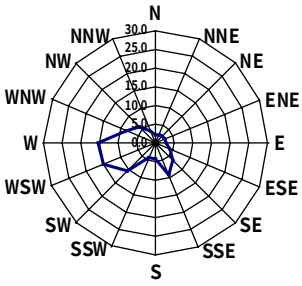
Wind Rose (%), August 2000



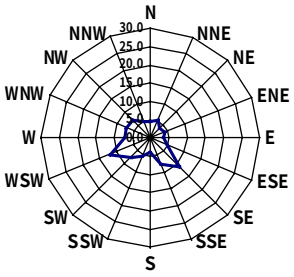
Wind Rose (%), September 2000



Wind Rose (%), October 2000

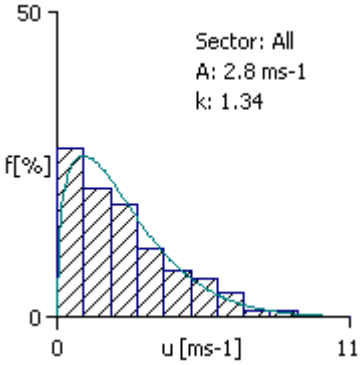


Wind Rose (%) , November 2000

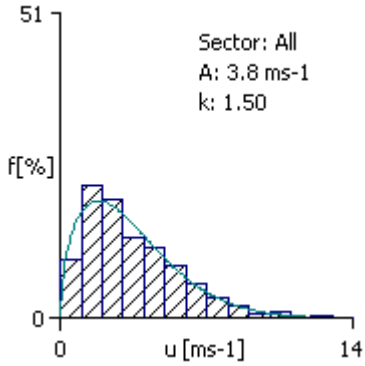


Wind Rose (%), December 2000

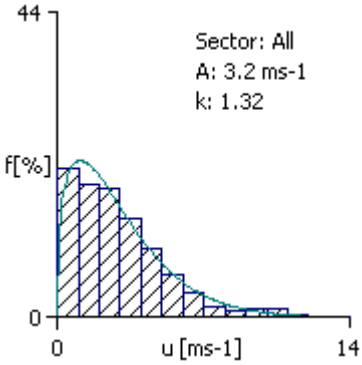
Figure 7.3 Weibull Distribution in Chachacomani, Oruro



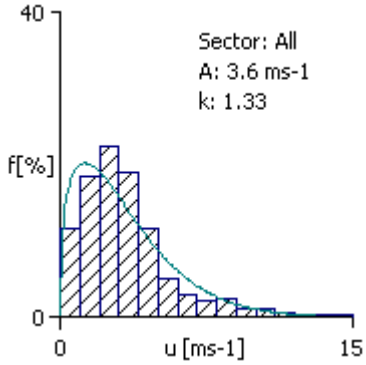
Chachacomani, January 2001



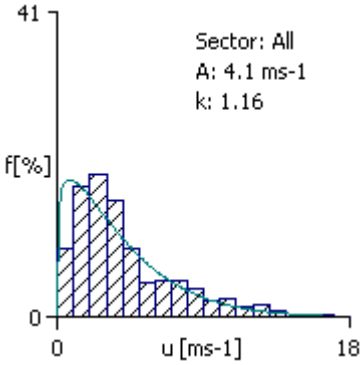
Chachacomani, February 2000



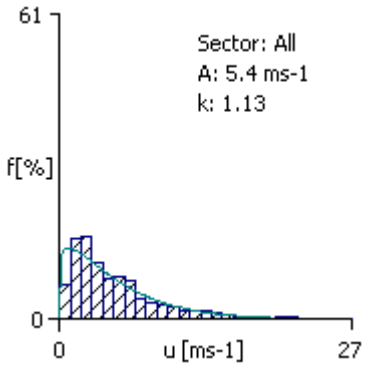
Chachacomani, March 2000



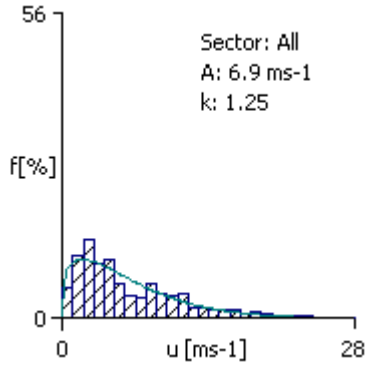
Chachacomani, April 2000



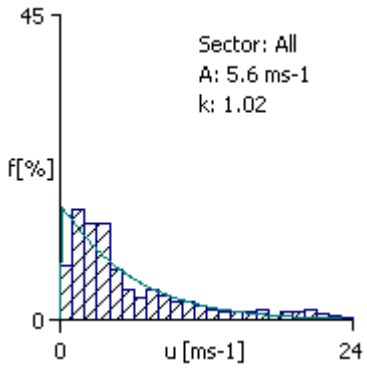
Chachacomani, May 2000



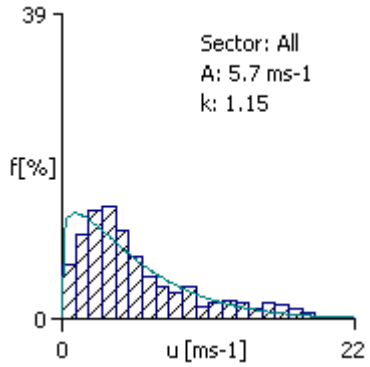
Chachacomani, June 2000



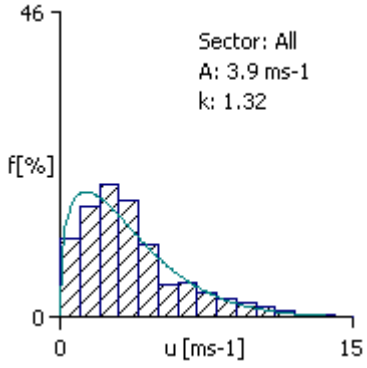
Chachacomani, July 2000



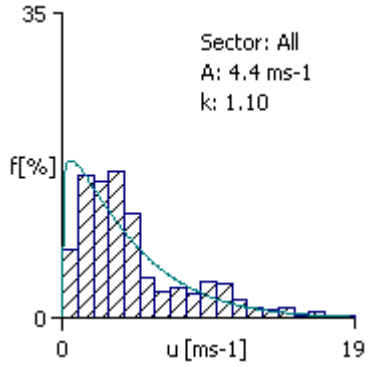
Chachacomani, August 2000



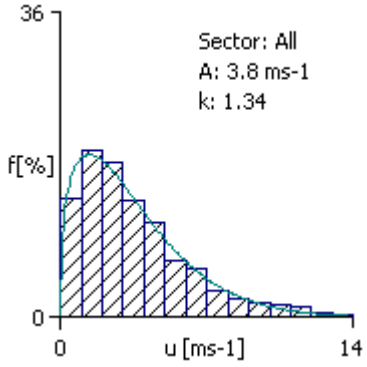
Chachacomani, September 2000



Chachacomani, October 2000

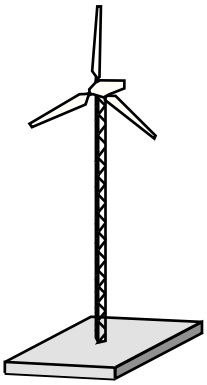


Chachacomani, November 2000



Chachacomani, December 2000

Micro-Hydro Power 3 kW



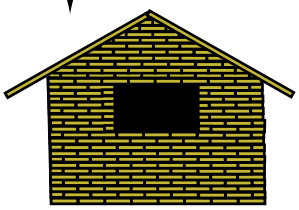
Wind Generator 20 kW

Converter 10 kVA

DC Controller

Inverter 14 kVA

Batery Bank 400 Ah



Demand	
Household	70
Cafe	3
Store	4
School	1
Health Clinic	1
Community Center	1

Figure 7.4
Wind - Micro Hydro System Hybrid System in Chachacomani, Oruro Department

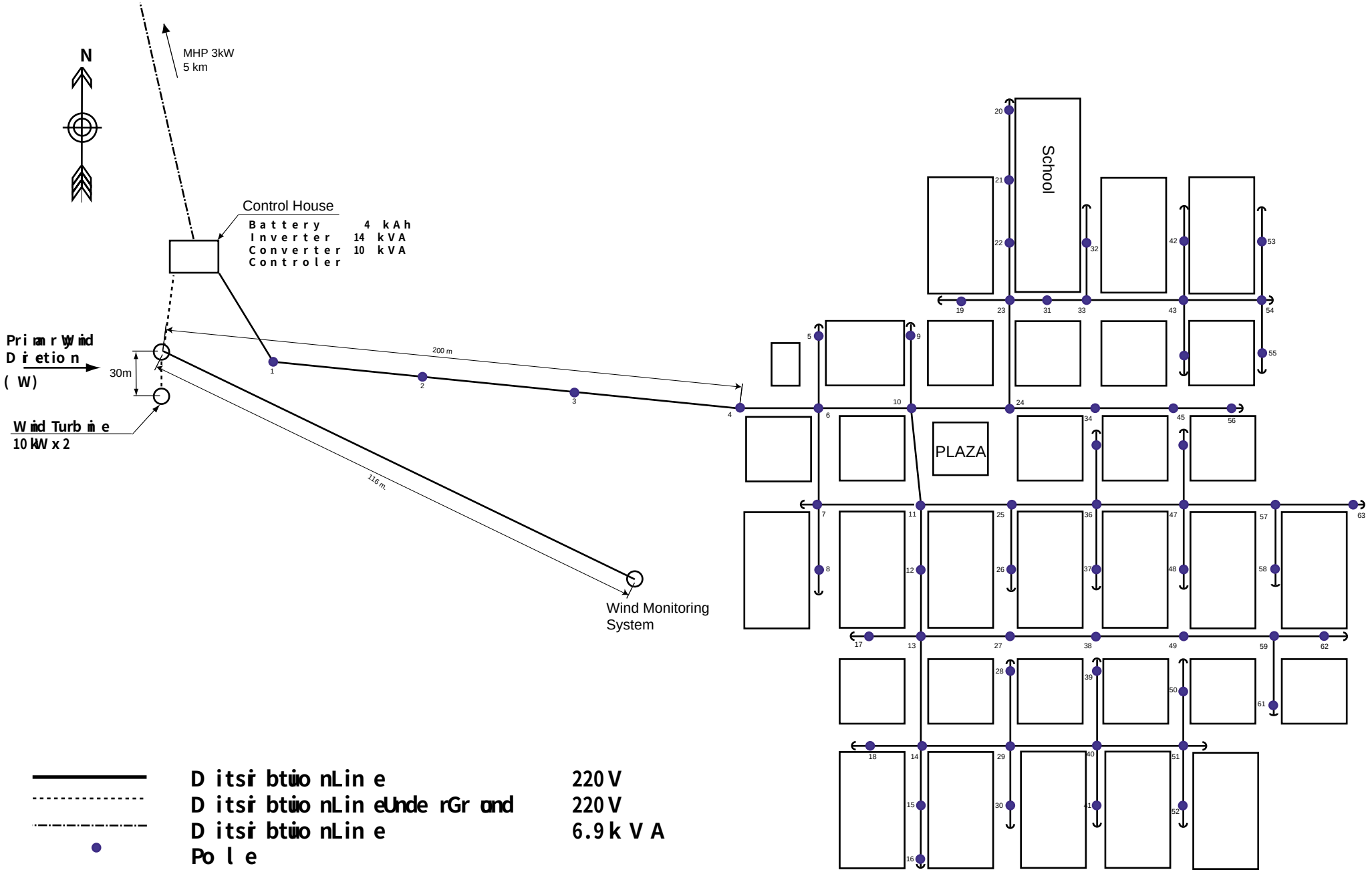
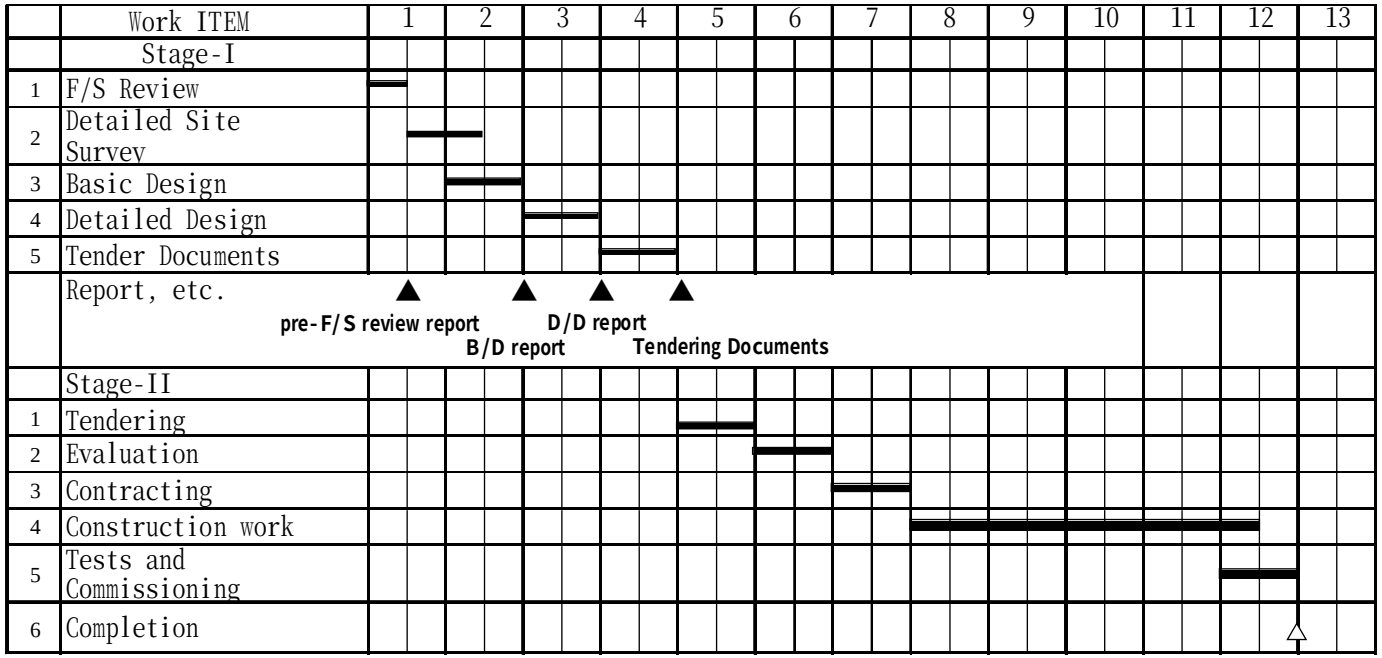


Figure 7.5
Installation Map of Wind / Micro Hydro Hybrid Generation System in Cchacoma in, Cuzco Department

Figure 7.6 Construction Schedule of Chachacomani Wind Power Project



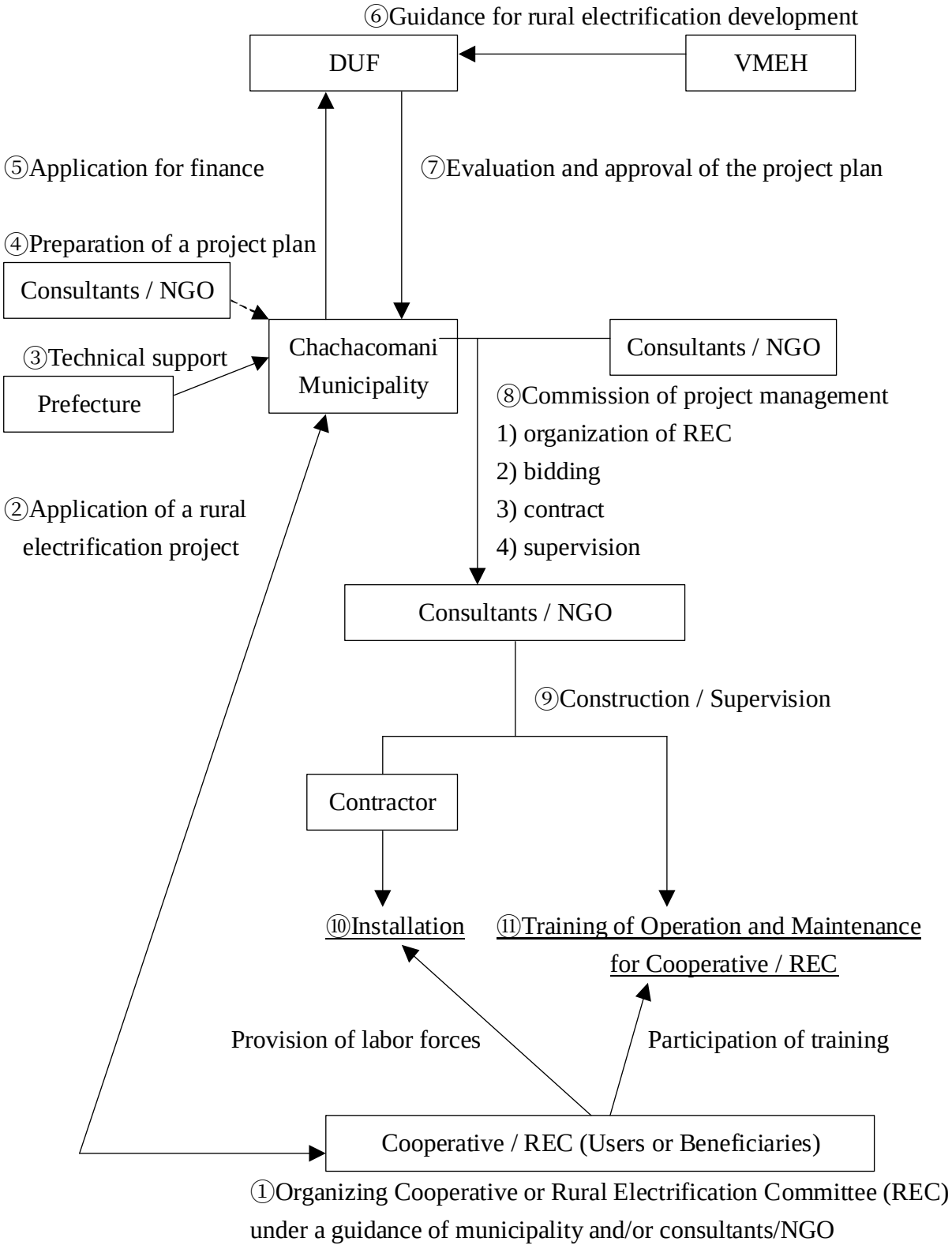


Figure 7.7 Proposed Project Implementation for Chachacomani Wind Power Project

Source: JICA Study Team