Tabla 6.2 **Demanda Mensual de Energía en 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

Tabla 6.3 **Distribución / Frecuencia Mensual de la Velocidad de Viento, Caripe**

	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

Tabla 6.4 **Energía de la Densidad Mensual, Caripe**

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

Tabla 6.5 **Intensidad de la Turbulencia, Caripe**

	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

Tabla 6.4 Energía de la Densidad Mensual, Caripe

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

Tabla 6.5 Intensidad de la Turbulencia, Caripe

	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

Tabla 6.6 Costo de Construcción para Proyecto de Energía Eólica en Caripe

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.

Tabla 7.1 Condición Socio-economica de 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

Tabla 7.2 **Demanda Mensual de Energía en 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

Tabla 7.3 **Distribución / Frecuencia Mensual de la Velocidad de Viento, Chachacomani**

	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

Tabla 7.4 **Energía de la Densidad Mensual, Chachacomani**

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

Tabla 7.5 **Intensidad de la Turbulencia, Chachacomani**

	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

Tabla 7.4 Energía de la Densidad Mensual, Chachacomani

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

Tabla 7.5 Intensidad de la Turbulencia, Chachacomani

	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

Tabla 7.6 **Costo de Construcción para Proyecto de Energía Eólica en Chachacomani**

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.

Tabla 8.1 Tasa Economica Interna de Retorno para Proyecto de Energia Eolica en 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,	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%

Tabla 8.2 Tasa Economica Interna de Retorno para Proyecto de Energia Eolica en 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, e	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

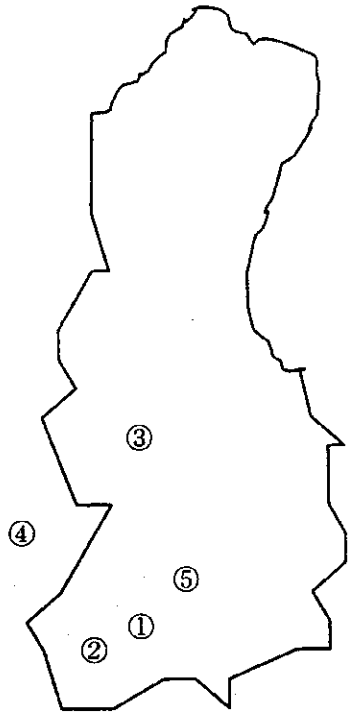
EIRR	1.0%

Tabla 8.3 Tasa Economica Interna de Retorno para Proyecto de Energia Eolica en 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, e	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

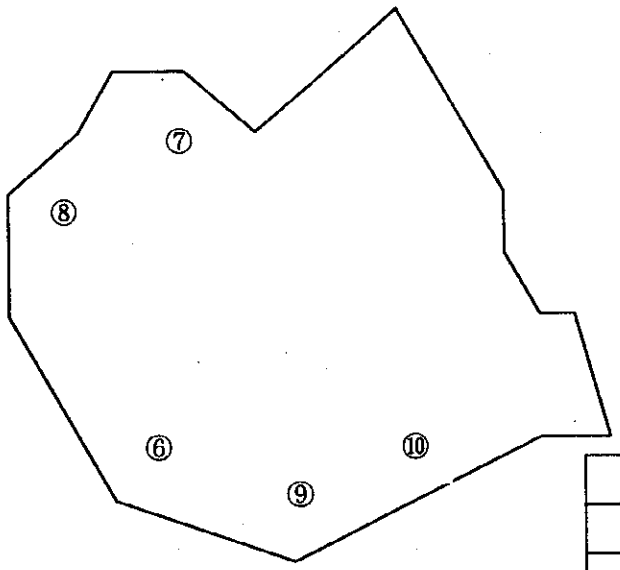
EIRR	-0.9%

FIGURAS



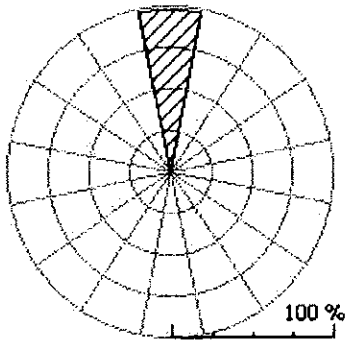
ID. No.	Site Name
1	Achiri
2	Charana
3	Ramon Gonzales
4	Isla Taquiri
5	SanTiago de Llallagua

Figura 3.1 Sitio para el Sistema Monitoreo de Viento en La Paz

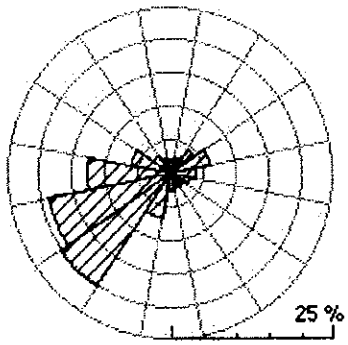


ID. No.	Site Name
6	Comjo / Coipasa
7	Caripe
8	Chachacomani
9	Salinas de Garci Mendosa
10	Sevaruyo

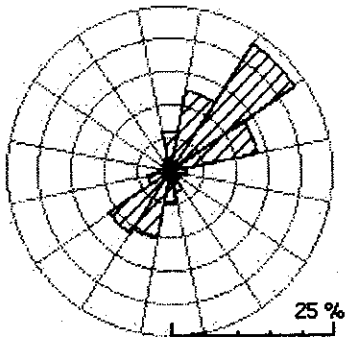
Figura 3.2 Sitio para el Sistema Monitoreo de Viento en Ouro



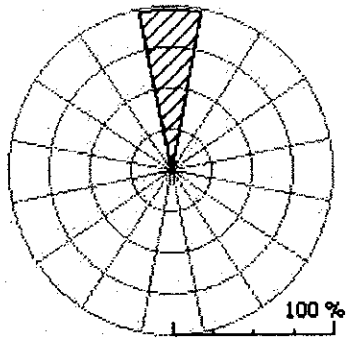
01 Achiri



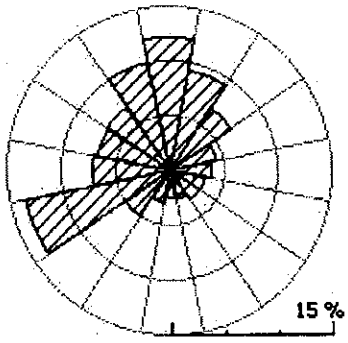
02 Charana



03 Ramon Gonzales

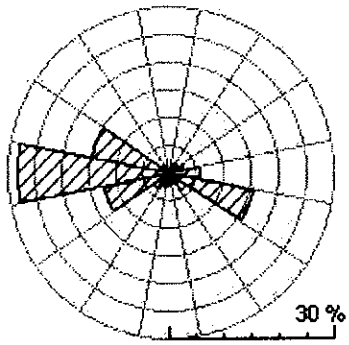


04 Isla Taquiri

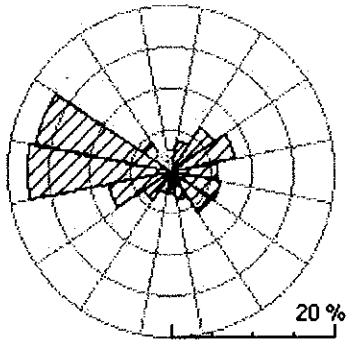


05 Santiago de Llallagua

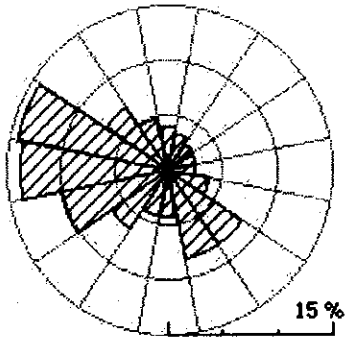
Figura 3.3
Dirección del Viento (20m), La Paz
feburero 2000 a enero 2001



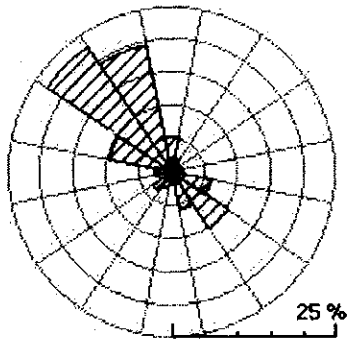
06 Between Comjo and Coipasa



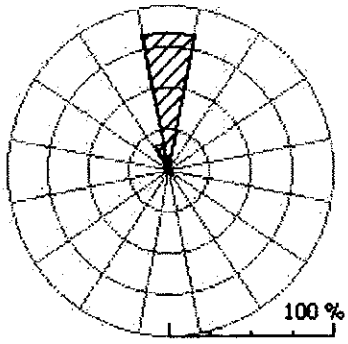
07 Caripe



08 Chachacomani

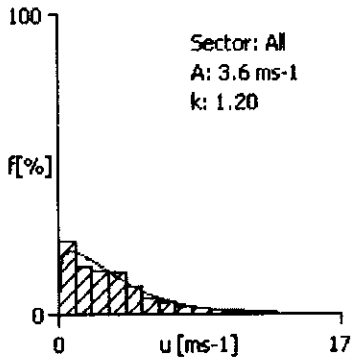


09 Salinas

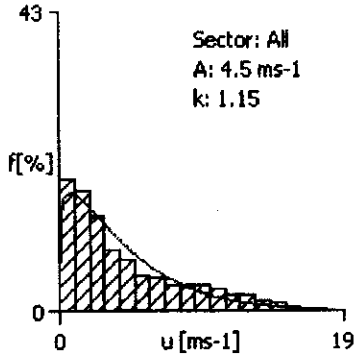


10 Sevaruyo

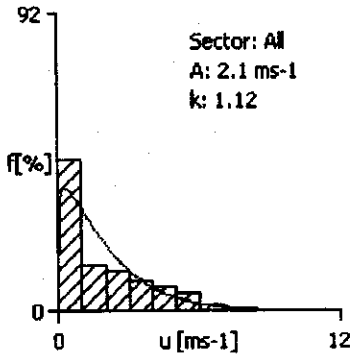
Figura 3.4
Dirección del Viento (20m), Oruro
feburero 2000 a enero 2001



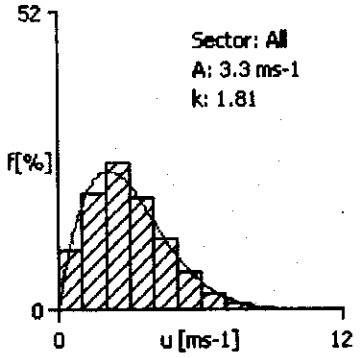
01 Achiri



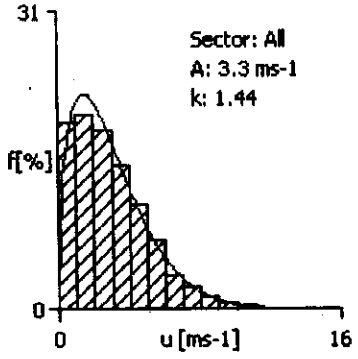
02 Charana



03 Ramon Gonzales

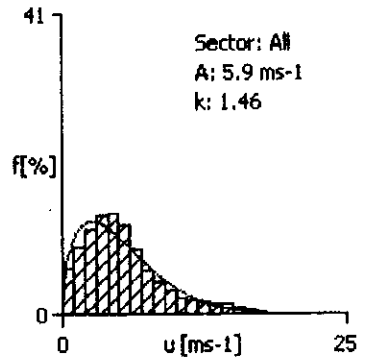


04 Isla Taquiri

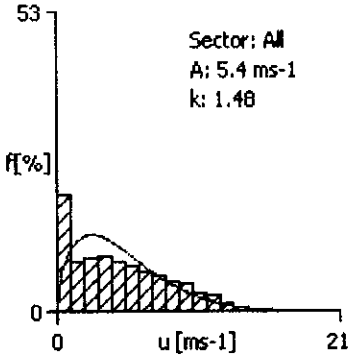


05 Santiago de Llallagua

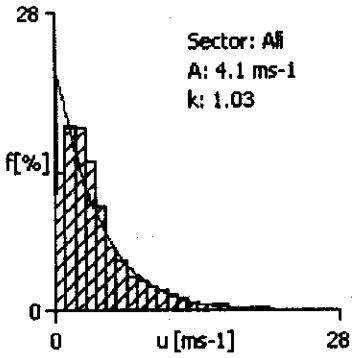
Figura 3.5
Dirección del Viento (20m), La Paz
feburero 2000 a enero 2001



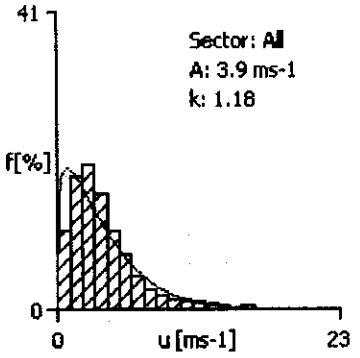
06 Between Comjo and Coipasa



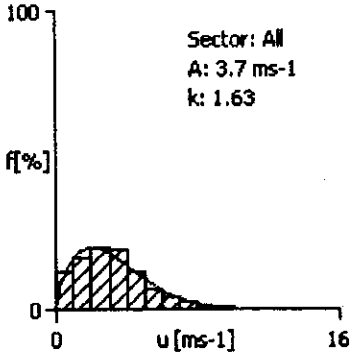
07 Caripe



08 Chachacomani

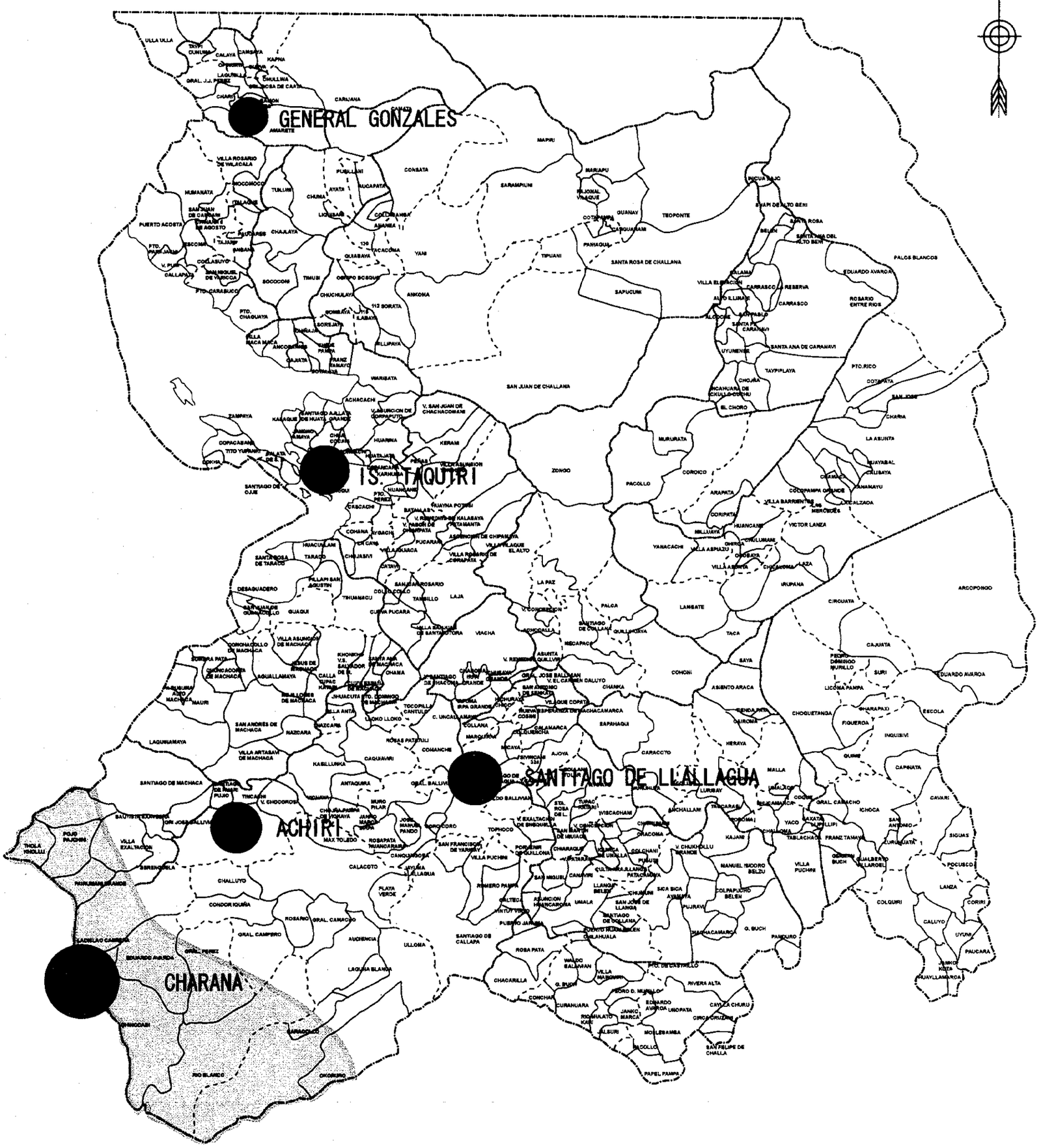


09 Salinas



10 Sevaruyo

Figura 3.6
Frequencia de la Velocidad del Viento (20m), Oruro (feburero 2000 a enero 2001)



LEGEND

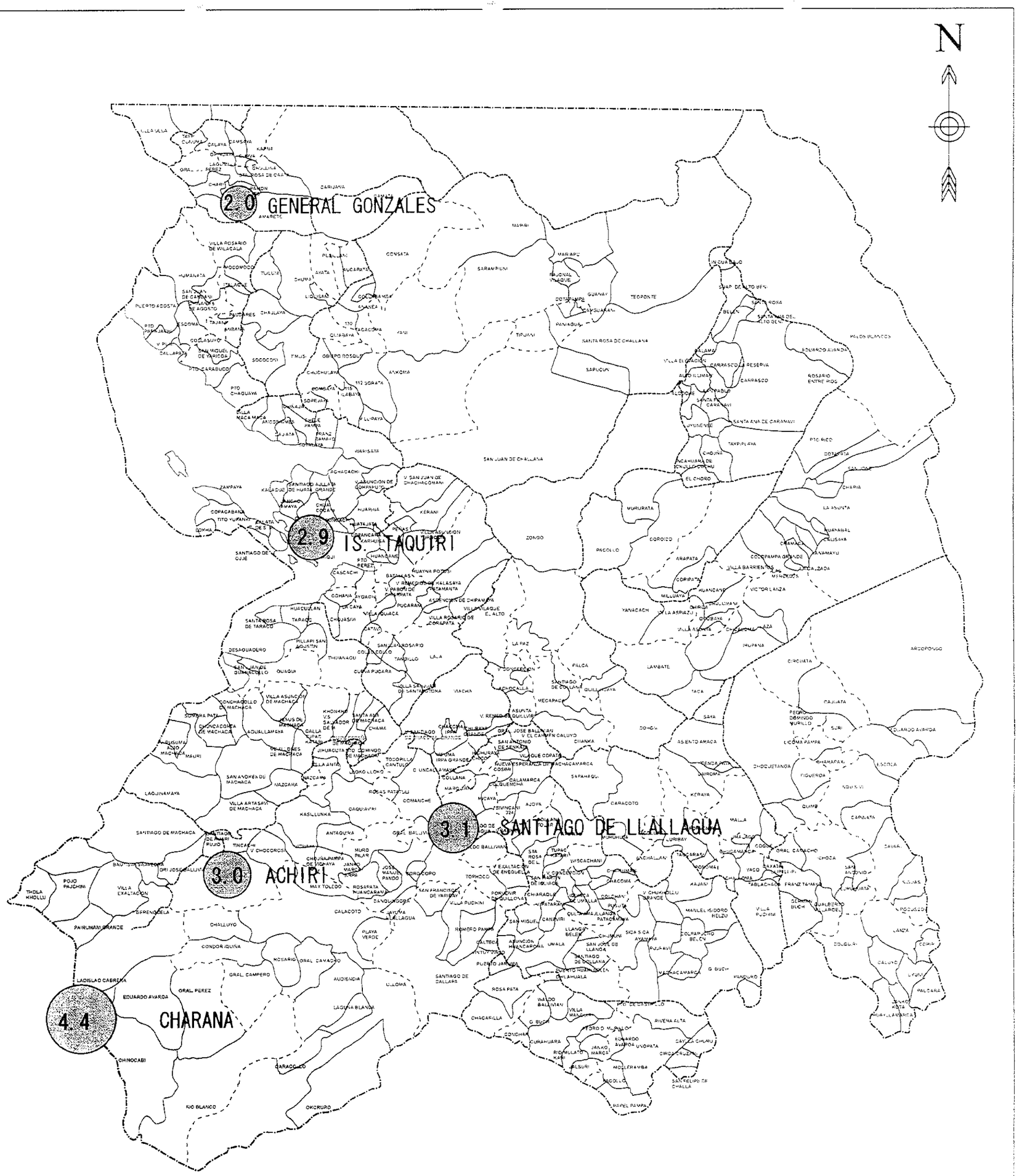
4.5 Annual Average Wind Speed (m/s)
20 meters above ground level

> 4.0 m/s (High Potential Area)

0 20 40 60 80 100

Figura 4.1 Mapa de Energia Eolica Potencial La Paz

JICA Study Team



LEGEND

4.5 Annual Average Wind Speed (m/s)
20 meters above ground level

> 4.0 m/s (High Potential Area)

0 20 40 60 80 100

Figura 4.1 Mapa de Energia Eolica Potencial La Paz

JICA Study Team

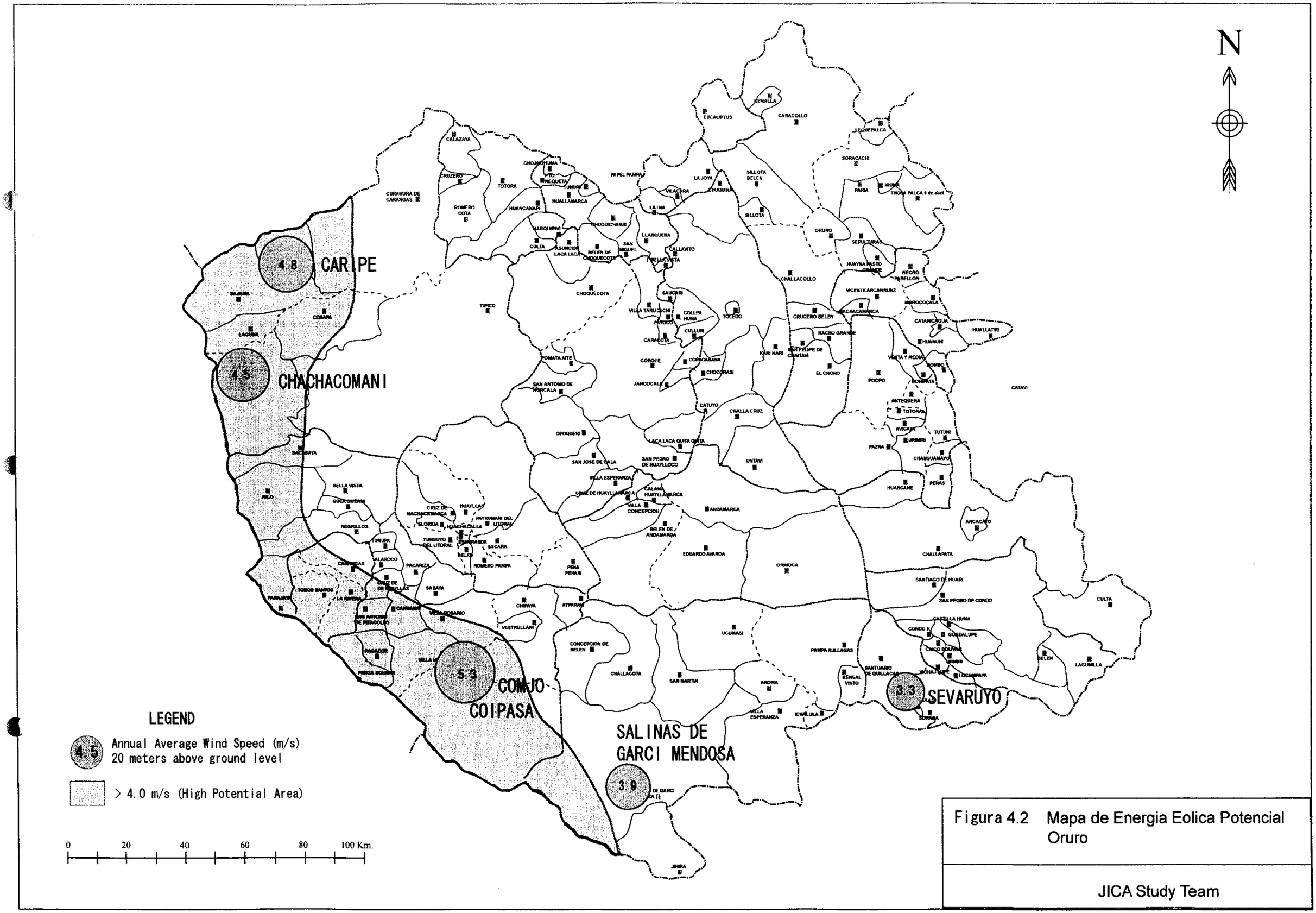
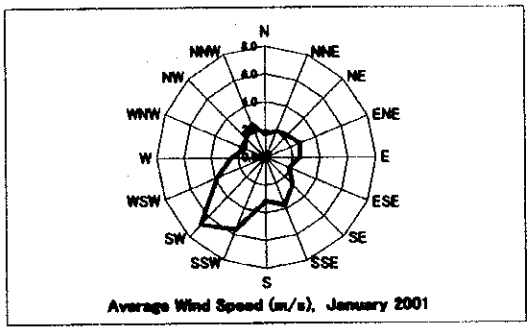
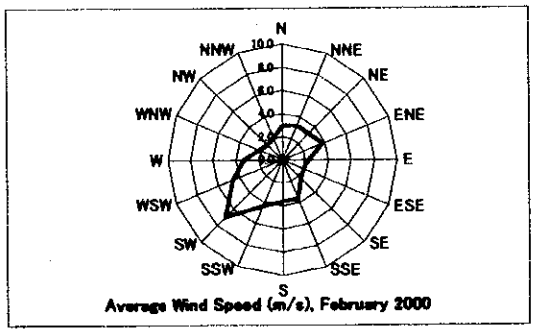


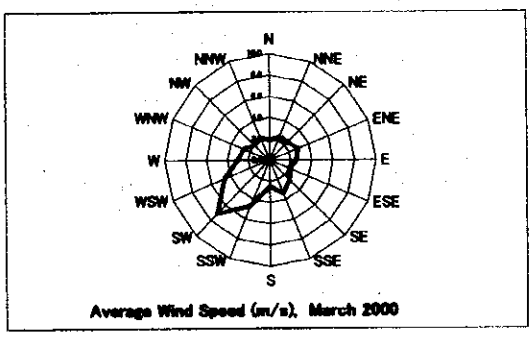
Figura 4.2 Mapa de Energia Eolica Potencial Oruro

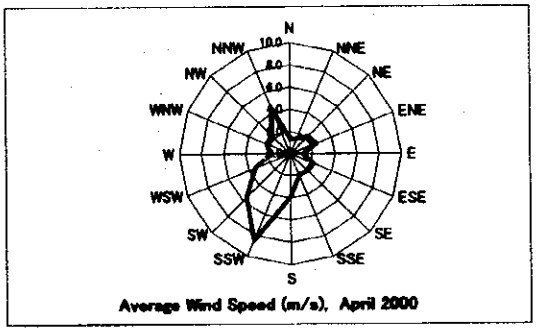
JICA Study Team

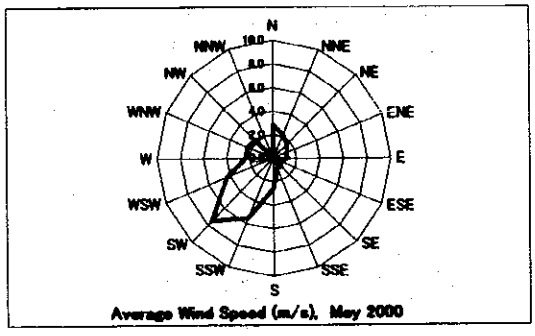
Figura 5.1 Velocidad de Viento Direccional (m/s) en Charana, La Paz

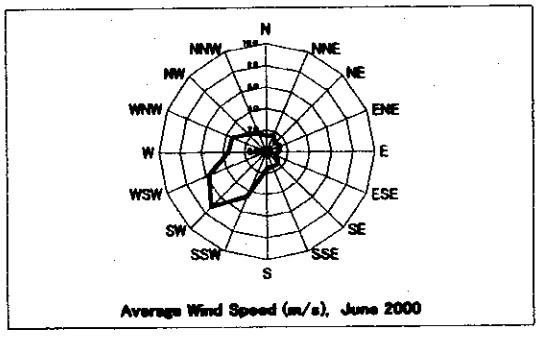


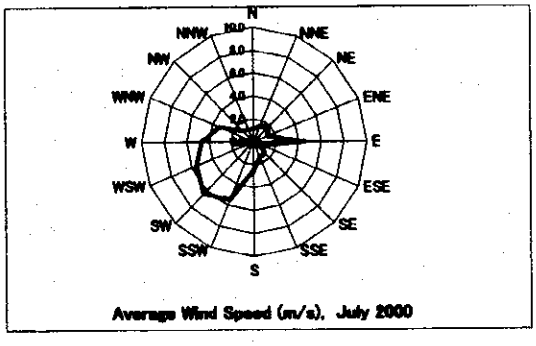


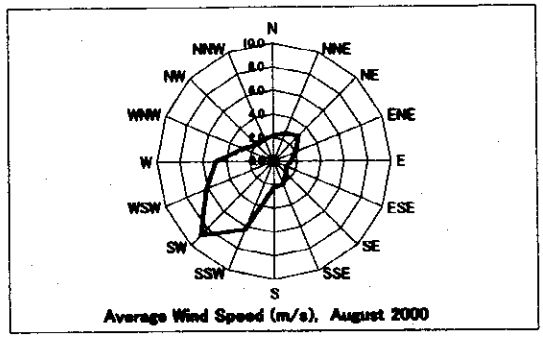


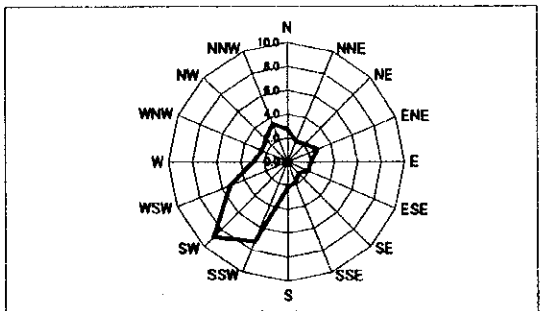




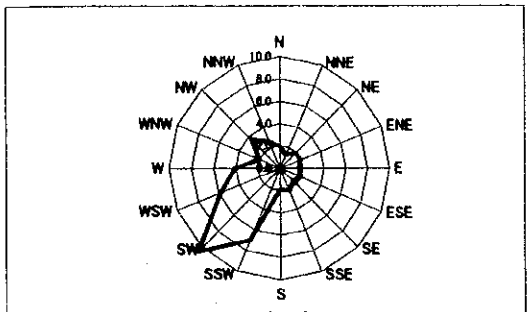




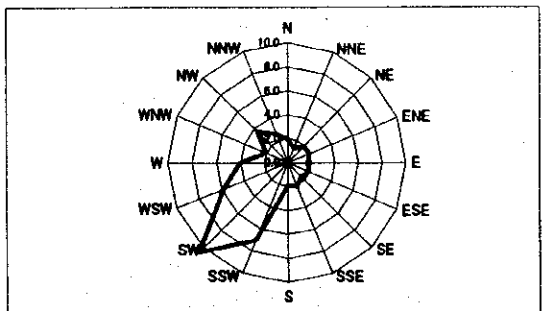




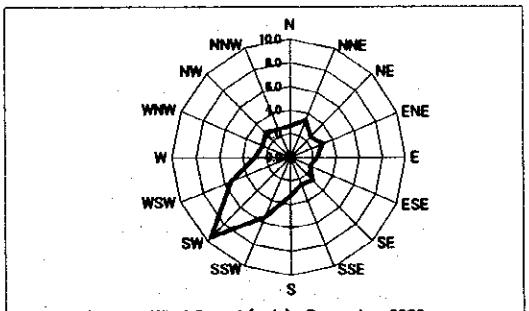
Average Wind Speed (m/s), September 2000



Average Wind Speed (m/s), October 2000

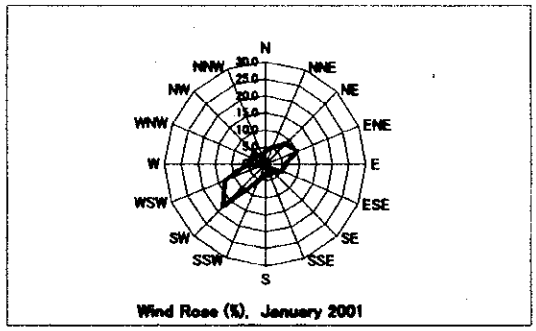


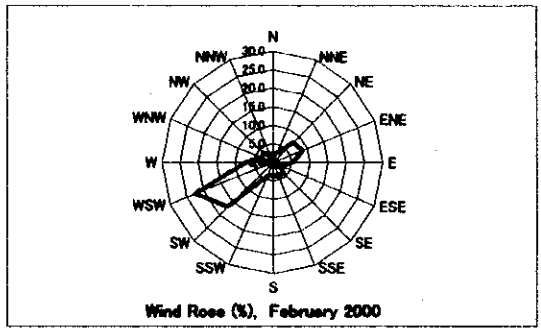
Average Wind Speed (m/s), November 2000

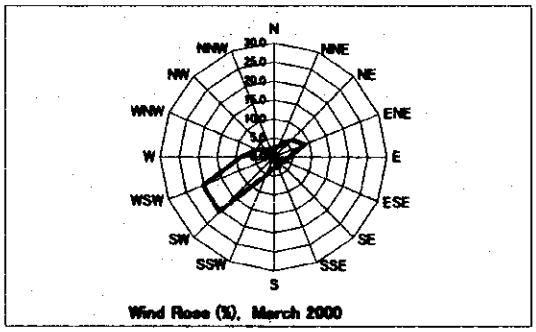


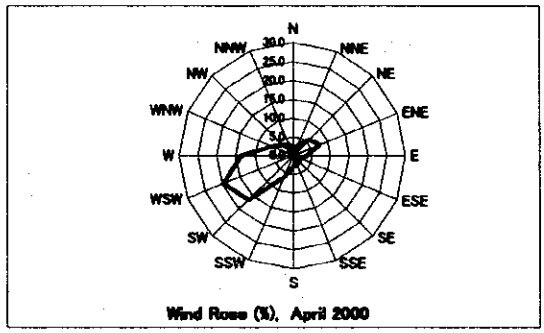
Average Wind Speed (m/s), December 2000

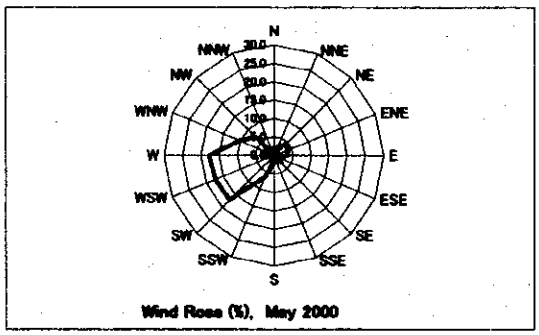
Figura 5.2 Distrbución Direccional y Frequencia Mensual de la Velocidad de Viento en Charaña La Paz

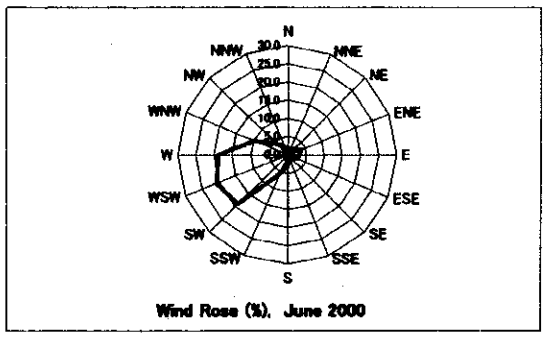


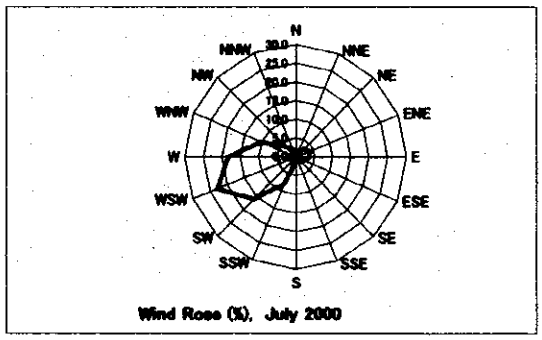


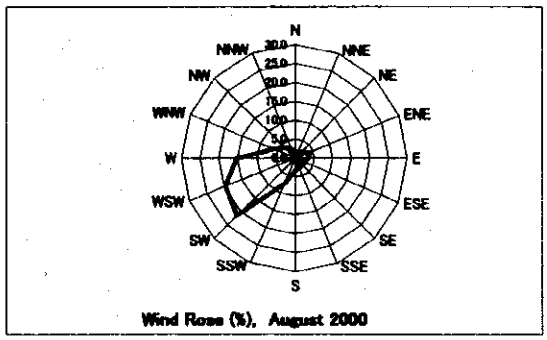


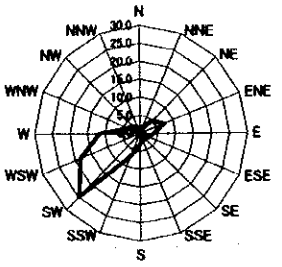




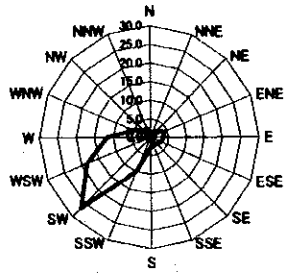




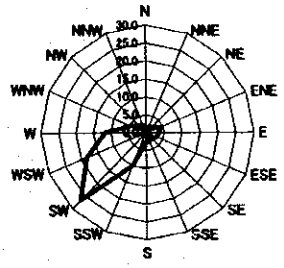




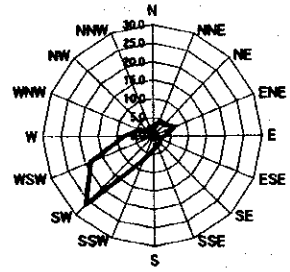
Wind Rose (%), September 2000



Wind Rose (%), October 2000

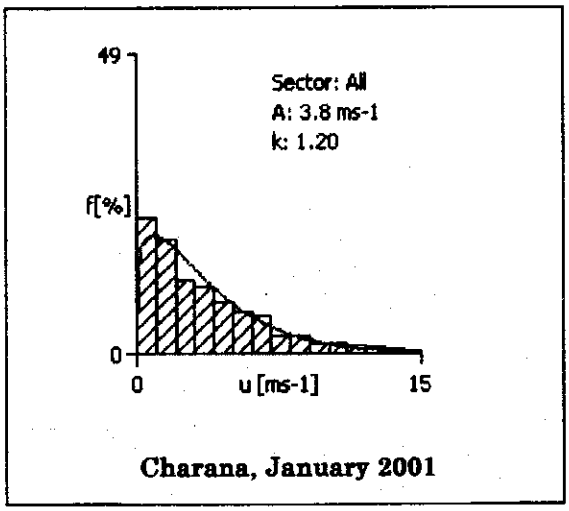


Wind Rose (%), November 2000

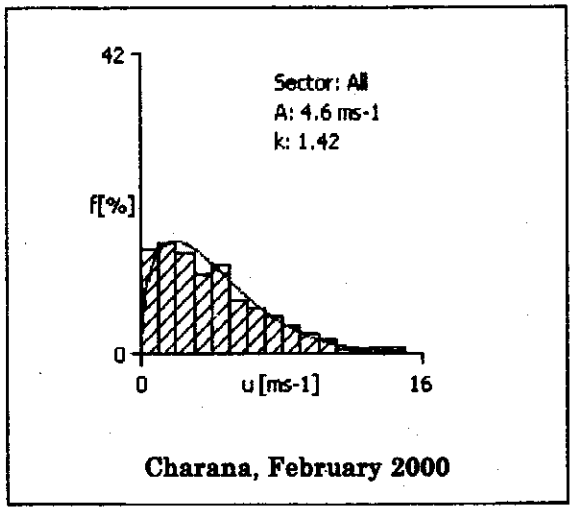


Wind Rose (%), December 2000

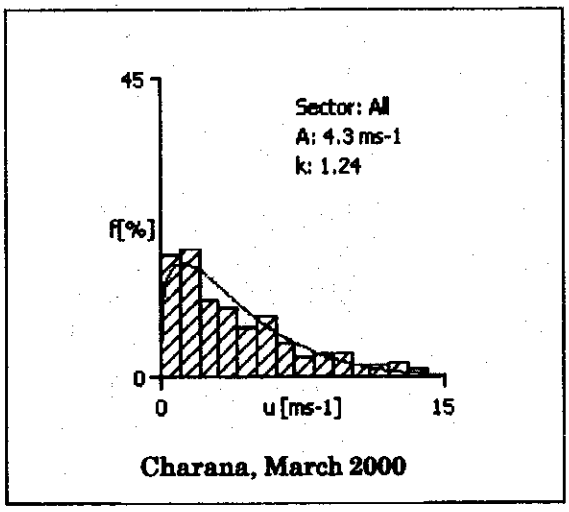
Figura 5.3 **Distribución de Weibull en Charaña, La Paz**



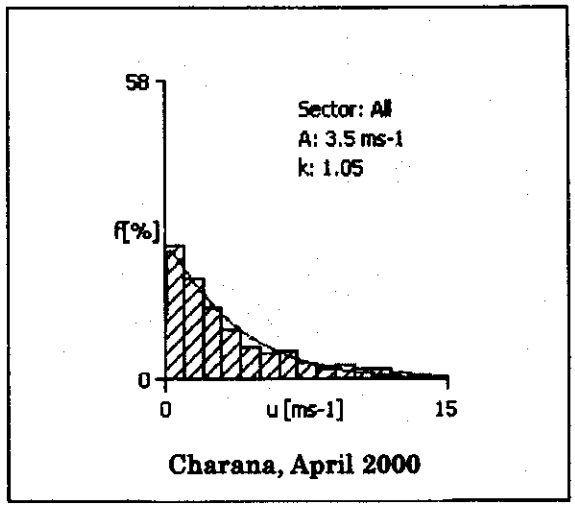
Charana, January 2001



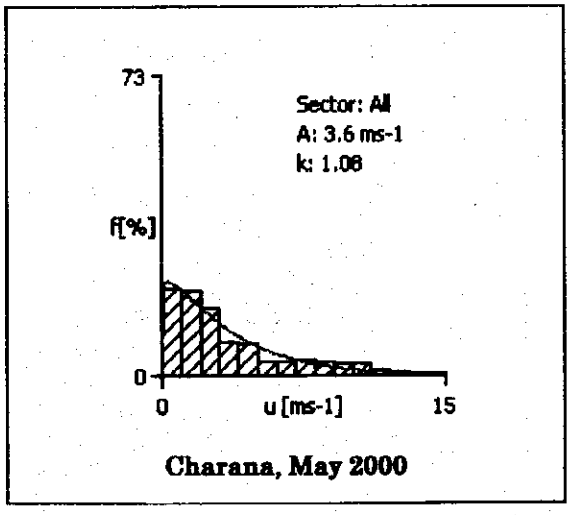
Charana, February 2000



Charana, March 2000



Charana, April 2000



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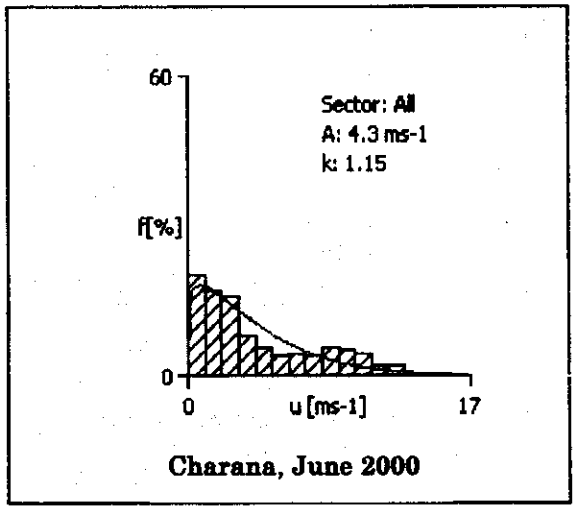
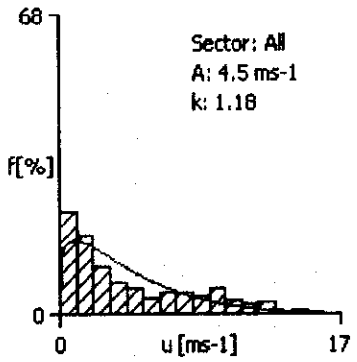
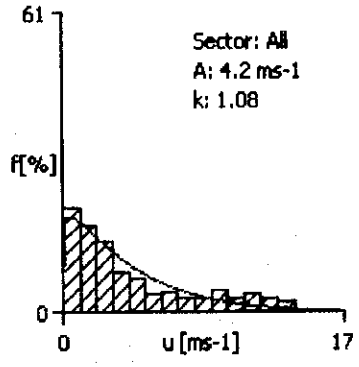


Charana, June 2000



Charana, July 2000



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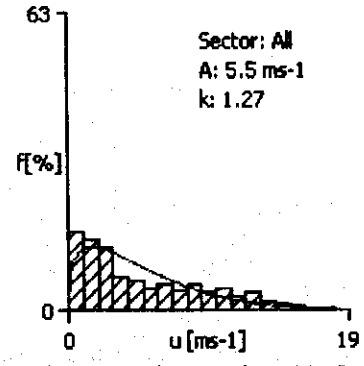
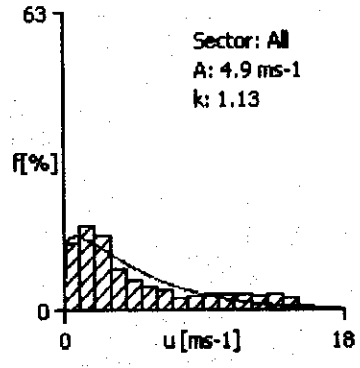
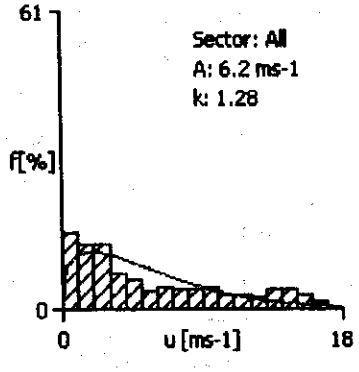


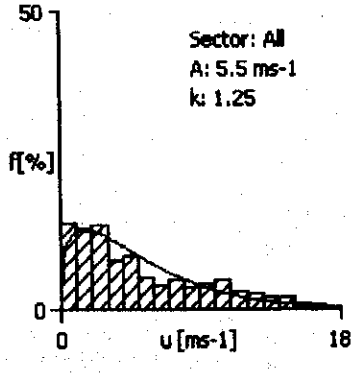
Charana, September 2000



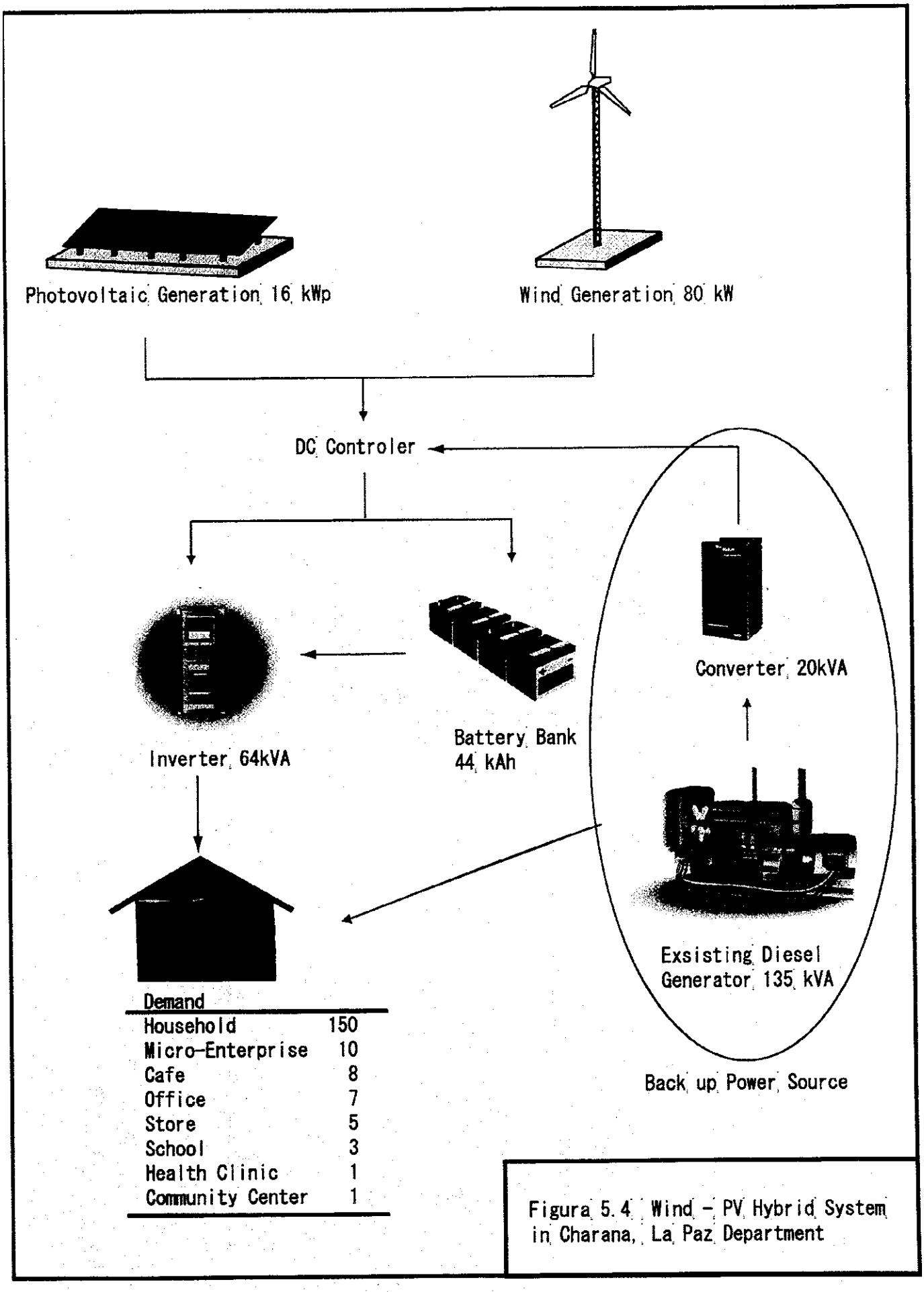
Charana, October 2000



Charana, November 2000



Charana, December 2000



Demand	
Household	150
Micro-Enterprise	10
Cafe	8
Office	7
Store	5
School	3
Health Clinic	1
Community Center	1

Figura 5.4 Wind - PV Hybrid System in Charana, La Paz Department

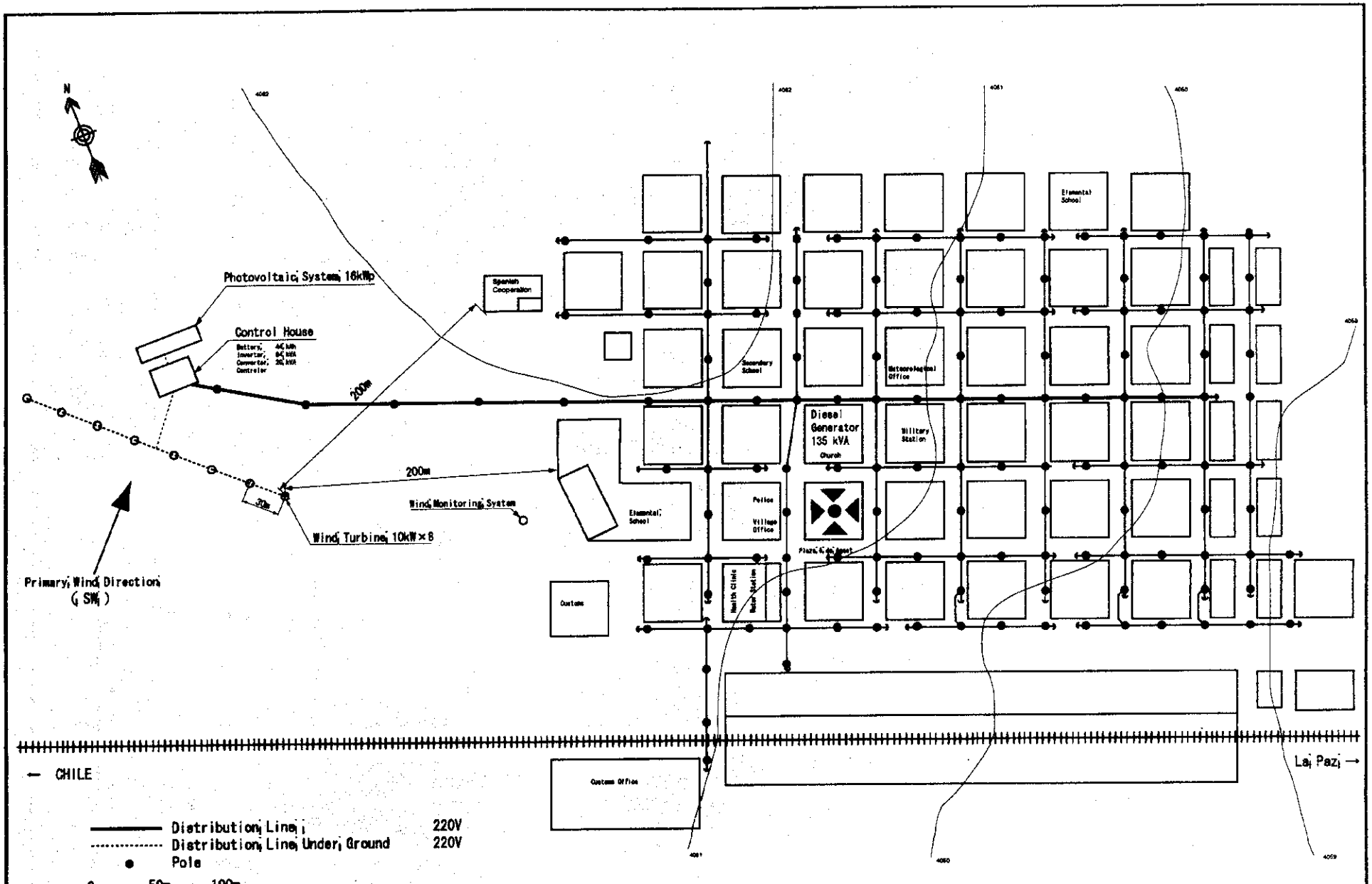
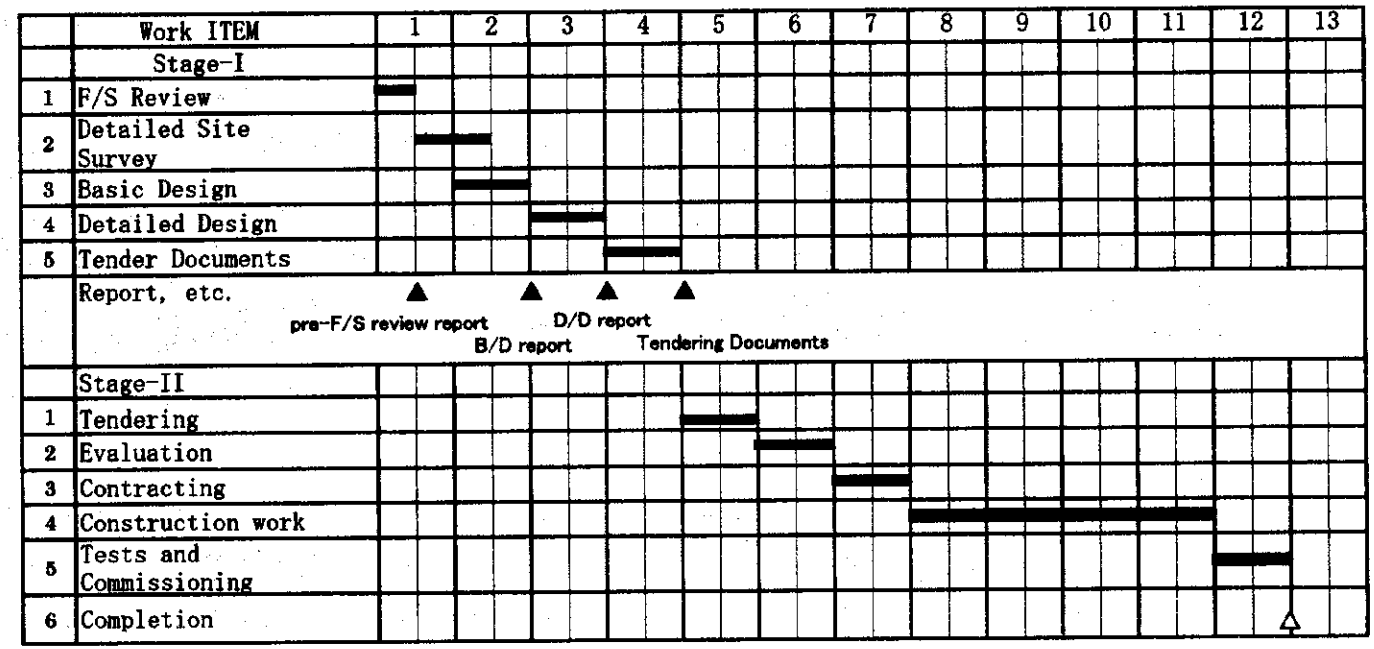


Figura 5.5
Installation Map of Wind-PV Hybrid Generation System in Charana, La Paz Department

Figura 5.6 **Calendario de Construcción para Proyecto de Energía Eólica en Charaña**



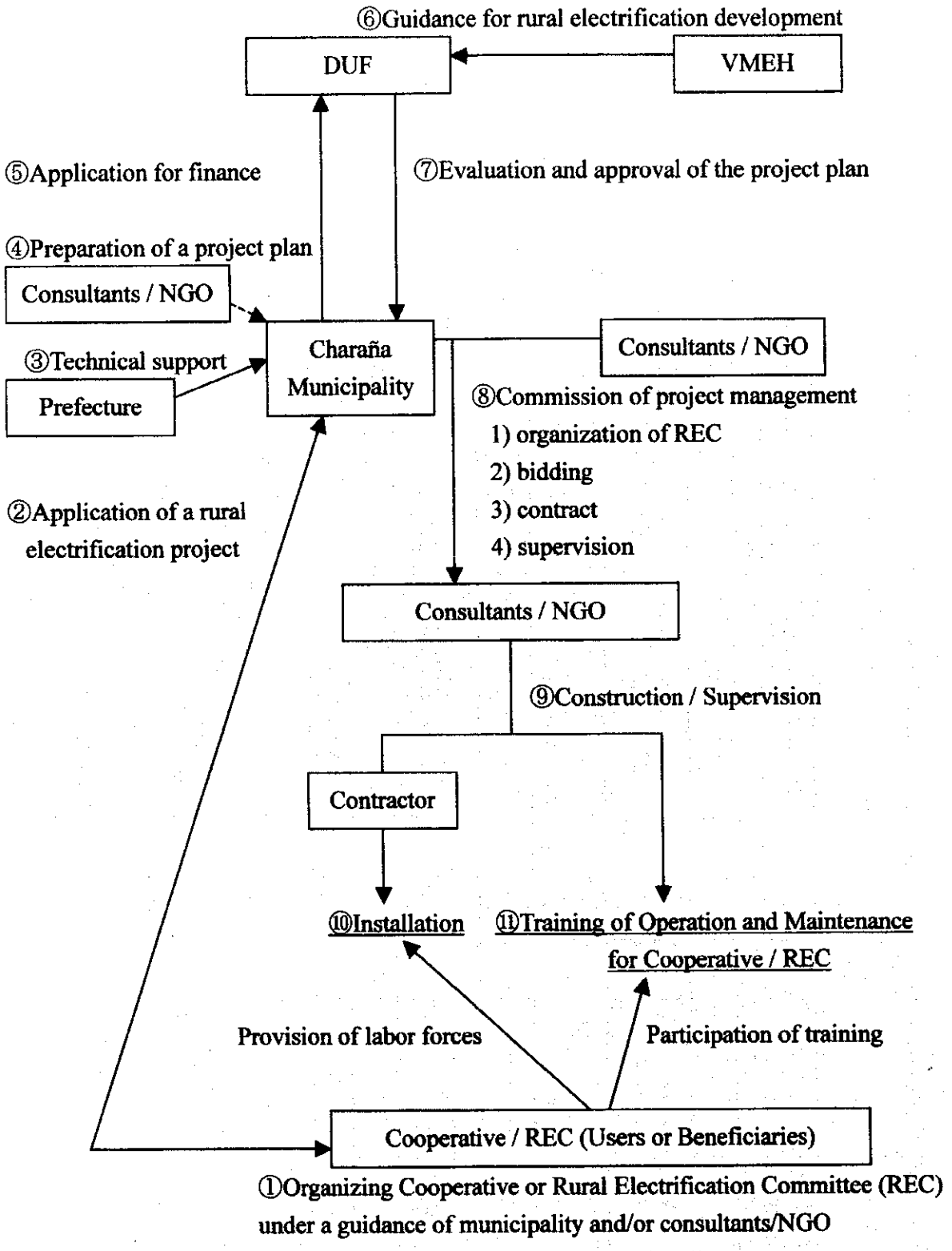
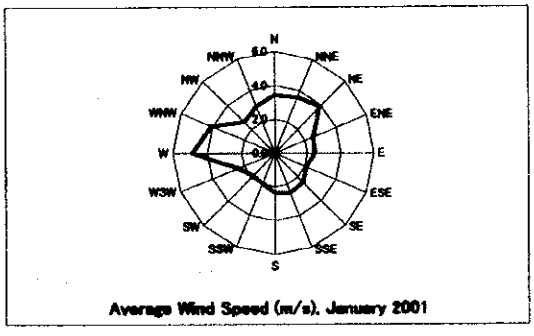


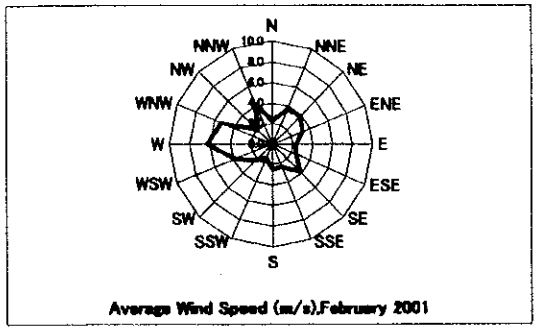
Figura 5.7 Implementación del Proyecto para Proyecto de Energía Eólica en Charaña

Fuente: JICA Study Team

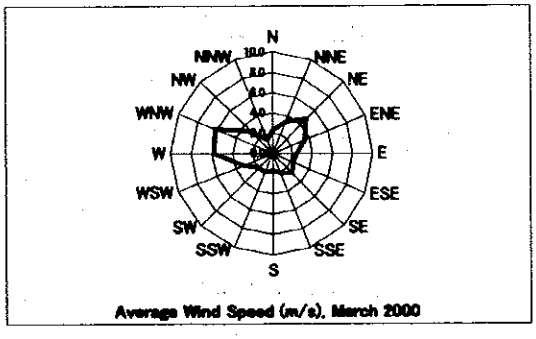
Figura 6.1 **Velocidad de Viento Direccional (m/s) en Caripe, Oruro**



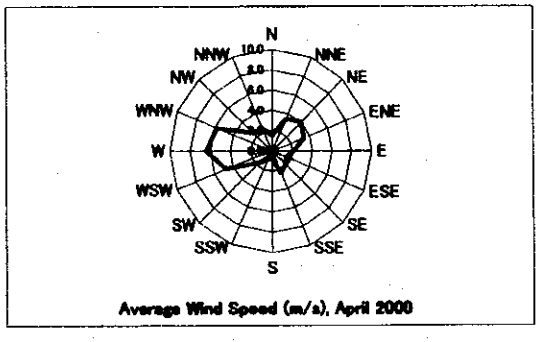
Average Wind Speed (m/s), January 2001



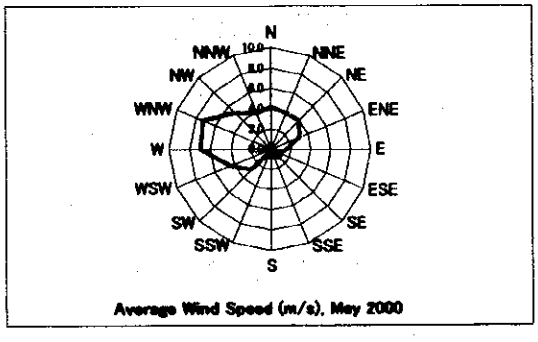
Average Wind Speed (m/s),February 2001



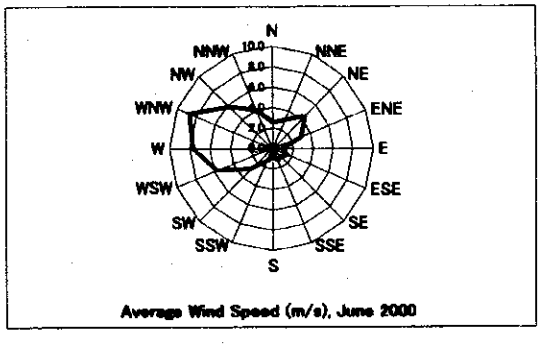
Average Wind Speed (m/s), March 2000



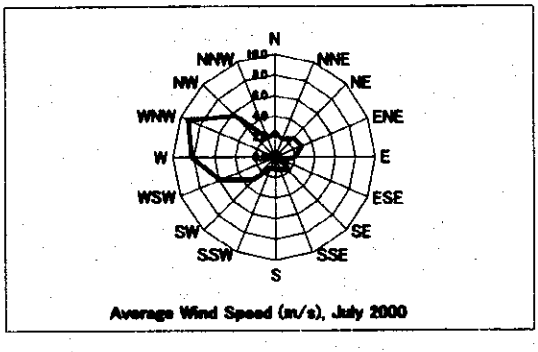
Average Wind Speed (m/s), April 2000



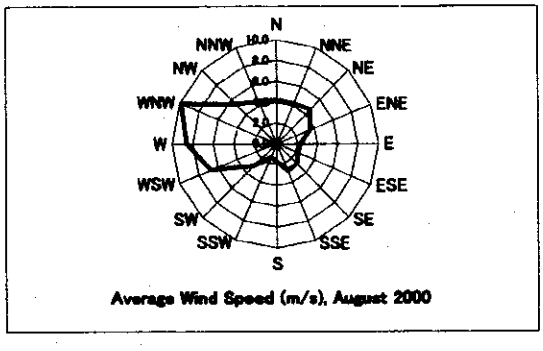
Average Wind Speed (m/s), May 2000



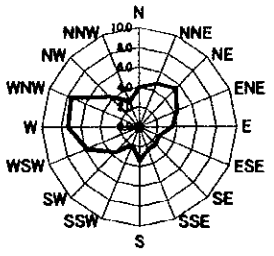
Average Wind Speed (m/s), June 2000



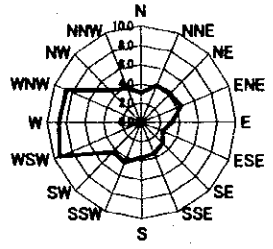
Average Wind Speed (m/s), July 2000



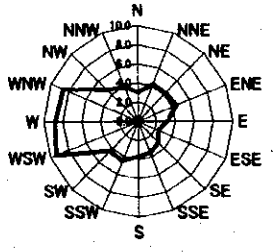
Average Wind Speed (m/s), August 2000



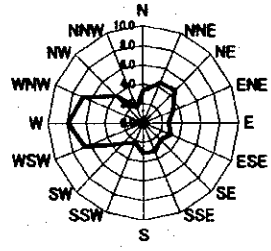
Average Wind Speed (m/s) September 2000



Average Wind Speed (m/s) October 2000

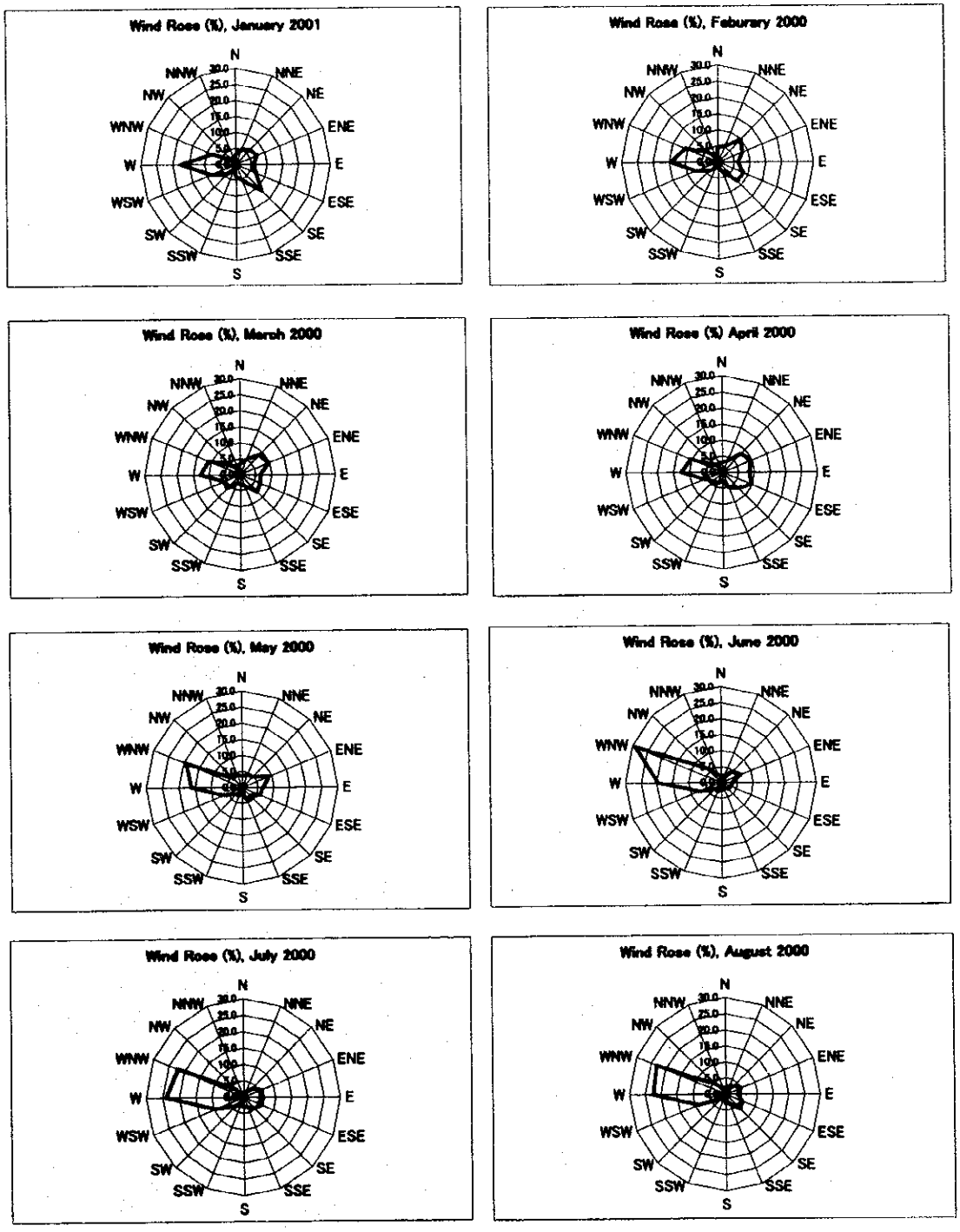


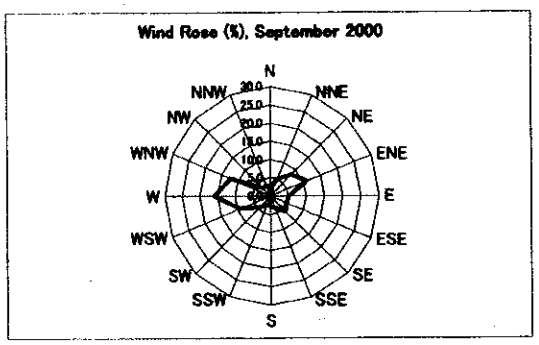
Average Wind Speed (m/s) November 2000

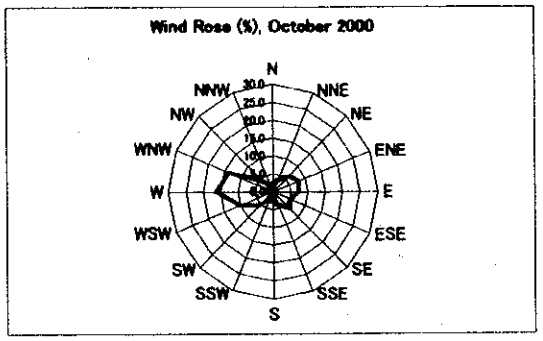


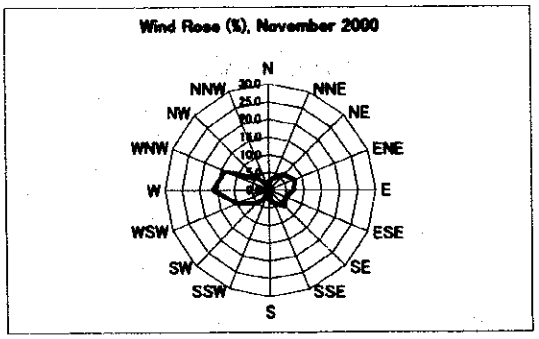
Average Wind Speed (m/s) December 2000

Figura 6.2 Distrbución Direccional y Frequencia Mensual de la Velocidad de Viento en 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
20.0
15.0
10.0
5.0
0.0

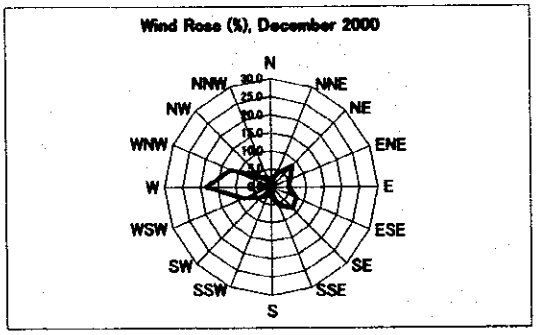
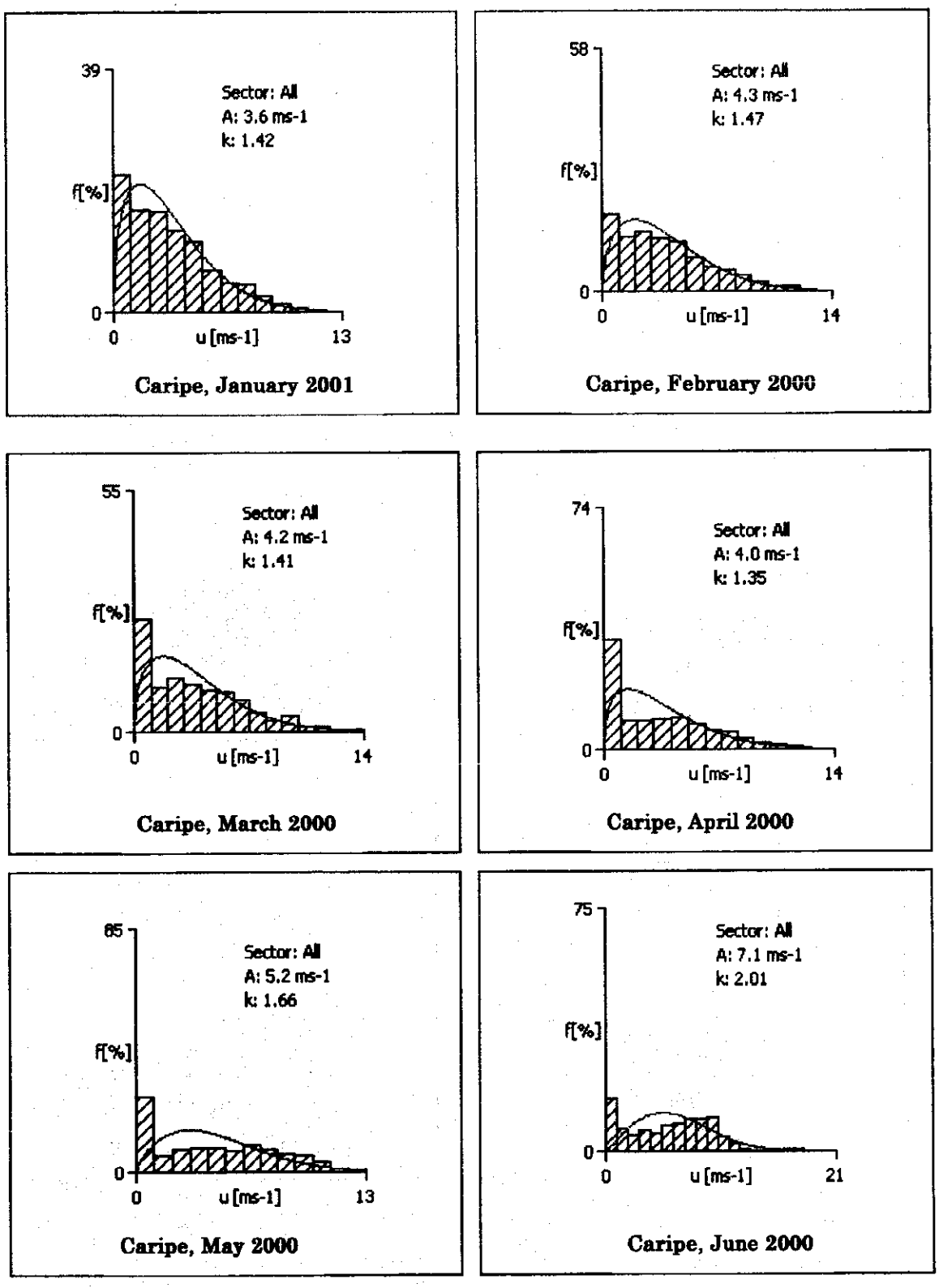
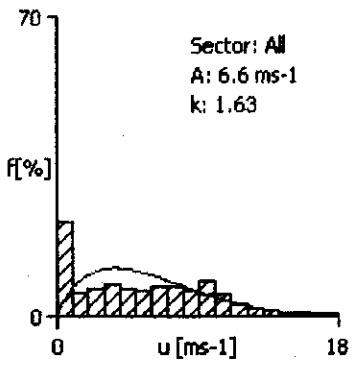
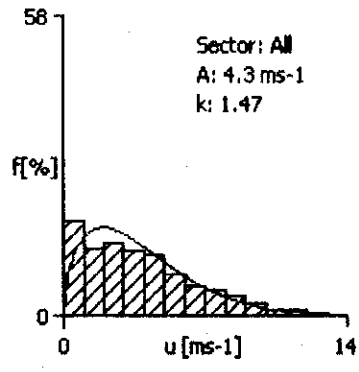

Wind Rose (%), December 2000
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30.0
25.0
20.0
15.0
10.0
5.0
0.0

Figura 6.3 **Distribution de Weibull en Caripe, Oruro**

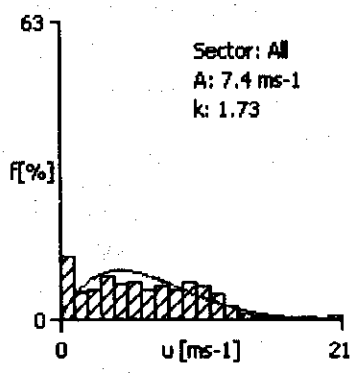




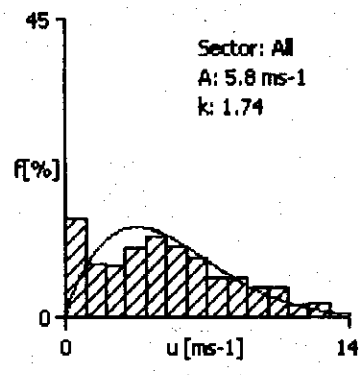
Caripe, July 2000



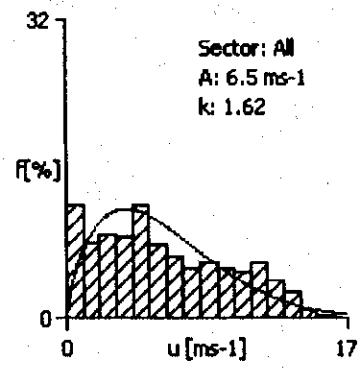
Caripe, August 2000



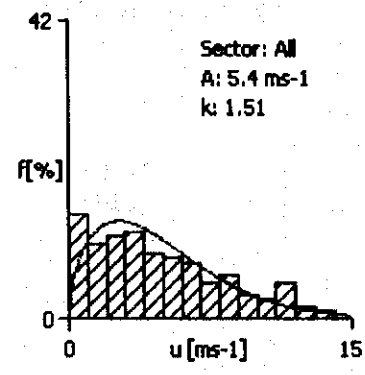
Caripe, September 2000



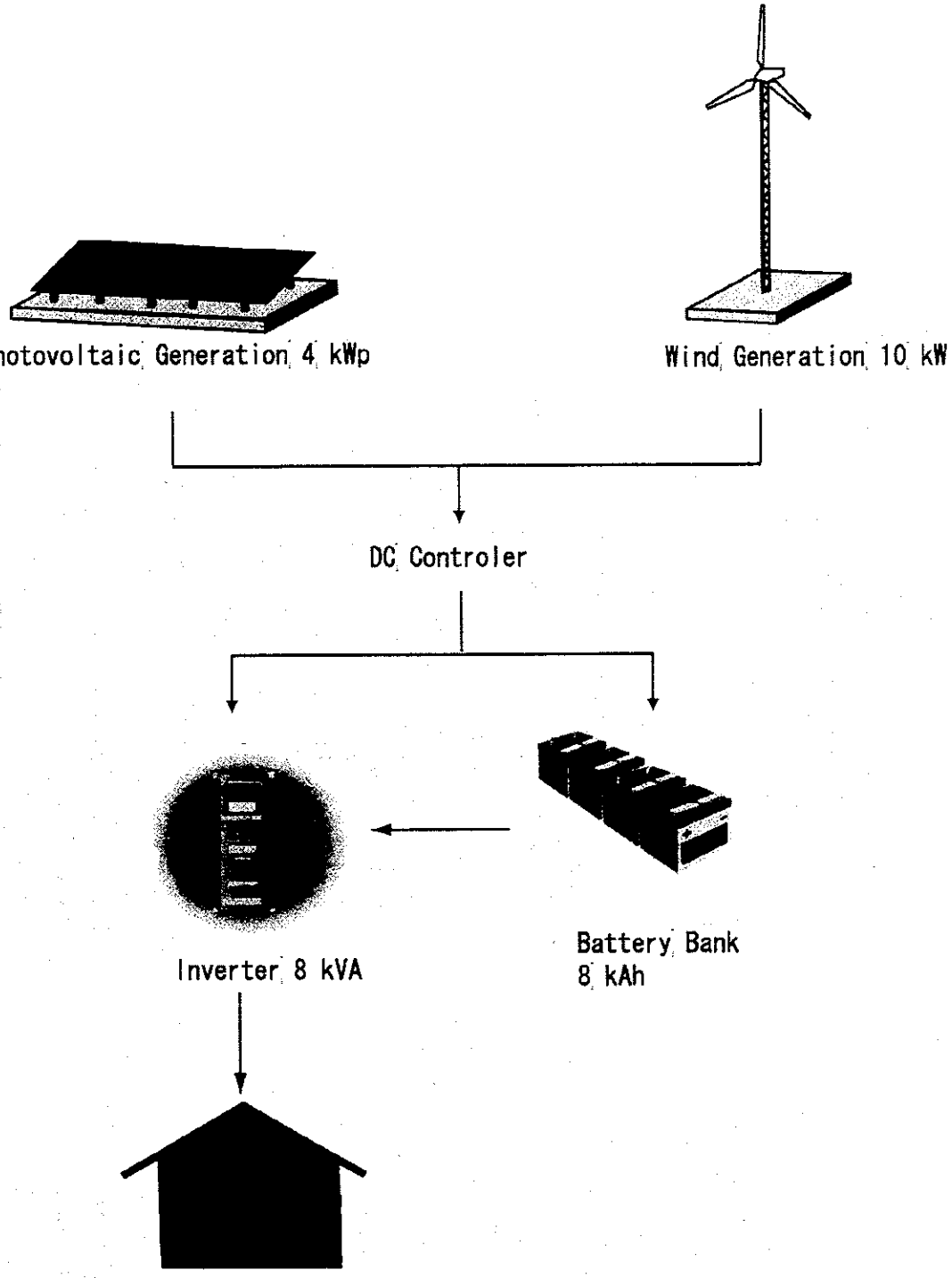
Caripe, October 2000



Caripe, November 2000



Caripe, December 2000



Demand	
Household	30
Cafe	3
Store	2
School	1
Health Clinic	1
Community Center	1

Figura 6.4
Wind - PV Hybrid System
in Caripe, Oruro Department

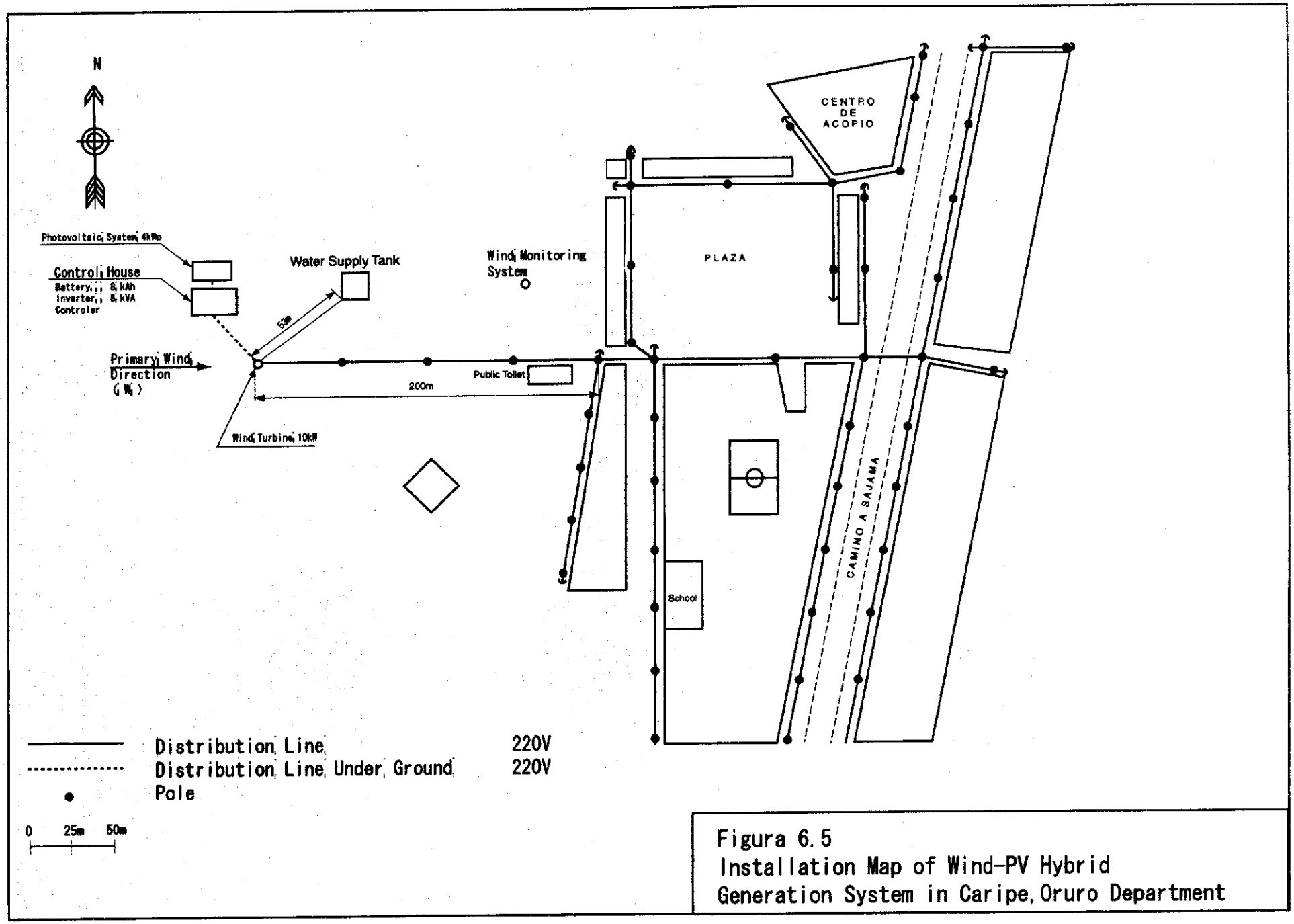
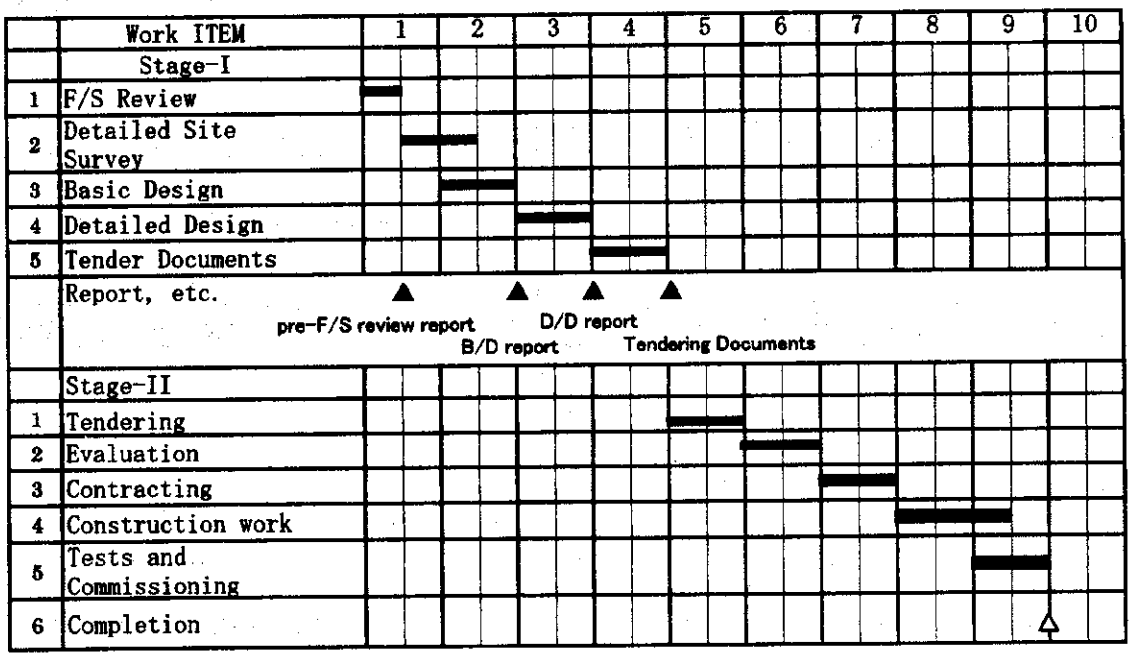


Figura 6.5
Installation Map of Wind-PV Hybrid Generation System in Caripe, Oruro Department

Figura 6.6 Calendario de Construcción para Proyecto de Energía Eólica en Caripe



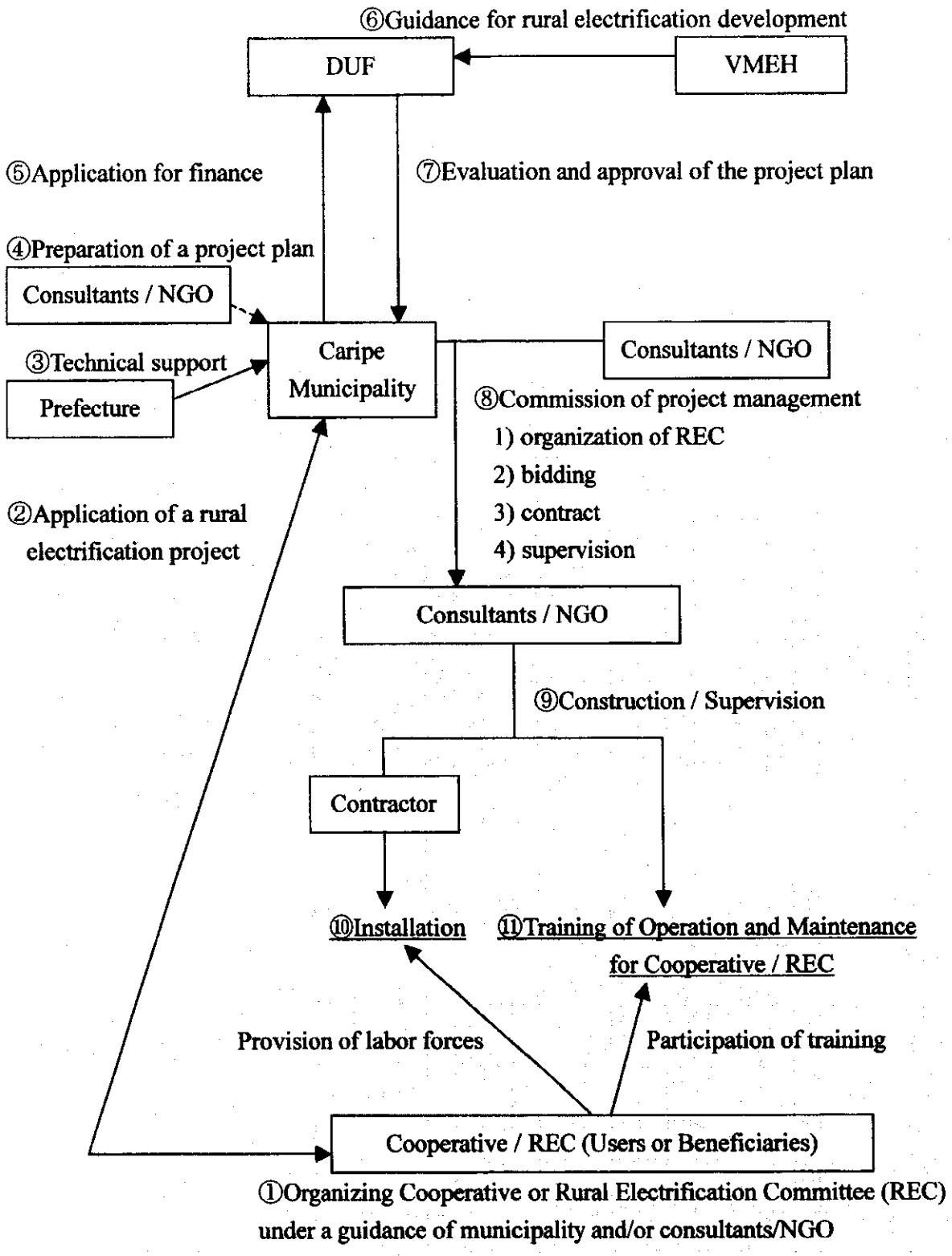
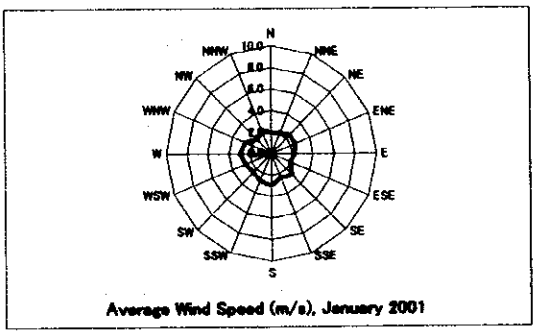


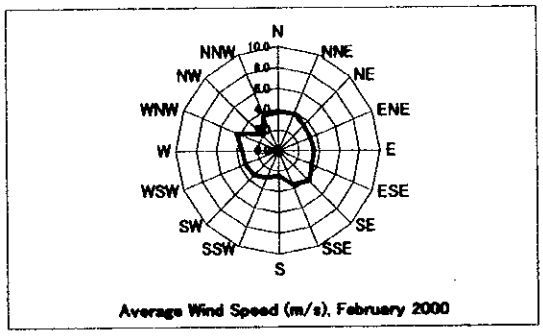
Figura 6.7 Implementación del Proyecto para Proyecto de Energía Eólica en Caripe

Fuente: JICA Study Team

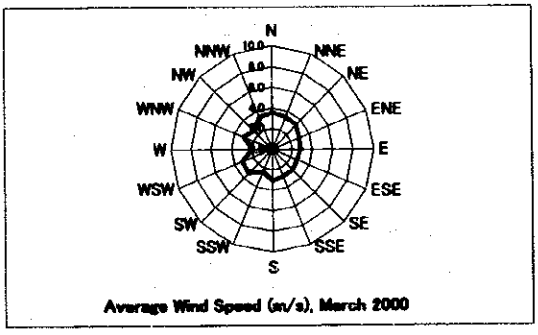
Figura 7.1 Velocidad de Viento Direccional (m/s) en Chachacomani, Oruro



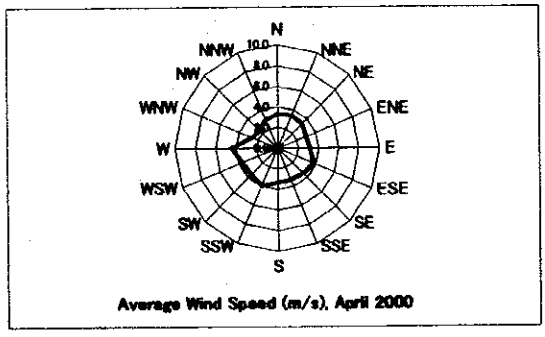
Average Wind Speed (m/s), January 2001



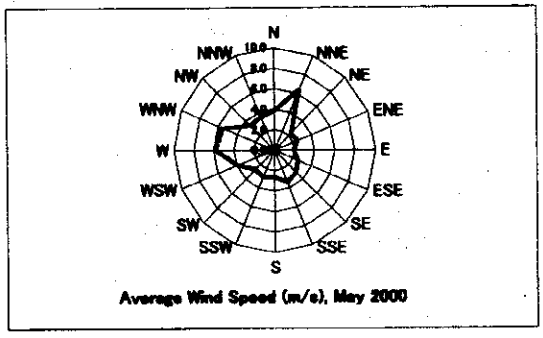
Average Wind Speed (m/s), February 2000



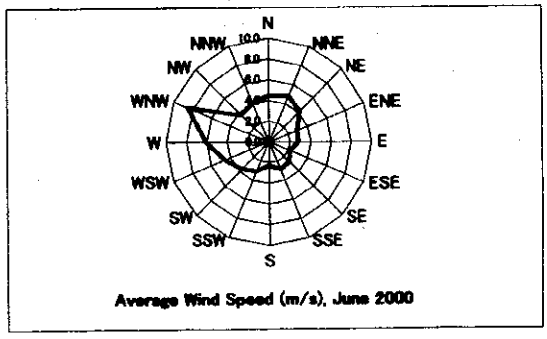
Average Wind Speed (m/s), March 2000



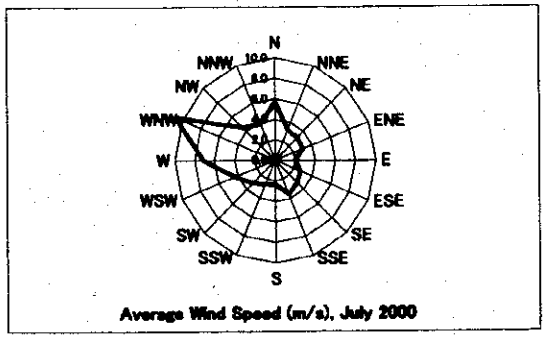
Average Wind Speed (m/s), April 2000



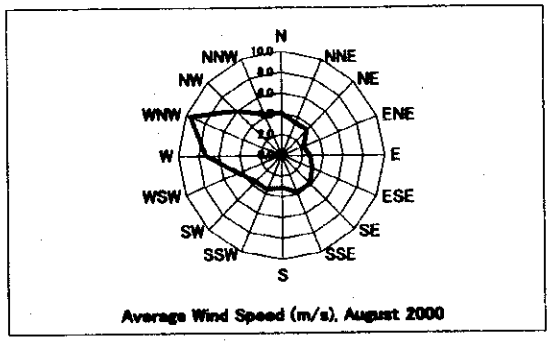
Average Wind Speed (m/s), May 2000



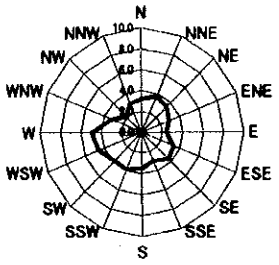
Average Wind Speed (m/s), June 2000



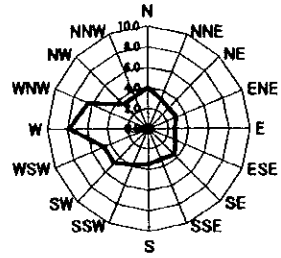
Average Wind Speed (m/s), July 2000



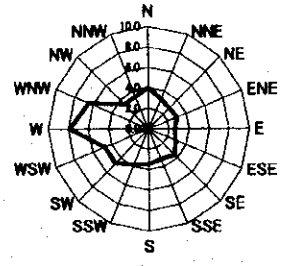
Average Wind Speed (m/s), August 2000



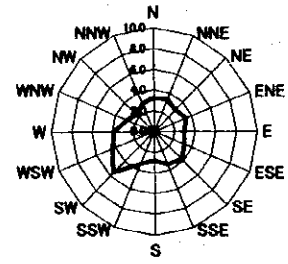
Average Wind Speed (m/s), September 2000



Average Wind Speed (m/s), October 2000

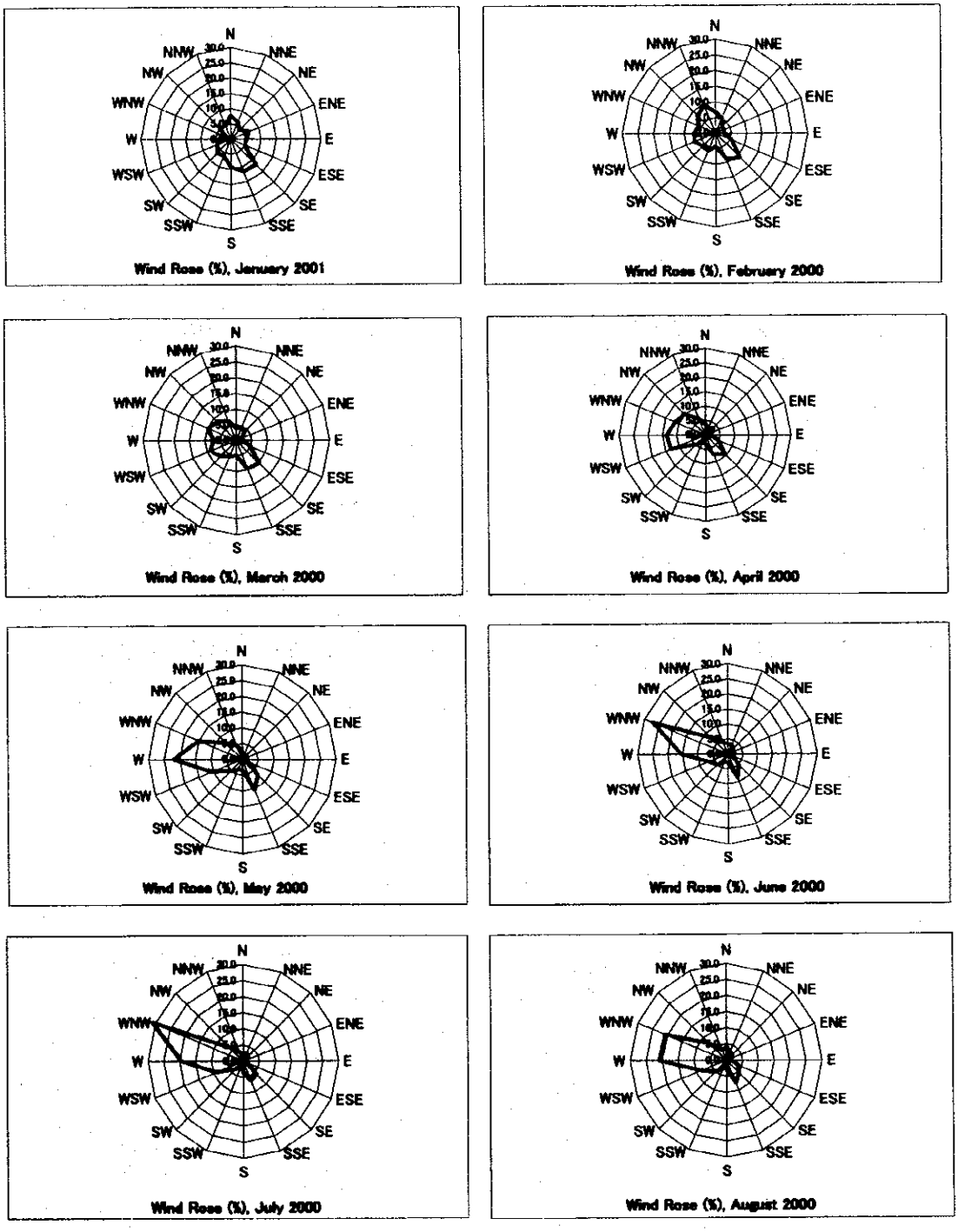


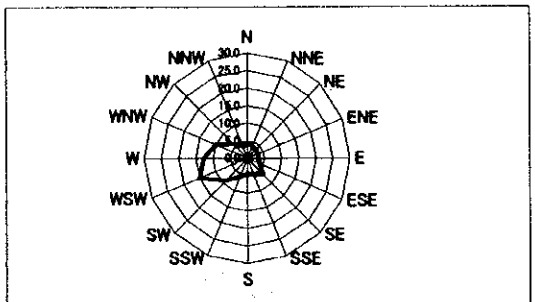
Average Wind Speed (m/s), November 2000



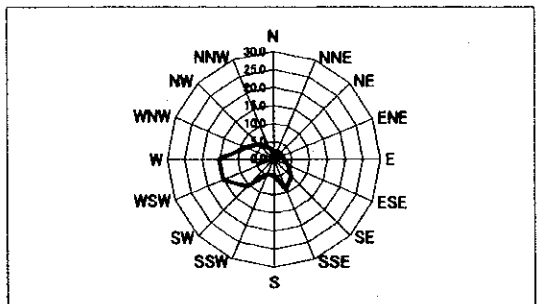
Average Wind Speed (m/s), December 2000

Figura 7.2 **Distrbución Direccional y Frequencia Mensual de la Velocidad de Viento en Chachacomani, Oruro**

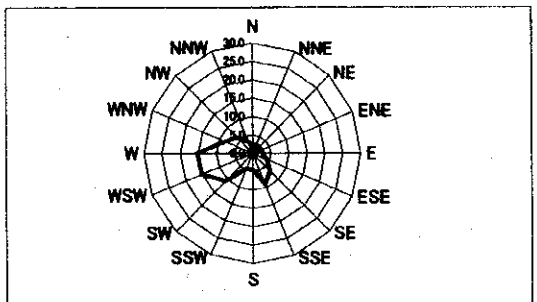




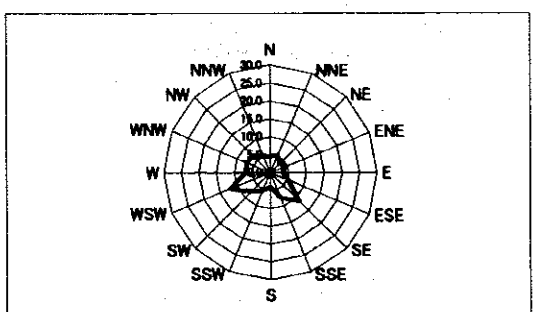
Wind Rose (%), September 2000



Wind Rose (%), October 2000

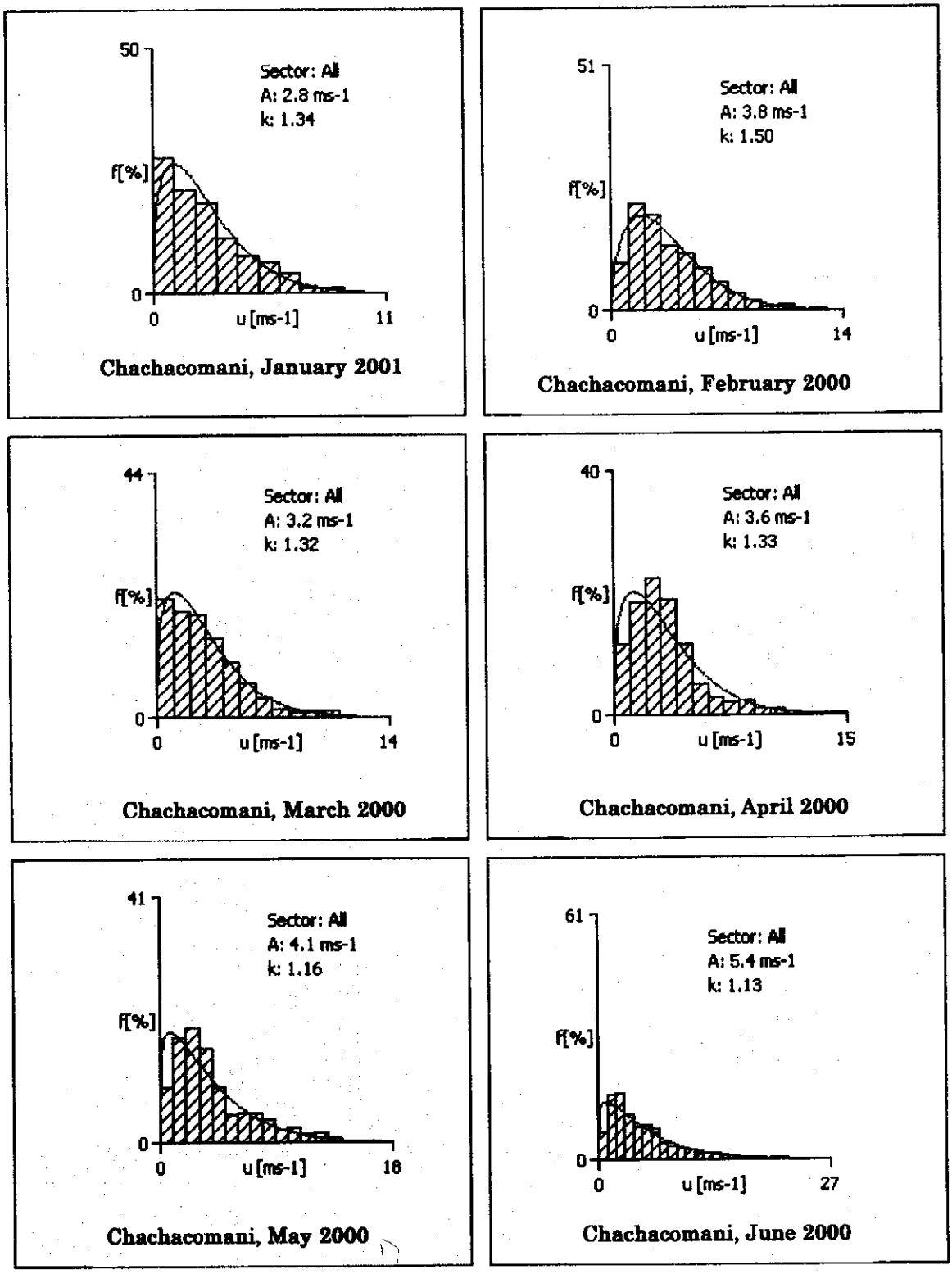


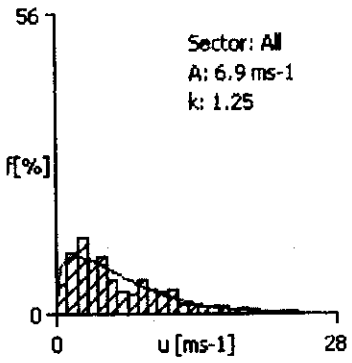
Wind Rose (%) , November 2000



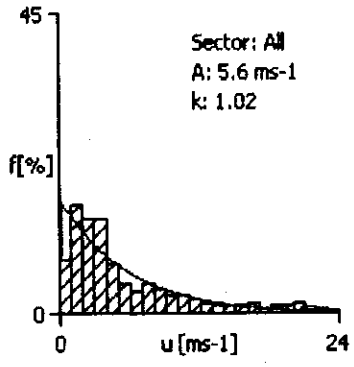
Wind Rose (%), December 2000

Figura 7.3 **Distribución de Weibull en Chachacomani, Oruro**

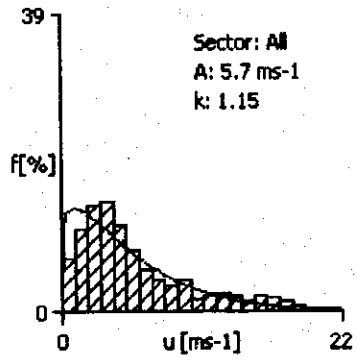




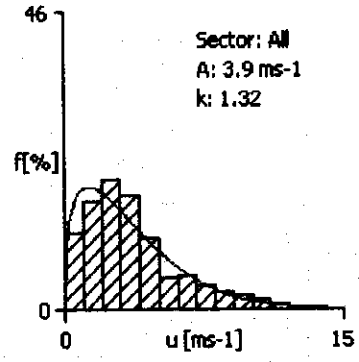
Chachacomani, July 2000



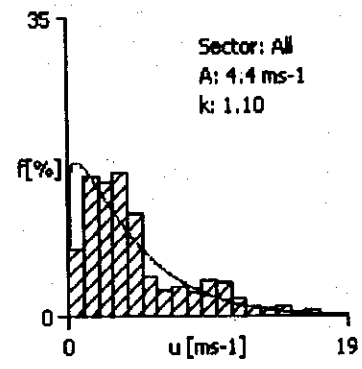
Chachacomani, August 2000



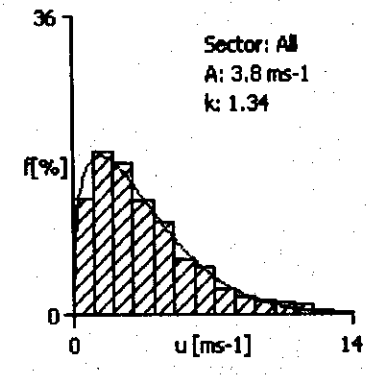
Chachacomani, September 2000



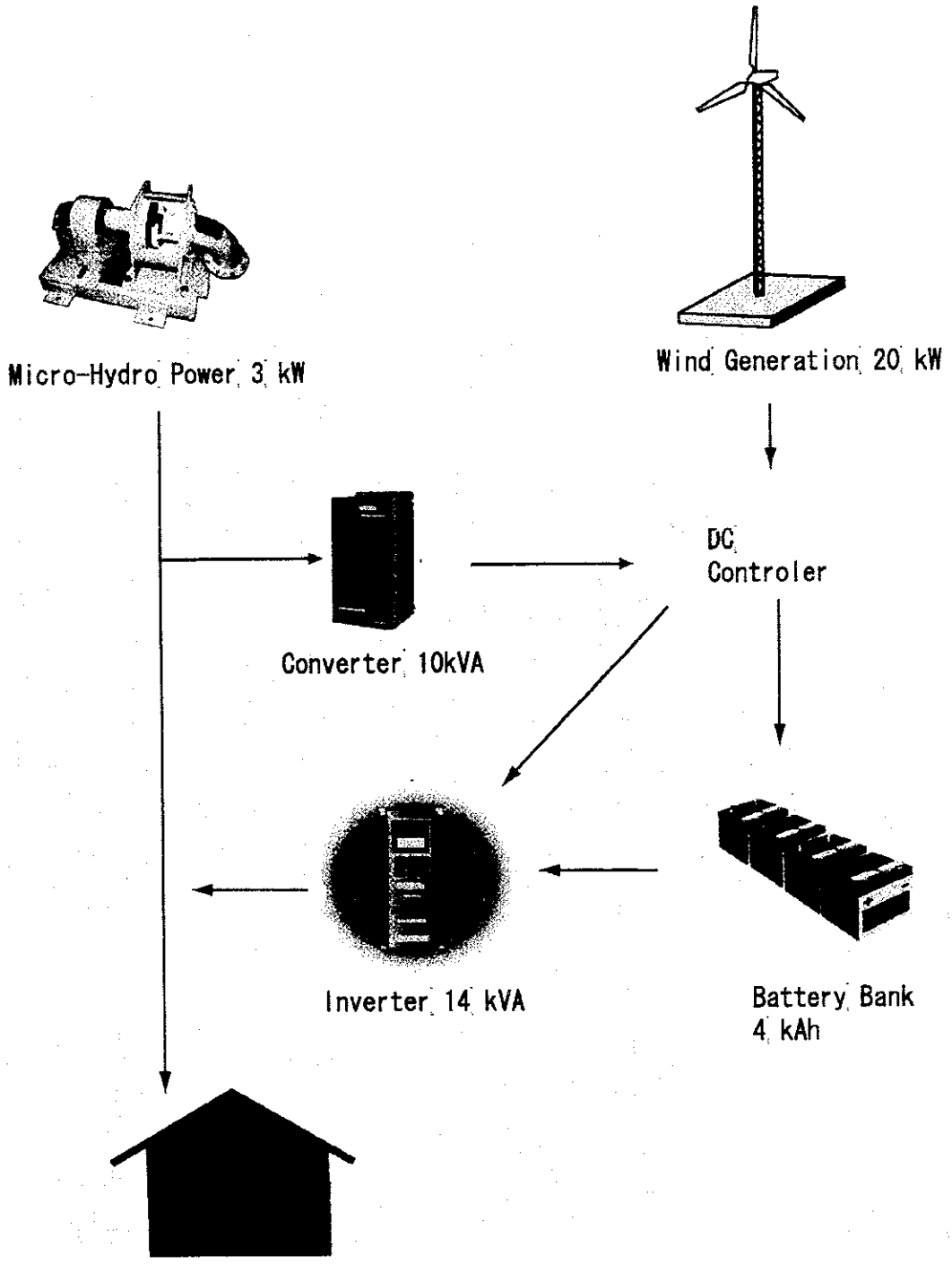
Chachacomani, October 2000



Chachacomani, November 2000



Chachacomani, December 2000



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

Figura 7.4
Wind - Micro Hydro Hybrid System
in Chachacomani, Oruro Dapartment

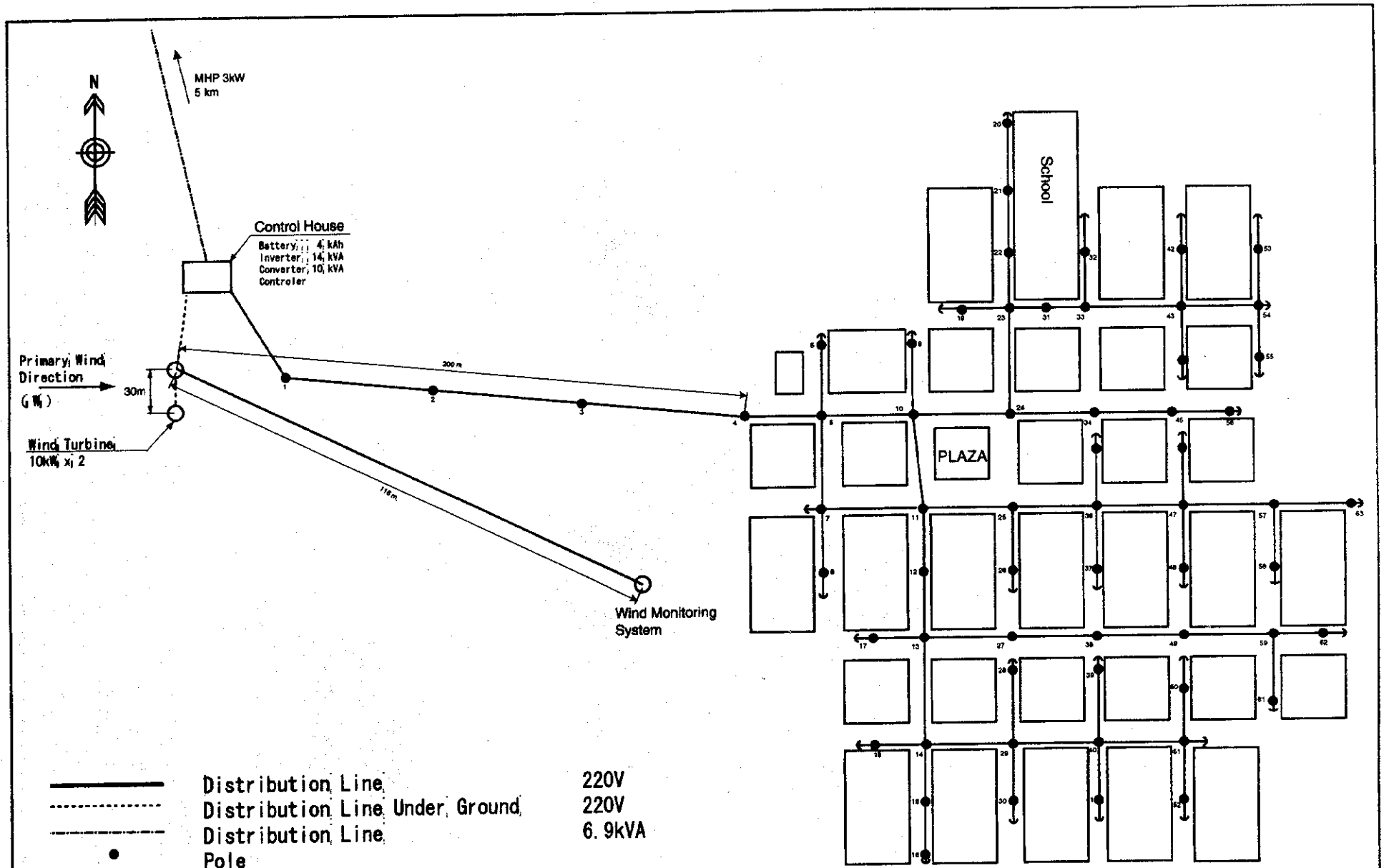
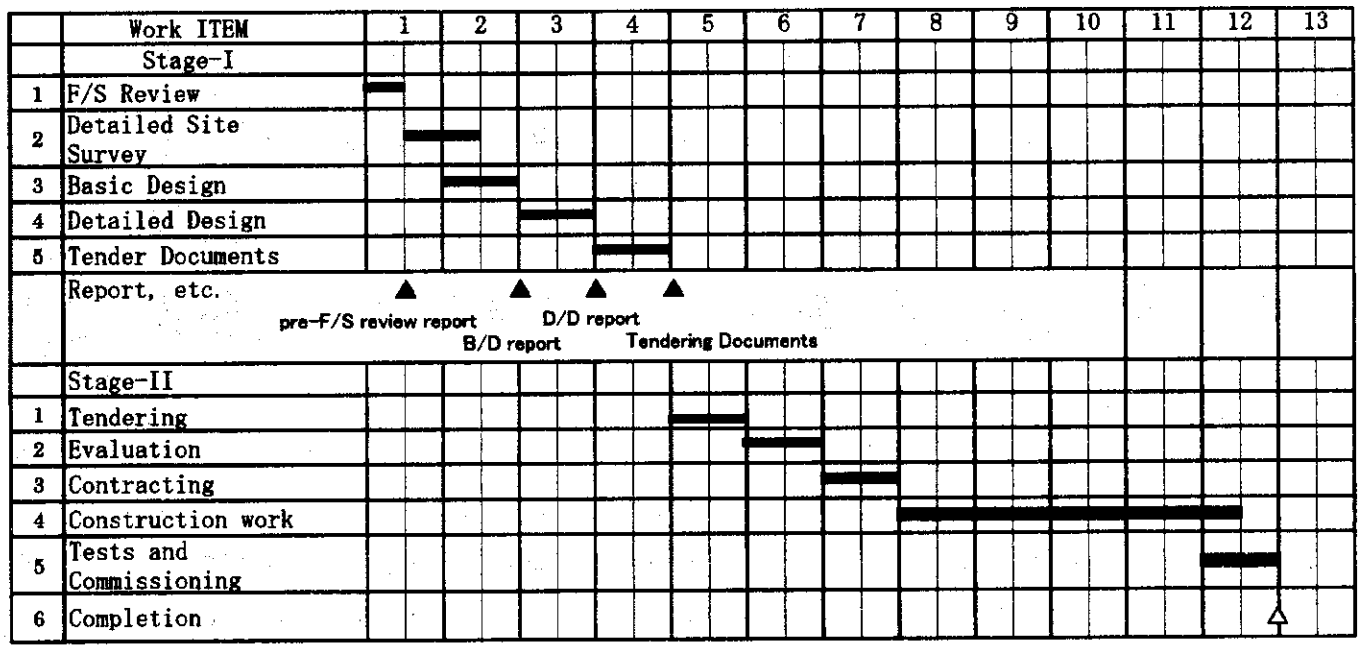


Figura 7.5
Installation Map of Wind / Micro-Hydro Hybrid Generation System in Chachacomani, Oruro Department

Figura 7.6 Calendario de Construcción para Proyecto de Energía Eólica en Chachacomani



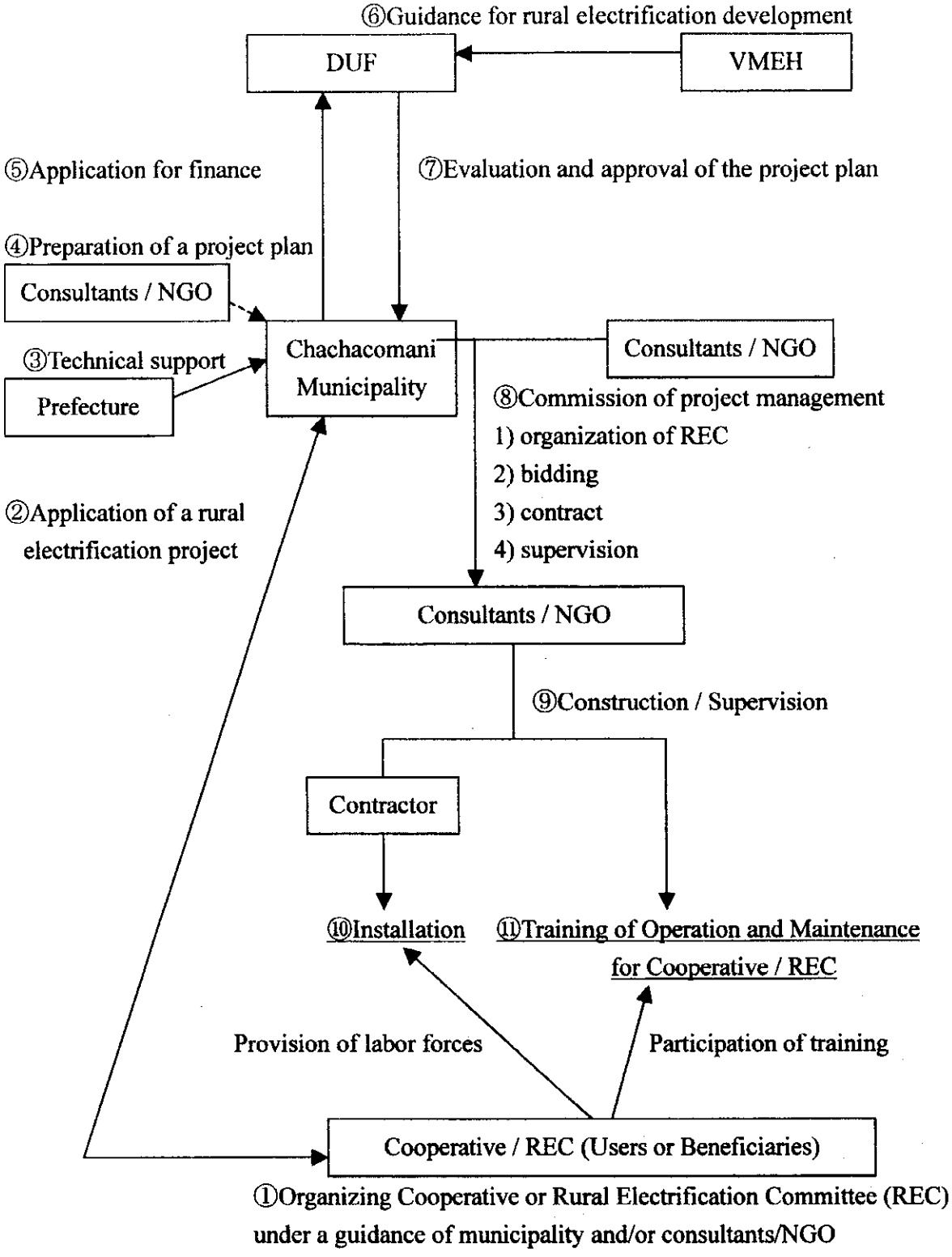


Figura 7.7 Implementación del Proyecto para Proyecto de Energía Eólica en Chachacomani

Fuente: JICA Study Team

APENDICE IV

INFORME DE LA TRANSFERENCIA TECNOLÓGICA

INFORME DE LA TRANSFERENCIA TECNOLÓGICA

La transferencia tecnológica para las contrapartes y otros sectores relacionados a la electrificación rural fue llevada a cabo durante los estudios de campo. Los principales temas tratados en la transferencia tecnológica durante los estudios de campo se resumen a continuación.

1. Sistema Fotovoltaico

(1) Primer Trabajo de Campo

- Selección de sitios para el sistema FV
- Inspección de los equipos FV proporcionados
- Formulación de la organización OM
- Método de instalación para el sistema FV

(2) Primer Seminario

- Temas recientes de FV
- Manual y guía del usuario de OM

(3) Segundo Trabajo de Campo

- Inspección de los sistemas FV instalados
- Guía y manual de mantenimiento del usuario
- Monitoreo

(4) Segundo Seminario

- Guía de instalación del sistema FV
- Presentación del sistema de adquisición de datos
- Presentación del esquema modificado de OM

(5) Tercera Investigación de Campo

- Explicación del método de instalación del sistema FV durante la inspección final de los sistemas FV instalados con manuales impresos

- Monitoreo del sistema de adquisición de datos
- Enseñar el método de mantenimiento para los sistema FV por medio de manuales impresos
- Explicar a los usuarios la manera apropiada de utilizar el sistema FV con manuales impresos en las reuniones sostenidas en cada comunidad
- Explicar a los Operadores y Prefecturas la operación del monitoreo

(6) Quarta y Quinta Investigaciones de Campo

Entrenamiento para operadores en métodos de mantenimiento:

- Transferencia tecnológica a los usuarios del operador para el mantenimiento con el folleto impreso "manual de mantenimiento"

Guía del usuario:

- Instrucción para la operación diaria y mantenimiento con el folleto impreso "guía del usuario" en la orientación llevada a cabo en cada comunidad

Monitoreo:

- Método de monitoreo para operadores y prefecturas

(7) Tercero Seminario

- Proyecto del Piloto FV y O&M
- Plan Desarrollo de Sistema FV

2. Micro hidro Energía

(1) Primer Trabajo de Campo

- Selección de sitios potenciales incluyendo el criterio de selección
- Recolección de datos para energía hidroeléctrica
- Medición del nivel del agua, y observaciones de descarga
- Instalación de la vara de medición

(2) Primer Seminario

- Principios básicos de energía hidroeléctrica
- Caso de estudio de Energía hidroeléctrica (buenos y malos ejemplos)

(3) Segundo Seminario

- Recolección de datos para sistemas micro-hidro

(4) Tercera Investigación de Campo

- Método de selección de sitios candidatos incluyendo la preparación del criterio de selección
- Método de diseño de la investigación
  - a) investigación de las condiciones topográficas
  - b) investigación de las condiciones geológicas
  - c) investigación hidrológica incluyendo mediciones de descarga
- Método para la investigación socioeconómica
  - a) investigación de la demanda de electricidad
  - b) investigación del ambiente del río

(5) Quarta y Quinta Investigaciones de Campo

Métodos de Estudio de Ingeniería:

- Investigación hidrológica incluyendo medición de descarga y recolección de información
- Análisis hidrológico y Estudio Topográfico (Estudio topográfico y mapeo)
- Métodos de selección del emplazamiento y planificación del diseño para la estación de la estación de energía (localización y tamaño de la toma, desarenado, y ruta del canal, conducto de entrada, planta de energía, etc.).
- Estudio de campo sobre condiciones geológicas

Método de investigación socioeconómica e impacto sobre el medio ambiente:

- Estudio de la demanda de energía hidráulica
- Estudio de condiciones socioeconómicas
- Estudio del impacto sobre el medio ambiente

(6) Tercero Seminario

- Investigación y Estudio para Energía Hidroeléctrica
- Plan Desarrollo de Energía Hidroeléctrica

3. Energía Eólica

(1) Primer Trabajo de Campo

- La importancia de los datos del viento para la planeación de la energía eólica y el método de recolección de datos
- Criterio de selección de sitios para el monitoreo de vientos
- Condiciones de los sitios para el monitoreo

(2) Primer Seminario

- Temas actuales
- Resumen del primer estudio

(3) Segundo Trabajo de Campo

- Instalación del sistema de monitoreo de vientos
- Método de monitoreo y método de recolección de datos

(4) Segundo Seminario

- Proceso de instalación del sistema de monitoreo de viento
- Método de monitoreo de viento
- Temas actuales

(5) Tercera Investigación de Campo

- Remplazo de las tarjetas SIM de los sistemas de adquisición de datos
- Operación y mantenimiento del sistema de monitoreo
- Método del análisis de datos

(6) Quarta y Quinta Investigaciones de Campo

Método de Estudios de Ingeniería:

- Operación y mantenimiento del sistema de monitoreo
- Método de análisis de datos

- Método de selección del emplazamiento y planificación del diseño para energía eólica
- Estudio de campo sobre las condiciones geológicas

Método de investigación socioeconómico e impacto sobre el medio ambiente:

- Estudio de la demanda de energía eólica
- Estudio de las condiciones socioeconómicas
- Estudio del impacto sobre el medio ambiente

(7) Tercero Seminario

- Sistema de Monitoreo para Viento y Estudio de Energía Eólica
- Plan Desarrollo de Energía Eólica

4. Estudio Social

(1) Segundo seminario

- Presentación de los resultados del estudio social

(2) Tercera Investigación de Campo

- Método de monitoreo del estudio de los usuarios

(3) Quarta y Quinta Investigaciones de Campo

- Método de Investigación de monitoreo de los usuarios
- Método de análisis de la investigación del monitoreo

I. Primer Seminario

1.1 Programa del Primer Seminario

Date: January 11, 2000 (Tuesday) 10:00 a.m. – 17:10 p.m.
Place: Hotel Presidente (La Paz)

10:00 a.m. – 10:30 a.m.
Opening Greeting:
Juan Mendoza R., Chief of Energy Development Department, VMEH
Mitsuo Sugiyama, Subdirector of JICA Bolivia office

10:30 a.m. – 11:00 a.m.
1. Objectives and Scope of JICA Study (Tai)

(11:00 a.m. – 11:20 a.m.: Coffee Break)

11:20 a.m. – 12: 35 p.m.
2. Results of First Field Survey
   Photovoltaic Energy (Wakabayashi)
   Micrho-Hydro Power (Tai)
   Wind Power (Ikeno)
   Social Survey (Ikeno)

12:35 p.m. – 12:50 p.m.
Questions and Answers (1)

(13:00 p.m. – 14: 25 p.m.: Lunch)

14:30 p.m. – 15:15 p.m.
3. Basic Concept and Current Topics (Wakabayashi)

(15:15 p.m. – 15:40 p.m.: Coffee Break)

15:40 p.m. – 16:40 p.m.
4. PV Operation & Maintenance (Wakabayashi)

16:40 p.m. – 17:10 p.m.
Questions and Answers (2)

17:10 p.m.
Closing Speech (Tai)

1.2 Lista de Participantes al Primer Seminario

VMEH (3)

Juan Mendoza (Jefe Unidad de Desarrollo Energético)
Carlos Gordillo (Consultor Unidad de Desarrollo Energético)
Renan Orellana L. (Consultor VMEH)

Prefectrura de Departamento de La Paz (6)

Raul Ruiz (Director, Departament de Infraestructura)
Joaquin Pando
Clemente Rojas Ugarte (Jefe, Unidad de Energía)
Mario Eguez C.
Carlos Lopez Saravia
Carlos Cruz

Prefectrura de Departamento de Oruro (8)

Felix Castañares A. (Director, Departamento de Infraestructura)
Jorge Guzman (Jefe, Unidad de Energía)
Ramiro Pinto Villarrod
Fernando Veliz
Edgar Torrez

Operators (4)

Lutgardo Alvarez (Gerente General de ELFA, S.A. en La Paz)
Jaime Yañez Saavedra (ELFA, S.A.)
Demetrio León (Administrador de COSEP en Oruro)
Ninoska Pardo Echalar (COSEP)

Installer of PV System (1)

Javier López Videla

REC in La Paz and Oruro ()

Raymundo Vicente Marca
Tito Quispe Marca
Juan Prado Garnica
Jose Mendoza Condori

Simón Checa
Daniel Mamani
Martin Coaquira

JICA Bolivia office (1)
Mitsuo Sugiyama
Tatsuaki Inoue

JICA Study Team (7)
Toshikazu Tai (Team Leader)
Hidehito Wakabayashi
Tsutomu Dei
Masafumi Ikeno
Tsutomu Dei

1.3 Contento del Primer Seminario

Los contentos del primer seminario son presentado en el Anexo IV-1.

II. Segundo Seminario

2.1 Programa del Secondo Seminario

Date: June 9, 2000 (Friday)
Place: International Park Hotel in Oruro

13:30 – 13:45
Opening Greetings:
1) Mr. Boris Medina C, Director General de Prefectura Oruro
2) Mr. Juan Mendoza, VMEH
3) Mr. Inoue, JICA Bolivia office

13:45 – 14:15
The summary of the study (JICA Study Team)

14:15 – 14:45
Installation of Wind Monitoring System & Data collection (JICA Study Team)

14:45 – 15:15
Coffee Break

15:15 – 16:00
PV system installation & Data Collection (JICA Study Team)

16:00 – 16:30
Questions & Answer

16:30 – 16:45
Closing speech (Mr. Tai, Team Leader of the JICA Study Team)

2.2 Lista de Participantes al Segundo Seminario

VMEH (3)

Juan Mendoza (Jefe Unidad de Desarrollo Energético)
Carlos Gordillo (Consultor Unidad de Desarrollo Energético)
Renan Orellana L. (Consultor VMEH)

Prefectrura de Departamento de Oruro (8)

Boris Medina C. (Director General de Prefectura Oruro)
Felix Castañares A. (Director Departamento de Infraestructura)
Fernando Tapia C.
Jorge Guzman (Jefe Area de Energía)
Rumiro Pinto Villarrod
Fernando Veliz
Ana Maria Sanchez A
Patricia Valdivia Irahola

Prefectrura de Departamento de La Paz (4)

Clemente Rojas Ugarte (Jefe Area de Energía)
Mario Eguez C.
Carlos Lopez Saravia
Marcelo Portillo

Operators (4)

Lutgardo Alvarez (Gerente General de ELFA, S.A. en La Paz)
Giovanny Bustillos (ELFA, S.A.)
Demetrio León (Administrador de COSEP en Oruro)
Ninoska Pardo Echalar (COSEP)

Other Related Organizations (4)

Javier Lopez V. (PV supplier, ICM)
Ernesto Uchazra (PV supplier, ICM)
Emilio Montaño Gonzales (UMSA)
Eleuterio Escobar Canaviri (Feredacion Cooperativos Huanconi)

REC in La Paz (14)

Adalberto Quispe (San francisco de Llallagua)
Tito Quispe Marca (San francisco de Llallagua)
Sacarias Vicente Q. (Santiago Hiruyo)
Emigdio Herrera Q. (Catavi)
Ysmael Mamani M. (Catavi)
Teofilo Guayguasi (Millo)
Santiago Quispe (Millo)
Sacarias Lima (Culli Culli Alto)
Pedro Mamani T. (Culli Culli Alto)
Dionicio Pancata Santos (Culli Culli Alto)
Luis Vera Marca (Calteca)
Martin Bautista T. (Calteca)
Petrona C de Bautista (Calteca)
Guillermo Guarachi Huanca (Muruchapi)

REC in Oruro (2)

Simon Checa M. (Paria Pampita)
Jose Mendoza C. (Laguna Ancocota)

JICA Bolivia office (1)

Tatsuaki Inoue

JICA Study Team (7)

Toshikazu Tai (Team Leader)
Hidehito Wakabayashi
Tsutomu Dei
Kinuyo Fukuda
Masafumi Ikeno
Luisa Rovollo (Interpreter)
Rolando Calla Z. (Interpreter)

2.3 Contentos del Segundo Seminario

Los contentos del segundo seminario son presentado en el Anexo IV-2.

III. Tercero Seminario

3.1 Programa del Tercero Seminario

Date: September 3, 2001 (Monday)
Place: Radisson Hotel in La Paz

1. Introduction of JICA Study
   - 1.1 Objectives of the Study
   - 1.2 Study Organization
   - 1.3 Schedule of Survey and Study
   - 1.4 Contents of the Study

2. Rural Electrification in Bolivia/La Paz and Oruro
   - 2.1 Rural Electrification in Bolivia
     - 1) VMEH Policy
     - 2) Progress of PRONER
     - 3) Rural Electrification Investment
   - 2.2 Rural Electrification in La Paz and Oruro
     - 1) Trend of Rural Electrification
     - 2) Present Situation of Rural Electrification
     - 3) Target Households for Rural Electrification
     - 4) Potential Demand for Electricity

3. PV Pilot Project and O&M
   - 3.1 Survey and Study Conducted
   - 3.2 PV System Installed and O&M System
     - 1) Components of PV System
     - 2) Organization for O&M
   - 3.3 Monitoring and Analysis
     - 1) O&M by Operator
     - 2) Payment of Tariff
     - 3) Monitoring of Users
     - 4) Radiation Analysis
   - 3.4 PV Inventory and PV Potential
     - 1) PV Inventory
     - 2) PV Potential
   - 3.5 Technical Evaluation of PV System

3.6 Evaluation of O&M

4. Survey and Study on Micro-hydro Power
4.1 Survey and Study Conducted
4.2 Micro-hydro Power Inventory and Power Potential
4.3 Installation of Staff Gauges and Discharge Measurement
4.4 Selection of Candidate Projects for Pre-feasibility Study
    1) Selection Criteria
    2) Selected Projects
4.5 Process of Pre-feasibility Study and Results
    1) Work Flow of Pre-feasibility Study
    2) Optimization Study
    3) Formulated Schemes
    4) Results of Evaluation

5. Wind Monitoring System and Study of Wind Power
5.1 Survey and Study Conducted
5.2 Installation of Monitoring System
5.3 Monitoring and Data Collection
    1) Collected Data and Analysis
    2) Wind Power Potential
5.4 Selection of Candidate Sites for Pre-feasibility Study
5.5 Process of Pre-feasibility Study and Result
    1) Work Flow of Pre-feasibility Study
    2) Optimization Study
    3) Formulated Schemes
    4) Results of Evaluation

(Lunch)

6. Rural Electrification Plan by Renewable Energy
6.1 Objective Renewable Energy and Planning Methodology
    1) Objective Renewable Energy Sources
    2) Cost Comparison
    3) Methodology of Rural Electrification Planning
6.2 Rural Electrification Plan

1) Micro-hydro Power Development Plan
2) Wind Power Development Plan
3) PV System Development Plan
4) Grid Extension Plan
5) Overall Projection of Rural Electrification
6) Environmental Impacts

7. Organizational and Financial Plan

7.1 Implementing Structure

1) Implementing Organization
2) Operation and Maintenance System

7.2 Fund Arrangement Plan

7.3 Institutional Support

1) Planning Capacity Improvement
2) Improved Coordination
3) Research and Training

8. Recommendation

3.2 Lista de Participantes al Tercero Seminario

1) Central Government: (14)

a) VMEH

General Director of Energy	Ing. Mario Candia Moya
Coordinating Group	Ing. Juan Mendoza
	Ing. Carlos Gordillo
	Ing. Renán Orellana
E.F.P	Ing. Julio Patiño
	Mr. Alvaro Hubner
b) DUF	Lic. Marco Zapata
FNDR	Ing. Raúl Cosulich

2) Prefecture and Local Organizations/Operators: (27)

a) La Paz Prefecture:

Coordinating group, Working group:

Arq. Ramiro Ostria
Ing. Clemente Rojas
Ing. Carlos Lopez
Ing. Mario Egüez

b) Oruro Prefecture:

Coordinating group, Working group:

Ing. Felix Castañares
Ing. Raul Antezana
Ramiro Pinto
Ing. Jorge Castillo

c) Rural Electrification Committee

La Paz:

- Calteca	Mr. Martín Bautista
	Mr. Petronade Bautista
- Catavi	Mr. Cristóbal Torrejón
- C.C. Alto	Mr. Dionicio Pancata

- Calacachi	Mr. Alberto Mamani
	Mr. Ronald Mamani
- Cañuma	Mr. Angel Torrez
- Sica Sica	Mr. Edgar Espiñoza
	Mr. Angel Tito Panama
	Mr. Pedro Herrera
	Mr. Juan Carlos Quispe G.
- Charaña	Ms. Rufina S. De Mamani
Oruro:	
- Paria Pampita	Mr. Simon Checa
	Mr. Yreneo Checa
- Laguna Ancocota	Mr. José Mendoza
d) Operators	
- ELFASA	Mr. Lutgardo Alvarez
- COSEP	Mr. Demetrio León
e) Municipalities	
Major of Sica Sica	Mr. Rolando Montaño
Major of Ayo Ayo	Mr. Benjamín Altamirano
	Mr. Adelio Huanca

3) International Organizations: (5)

a) NRECA	Mr. Omar Vargas
b) Cooperaciòn Española	Mr. David Lopez
c) PROADIN	Mr. V. Daniel Paz

4) Collaborating Organizations (3)

a) UMSA	Mr. Emilio Montaño
	Mr. José Luis Monroy
b) Edeser	Mr. Albaro Pol
b) PSM Consultores	Mr. Roger Mattos Ruedas

5) Japanese Embassy and JICA: (4)

a) JICA Tokyo Headquaters Mr. Yoshiki Maruyama

	Mr. Shobu Nagatani
b) JICA Bolivia Office	Mr. Kazuo Nagai
	Mr. Tatsuaki Inoue
	Mr. Carlos Omoya

6) JICA Study Team and Assistants: (7)

Mr. Toshikazu Tai
Mr. Hidehito Wakabayashi
Mr. Masafumi Ikeno
Mr. Kiyoshi Hirata
Mr. Tsutomu Dei
Ms. Kinuyo Fukuda
Ms. Luisa Revollo

3.3 Contentos del Tercero Seminario

Los contentos del segundo seminario son presentado en el Anexo IV-3.

ANEXO IV-1

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)
VICEMINISTERIO DE ENERGIA E HIDROCARBUROS
DE LA REPUBLICA DE BOLIVIA (VMEH)

ESTUDIO
DE
IMPLEMENTACION PLAN DE ELECTRIFICACION RURAL CON ENERGIAS RENOVABLES
EN
LA REPUBLICA DE BOLIVIA

Objetivos y Alcance del Estudio de JICA

Objetivos

- Elaborar el Plan de Implementación de Electrificación Rural con Energía Renovable en los Departamentos de La Paz y Oruro
- Transferencia de tecnología

Area Objeto y Energía Renovable

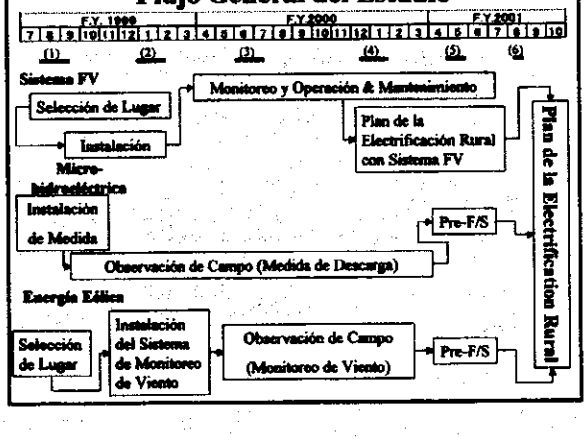
- Area Objeto: La Paz y Oruro
- Fuentes de Energias Renovable:

(i) Célula Fotovoltaica (FV) :

(ii) Micro-hidroeléctrica :

(iii) Energía eólica :

Flujo General del Estudio



2. Resultados del Estudio Primero de Agosto a Septiembre 1999

Resumen del Estudio Realizado

- Célula Fotovoltaica (FV)
- Micro-hidroeléctrica
- Energía eólica
- Sector Socio-economico
- Célula Fotovoltaica (FV)

Resumen del Estudio Realizado - Célula Fotovoltaica (FV) (1) -

- Primer Estudio de Campo
  - Selección de localidades para el proyecto piloto fotovoltaico (270 sistemas)
  - Inspección del sistema FV proporcionado en Bolivia
  - Formulación de sistemas de operación y mantenimiento para el sistema FV incluyendo la organización y línea de estructura de mando
  - Supervisión de la instalación

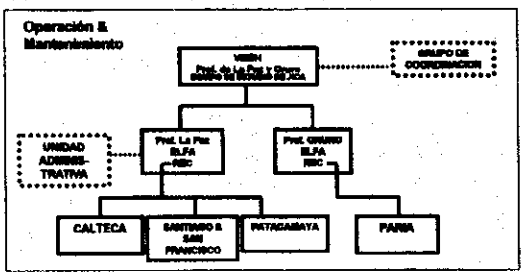
Resumen del Estudio Realizado - Célula Fotovoltaica (FV) (2) -

- Segund Estudio de Campo
  - Supervisión de la instalación de los sistemas FV
  - Instalación del equipo de irradiación con data logger
  - Formulación de guías de Operación y Mantenimiento para usuarios y operadores
  - Preparación para el monitoreo

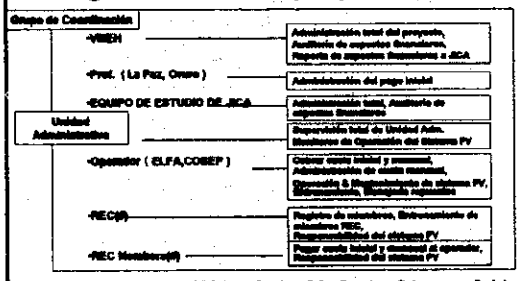
Proyecto FV de JICA en Bolivia

Estructura de sustentabilidad

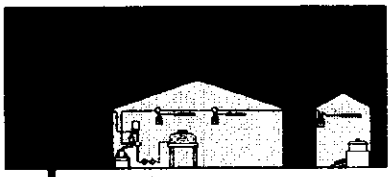
Organización del proyecto



Organización del proyecto



Sistema Solar Domiciliario



- FV : 58WP
- Controlador : Protección para sobrecarga / sobredescarga
- Batería : 12V 100Ah (Producto boliviano)
- Carga : Tres tubos fluorescentes @15W
  Radio o TV blanco y negro (a opción del usuario)

Sistema Tarifario

Cuota inicial	Bs 700
Costo de Capital del sistema	
Cuota mensual	Bs 30
Costo de Operación & Mantenimiento	

- La tarifa mencionada es básicamente fija
- La Unidad Administrativa discutirá y acordará cambios a la tarifa cuando se dén cambios económicos substanciales.

Pago inicial Bs 700
(Costo total Bs 5300)

8 pagos por instalación

Pago por contrato		Bs 50
Enero	2000	Bs350
Marzo	2000	Bs 50
Mayo	2000	Bs 50
Julio	2000	Bs 50
Septiembre	2000	Bs 50
Noviembre	2000	Bs 50
Enero	2001	Bs 50

Cuota Inicial Bs 700
(Costo Total Bs 5300)

- Pago a Operadores (ELFA & COSEP) al final de meses específicos
- Administrado por Prefecturas en una cuenta bancaria exclusiva
- Auditado por VMEH & JICA
- Fondo rotativo para implementación del sistema FV (en discusión con el Grupo de Coordinación y Unidad Adm.)

El sistema FV será retirado ante retraso en los pagos

Cuota mensual Bs 30

Costo de Operación y Mantenimiento

- Pago a operadores (ELFA & COSEP) al final de cada mes
- Administrado por operadores (ELFA & COSEP) en cuentas bancarias exclusivas.
- Auditado por VMEH y JICA
- Costo de Mano de Obra de Operadores
- Costo de Materiales
- Costo de reemplazo de partes

Cuota Mensual Bs 30

Costo de Operación y Mantenimiento

- Costo de Mano de Obra de Operadores
  - Patrullaje Mensual
  - Problemas de disparo
  - Costo de Materiales
  - Agua destilada para baterías
  - Cables y arreglos (excepto los de los usuarios)
  - Costo de reemplazo de las partes
  - Batería y Controlador (Excepto internas, panel FV)

Monitoreo

Propósito

Obtener la mejor manera
para
Electrificación Rural
utilizando sistema FV
en
Bolivia

Monitoreo

Monitoreo por Software

- Operación & Mantenimiento
  - Rol
    - ELFA & COSEP patrullarán casas mensualmente
    - Usuarios utilizan el sistema cada día
- Uso del Sistema
  - Rol
    - Usuarios utilizan el sistema cada día
    - Usuarios son responsables por cuidado del sistema
- Administración Financiera
  - Rol
    - Pref. De La Paz y Oruro cobrarán cuota inicial
    - ELFA & COSEP cobrarán cuota mensual
- Cambio Socioeconómico
  - Rol
    - Usuarios utilizan el sistema cada día y harán el pago

Monitoreo

Monitoreo Técnico

Por registro de datos
- Irradiación vs Poder
- Poder vs Uso

Por oído
- Cargas de uso
- Horas de uso
- Condiciones del sistema

Monitoreo
Operación & Mantenimiento

Tópicos	Examinadores
Mantenimiento mensual Mantenimiento Ocasional	ELFA & COSEP RECs

Organización a cargo
Prefecturas de La Paz
y Oruro

Monitoreo
Uso del Sistema

Tópicos	Examinadores
Uso apropiado Mantenimiento diario Demanda tamaño / calidad /costo aplicación	RECs Usuarios

Organización a cargo
ELFA
COSEP

Monitoreo
Administración Financiera

Tópicos	Examinadores
Administración Financiera	Prefecturas de La Paz y Oruro ELFA & COSEP

Organización a cargo
VMEH

Monitoreo
Cambio Socioeconómico

Tópicos

- Pago
- Estilo de vida / Mérito
- Economía doméstica / Costo

Examinadores

RECs

Usuarios

Organización a cargo

ELFA

COSEP

Monitoreo
Datos Técnicos

Tópicos

- Irradiación vs Poder
- Poder vs Uso apropiado

Examinadores

RECs

Usuarios

Recolección de datos técnicos

Organización a cargo

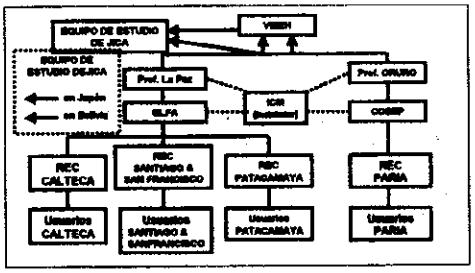
ELFA

COSEP

Monitoreo
Matriz de Responsabilidades y Objetos

	[illegible]	[illegible]	Asun. Financiero 3 Meses	Socio-Económico 3 Meses	Datos Técnicos Mensual
VMEH	[illegible]	[illegible]	A CARGO		
Prof. de La Paz	A CARGO		OBJETO		
Prof. De Oruro	A CARGO		OBJETO		
ELFA	OBJETO	A CARGO	OBJETO	A CARGO	A CARGO
COSEP	OBJETO	A CARGO	OBJETO	A CARGO	A CARGO
REC	OBJETO	OBJETO		OBJETO	OBJETO
USUARIO		OBJETO		OBJETO	OBJETO

Monitoreo
Organización Informativa



Monitoreo
Proceso de datos recolectados

Datos del Registro de datos

- Transferir datos recolectados utilizando una tarjeta de PC
- Quitar la tarjeta y reinstalar la tarjeta de repuesto en su sitio
- Llevar la tarjeta a la oficina y leer los datos con una PC
- Se debe sacar una copia de seguridad en disco de los datos recolectados
- Enviar los datos al Equipo de Estudio en Japón por e-mail
- Inicializar la tarjeta de PC card para la recolección de datos en el siguiente mes

Monitoreo

Monitoreo por Software

- **Operación & Mantenimiento**
  - Rol
  - • ELFA & COSEP patrullarán casas mensualmente
  - • Usuarios utilizan el sistema cada día
- **Uso del Sistema**
  - Rol
  - • Usuarios utilizan el sistema cada día
  - •Usuarios son responsables por cuidado del sistema
- **Administración Financiera**
  - Rol
  - • Prof. De La Paz y Oruro cobrarán cuota inicial
  - • ELFA & COSEP cobrarán cuota mensual
- **Cambio Socioeconómico**
  - Rol
  - • Usuarios utilizan el sistema cada día y harán el pago

Monitoreo

Monitoreo Técnico

Por registro de datos
- Irradiación vs Poder
- Poder vs Uso

Por oído
- Cargas de uso
- Horas de uso
- Condiciones del sistema

Monitoreo
Operación & Mantenimiento

Tópicos
- Mantenimiento mensual
- Mantenimiento
- Ocasional

Examinadores
- ELFA & COSEP
- RECs

Organización a cargo
- Prefecturas de La Paz y Oruro

Monitoreo
Uso del Sistema

Tópicos
- Uso apropiado
- Mantenimiento diario
- Demanda tamaño / calidad /costo aplicación

Examinadores
- RECs
- Usuarios

Organización a cargo
- ELFA
- COSEP

Monitoreo
Administración Financiera

Tópicos
- Administración
- Financiera

Examinadores
- Prefecturas de La Paz y Oruro
- ELFA & COSEP

Organización a cargo
- VMEH

Monitoreo
Cambio Socioeconómico

Tópicos
- Pago
- Estilo de vida / Mérito
- Economía doméstica / Costo

Examinadores
- RECs
- Usuarios

Organización a cargo
- ELFA
- COSEP

Monitoreo
Datos Técnicos

Tópicos
- Irradiación vs Poder
- Poder vs Uso apropiado

Examinadores
- RECs
- Usuarios
- Recolección de datos técnicos

Organización a cargo
- ELFA
- COSEP