MANAGEMENT CASE

describes a real-life situation faced, a decision or action taken by an individual manager or by an organization at the strategic, functional or operational levels

Enercon India: Project Planning

Saral Mukherjee and G Raghuram

KEY WORDS

Project Management

Wind Energy

Logistics

Delivery Reliability

Outsourcing

August 23, 2003, 7.30 a.m.

Prithwiraj Rathore had just finished his tea in the morning when his cellphone rang. As the team leader of erection and commissioning activities at the Nawapur site of Enercon, Prithwiraj was habituated to getting calls at odd hours. But, this telephone call seemed ominous. The villagers had been agitating for the better part of last week as they were under the impression that the wind turbine generators being constructed by the company near their agricultural land would affect the growth of their crops. While Prithwiraj had used all his reasoning powers to enlighten the villagers, he knew that what was driving the agitation was greed and not fear of stunted crop growth. He had seen such agitations under one pretext or another in almost every site he had managed in the last seven years at Enercon. Essentially, the villagers who held land close to the project site wanted to grab as much compensation as possible. In order to bring the situation under control, last night, Prithwiraj had requested the company for posting armed guards at the site. Vikrant Singh, Project Manager at the Vadodara project office, had indicated that such guards would be available within two days.

Fortunately, it turned out that the phone call was not about reporting any trouble with the villagers. Instead, Jayant Shah, Site Engineer, was reporting a snag with the 220 tonne crane. To avoid high winds during erection of the wind turbine generator sections, the erection team usually worked either at dawn or late afternoon. While work was in progress at location W7 that morning, the crane stopped functioning because of a printed circuit board (PCB) blowout. Repairing such faults usually meant replacement of the PCB. Jayant reported that he had already informed the firm that supplied the crane. A similar PCB blowout had happened two weeks earlier and it had taken two days to replace the PCB.

Within half an hour, Prithwiraj was on his way to the project site at Nawapur. Even though the morning traffic on the Porbandar-Dwarka highway was light, it would take him around one and a half hours to cover the 40-km stretch between Porbandar and Nawapur. Porbandar is a small town on the western coast of Gujarat that is reachable from Vadodara by overnight train. The remoteness of the Nawapur project site implied that any supply of spare part would take time. Nawapur was located in a region that had been identified as having significant wind energy potential. Innumerable wind turbine generators set up by different operators dotted the landscape. While it would not be a problem for arranging cranes of 80 tonne capacity, there were only six or seven cranes of 220 tonne capacity available for hire in the entire country out of which Enercon had hired four, one for each of its four project teams. Hence, asking for a replacement crane meant that an entire project team had to be relocated to the Nawapur site. The Nawapur project was already running late owing to the agitation and heavy rainfall during the ongoing monsoon season. Any further delay would significantly affect the probability of finishing the project within the due date of end September. More importantly, the delay would lead to serious concerns whether the project would get completed if the villagers started a bigger agitation. On the other hand, asking for a replacement crane would result in a huge increase in the project cost.

There were other issues too that required attention. Out of the 14 wind energy converters (WECs) to be erected at the Nawapur site, materials for only ten had been received so far. Among these, one consignment of the nacelle assembly (a critical part of the WEC) was damaged in transit.

COMPANY BACKGROUND

Enercon India Limited (EIL) was founded in 1995 as a collaboration between the Mehra family and Enercon GmbH of Germany. Enercon GmbH held 56 per cent of the shares in EIL while the rest was held by the Mehra Family. Enercon GmbH was founded by Aloys Wobben in 1984. Starting with the 30 KW capacity E12 model, Enercon GmbH went on to introduce the 4.5 MW capacity E112 in 2002. (A chronology of major events and product introductions at Enercon GmbH is provided in Exhibit 1.) One of the major breakthroughs occurred in 1991 when Enercon GmbH introduced a gearless WEC, the E40. A gearless WEC could deliver optimal power under any wind speed and did not draw reactive power from the grid during low wind periods. The wear and tear of machine parts was also considerably less. The phenomenal success of the gearless design had helped Enercon GmbH corner 18.5 per cent of the global WEC market (Exhibit 2) and 38.9 per cent of the German market (Exhibit 3). The features of various WECs designed by Enercon are provided in Exhibit 4. WECs were manufactured in the cities of Aurich and Magdeberg in Germany, the union territory of Daman in India, and in the state of Sao Paolo in Brazil.

EIL introduced the gearless design in India at a time when the wind energy business in India was going through a downturn. The initial excitement about wind energy had given way to the problems of maintenance and upkeep. The strategy of EIL was to offer a complete gamut of services ''from concept to commissioning and beyond." This included exploration of potential high wind locations, micrositing WECs within a location, interfacing with regulatory authorities for required permissions, agreements with Electricity Boards (EBs) for evacuation of power, preparing approach roads, construction of WEC, erection and commissioning of WEC, installing transformers and internal grid for evacuation of power to EB substation, and operation and maintenance of WECs. To overcome the client's concerns about uptime of WECs, EIL offered a guarantee of 95 per cent uptime subject to grid availability from EB. EIL attempted to offer its clients a hassle-free avenue for investing in wind power, shielding them from the need to understand the intricacies of the technology. Indeed, many of the EIL customers had never visited WEC locations owned by them.

The installed base of Enercon machines had increased significantly in the last eight years as shown in Exhibit 5. The growth of the installed base reflected in the sales performance of the firm as shown in Exhibit 6. During 2003-04, EIL planned to instal 263 E40 converters as shown in Exhibit 7. It had decided to discontinue the production of the 230 KW E30 model and planned to introduce the 300 KW E30 model in the future. It had set itself the target of having an installed base of 1,000 MW by 2010. The market share of different WEC manufacturers is given in Exhibit 8. EIL had become a significant player in the Indian market, though not the market leader.

EIL's manufacturing facilities (two plants) were located in the union territory of Daman. They manufactured various components of 230 KW and 600 KW WECs. Synchronous generators were wound and therafter vacuum impregnated, backed, and lacquered. Fibre glass epoxy resin blades were moulded for home and export markets and assembly of electric control panels and mechanical machine parts were undertaken. Enercon was the only Indian company that exported wind turbine blades. It had received export house status from the Government of India and held the distinction of being the first Indian company to export complete WECs to

Australia. Enercon Exports Limited was a 100 per cent subsidiary of EIL having the primary objective of exporting electronic parts to Enercon GmbH. EIL's staff of 945 included 150 managers and engineers who had undergone extensive training in Germany. The company was ISO-9002 certified for manufacturing, installation, and services. Enercon GmbH supported the Indian affiliate with the latest design and development.

ORGANIZATION STRUCTURE

EIL's employees were located at the corporate office in Mumbai, two factories in Daman, the business development offices (BDOs) in the key states, and the site offices at the WEC locations. The staff strength consisted of 500 in the two plants, 200 in operations and maintenance of WECs, 125 in installation, 50 in project offices, and 70 in the corporate office including marketing. Exhibit 9 shows the organization chart at the corporate level. The functional heads of Finance, Marketing, Projects, and Information Technology were located at the Mumbai office while the others were stationed at Daman. Two separate divisions formed in the recent times included Enercon Finance and Enercon Wind Farms Limited. The former was devoted to arranging for the financing needs of the clients while the latter owned and operated wind farms as an independent power producer. These divisional heads were also located at the Mumbai office.

The structure followed in the project sub-division is shown in Exhibit 10. The business development office (BDO) (Exhibit 11), headed by a manager, dealt with the identification of potential locations within that state and interfaced with the regulatory authorities and EBs. The site offices could either be a temporary project office at a site or a permanent office serving several WECs at a particular location. EIL used four project teams that dealt with the erection and commissioning activities. The team leader reported to both the installation head at Daman and the business development manager located at the region. The location of the BDO in a state depended on the location of the regulatory authority in that state. For example, the BDO for the state of Gujarat was located in Vadodara since the Gujarat Energy Development Agency (GEDA), the nodal authority for the development of the renewable energy sector in Gujarat, was located there. All offices, including the remote site offices, were linked by computer networks and an ERP platform from SAP enabled real time planning and control.

THE NAWAPUR PROJECT

The BDO in Vadodara had identified two potential locations in Jamnagar district of Gujarat. One was the Nawapur site situated on the Porbandar-Dwarka highway and the other was the Jangpura site situated on the Porbandar-Rajkot highway, about 70 km from Porbandar. The Jangpura site was on a government land and the Vadodara office had filed all the necessary documents with GEDA for the transfer of the land to EIL for the development of wind power. EIL had offered this site to a prominent client based in Gujarat. The agreement with the client called for commissioning of WECs by end September 2003 so that the client could claim depreciation benefits.

The total cost of the project to the client was Rs 600 million. Any delay beyond September 30 would imply that the client could claim only half (instead of the whole) of the 80 per cent depreciation benefits during 2003-04. Consequently, the remaining tax benefits (at 30 per cent corporate tax rate) would get postponed by a year. Also, for the delay period, the client would not have the benefit of wind power-based electrical energy which normally costs Rs 5 per unit from Gujarat EB. The 1.4 million units (KWH) of energy from the 14 WECs could be wheeled to the client's site at a 4 per cent wheeling charge and an expected 10 per cent loss.

A dispute arose regarding the ownership of the land in April 2003 and villagers in Jangpura obtained a stay order from the court. Even though the dispute was between GEDA and the villagers, EIL did not want this dispute to affect its relationship with the client. Therefore, it offered the Nawapur site to the client, keeping its earlier due date commitments. By end June, the decision to finish the commissioning of 14 WECs at Nawapur by end September was taken. Some of the material (including over-dimensional consignments) which had already been brought to the Jangpura site had to be shifted to a coastal site (near Nawapur) where EIL had operating WECs.

The Nawapur site (Exhibit 12) was on private land and EIL needed to negotiate with each landowner. The land acquisition part of a project generally takes about four to five months and comprise several rounds of negotiations. The speeding up of this process meant that the villagers could gauge the desperation of EIL in clinching the deal. Consequently, the land prices went up. EIL estimated that it had to finally settle for prices which were about 30-35 per cent more than the normal rates. The total land cost was about Rs 15 million for 300 acres.

Exhibits 13 and 14 give a bar chart plan of the Nawapur project as viewed by the installation head (Daman) and BDO (Vadodara) respectively.

By the time the land acquisition process was nearing completion, the monsoon had set in. Heavy rains disrupted the movement of trailers carrying WEC equipments from Daman to the project site. The approach roads could not handle the heavy loads and trailers got stuck in the mud. New roads needed to be built and the earlier ones strengthened before the trailers could deliver their loads. By the middle of August, rains had subsided and work was on at full steam.

Exhibits 15 and 16 show the activities involved in the Nawapur project and their precedence relationships respectively. The composition of the project team is given in Exhibit 17. The project progress report from the SAP software is given in Exhibit 18.

August 23, 2003, 5.30 p.m.

As Prithwiraj settled into the front seat of the car for the return journey to Porbandar, thoughts about the competition deadline of the project crowded his mind. The 220 tonne crane was yet to be repaired. He had spoken to the Vadodara and Daman offices several times about the alternatives. Vikrant Singh was worried that the crane breakdown had occurred just when the villagers' agitation seemed to peter out. The financial deal inked with the client stipulated that WECs would be erected and commissioned before September 30. Any failure in this delivery commitment would mean that EIL would have to make good the financial loss suffered by the client. More importantly, it would affect the customer confidence in EIL's ability to handle wind energy projects "from concept to commissioning and beyond."

The project office at Daman was, however, of the opinion that nothing much could be done except expediting the repair of the crane by the vendor. The option of moving another project team to Nawapur would invariably result in stopping the work at some other project site. Such decisions could be taken by the VP-Project only after considering the workloads of other project teams. Considerations of EIL owning more cranes of the 220 tonne capacity also seemed important especially in the context of the growing business. (Exhibit 19 gives the cost economics).

Everything was not lost yet. During the day, Prithwiraj had supervised the laying of foundation bolts at some of the WEC locations. He had given a directive to his team that all work that did not require the services of the 220 tonne crane should be completed so that the erection work could proceed at full steam once the crane was ready. He estimated that, by tomorrow, almost 65 per cent of the project work would be completed.

But, tomorrow, as the saying goes, is another day!

Exhibit 1: History of Enercon

1984

- Company founded by Aloys Wobben
- Development of first generation of ENERCON wind energy converters

1985

- Series production and installation of E-15/16 with 55 KW

1987

- Construction of a wind farm with 10 ENERCON E-16

1988

- Construction of company's first own production facility (900 m^2)
- Development and installation of prototype E-17/80 KW as well as E-32/300 KW

1989

- Series production of E-17/80 KW and E-32/300 KW

1990

- Further development of E-17 for E-18/80 KW and E-32 for E-33/300 KW with subsequent series production

1993

- Starting of series production of E-40/500 KW as first gearless wind turbine worldwide
- Construction of a production plant for series production of rotor blades
- Development of E-30 / 200 KW, also based on gearless ENERCON concept
- Starting of development of gearless E-66/1,500 KW

1994

- Construction of a production plant for series production of ring generators
- Purchasing of an assembly shop
- Installation of prototype of gearless E-30/200 KW and starting of series production
- ISO 9001 certificate awarded to ENERCON
- Construction of an E-30 production plant in India

1995

- Series production of gearless E-30/230 KW in India

- Installation of prototype of E-66/1,500 KW on company site in Aurich

1996

- Installation of prototype of E-12/30 KW on company site in Aurich
- Purchasing of a production plant in Brazil

1997

- Series manufacture of E-66/1,500 KW
- Starting of series production in Brazil
- Installation of a wind-powered desalination plant on Tenerife

1998

- Participation in SKET Maschinen- und Anlagenbau GmbH, thereby doubling manufacturing capacity
- Setting up of E-66/1,500 KW production facility in Magdeburg

1999

- Setting up of prototype of E-58/1,000 KW

2000

- EWP ENERCON Windtower Production AB founded as a new production facility for steel towers in Sweden
- Further development of E-40 to 600 KW and of E-66 to an output of 1,800 KW
- Series manufacturing of E-58/1,000 KW
- German Environmental Award presented to Aloys Wobben, Dipl.-Ing.
- Completion of E-40 production facility in India
- Setting up of WEC Turmbau GmbH production facility in Magdeburg for pre-fabricated towers

2001

- Construction of foundations and tower of prototype E-112/4,500 KW
- Setting up of a new production facility in Magdeburg-Rothensee

2002

- Setting up of a new production facility for rotor blades in Turkey
- Erection of the E-112 prototype (4.5 MW) in Egeln near Magdeburg, the largest wind turbine in the world

2003

- New production facility for E-112 rotor blades in Magdeburg-Rothensee
- Modification of E-66/18.70 from 1.8 MW to 2 MW (E-66/20.70)
- Erection of the second E-112 near Wilhelmshaven.
- ENERCON has the following capacities installed by 01.09.03.:

  517 x E-30

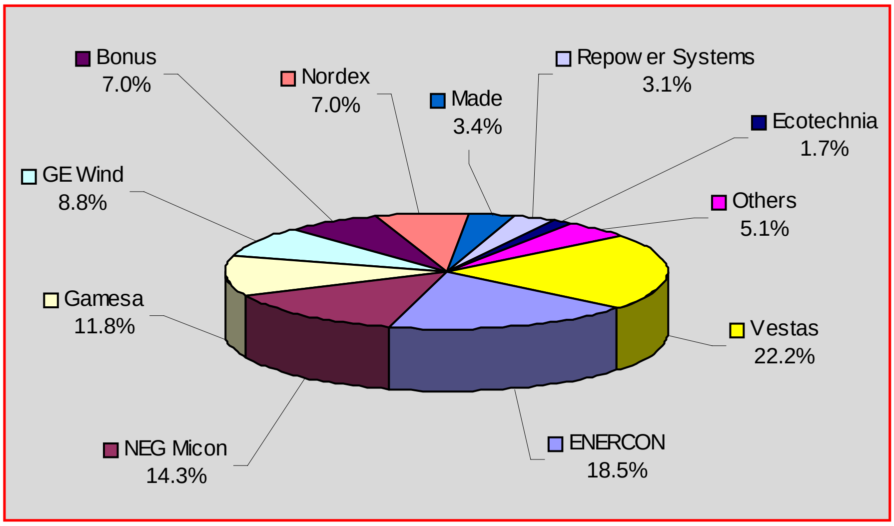
  3,469 x E-40

  145 x E-58

  1,648 x E-66
- Installed capacity worldwide is more than 5 gigawatts.

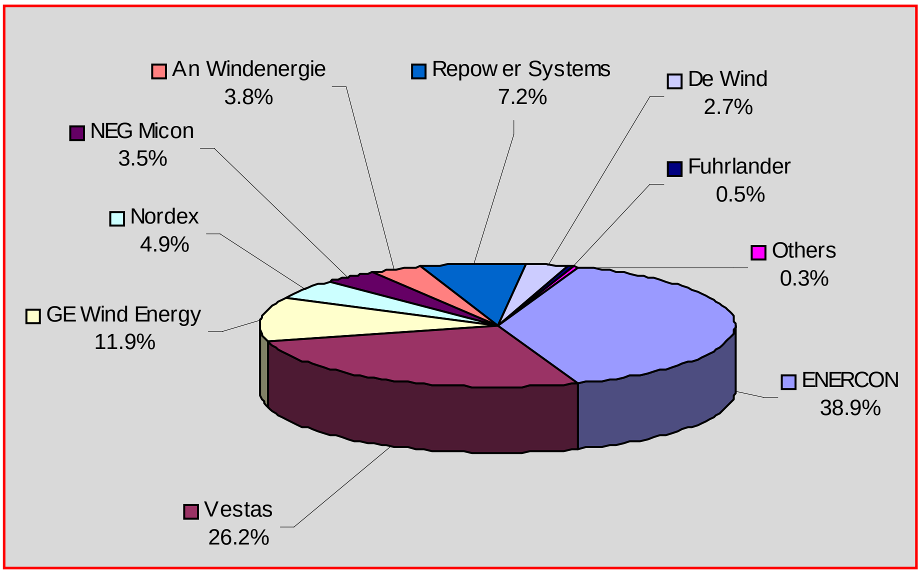
Source: www.enerconindia.net, 2003.

Exhibit 2: Market Shares Worldwide (2002)



Source: www.enerconindia.net, 2003.

Exhibit 3: Market Shares in Germany (first half year 2003)



Source: www.enerconindia.net, 2003.

Exhibit 4: Features of WECs Designed by Enercon

Model	E-12	E-30		E-40		E-58		E-66	
Rated capacity (KW)	30	280	200/230	600	500/600	1000	850-1000	1800	1500/1800
Rotor diameter (m)	12	26	30	40	44	Under development	58	60	66/70
Cut-in wind speed (m/s)	3.0	2.5		2.5		2.5		2.0	
Rated wind speed (m/s)	11.0	12.0		13.0		12.0		13.0	

Unique Features of E-30 and E-40

- Gearless rotor and generator mounted on the same shaft eliminating the gearbox.
- Variable speed function ensuring optimum efficiency at all times with speed range of 18 to 50 rpm.
- Variable pitch function ensuring maximum energy capture.
- Hub height of 50 and 58 m capturing better wind speed.
- Rotor diameter of E-30 is 30 m with a swept area of 707 sq m.
- Rotor diameter of E-40 is 44 m with a swept area of 1,521 sq m.
- Near to unity power factor at all times. Less drawing of reactive power from the grid.
- Grid supportive features due to no voltage peaks at any time.
- Operating range of wind energy converters with voltage fluctuation of -20 to +20%.
- Less wear and tear since the system eliminates mechanical brakes.
- Generator achieves rated output at only 34 rpm and 50 rpm for E-40 and E-30 respectively.
- Three independent braking systems.
- Incorporates lightning protection system including the blades.
- Low cut in wind speed of only 2.5 m/sec.

Source: Company data, 2003.

Exhibit 5 : EIL's Installation History

Year	E30	E40	New E30
1995-96	42	-	-
1996-97	33	-	-
1997-98	37	-	-
1998-99	40	-	-
1999-00	66	11	-
2000-01	59	37	-
2001-02	79	88	-
2002-03	63	132	-
Total	**419**	**268**	**-**
2003-04 In progress	**51**	**263**	**10**

Source: Company data, 2003.

Exhibit 6: Sales Highlights of EIL

Year	Sales(Rs. billion)
1997-98	0.54
1998-99	0.73
1999-00	1.53
2000-01	2.25
2001-02	4.45

Source: www.enerconindia.net, 2003.

Exhibit 7: Installation Plan (2003-04)

April 2003-September 2003

	E-40			E-30	
Project	56 m	45 m	Total	Project	Nos
GIM-1 (EWF)		15	15	Jaisalmer (TR)	5
Jaisalmer		13	13	Tirupati	1
Nawapur (PCBG)	14		14	Navadra, Gujarat	5
Moopandal	36		36	Tamil Nadu	4
Nawapur Extension	2		2	Jaisalmer (NKD)	4
Jaisalmer Extension	18		18		
Total	**70**	**28**	**98**	**Total**	**19**

October 2003-March 2005

	E-40			E-30	
Project	56 m	45 m	Total	Project	Nos
Rajasthan I	80		80	230 KW (Rj)	16
Rajasthan II	20		20	230 KW (TN)	7
Tamil Nadu	18		18	230 KW (GJ)	9
Tamil Nadu (MCL)	22		22	300 KW (Rj/TN)	10
Gujarat	25		25		
Total	**165**		**165**	**Total**	**42**

Source: Company data, 2003.

Exhibit 8: Wind Energy Converters Installed in India

Sl. No.	Name of Manufacturer	WEG Rating	Capacity Addition during April 2002 - March 2003		Details as on March 31, 2003	
		KW	No.	MW	No.	KW
1	ABAN - Kenetech	410	-	-	231	94.71
2	AMTL- Wind World	220	-	-	2	0.44
		250	-	-	325	81.25
		500	-	-	3	1.5
	Total		**-**	**-**	**330**	**83.19**
3	BHEL	55	-	-	16	0.88
		200	-	-	17	3.4
	Total		**-**	**-**	**33**	**4.28**
4	BHEL Nordex	200	-	-	79	15.8
		250	-	-	184	46
	Total		**-**	**-**	**263**	**61.8**
5	C-WEL	250	2	0.5	15	3.75
		600	-	-	2	1.2
	Total		**2**	**0.5**	**17**	**4.95**
6	Danish Windpower	150	-	-	12	1.8
7	Das Lagerwey*	80	-	-	9	0.72
		250	-	-	284	71
	Total				**293**	**71.72**
8	Elecon-HMZ	200	-	-	1	0.2
		300	-	-	51	15.3
		600	-	-	1	0.6
	Total				**53**	**16.1**
9	Enercon	230	45	10.35	398	91.54
		600	92	55.2	233	139.2
	Total		**137**	**65.55**	**630**	**239.74**
10	Himalaya	140	-	-	4	0.56
		200	-	-	24	4.8
	Total		**-**	**-**	**28**	**5.36**
11	JMP-Ecotecnia	225	-	-	10	2.25
12	Kirloskar -WEG	400	-	-	8	3.2
13	Micon (Pearl)	90	-	-	99	8.91
14	Mitsubishi	315	-	-	6	1.89
15	NEG Micon	750	80	60	146	109.5
		950	5	4.75	5	4.75
	Total		**85**	**64.75**	**151**	**114.25**
16	NEPC-Micon	55	-	-	14	0.77
		110	-	-	2	0.22
		200	-	-	50	10
		225	-	-	586	131.85
		250	-	-	531	132.75

Contd.

Sl. No.	Name of Manufacturer	WEG Rating	Capacity Addition during April 2002 - March 2003		Details as on March 31, 2003	
		KW	No.	MW	No.	KW
		400	-	-	121	48.4
		600	-	-	2	1.2
	Total		**-**	**-**	**1306**	**325.19**
17	NEPC-India	225	19	4.275	165	37.125
		250	-	-	7	1.75
		400	-	-	7	2.8
	Total		**19**	**4.275**	**179**	**41.675**
18	Nedwind-Windia	250	-	-	4	1
		500	-	-	20	10
		550	-	-	35	19.25
	Total		**-**	**-**	**59**	**30.25**
19	Pegasus	250	-	-	9	2.25
20	Pioneer Wincon	110	-	-	10	1.1
		250	3	0.75	94	23.55
		755	-	-	1	0.755
	Total		**3**	**0.75**	**105**	**25.35**
21	REPL- Bonus	55	-	-	22	1.21
		100	-	-	1	0.1
		320	3	0.96	56	17.92
	Total		**3**	**0.96**	**79**	**19.23**
22	RES-Adavanced Wind Turbine*	250	-	-	65	16.25
23	Sangeeth - Carter	300	-	-	25	7.5
24	Suzlon	270	-	-	2	0.54
		350	20	7	702	245.7
		1000	8	8	73	73
		1250	49	61.52	49	61.25
	Total		**77**	**76.25**	**826**	**380.49**
25	Tacke ***	250	-	-	4	1
		600	-	-	21	12.6
		750	-	-	1	0.75
	Total				**26**	**14.35**
26	Textool-Nordtank	300	-	-	65	19.5
		550	-	-	5	2.75
	Total		**-**	**-**	**70**	**22.25**
27	TTG - Husumer	250	11	2.75	175	43.75
28	Vestas - RRB	55	-	-	31	1.705
		90	-	-	21	1.89
		100	-	-	5	0.5
		200	-	-	56	11.2
		225	19	4.275	707	159.075
		500	40	20	109	54.5
	Total		**59**	**24.275**	**929**	**228.87**
29	Wind Power	330	-	-	29	9.57
30	Wind Master	200	-	-	1	0.2
31	Windmatic	55	-	-	30	1.65
	Total		**396**	**240.060******	**6077**	**1873.975 ****

* Details not confirmed by the manufacturer.

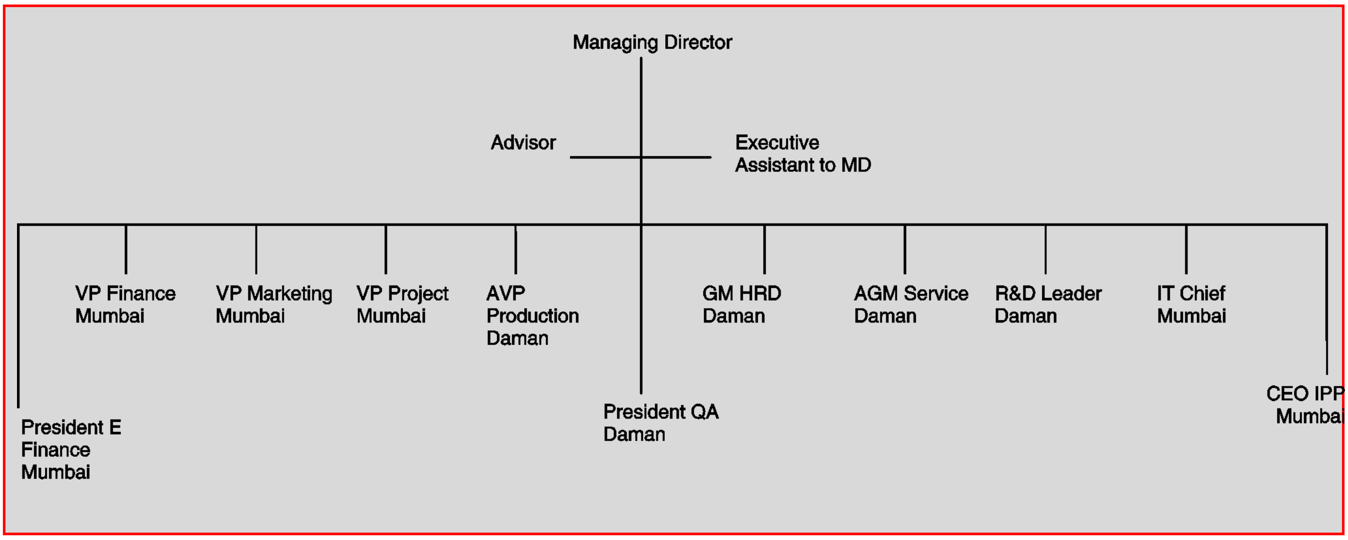
** The total installed capacity as per the Ministry of Non-Conventional Energy Sources (MNES) is 1869.500MW.

*** Tacke has been taken over by GE Wind Energy.

**** Capacity addition as per MNES is 241.30MW.

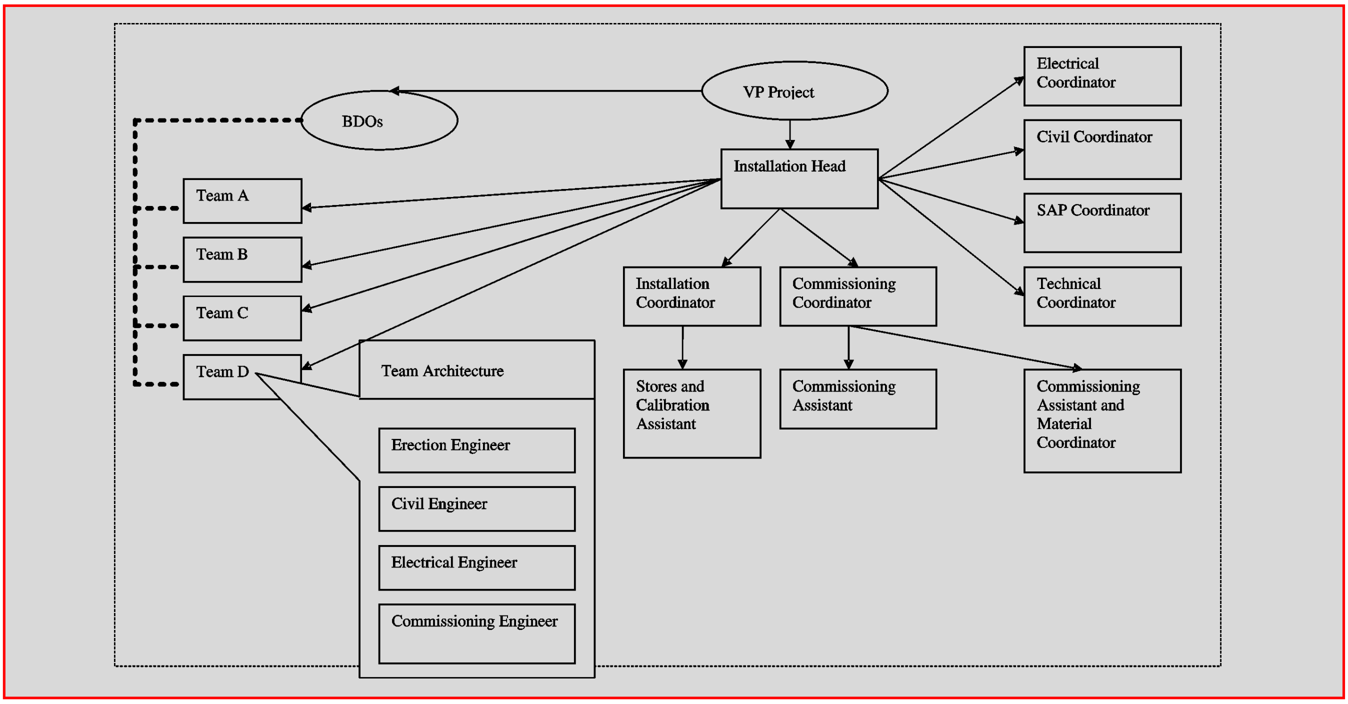
Source: www.windpowerindia.com/statmanuf.html

Exhibit 9: Organization Chart (Corporate)



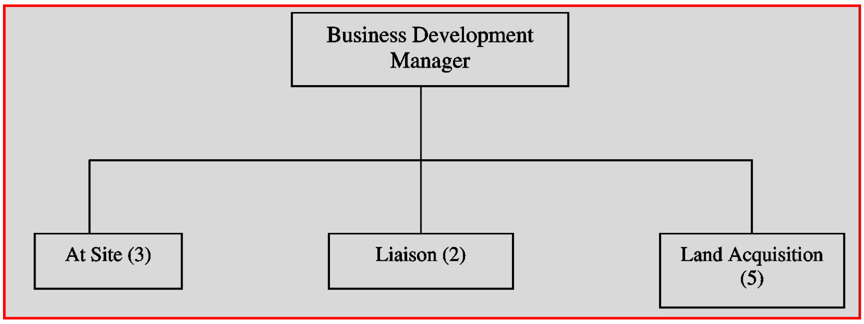
Source: Company data, 2003

Exhibit 10: Organization Chart (Installation)



Note: There were four BDOs, one each in Bangalore, Jaipur, Pune, and Vadodara.
Source: Company data, 2003.

Exhibit 11: Organization Chart (Business Development Office)



Source: Company data, 2003.

Exhibit 12: Site Map of Nawapur Project

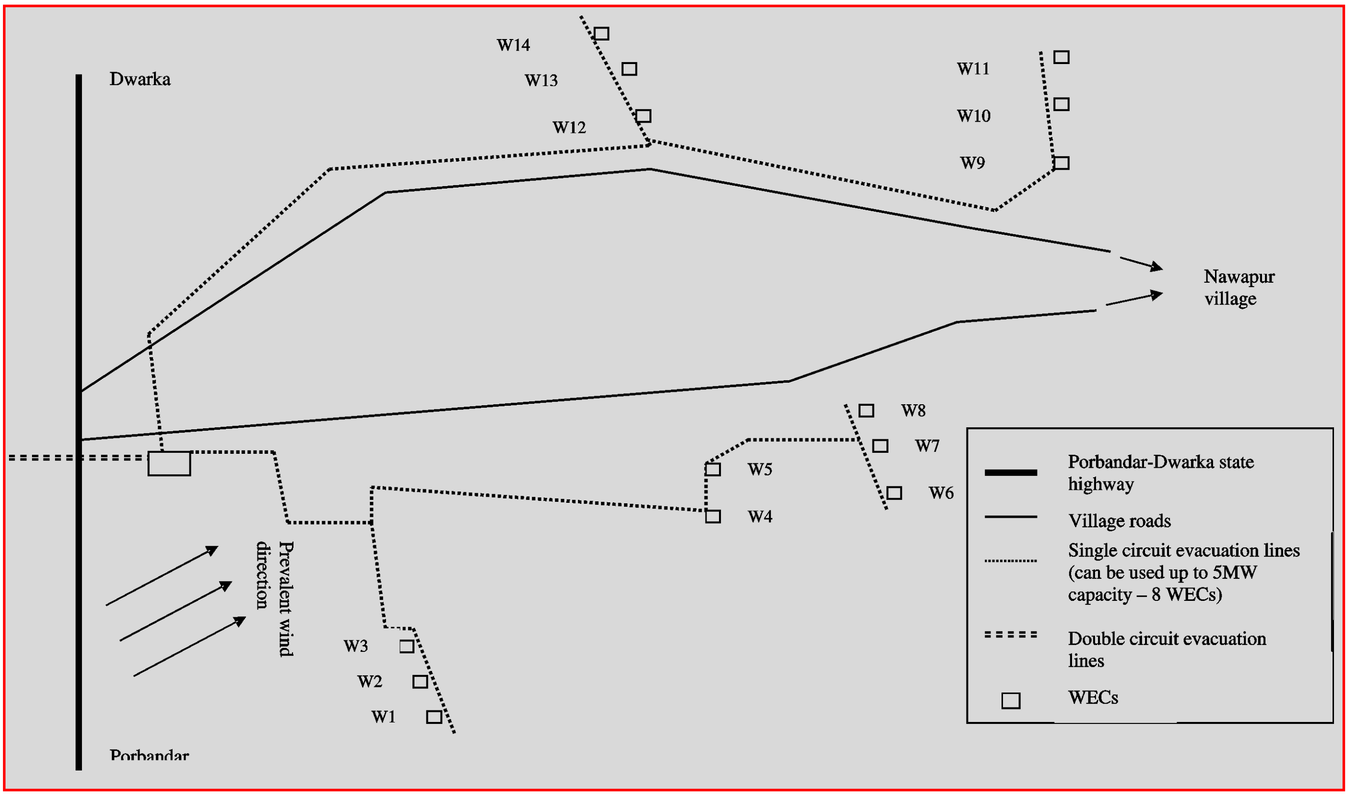
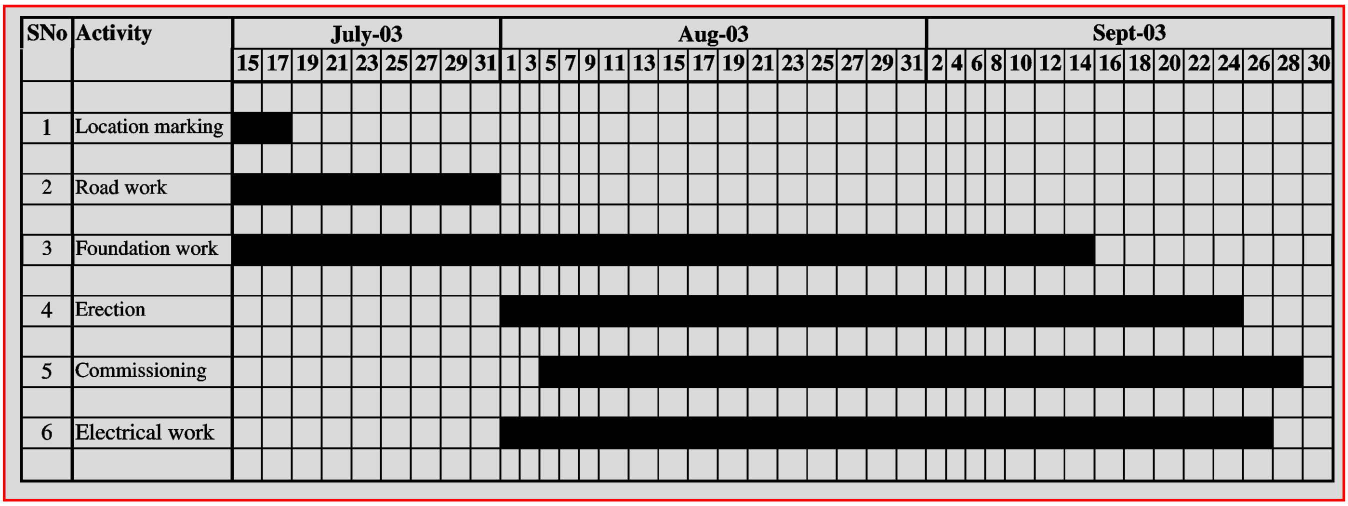


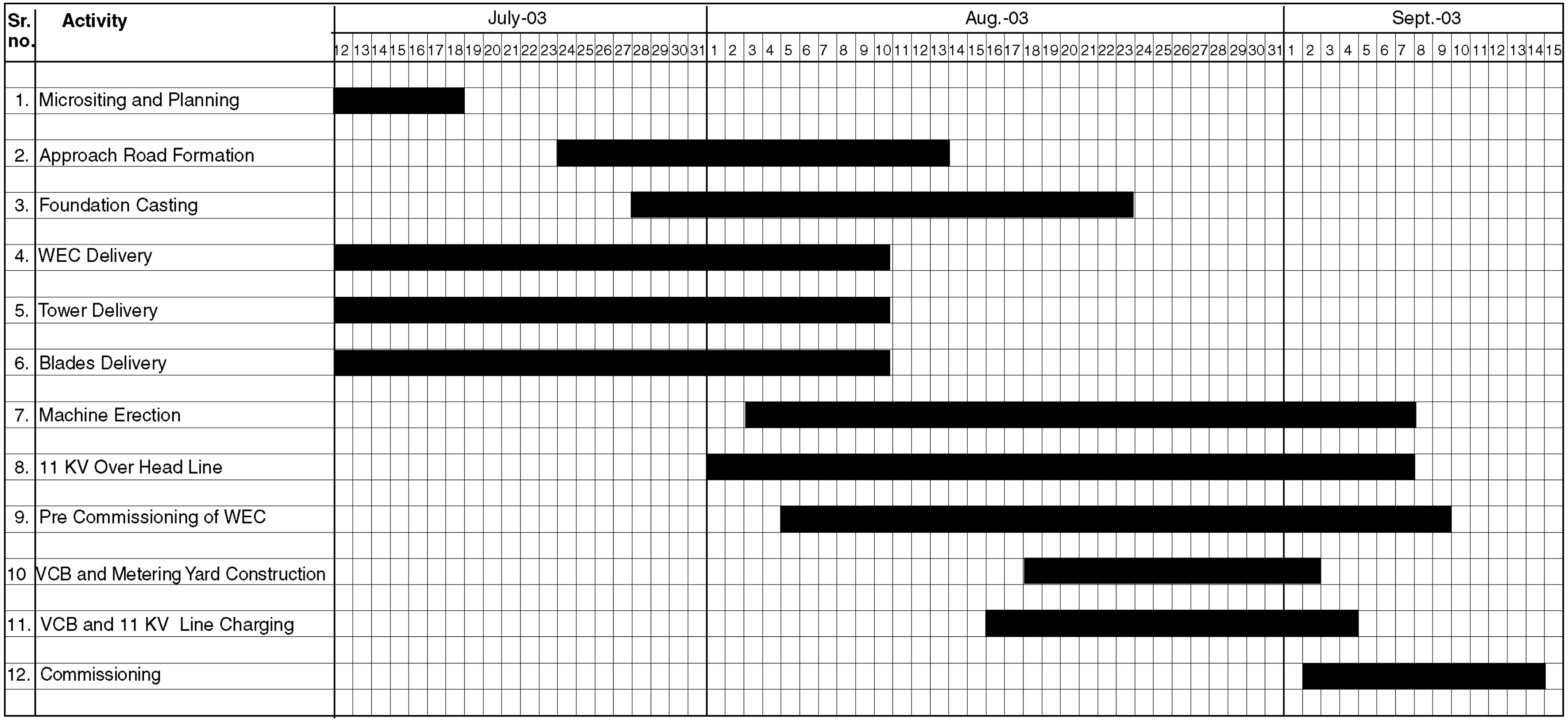
Exhibit 13: Bar Chart – Installation Head, Daman (14 x E-40 PCBG-Project, Nawapur Site)



Notes:
1. The bar chart is prepared without considering any margin for unforeseen circumstances.
2. Considering the customer requirement, we have split this project into four groups (A,B,C, and D).
3. Group A: Survey No: 314/2, 316, 318, and 320.
4. Group B: Survey No: 278/2 and 278/3.
5. Group C: Survey No: 272 and 273.
6. Group D: Survey No: 52.

Source: Company data, 2003.

Exhibit 14: Bar Chart — BDO, Vadodara (14 x E-40 PCBG-Project, Nawapur Site)



Note: The bar chart is prepared without considering any margin for unforeseen circumstances.
VCB: Vacuum Circuit Breaker.

Source: Company data, 2003.

Exhibit 15: Activities Involved in the Nawapur Project

1.1 Land Identification Process: 1 Year
a. Identification of a probable site
b. Installation of wind mast
c. Identification of commercially viable land plots
d. Collection of ownership details (7/12 Extract, Government of Gujarat)

1.2 Private Land Acquisition: 45-60 Days
a. Making land sale deeds with owners
b. Applying to GEDA with copy of land deeds
c. Clearance by GEDA

Activity 1.2 would normally take 120 to 150 days providing time for multiple rounds of negotiations. In the case of revenue land, the acquisition time was longer usually requiring 180 days because of bureaucratic delays. Revenue land acquisition involved the following steps:

- Collecting village maps with survey numbers of plots
- Applying to GEDA with village maps
- Serving no objection certificate from GEDA
- Approaching respective District Collector for certification and recommendation
- Sending recommendation of Collector to Gandhinagar for clearance by the cabinet
- Sending approval of the cabinet to Collector
- Allocation of land to GEDA by Collector
- Leasing of land to EIL

1.3 Plain Table Survey: 2-3 Days

2. Micrositing and Planning: 7 Days
a. Micrositing
b. Planning of power evacuation and approach roads Release to marketing

3. Approach Road Formation: 20 Days (plain terrain)
a. Excavation/Levelling
b. Final levelling and side cutting

4. Foundation Casting: 10 Days (including 7 days for curing) per WEC
a. Excavation
b. Concreting
c. Backfilling and curing

5. WEC Delivery: 4-5 Days for Each Truckload
(2 truckloads per WEC)
a. Loading at factory and despatch
b. Travelling time
c. Unloading and storage

6. Tower Delivery: 4-5 Days for Each truckload
(3 truckloads per WEC)
a. Delivery of 1st section
b. Delivery of 2nd section
c. Delivery of 3rd section
d. Delivery of 4th section
e. Delivery of 5th section

7. Blades Delivery: 4-5 Days for Each Truckload
(4 blades per truck, 3 blades per WEC)
a Loading at factory and despatch
b. Travelling time
c. Unloading and storage

8. Machine Erection: 2 Days per WEC (Using a 220 Tonne Crane)
a. Erection of tower
b. Erection of nacelle
c. Erection of hub
d. Erection of control panel
e. Control wiring and cable connection

9. 11 KV Overhead Line: 30 Days
a. Foundation
b. Erection of poles
c. Stringing

10. Pre-Commissioning of WEC: 1 Day per WEC

11. VCB and Metering Yard Construction: 7 Days
a. Construction of VCB
b. Construction of metering yard

12. VCB and 11 KV Line Charging: 0.5 Days
a. Charging of VCB
b. Charging of 11 KV line

13. Commissioning: 1 day for 6 or 7 WECs

Notes: 1. Movement time for the 220 tonne crane between WEC locations is one day.
2. With two project teams, machine erection time can be brought down to 1.5 days because of the possibility of continuous working subject to wind conditions.
3. One project team can oversee two erections within walking distance if cranes are available.

Exhibit 16: Precedence Relationships

Activity No.	Description	Immediate Predecessor
1	Land acquisition process	-
2	Micrositing and planning	1
3	Approach road formation	2
4	Foundation casting	3
5	WEC delivery	2
6	Tower delivery	2
7	Blades delivery	2
8	Machine erection	4, 5, 6, 7
9	11KV Overhead line	4
10	Pre-commissioning of WEC (diesel generator)	8
11	VCB and metering yard construction	2
12	VCB and 11KV line charging	9, 10, 11
13	Commissioning	12

Source: Company data, 2003.

Exhibit 17: Composition of the Nawapur Project Team

Description	No.
Deputy Manager/Manager	1
Civil Engineer, Supervisor, and Trainee Engineer	3
Electrical Supervisors	4
Mechanical Supervisors	3
For SAP, one Supervisor/Engineer in Rotation	1
Mechanical Fitters	5
Store Keepers	1
Fitters for Hilly Region	3
Commissioning Team	5

Source: Company data, 2003.

Exhibit 18: Nawapur Project Progress Report

As on 23-8-2003

Act No	Activity/Sub-activity Description	Plan Start	Plan Completion	Actual Start	Actual Completion	Status
0060	11KV External SCOH line	28/7/2003	30/8/2003	28/7/2003	21/8/2003	Completed
0430	11KV External DCOH line	11/8/2003	9/9/2003	11/8/2003		Under progress
0580	Road survey	15/7/2003	20/7/2003	15/7/2003	20/7/2003	Completed
0620	Approach road formation	20/7/2003	30/8/2003	20/7/2003	21/8/2003	Completed
0670	WBM formation	10/9/2003	30/10/2003			
0030	GEDA approvals	1/8/2003	14/8/2003			
0450	Land lease with customer	11/8/2003	15/9/2003			
0460	PPA approval	2/6/2003	10/7/2003	1/6/2003	10/7/2003	Completed
0470	PPA signing	1/9/2003	10/9/2003			
0480	Drawing approval from GEDA	1/5/2003	17/5/2003	1/5/2003	17/5/2003	Completed
0490	Commissioning certificate	5/9/2003	10/9/2003			
0500	First bill—Payment collection	11/10/2003	27/10/2003			
0510	CEIG approval	16/8/2003	15/9/2003			
WC01	WEC - 01 (56 Mtrs)	5/9/2003	7/9/2003			
WC02	WEC - 02 (56 Mtrs)	3/9/2003	5/9/2003			
WC03	WEC - 03 (56 Mtrs)	1/9/2003	3/9/2003			
WC04	WEC - 04 (56 Mtrs)	30/8/2003	1/9/2003			
WC05	WEC - 05 (56 Mtrs)	28/8/2003	30/8/2003			
WC06	WEC - 06 (56 Mtrs)	25/8/2003	27/8/2003			
WC07	WEC - 07 (56 Mtrs)	1/9/2003	2/9/2003			
WC08	WEC - 08 (56 Mtrs)	19/8/2003	20/8/2003	19/8/2003		Under progress
WC09	WEC - 09 (56 Mtrs)	18/8/2003	20/8/2003	17/8/2003		Under progress
WC10	WEC - 10 (56 Mtrs)	26/8/2003	28/8/2003			
WC11	WEC - 11 (56 Mtrs)	21/8/2003	25/8/2003	21/8/2003		Under progress
WC12	WEC - 12 (56 Mtrs)	29/8/2003	30/8/2003			
WC13	WEC - 13 (56 Mtrs)	5/9/2003	6/9/2003			
WC14	WEC - 14 (56 Mtrs)	2/9/2003	5/9/2003			
0020	11KV DP structure — 1 to 14 (14 Nos.)	18/8/2003	7/9/2003	18/8/2003		Under progress
0030	11KV Two pole metering	25/8/2003	7/9/2003	21/8/2003		Under progress
0060	11KV Internal overhead line	28/7/2003	30/8/2003	28/7/2003	21/8/2003	Completed
0630	Internal and external road	14/4/2003	15/7/2003			Under progress
0730	11KV Metering and VCB four pole structure	25/8/2003	14/9/2003			
1580	Handing over	16/9/2003	23/9/2003			
1660	Soil testing	20/7/2003	20/8/2003	20/7/2003	21/8/2003	Completed
1670	Foundation-01 [Contractor A]	5/8/2003	21/8/2003	5/8/2003		Under progress
1700	Commissioning	21/8/2003	13/9/2003			
2170	Office construction	1/9/2003	15/11/2003			
2280	SCADA	1/9/2003	15/10/2003			
2300	Foundation-02 [Contractor A]	3/8/2003	27/8/2003	3/8/2003		Under progress
2350	Foundation-03 [Contractor A]	1/8/2003	25/8/2003	1/8/2003		Under progress
2400	Foundation-04 [Contractor A]	30/7/2003	23/8/2003	30/7/2003		Under progress
2450	Foundation-05 [Contractor A]	28/7/2003	21/8/2003	28/7/2003	21/8/2003	Completed
2500	Foundation-06 [Contractor A]	26/7/2003	18/8/2003	26/7/2003	18/8/2003	Completed
2550	Foundation-07 [Contractor A]	24/7/2003	24/8/2003	24/7/2003		Under progress
2600	Foundation-08 [Contractor A]	22/7/2003	13/8/2003	22/7/2003	13/8/2003	Completed
2650	Foundation-09 [Contractor A]	20/7/2003	11/8/2003	20/7/2003	11/8/2003	Completed
2700	Foundation-10 [Contractor A]	20/7/2003	19/8/2003	20/7/2003	22/8/2003	Completed
2750	Foundation-11 [Contractor A]	22/7/2003	15/8/2003	22/7/2003	15/8/2003	Completed
2800	Foundation-12 [Contractor A]	24/7/2003	21/8/2003	24/7/2003		Under progress
2850	Foundation-13 [Contractor A]	26/7/2003	23/8/2003	26/7/2003		Under progress
2900	Foundation-14 [Contractor A]	28/7/2003	25/8/2003	28/7/2003		Under progress

Source: Company data, 2003.

Exhibit 19: Comparative Statement between Owning and Hiring of Crane by EIL

Sr No	Expense Description	Annual Cost (Rs 000)
A	**Cost of Crane AC 665 Ex duty**	**20,000**
1	Unloading of the crane at the docks	-
2	Custom clearance and other legal formalities	10,000
3	RTO registration and related legal expenses	500
4	Road tax	50
5	Insurance of the crane	300
6	Mobilization of the crane to the site	800
7	Transit insurance	-
	Total landed cost	31,650
B	**Spares Inventory Cost @ 5% of Landed Cost**	**1,500**
C	**Operating Cost**	
1	Diesel expenses: Lower engine	240
2	Diesel expenses: Upper engine	720
3	Hydraulic oil	25
4	Engine oil	20
5	Gear oil	20
6	MP grease	15
7	TQ oil	20
8	Wooden sleepers (about 50 nos)	60
9	Slings/D-shackles/Belt slings/Nylon rope	50
10	Tool box, Special spanner set, Sledge hammer, Wheel spanner, Hydraulic jack, etc.	40
11	Filters of all type, i.e., diesel, oil, and air for both the engines, hydraulic oil, torque converter, etc.	40
12	Six tyres at Rs. 75,000 per tyre	450
13	Electrical works, painting works, regular washing, and other expenses	25
14	Operator's salary, over-time, lodging, boarding, etc.	300
15	Helpers' (two) salary and other expenses	240
	Total	**2,265**
D	**Annual O&M Contract Cost**	**700**
E	**14% Annual Interest on Capital Investment (A+B)**	**4,641**
F	**Annual Cost for Hiring Similar Crane**	
1	12 lakh/month x12	**14,400**
2	MOB/DMOB (for 4,000 km @ 300/km)	1,200
	Total	**15,600**
1. Annual cost for operating Demag AC 665 crane by EIL (C+D+E)		**7,606**
2. Annual cost for equivalent crane from market (F)		**15,600**
3. Difference 1-2		**-7,994**

Break-even will be within three years.

Source: Company data, 2003.

Appendix: Wind Energy Business

World Scenario

Wind energy is a renewable energy source and is a pollution-free alternative to burning fossil fuels. While wind energy has been used for a long time (e.g., 18th century wind turbine generators), commercialization of wind energy as an alternate source of power is a relatively new phenomenon. This has been aided by advancements in the electrical and electronics industry during the latter part of the 20th century. The result can be seen in the growth of the total installed base of wind energy as shown in Exhibit A.1. The compounded annual growth rate (CAGR) between 1998 and 2002 has been 33.3 per cent. A comparison of the installed base in different countries is provided in Exhibit A.2

Several reasons can be ascribed to this growth in the installed base of wind energy. Advancements in engineering design over the last century have steadily brought down the per unit cost of electricity generated through WECs. The cost of setting up a wind power plant per MW of energy generated is higher compared to a conventional power plant. However, the low running costs of a WEC make the cost per MW generated over the lifetime of the WEC comparable to that of a conventional power plant. The wind power plants located at remote places also allow decentralization of power distribution thereby avoiding large losses in transmitting power. However, the biggest driver for the growth of the wind energy business has been government policy. Given the depleting sources of fossil fuel and the environmental hazards of nuclear fuel, many government policy makers favour increasing dependence on renewable sources. For example, Germany has decided to close down all its nuclear power plants within the next 20 years. Wind energy has emerged as one of the leading options for filling up the resultant supply gap. Similarly, the UK government has set a target of supplying 10 per cent of its energy needs from renewable energy sources by 2010.

Indian Scenario

The wind energy business started in India around 1991 when the first WEC was erected in Gujarat. The potential for wind energy generation in India has been estimated to be around 45,000 MW. However, the technical potential is estimated to be only 10,000 MW considering the absorbing capacity of the existing grid. Exhibit A.3 gives perspectives on the wind power potential in India including a map showing the distribution of high wind locations. The installed base of wind energy in India in December 2002 was around 1,700 MW. Exhibit A.4 gives the growth of the installed capacity for wind energy in India. The CAGR has been 15.2 per cent. The players in the wind energy business can be clubbed into the WEC manufacturers, the wind energy firms, and the firms involved in maintenance of WECs. The wind energy firms deal with identification of potential sites, promotion of the identified sites to prospective clients, site preparation, building of infrastructure for evacuation of power, and erection and commissioning of WECs. Most wind energy firms have tied up with specific WEC manufacturers. Maintenance and running of WECs are generally covered by annual O&M contracts and may or may not be handled by the wind energy firm that installed it.

Investments in WECs are entitled for availing accelerated depreciation of 80 per cent of the value in the first year itself. Manufacturing firms can also set off its electricity bill against the generation from its WECs. For an industrial firm, the tariff differential between the per KW high-tension charges payable to the electric utility and the per KW generating cost from its own WECs can be substantial. The customer base can be segmented into (i) firms that have established businesses and are interested in depreciation benefits and tariff differentials and (ii) wind farms that operate as independent power producers (IPPs). The initial days saw a large number of industrial firms getting interested in the wind energy business purely for the sake of depreciation benefits. Since the accelerated depreciation rate in the first year was 100 per cent in those days, decisions regarding technology, quality, and maintainability were relegated to the background. It did not take long for industrial firms to realize that setting up a wind farm and running it productively on a daily basis were two different things. Customer confidence in wind energy reached its bottom and a shake-out occurred around 1994-95 after which only a few major players remained. These include Enercon India, Suzlon, and Vestas RRB.

Apart from wind energy promoting policies by the central government, the states have also formulated their own policies and incentives. Exhibit A.5 outlines the policy of the Gujarat government regarding wind power generation.

Exhibit A.1: World Trend of Wind Energy Development

Year	Installed Capacity (MW)
1998	10,153
1999	13,932
2000	18,449
2001	24,927
2002	32,037

Source: www.enerconindia.net, 2003.

Exhibit A.2: Top Five Countries in Wind Energy

Name	Installed Capacity(MW) September 2001	Installed Capacity(MW) December 2002	Wind Energy Share of Electricity Generation (%)
Germany	7,270	11,968	4
Spain	2,789	5,043	
USA	2,782	4,674	
Denmark	2,374	2,880	17
India	1,340	1,702	
Others	3,536	5,770	
World	20,091	32,037	0.4

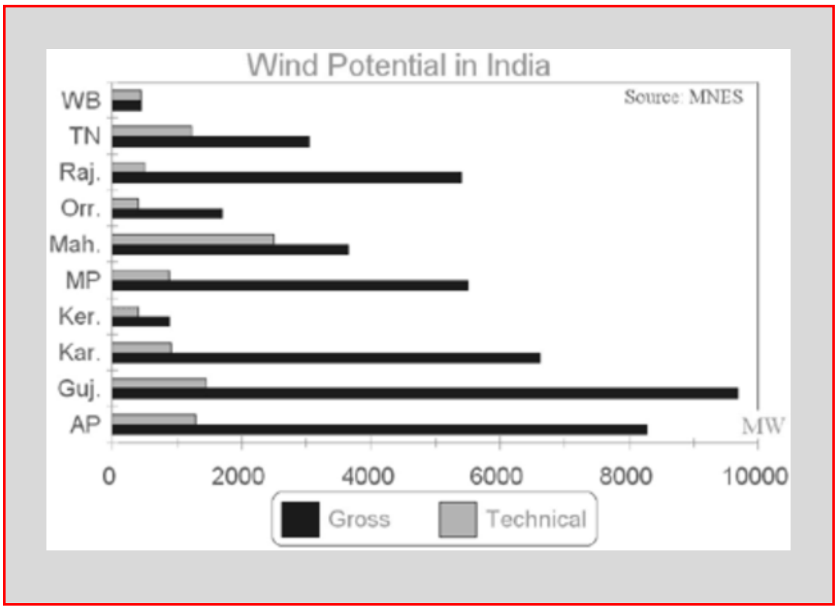
Note: Wind electrical energy production in the world was 65 tera watt hours in 2002.

Source: www.enerconindia.net, 2003.

Exhibit A.3: Wind Power Potential in India

The state-wise gross and technical wind power potential and potential wind location can be seen in Figures 1 and 2.

Figure 1: State-wise Wind Power Potential in India



Source: www.enerconindia.net, 2003.

Wind Resource Assessment: A nation-wide wind resource assessment is being carried out by the Centre for Wind Energy Technology (CWET), Chennai. As many as 24 states and union territories are covered under this programme with about 900 wind monitoring and wind mapping locations. Of these, 204 locations spread over 13 states and union territories have recorded viable annual average wind power density. Based on the data collected and resource studies carried out, the regions that are experiencing good winds have been identified and can be seen in Figure 2.

Wind Regime: The macro-scale atmospheric flow of wind in tropical India is determined strongly by the strength of the monsoon winds. The monsoon period in India can be categorized into south-west monsoon and north-east monsoon.

The south-west monsoon begins in the month of April and is formulated in the Indian ocean which later gradually moves in the north-east direction and first hits the state of Kerala by the second half of May. During this period, wind gradually gains strength and peaks during the month of July with wind speeds exceeding 20-30 kmph over Western India, Southern Tamil Nadu, Saurashtra, Kutch region, and coastal Bengal. Strong upper winds (150m above ground) are observed in the forenoons over the interior peninsula, Western Madhya Pradesh, Rajasthan, and Saurashtra during the peak monsoon period.

From September, the wind generally weakens over Saurashtra, Kutch, and Southern Tamil Nadu with the areas experiencing winds of over 15 kmph. This is the effect of large scale air-flow during the south-west monsoon period.

During the winter months, the large scale air-flow reverses, i.e., moves from the Himalayan belts towards the Indian ocean, which is called the north-east monsoon. Wind speeds over 10 kmph are experienced during this period in Orissa, Saurashtra, Kutch, and Southern Tamil Nadu.

Exhibit A.4: Development of Wind Energy in India

Year	Installed Capacity (MW)
1998	968
1999	1,095
2000	1,220
2001	1,340
2002	1,702

Source: www.enerconindia.net, 2003.

Figure 2: Potential wind Location

Exhibit A.5: Wind Power Generation Policy — 2002

Government of Gujarat
Energy & Petrochemicals Dept.
Govt. Resolution No. EDA-10-2001-3054-B (Part-II)
Sachivalaya, Gandhinagar
Dated the 20th June 2002

Resolution

Gujarat has the longest coastline in the country and the potential for wind energy in the state has been estimated at around 5,000 MW on the coastline of Saurashtra and Kutch. The Gujarat Energy Development Agency (GEDA) in collaboration with the Indian Institute of Meteorology, Bangalore has identified several excellent sites for wind power generation in the state. The Government of India has also announced guidelines for wind energy. The formulation of a sustainable wind power policy was, therefore, under the active consideration of the state government. After due consideration, the state government has decided to declare the Wind Power Generation Policy, 2002. The salient features of the policy are as under.

1. ***Title***: This scheme shall be known as the Wind Power Generation Policy, 2002.
2. ***Operative Period***: This policy will come into force from the date of this government resolution. It will remain in operation for a period of five years. It is necessary to clarify that the operative period would mean that the beneficiaries who set up wind energy generating units during the said period of five years and units installed during this operative period of this policy would become eligible for the benefits declared in the policy. This eligibility should however, be for 20 years or the life span of the wind energy generator whichever is earlier, i.e., the units would be eligible for the benefits available in the policy such as selling, wheeling, banking of electricity, exemption of electricity duty, demand cut, etc. wherever applicable for the entire eligibility period.
3. ***Eligibility***: Under this policy, no cash incentives or sales tax incentives are available primarily due to constraints of resources. It is, therefore, proposed to widen the eligibility for setting up such wind energy generators. The beneficiaries are classified as under:
   (i) ***Any registered industrial undertaking engaged in the manufacture of production of goods within the state***
   Such industrial units may be allowed to wheel power to their own manufacturing units (maximum up to 2 units) within the state at a wheeling price to be paid by them. This would encourage the industrial undertakings to set up such wind generators since they would be availing the benefits of cheaper electricity. Such wind energy generating units may also be allowed at their option to sell electricity to the Gujarat Electricity Board at a fixed price to be paid per unit. It should be made obligatory for them to give the option and the option once exercised should not be changed.
   (ii) ***Non-industrial non-manufacturing units***
   Non-industrial and non-manufacturing units and developers may also be allowed to set up wind energy generating units where they will have to sell electricity to the Board and may not be permitted to wheel the power to any unit either of their own or to a third party. Under the developer approach, permission may be granted to developers to set up wind energy generating units in advance to be transferred to the investors subsequently to ensure effective planning/energy generation and optimum use of the land.
4. ***Eligible sites***: The beneficiary may set up a wind-farm on its own land or a private leased land within the eligible sites or the leased land of GEDA.
5. ***Sale of energy***: As regards the purchase price of energy generated by wind-farms, it is proposed that in case of industrial undertakings, at their option, and in case of non-industrial units, the Gujarat Electricity Board may purchase electricity generated by such wind energy generating units at Rs 2.60 per unit. An increase of 5 paise is to be provided every year for 10 years. After the 10th year, the rate will be negotiable. In the case of industrial undertakings, the option of wheeling electricity is made available to them instead of selling it to the Gujarat Electricity Board.
6. ***Plant and machinery***: So far as plant and machinery are concerned, only those energy generators which are type tested and approved by the international testing houses recognized by the Ministry of Non-Conventional Energy Sources should be made eligible. In future, when the guidelines for such equipments are decided either by the Central Electricity Regulatory Commission or the Gujarat Electricity Regulatory Commission, it would be necessary to follow those guidelines.
   Second-hand generators, either indigenous or imported, would not be made eligible under this scheme. Wind turbine technology worldwide has considerably improved. The scheme aims at improved technology.
7. ***Land***: Since the land has already been acquired by GEDA, unless the developer has purchased the land, the Coordination Committee for allotment of land would consist of the following members (the Collector of the respective district/s has been nominated in this Committee so as to have effective coordination):

1)	ACS/PS/Secretary (EPD)	Chairman
2)	Director (IREP)/JS/DS (EPD)	Member
3)	Chief Electrical Inspector	Member
4)	General Manager (Comm), GEB	Member
5)	Collector of the district	Member
6)	Director, GEDA	Member Secretary

8. ***Wheeling of electricity***: The industrial undertakings setting up wind energy generators while opting for wheeling the electricity to their manufacturers may be allowed to do so at a wheeling charge of 4 per cent.
9. ***Third party sale of electricity***: Third party sale of electricity is not permitted under this policy.
10. ***Banking of electricity***: The surplus energy generated could be banked for a period of six months with GEB/AEC/SEC/license for a maximum period of six months.

Saral Mukherjee is an Assistant Professor in the Production and Quantitative Methods Area at the Indian Institute of Management, Ahmedabad. A Fellow of IIM Calcutta, he specializes in operations management and is involved in research, teaching, and consulting in the area of supply chain redesign, inventory policies, process analysis, project management, and operations strategy. He has published in reputed international journals and designed and delivered several customized training programmes for national and multinational firms.
e-mail: saralm@iimahd.ernet.in

G Raghuram is a Professor in the Public Systems Group at the Indian Institute of Management Ahmedabad. His interest areas are logistics and supply chain management, and infrastructure and transportation systems. He is a co-editor of three books: *Shipping Management: Cases and Concepts*, *Infrastructure Development and Financing: Towards a Public-Private Partnership*, and *Logistics and Supply Chain Management: Cases and Concepts*. He has published over 30 papers and written over 100 case studies. One of his recent studies was on the 'Turnaround' of Indian Railways. He has been a President of the Operational Research Society of India.
e-mail: graghu@iimahd.ernet.in