Feasibility report for the proposed 100 MW wind power project in Gujarat

Prepared for

Gujarat State Petrolem Corporation Limited

Project Report No. 2008RT07

The Energy and Resources Institute

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Executive summary

Background

The state of Gujarat has one of the best wind potentials in the country. The total identified wind power potential is 9675 MW from 38 identified sites.

Gujarat State Petroleum Corporation Limited plans to venture in to wind energy sector and plans to develop a wind power project of 100 MW capacities, for and sale of electricity to state utility in the state of Gujarat. A feasibility study was undertaken involving technical and financial analysis of potential wind sites in Gujarat, wind turbines of different capacities offered by different manufacturers, as well as analysing the policies and regulations in the wind power sector in Gujarat.

Site selection

To assess the feasibility of wind projects for GSPC, the sites that are currently being offered by the wind farm developers in Gujarat, along with other sites having good potential and wind power density above 240w/m^2 were analysed. Three sites Warshamendi, Kalyanpur and Poladia were selected for the detailed study as they cover the entire spectrum of sites available providing optimistic, average and pessimistic scenarios.

Selection of turbines

Wind turbines are available in India up to 2 MW capacities with different technical specifications. Selected wind turbines, of capacity of 500 kW and more, available in India, having type certification from Centre for Wind Energy Technology (C-WET), and currently being offered by the developers were analysed in line with the requirement of GSPCL. A detailed matrix of technical parameters and their score, depending upon the impact of the parameter on cost or performance, was developed. The critical technical parameters were: capacity, type of generator, cut in speed, rated wind speed, type of power control, class of turbine, geared/ gearless turbine, and reactive power control. Based on this ranking 6 wind turbines NM1650, and NM750 of Vestas wind technologies India Limited, S1500, and S2100 of Suzlon Energy Limited, E-53-800kW of Enercon India Limited, and 600 KW Pawan Shakti RRB Energy is selected for the detailed study.

Energy generation

Based on the monthly wind data at the selected sites, monthly energy generation for each of the selected turbines was estimated at each of the sites. The net generation was estimated taking into account various losses and the corrections factors.

The government policies and regulations play an important role in development of wind power projects. The latest tariff order issued by the Gujarat Electricity Regulatory Commission (GERC) was studied and its provisions regarding wind power purchase tariff, captive use etc. were used in the analysis. As per the tariff order, the generation from the wind project can be used as self-consumption in the same month and surplus generation would be considered as sale to Distribution Company at tariff Rs. 3.37/kWh. Detailed consultations with the Gujarat Energy Development Agency (GEDA), GERC, Gujarat Urja Vikas Nigam Limited (GUVNL) were undertaken to identify the clearance and contractual requirements.

Project cost

The project cost has been estimated for a 100 MW project at Rs. 679.67 cr., as determined from the present costs of wind turbines based on quotes available for wind energy projects in Gujarat.

Financial analysis

Financial analysis has been carried out with return on equity (RoE), internal rate of return (IRR), Debt Service Coverage Ratio (DSCR), and cost of generation as indicators for all three sites and six turbines. Available incentives like accelerated depreciation and tax holiday under section 80I A of Income Tax Act have been considered while estimating RoE, IRR and DSCR.

It has been observed that the IRR varies from 7% for combination of turbine with lower rank (Vestas Wind Technologies 750kW) at site with lowest rank (Poladia), to 18.5% for turbine with highest rank (Suzlon 2100 kW) at site with highest rank (Warshamendi).

Sensitivity analysis

Further, sensitivity analysis has been carried out to analyse the impact of +/- 10% variation in generation, and +/- 5% cost variation. It has been observed that the IRR changes by about +/- 1.5 to 2.5% points with variation in generation, by +/-0.1% points with cost variations for 100 MW project.

The issue of fluctuation in cost & generation, and the resultant lowering of NPV and IRR is mitigated in developer approach through tendering. The lump sum costs received in the tender would be firm and as the projects are of very short gestation period, the cost escalation would not arise. Through tendering the best turbine/site combination, which would meet the financial norms, would get selected; there by ensuring required returns even in worst case scenarios.

The wind power projects are also eligible for benefits under the Clean Development Mechanism (CDM) projects. With the CDM benefit the IRR for wind power project will be improved.

Conclusion & recommendation

Based on all the analysis carried out, the wind sites with medium to high wind resource, with wind power density above 300 W/m^2 at 50 m height, as represented by two sites Warshamendi and Kalyanpur, should be focused for the proposed project.

The analysis also shows that turbines Enercon 800 kW, Suzlon 1500 kW, Vestas Wind Technology India Pvt. Ltd. 1650 kW and RRB Energy Ltd. 600 kW at above type of sites make the project financially viable, while turbine NM750 makes the project unviable across sites. Therefore, any of these four turbines, which make the project financially viable, should be considered. Here Suzlon 2100 kW turbine is not recommended because M/s Suzlon Energy limited is currently not offering this turbine in India.

The developer approach with tendering would mitigate the possible fluctuations in cost and generation and would allow selection of best site and turbine combination offered which would make the project viable.

1. Methodology adopted for Feasibility Study

The methodology adopted for analysing the feasibility of developing 100 MW wind power project in Gujarat had following steps:

1. Assessment of overall renewable energy scenario in India
2. Assessment of wind technology
3. Development of wind power in India
   - Wind resource
4. Analysis of government policies
   - Central Government
   - Gujarat Government
5. Assessment of wind potential and installed wind power capacity in Gujarat
6. Evaluation of potential sites and selection of sites based on the wind resource and other infrastructure like grid and road.
7. Analysis of the wind turbines available in India
8. Estimation of possible generation at the selected sites for different selected turbines
9. Analysis of policies regarding sale of wind power in the state of Gujarat
10. Financial analysis to assess the feasibility based on various factors like, the tariffs of electricity in these facilities, amount of power which would be sold to the utility, capital cost of the project and projected energy generation at the short listed sites. Further, to assess the impact of possible variation in generation and cost estimation, sensitivity analysis was carried out.

The results of the financial analysis along with the wind resource data and government policies have been used to arrive at the recommendations regarding probable sites and methodology for project development.

2. Renewable energy

There are different renewable energy sources like solar, wind, biomass, small hydro, waste to energy, geothermal, ocean energy etc. Out of these, solar, wind, small hydro, and biomass technologies have been successfully demonstrated in India. All these technologies, with the exception of solar energy, have been extensively used for power generation in grid-connected mode. Out of these three options, wind power has maximum potential of 45,000MW in India. The potential along with the support from government in the form of accelerated depreciation, and power purchase tariff, makes this technology viable in India. However, unlike other two sources i.e. small hydro and biomass, the wind power at given site does not face any resource availability constraint with proper resource assessment and site selection. In case of small hydro, the identified sites are limited in the range of

5–10MW, while biomass project face the challenge of biomass supply and cost issues. Thus, wind power is comparatively viable option for power generation with availability of detailed wind resource data, and policy and regulatory support from Government.

3. Wind energy

3.1 Wind resource

Wind speed

The wind speed or the average wind speed is the most critical indicator of the wind potential at a given site. The wind speed at any site is influenced by large number of parameters e.g. the weather system, local land use, geography of the site. The wind speeds at any location have daily as well as seasonal variations. In case of India, generally the monsoon months have highest wind speeds. The variations in the wind speed are described by the weibull distribution.

$P(V) = ((k/c)(V/c))^{k-1} e^{-(V/c)^k}$

Where P (V) is the probability of having wind speed V, k is the shape factor, and c is the scale factor. A typical wind distribution is shown in Figure 1 given below. The average wind speed and the shape factor 'k' decide the shape of frequency distribution curve at a given location.

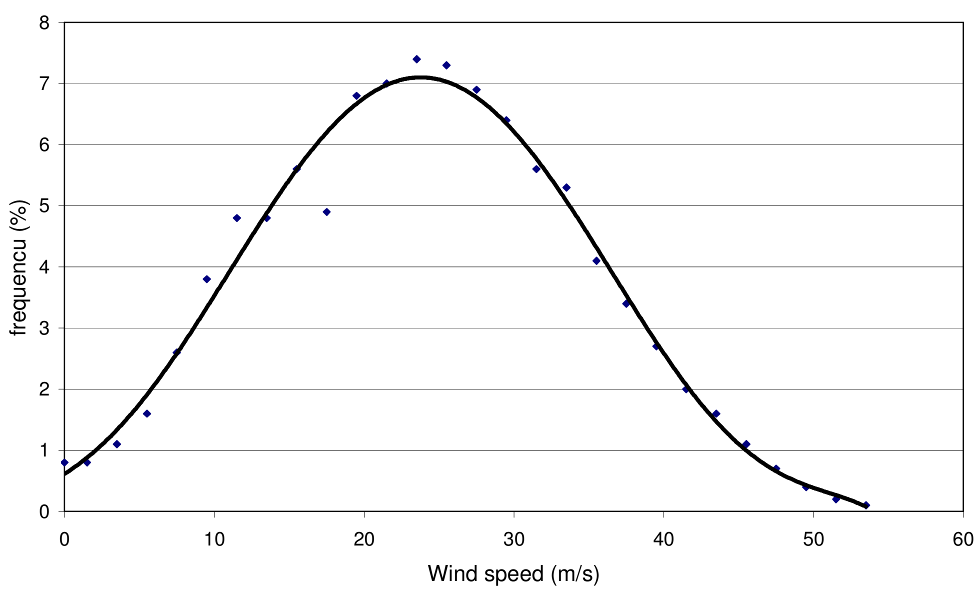


Figure 1 Typical frequency distribution of wind speed

Power law index

The wind speeds vary with height. The variation in the wind speeds with height is given by the 'power law index'.

$$(V2/V1) = (H2/H1)^{p}$$

Where V1 and V2 are wind speeds at heights H1 and H2 respectively and p is the power law index.

Wind direction

Like the wind speed the wind direction also varies. This variation in the wind direction is shown as the 'wind rose'. Wind rose is a diagram as shown in figure 2 below, showing the percentage of wind blowing from each of the eight directions. It also indicates the strength of the wind in each direction. The wind rose given below shows the percentage frequency of wind blowing from that direction. The wind rose and the frequency distribution of wind direction data are used in siting of wind turbines.

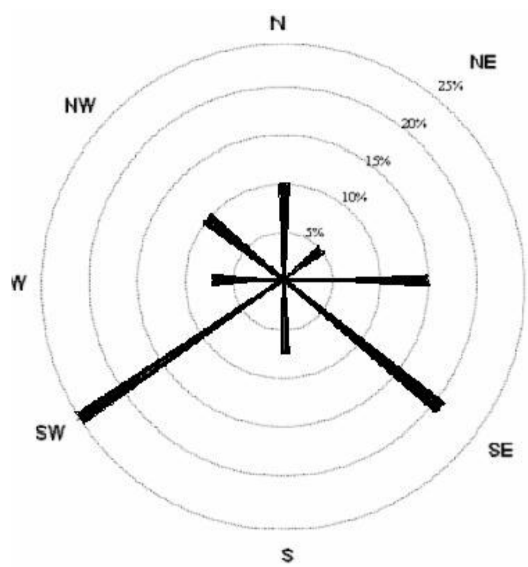


Figure 2 Typical wind rose

Energy conversion by c wind turbine

The energy content in wind is given by following equation

$$P = ½ A \rho V^3$$

Where P is power in wind, A is area of cross section, ρ is air density and V is wind velocity. A useful way to evaluate the wind resource available at any site is wind power density. The wind power density P_d is power in wind per unit area (W/m^2) of cross section perpendicular to wind direction

$$P_d = ½ \rho V^3$$

The wind turbines convert this wind power in to electricity through use of blades coupled with shaft and generator. Classes of wind power density for two standard wind measurement heights are listed in the table below.

Table 1 Classes of wind power and wind power density

Classes of Wind Power Density at 10 m and 50 m(a)				
Wind Power Class	Wind Power Density (W/m^2)	Wind Speed m/s (mph)	Wind Power Density (W/m^2)	Wind Speed (m/s)
1	<100	<4.4 (9.8)	<200	<5.6 (12.5)
2	100–150	4.4 (9.8) / 5.1 (11.5)	200–300	5.6 (12.5) / 6.4 (14.3)
3	150–200	5.1 (11.5) / 5.6 (12.5)	300–400	6.4 (14.3) / 7.0 (15.7)
4	200–250	5.6 (12.5) / 6.0 (13.4)	400–500	7.0 (15.7) / 7.5 (16.8)
5	250–300	6.0 (13.4) / 6.4 (14.3)	500–600	7.5 (16.8) / 8.0 (17.9)
6	300–400	6.4 (14.3) / 7.0 (15.7)	600–800	8.0 (17.9) / 8.8 (19.7)
7	>400	>7.0 (15.7)	>800	>8.8 (19.7)

(a) Vertical extrapolation of wind speed based on the 1/7 power law

Different wind turbines have different generation at given wind speed; the relation between the wind speed and the output from the turbine is called as power curve. A typical power curve is shown in Figure 3 below.

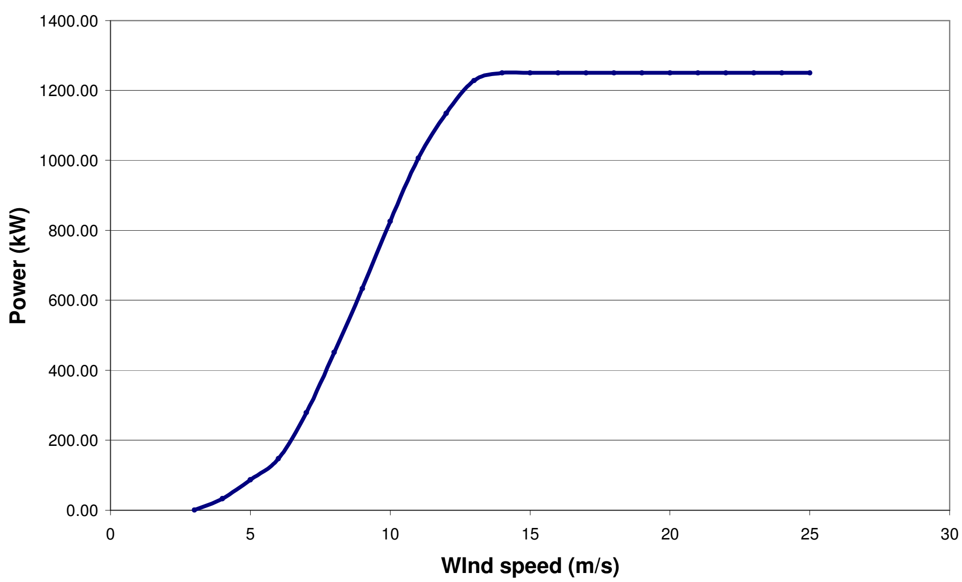


Figure 3 Typical power curve of a wind turbine

The wind speed at which the wind turbine starts power generation is called as *cut in wind speed*. The *rated wind speed* for a wind turbine is a wind speed at which the generation from the wind turbine reaches its rated capacity. In case of higher wind speeds the wind turbine shuts down if the wind speeds are higher than the *cut out wind speed* of that wind turbine.

The power generation from the wind turbine depends on the turbine characteristics i.e. the power curve and wind speed. Depending upon the wind speeds the generation from the wind turbine varies. In order to evaluate performance of the wind turbine the Capacity Utilisation Factor (CUF) is estimated. The CUF is ratio of energy generation from the wind turbine to maximum possible generation.

Annual CUF = annual generation (kWh)/ 8760 * Turbine capacity (kW)

The maximum possible generation is the rated generation from wind turbine throughout the year i.e. for all 8760 hours in a year.

3.2 Wind turbine

The wind turbines convert the kinetic energy of wind into electricity. The important components of a wind turbine are:

1. Rotor blades
2. Aerodynamic power regulation
3. Generator
4. Reactive power control
5. Yaw mechanism
6. Tower

Rotor blades

The rotor blade is the most critical component of the wind turbine. It captures the wind energy and transfers it to torque required to generate power. The aerodynamic design of the blade is important as it determines the energy capture potential. The type of power control mechanism used also needs to be considered while designing the blades. Another important parameter is the blade material. Commonly used materials are composite materials like glass fibre epoxy, carbon epoxy, fibre-reinforced plastic etc. Out of these materials, the carbon fibres are stronger and stiffer, followed by glass fibre. Sometimes, in order to reduce cost, carbon fibres along with glass fibres are used.

Power regulation of blades

The blades of the wind turbine, through its orientation or design, can regulate/optimise power output. This is called aerodynamic power regulation. There are three different techniques used for power regulation as described below.

Pitch control

In a pitch controlled wind turbine, the turbine's electronic controller checks the power output of the turbine several times per second. When the power output becomes too high, it sends a signal to the blade pitch mechanism, which immediately pitches (turns) the rotor blades slightly out of the wind. Conversely, the blades are turned back into the wind whenever the wind speed drops again. During normal operation the blades will pitch a fraction of a degree at a time - and the rotor will be turning at the same time.

Stall control

It is also known as 'Passive control' since control is affected through blade design itself and it involves no moving part. The profile of the rotor blade however is aerodynamically designed to ensure that the moment the wind speed becomes too high; it creates turbulence on the side of the rotor blade, which is not facing the wind, reducing the power output. The basic advantage of stall control is that one avoids moving parts in the rotor itself, and a complex control system. On the other hand, stall control represents a very complex aerodynamic design problem, and related design challenges in the structural dynamics of the whole wind turbine, e.g. to avoid stall-induced vibrations.

Active stall/active pitch

An increasing number of larger wind turbines (1 MW and above) are being developed with an active stall control mechanism. At low wind speeds, the machines will usually be programmed to pitch their blades much like a pitch-controlled machine. However, when the machine reaches its rated power and the generator is about to be overloaded, the machine will pitch its blades in the opposite direction from what a pitch-controlled machine does. This is similar to normal stall power limitation, except that the whole blade can be rotated backwards (in the opposite direction as is the case with pitch control) by a few (3-5) degrees in order to give better rotor control. In other words, it will increase the angle of attack of the rotor blades in order to make the blades go into a deeper stall, thus wasting the excess energy in the wind. The result is known as the 'deep stall' effect, which leads to the power curve bending sharply to a horizontal output line at nominal power and keeping this constant value for all wind speeds between nominal and cut-out. One of the advantages of active stall is that one can control the power output more accurately than with stall, so as to avoid overshooting the rated power of the machine at the beginning of a gust of wind. Another advantage is that the machine can be run almost exactly at rated power at all high wind speeds.

In active pitch control, the blade pitch angle is continuously adjusted based on the measured parameters to generate the required power output. It has been established that active pitch regulation reduces the wind generator output fluctuations.

Generator

Wind turbines are equipped with generator located in the hub of the turbine. There are two types of turbines, 1.with induction generator with gearbox and 2.with synchronous generator. The wind machines with induction generators come with gearboxes which convert the cut-in to cut-out speed variations to 1-2-3 speeds for the generator. The induction machines are generally rated at 1,500 rpm. A two-speed generator has 4 poles for 1,500 rpm and 6 poles for 1,000 rpm.

Wind machines, which have synchronous generators, have no gearboxes since they could be designed for high speeds or for low speeds and have continuous variation according to the speed of the wind. These machines have an added advantage over induction machines because it is inherently variable speed and it has been proved that variable speed increases the energy capture and hence more energy could be generated. In this respect it has been found from various methods that there would be increase of 4-18% in energy capture by variable speed than the fixed speed machines.

Reactive power control

When the voltage and current go up and down simultaneously 'in an AC supply' there is no reactive power transmitted or consumed. Wind turbines impact this current and voltage synchronisation and result in 'consumption of reactive power'. The adverse impact due to wind turbines or 'consumption of reactive power is charged/compensated by utilities by charging for reactive power consumption.

Synchronous generators are better than asynchronous generators in reactive power handling. They are flexible in the sense that they could be made to generate or consume reactive power whenever required by altering the field current of the machine. Thus, reactive power could be fed into the grid if required by synchronous machines. Asynchronous machines, whether in motoring or generating mode, are reactive power sinks and need reactive power compensation by means of capacitors. Switching surges of capacitors during their cutting in and cutting off is a major concern if done by mechanical switches. This concern could be minimized by introduction of power electronic devices. Dynamically varying compensation systems could be provided for smooth variation of capacitors.

Yaw control

The yaw control continuously orients the rotor in the wind direction. The yaw bearing includes gear teeth around its circumference. A pinion gear on the yaw drive engages with those teeth, so that it can be driven in any direction. The yaw drive normally consists of electric motors, speed reduction gears, and a pinion gear. This is controlled by an automatic yaw control system with its wind direction sensor usually mounted on the nacelle of the wind turbine. Some times yaw brakes are used to hold the nacelle in the position.

Tower

Two most common tower designs are, lattice and tubular. Lattice tower is cheaper compared to the tubular tower and being usually a bolted structure, makes it easy to transport. The external forces, primarily due to the wind and motions of the various components of a wind turbine result in stresses. By nature, tubular tower is stiffer than the lattice one. Secondly, since lattice tower has many bolted connections, these connections need to be tightened and checked periodically, thereby increasing the O&M. Moreover, tubular tower allows full internal access to the nacelle.

It has also been established that tubular towers give a better mitigation option to the problem of avian (birds) interaction with wind turbines. This is due to the fact that the lattice towers offer a lot of perch sites to birds.

The tubular towers are of either steel towers or concrete towers. In India most of the towers for windmills are steel towers. Among all the wind turbine manufacturers in India the only manufacturer who uses both concrete and steel towers for windmills is Enercon India Limited. Steel towers have an advantage that it can be easily constructed and transported to the wind farm site and can be erected easily. Concrete towers are made of cement concrete with steel reinforcement and are precasted towers, which can be transported to the wind farm sites and erected. Concrete towers are mostly used for marine sites, especially for offshore windmills.

4. Development of wind power in India

The wind power development in India started in early 90's with demonstration wind power projects in Gujarat and Maharashtra. Simultaneously, a wind resource assessment exercise was initiated by the Ministry of Non-conventional Energy Sources (MNES), presently renamed as Ministry of New and Renewable Energy (MNRE), along with Indian Institute of Tropical Meteorology (IITM). The first five volumes containing wind resource data for sites in Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Tamil Nadu, were published by IITM. With formation of Centre for Wind Energy Technology (C-WET), the wind resource assessment exercise along with testing and certification of wind turbines is now undertaken by C-WET. Till now, C-WET has published two volumes (vol VI and VII) of the "Wind Energy Resource Survey in India". With publication of seven volumes of the wind data, the wind resource for 208 stations covering 15 states and 2 union territories has been published.

The total potential for wind power in India, based on the resource assessments carried out under MNRE wind power program, is about 45000MW distributed in different states as given in Table 2 below.

Table 2 Estimated wind power potential in states

State	Gross potential (MW)	Technical potential (MW)
Andhra Pradesh	8275	2110
Gujarat	9675	1900
Karnataka	6620	1310

State	Gross potential (MW)	Technical potential (MW)
Kerala	875	610
Madhya Pradesh	5500	1050
Maharashtra	3650	3060
Orissa	1700	1085
Rajasthan	5400	1050
Tamil Nadu	3050	2150
West Bengal	450	450
Total	**45195**	**14775**

Source: Directory Indian Windpower 2006

Indian wind energy association has estimated that with current level of technology the onshore potential for utilisation of wind energyfor electricity generation is of the order of the 65,000 MW. The unexploited resource availability has the potential to sustain the growth of wind energy sector in India in the years to come.

The technical potential is estimated based on the availability of grid, land and other infrastructure like roads etc.

The wind power projects are being supported and promoted by Government through various financial and fiscal incentives. The most important is the accelerated depreciation benefit for wind energy projects. The other important factor is the power purchase tariff for the power generated from wind projects. In 1993-94, MNRE issued the guidelines for purchase of power from renewable energy based projects. Subsequently, with the power sector restructuring and passing of The Electricity Regulatory Commission (ERC) Act–1998, the state electricity regulatory commissions started playing crucial role in tariff determination of power including power generation from renewable energy sources like wind. The Electricity Act 2003 provided a major boost to renewable energy sector through the specific mandate to the state regulators to decide the minimum percentage of power to be procured from renewable energy sources. Most of the states with good wind resource have issued tariff orders for purchase of power from renewables. This has created an assured market for power from renewable energy sources. In addition to the sale of power, the state regulatory commissions have also provided guidance on consumption of power from renewable energy sources as a captive use. As a result of the policy support and incentives, the total installed capacity of wind power projects has reached 8757MW as on 31st March 2008.

At present there are four major wind turbine manufacturers in India viz. Enercon India Pvt. Ltd., Suzlon Ltd., Vestas Wind Technologies India Pvt. Ltd. and Vestas R R B (Now RRB Energy) India Ltd. The present business model in India is different from that of the European model. In India, the wind turbine manufacturer also acts as a wind power project developer. Essentially, the turbines manufacturer purchases the land at potential sites, undertakes its own wind measurement, develops the site, undertakes the micro-siting of turbines, puts the necessary evacuation facility in place and facilitates the signing of power purchase agreement (PPA) by the investors with the utility. The manufacturer/developer also undertakes operation and maintenance of the wind project.

The analysis of feasibility of wind power projects is specific to the state policies and the potential wind resource sites along with the turbine characteristics. The subsequent sections look into these issues in detail.

5. Government policies

5.1 Central Government policies / legislations

Electricity Act 2003

The Electricity Act 2003 imposed an obligation on the regulator towards promoting renewable energy. The section 86(e) clause 1 of the Electricity Act 2003, as one of the functions of the state regulatory commission, read as "to promote co-generation and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons, and also specify, for purchase of electricity from such sources, a percentage of total consumption of electricity in the area of a distribution licensee". The state regulator hence plays an active role in development of renewable energy across states by creating a portfolio for renewable energy purchase as well as by pricing of energy generated from them. The tariff orders, which are the outcome of such regulation, state the wheeling charges, banking provisions, third part sales, grid interconnection requirements etc, in addition to purchase price for different renewable energy projects including wind energy.

Renewable energy policy

Ministry of New and Renewable Energy sources (MNRE) has formulated a draft comprehensive renewable energy policy. The objectives of the policy are:

a) Minimum energy needs to be met from renewables
b) Decentralized energy options for agriculture, commercial, residential and industry using renewables

The policy also aims at enhancing public private partnerships, private investments as well as FDI also including fiscal and financial incentives. Simplification of procedures, technology upgradation, new technologies and export promotion are some of the features. Incentives include tax holidays, 80% depreciation benefits for first year of installation of the projects, custom duty concessions, excise duty reduction, exemption from central sales tax/octroi etc and financial assistance and soft loans.

Indian Renewable Energy Development Agency (IREDA) provides the financing for renewable energy projects.

Recently MNRE has released policy for generation-based incentives for wind power projects. Under this policy a generation based incentive of Rs. 0.50 per kWh will be given to the power producers who are not getting the benefit of accelerated depreciation, for up to 10 years. This incentive will be above the tariff fixed by state electricity regulatory commission for the purchase of power from wind energy projects. For getting this benefit the power producer has to submit application in the required format to the ministry and a copy to IREDA. The detailed guidelines issued by MNRE for this is given in Annex X.

5.2 State government policies for development of wind resource in Gujarat

The government of Gujarat came up with a wind power generation policy in the year 2007. The policy highlighted upon the following:

i) Wheeling charge is set at 4%
ii) Banking is allowed for 1 month
iii) Third party sale is permitted
iv) Only type tested wind machines can be set up in Gujarat.

The wind power policy of Gujarat is given in Annex I.

The Gujarat Electricity Regulation Commission, in its regulation “Power procurement from renewable sources” dated 29/10/05, directs the distribution companies to purchase a quantum (in percentage) of electricity from renewables. The percentages are as given below.

Year	Percentage
2006-07	1.0%
2007-08	1.0%
2008-09	2.0%

The Gujarat Electricity Regulation Commission came out with an order on 11/08/06 in the matter of “Determination of price for procurement of power by the Distribution Licensees in Gujarat from Wind Energy Projects”. The main points of this order are:

i. A general single part tariff for wind power generation is considered
ii. The total evacuation infrastructure cost is to be borne by the developer
iii. A CUF of 23% has been considered by the commission in order to determine the tariff
iv. The capital cost considered is Rs. 4.65 Crore (inclusive of evacuation arrangement cost) for 1 MW project.
v. O&M expense of 1.5% of the capital cost with 5% escalation was considered
vi. A tariff of Rs.3.37/kWh was arrived at which remains constant for the entire project life of 20 years.
vii. It was decided by the Commission that GUVNL/distribution company and the developer enter into agreement
viii. The reactive power charges are 10 paise/kVArh for the drawal of reactive energy at 10% or less of the net energy

exported and 25 paise/kVArh for the drawal of reactive energy at more than 10% of the net active energy exported.

ix. The wheeling charges will be 4% of energy injected into the grid

x. 25% of the gross CDM benefit procured by the developer will be shared with the distribution licensee.

xi. As per the order, for wind energy generating units set up after 19th June, 2007 opting for self use, the generation shall be set off against the owner's monthly consumption at his manufacturing or other facility in a distribution licensee area. Any excess generation (over and above the set off against monthly consumption) will be treated as sale to the concerned distribution licensee at the tariff rate determined by the Commission. Monthly, the consumption bills will be adjusted against the generation and if generated units are extra, tariff will be paid for the same by the distribution licensee.

Other important issues

The developer is to register the project on per MW basis with GEDA. The cost of registration is Rs. 50,000/- per MW with maximum of Rs.2.5 lakh/project. The transfer charges of the wind farm are applicable as Rs. 20,000.00 per MW. An annual fee of re-certification of windmills is charged by GEDA at the rate of Rs. 10,000.00 per MW. The PPA will be signed between GUVNL/distribution Company and the developer.

The energy generated from wind power can only be wheeled to a maximum of two locations for self-consumption and surplus generation would be considered to be sold to the distribution company. The modality involved is to allocate particular wind project with two of the locations and get them approved by GUVNL. There is no previous experience of wheeling power to locations outside GUVNL or in the private DISCOM area. But according to GUVNL, the regulations remain same for private discom areas also.

Inter state open access issues

The section 29 of Gujarat Electricity Regulatory Commission, Open Access Regulation, Notification No. 13 of 2005, states "Open Access will require implementation of the Intra-State Availability Based Tariff (ABT) System". The tariff order in the matter of Determination of Price for procurement of power from Wind Energy Projects issued by Gujarat Electricity Regulatory Commission (Order No. 2 dated 11th August 2006) states that "As wind energy cannot be scheduled, the commission has kept the WEG's out of the settlement mechanism linked with Unplanned Interchange (UI) rate (which comes into play in case of deviations) under Intra State Availability Based Tariff". Since wind energy does not fall under ABT, and Gujarat has not yet implemented ABT, the open access is not into operation as of today.

6. Wind power development in Gujarat

Gujarat was one of the first states where development of wind power started with first demonstration wind power project in 1985 and first private project in 1992. Presently all the four major manufacturers of wind turbines are active in Gujarat as developers of the wind projects. The present institutional set up is as follows.

Gujarat Energy Development Agency (GEDA): Preparation of promotional policies for renewable energy projects including wind power project is the responsibility of GEDA.

Gujarat Electricity Regulatory Commission: In the case of renewable energy projects, GERC is responsible for deciding purchase tariff, quota for renewables and other issues like connectivity metering etc.

Gujarat Electricity Board (GEB) had promoted Gujarat State Electricity Corporation Ltd. in the year 1993 for the generation of electricity and Gujarat Electricity Transmission Corporation Ltd. for the transmission of electricity generated within the State of Gujarat. As a part of un-bundling process, the Board (GEB) incorporated four new companies to be engaged in distribution of electricity in the State of Gujarat viz. Uttar Gujarat Vij Company Ltd. (UGVCL), Madhya Gujarat Vij Company Ltd. (MGVCL), Dakshin Gujarat Vij Company Ltd. (DGVCL) and Paschim Gujarat Vij Company Ltd. (PGVCL). Further, the Gujarat Urja Vikas Nigam Limited was incorporated as a new company to carry out the residual functions (including Power Trading) of GEB.

In the case of wind power projects the power purchase agreement has to be signed with GUVNL. In the case of self-consumption, the GUVNL can enter into a PPA on behalf of the aforesaid four government distribution companies. However, wind energy generators would have to enter into PPA with private distribution companies - Torrent Power AEC Limited (TPAL) and Torrent Power SEC Limited (TPSL) separately.

The total installed capacity based on wind energy in Gujarat was 1253 MW as on March 2008. The analysis of wind power investments in Gujarat shows that some of the corporates had invested in wind power projects. These wind power projects include projects by Ajanta Transistors, Arvind Mills, Indian Petrochemicals Co. ltd. etc. Recently, i.e. after the recent tariff order the corporates have invested in wind power projects in Gujarat with sale of electricity to utility only. Some of the new projects, which were commissioned in 2007-08, are DLF's 150 MW project in Kuchchh district bu Suzlon and Hindustan Zinc Ltd's over 50 MW project in Jamnagar district by Enercon. As mentioned above these investments are 'sale to utility' mode, while as the "partly captive use, has higher returns. The higher returns are due to the fact that the industrial electricity tariff in Gujarat (Rs. 4.1) is higher than the tariff at which the utility buys electricity (Rs 3.37) from wind power project.

6.1 Wind resource in Gujarat

The state of Gujarat has one of the best wind potentials in the country. The total identified wind power potential is 9675MW and the total installed wind power capacity is about 1253MW as on March 2008. It is endowed with one of the best wind resources in India, with wind power densities in the range of 200–350 W/m² at 50 m height. The wind resource is spread in the costal regions of Gujarat as well as in Rajkot and Surendranagar districts. The wind speeds are in the range of 4–9 m/s with pre monsoon and monsoon months, April to August, having higher speeds. The southwest direction of monsoon winds is the predominant wind direction. The wind resource published by C-WET identifies about 38 potential sites where the wind power density is above 200W/m². The details of these sites are given in Annex II. As can be seen, the sites are clustered in districts of Jamnagar, Kutch, Rajkot, Surendranagar, Porbandar, Junagarh, Amreli and Surat. Out of 38 sites, there are 24 sites, shown in Table 3, which have wind power density above 240W/m².

Table 3 Wind sites with power density above 240W/m²

Station	Tehasil	District	Wind power density extrapolated to 50m
Butavadar			240
Amrapar (Gir)	Keshod	Junagarh	241
Jafrabad	Rajula	Amreli	242
Bamanbore II	Chotila	Surendernagar	243
Suvarda	Jamnagar	Jamnager	243
Sinai	Anjar	Kutch	244
Gala	Lalpur	Jamnager	254
Okha	Dwarka	Jamnager	260
Nani Kundal	Babra	Amreli	278
Poladia	Mandvi	Kutch	278
Navadra	Kalyanpur	Jamnager	297
Jamanvada	Lakhpat	Kutch	299
Bayath	Mandvi	Kutch	300
Mundra	Mundra	Kutch	303
Adesar	Bachhau	Kutch	307
Motisindholi	Naliya	Kutch	311
Rojmal	Gadhada	Bhavnagar	317
Kalyanpur	Kalyanpur	Jamnager	327
Godladhar	Jasden	Porbander	345
Dhank II	Upleta	Rajkot	367
Sanodar	Ghoga	Bhavnagar	373
Dhank I	Upleta	Rajkot	414
Surajbari	Bhachau	Kutch	444
Warshamendi	Maliya	Rajkot	499

These sites are concentrated in three wind belts – coastal areas of Jamnagar and Kutch districts and bordering areas of Rajkot and Surendranagar districts as shown in the map in Annex III.

7. Site selection

For this study the sites currently being offered by different developers in the state of Gujarat is analysed along with selected sites of power density more than 240W/m^2 with different parameters related to infrastructure in addition to wind resource. The parameters investigated are described below.

7.1 Grid availability and road infrastructure

As per the order of the Gujarat Electricity Regulatory Commission, on "Determination of price for procurement of power by the distribution licensees in Gujarat from Wind Energy Projects" the metering of power will be at 66 kV substations, which would be the Gujarat Electricity Transmission Company (GETCO) station. Thus, the power would be fed in to the grid at minimum 66 kV. If the wind power generation were for self-use, there would be energy accounting in the bill received by the user from the Distribution Company. Thus, the wind power project can be anywhere in Gujarat irrespective of the location of self-use.

The grid map of Gujarat with 132 kV lines is given in Annex IV, along with the list of 66kV substations, which was collected from GETCO. The road network in the three wind belts is shown in Annex III along with the wind belts. As it can be seen, good road infrastructure exists in the prominent wind belts.

7.2 Land availability

In Gujarat, the model followed for development of wind sites is through project developers. The wind turbine manufacturers who are also the project developers assess the potential at the identified site by collecting their own wind resource data as well as grid availability in the area. The land is then purchased (in case of private land) or leased (in case of Govt. land). Once the land is purchased, approval of GEDA is sought. Thus, the information available at GEDA is about those sites where the applications for development of wind power projects have been received. As per discussions with GEDA, and the developers of wind power, following sites are being developed

Kutch District
Nakthrwa
Poladia and Bayat in Mandwi Tehsil
Surajbari in Bhachhau Tehsil by all developers
Motisindhoni in Naliya Tehsil
Wandhia by Vestas wind technologies India Limited
Jamnagar District
Suvarda in Jamnagar Tehsil
Samana by Enercon India Ltd.

7.3 Shortlisting of sites

With the objective to shortlist representative sites or wind belts based on the grid and other infrastructure availability and land availability, a matrix of sites with information regarding the grid, road and land availability was prepared as shown in Table 4. The important criteria used for short-listing of three sites are grid availability, wind power density at 50m heights and the potential available. A site-wise detail of these criteria and the ranking are provided in the Annex V.

Table 4 Short-listed wind sites

Site	Tehasil	District	Total score
Warshamendi	**Maliya**	**Rajkot**	**24**
Dhank I	Upleta	Rajkot	18.9
Jamanvada	Lakhpat	Kutch	16
Kalyanpur	**Kalyanpur**	**Jamnager**	**15.6**
Bamanbore II	Chotila	Surendernagar	15.6
Surajbari	Bhachau	Kutch	15.3
Mundra	Mundra	Kutch	14.7
Sinai	Anjar	Kutch	13.8
Butavadar	Jamjodhpur	Jamnagar	13.2
Motisindholi	Naliya	Kutch	12.9
Bayath	Mandvi	Kutch	12
Okha	Dwarka	Jamnager	11.2
Dhank II	Upleta	Rajkot	11
Suvarda	Jamnagar	Jamnager	10.3
Gala	Lalpur	Jamnager	9.6
Adesar	Bachhau	Kutch	8.2
Navadra	Kalyanpur	Jamnager	7.9
Poladia	**Mandvi**	**Kutch**	**6.5**

Based on the above sites assessed, three sites were selected for further analysis of energy generation.

1. Warshamendi in the district Rajkot, the top-most ranking and representing the sites with high wind resource
2. Kalyanpur, in Jamnagar district, medium ranking and representing medium wind resource
3. Poladia, in kutch region with lower rank and representing the low wind resource,

The reason for selecting these three sites is that they cover the entire spectrum of sites available providing optimistic, average and pessimistic scenarios. The detailed maps for the shortlisted sites along with the nearby 66 kV substations are given in Annex VI.

7.4 Site details

Warshamendi

The Warshamendi site is in Rajkot district. The site had a mast installed by C-WET and data was collected by C-WET from January to December 2000. The mast has been dismantled now. This site is about 6km from sea and the land is arid and no crops grow. The access road is good and railways network found adjacent to the site. Pipiliya is the nearest 66kV substation. It is 10 km away from the site and 16 km along the road length. Pipliya sub station is equipped with 5MVA transformer, which has around 1 MVA as spare.

Poladia

The Poladiya site is in Kutch district. The access road is good and the land is barren. Both revenue and private land are available. A 256 kV line passes adjacent to the site. Nearest sub station is Bayat, which is 20 km from Poladia. Bayat substation has a 5MVA transformer. Suzlon has commissioned a wind farm of 20 turbines, each of 1.25MW capacity, adjacent to Bayat sub station. A pooling sub station is setup inside the Suzlon wind farm, where the voltage is stepped up to 66kV and then it is transmitted to GETCO 66kV sub station at Bayat and directly fed into the grid. The grid availability is 98% and above and the CUF of one of the machines was recorded as 19.1% producing 21, 00,000 units per annum.

Kalyanpur

The Kalyanpur site is in Jamnagar district. At Kalyanpur, NEPC and Suzlon wind machines are present. The CUF's are as follows: NEPC (250kW) generated around 3Lakh units with 13.6 % CUF. For Suzlon 350kW and 1250kW, CUF's observed were of around 16% and 22% respectively. The land is arid and both revenue and private land are available. GEDA has a pooling sub station which feeds in power to the grid at Kalyanpur 66kV sub station. The Kalyanpur sub station is 4km from the Kalyanpur site.

The details of the wind measurements at the three selected sites are given in Table 5 below.

It is found that around the Kalyanpur site NEPC and Suzlons wind turbines are already available. In Poladia site Suzlon has installed some wind turbines. In Warshamedi site the process of wind farm development is started now and Suzlon is approaching for the development around this site. Vestas Wind technologies India ltd. is currently active around the site near Wandhia village in Kutch region. Enercon also is active around Jamnagar district in Gujarat.

Table 5 Details of sites

Site	Latitude	Longitude	Elevation (m)	Mast height (m)	Measurement period	Air density (kg/m^3)	Shape factor (k)
Warshamendi	22^0 58'	70^0 34'	3	20	Jan 02–Dec02	1.173	2.2
Kalyanpur	22^0 03'	69^0 24'	80	20	Nov 90–Nov95	1.164	2.4
Poladia	23^0 06'	69^0 12'	150	20	Aug 98–Jul2000	1.164	1.9

The wind data along with monthly wind rose for these three sites is given in Annex VIII.

The wind rose provides information about the wind direction. All the three wind belts, represented by the three sites, have South West as the prominent wind direction, with North as the second highest direction in the months of November, December and January. The highest wind speeds occur in the months of May, June, July and August – primarily monsoon months. These sites are in three different wind belts. The wind climate of these sites can be assumed to be similar for the wind belts in which these sites are located. The distribution of wind direction results in a loss called wake loss through impact of other turbines in the windy direction. Generally, the wake loss is in the range of 2-3 %. With similar wind patterns i.e. wind rose at the three wind belts, a wake loss of 3% is assumed for estimation of net generation.

The duration of wind data measurements at the sites in all three-wind belts differs from 1 year to 2 years. The duration of wind data affects the confidence level of generation estimations as a result of possibility of variation in wind resource. It may also be noted that for the site Kalyanpur the data measurement is for a period of 5 years. However, the data is relatively old compared with other two sites. Considering this, sensitivity analysis with +/- 10% change in generation was carried out for all the three sites.

8. Technical comparison of wind turbines

The wind turbines which have received C-WET certification and which are above 500kW capacity are considered for evaluation. Especially the turbines, which are currently being offered by various developers suiting the site conditions of Gujarat, will be considered. The updated list of C-WET certified turbines is given in Annex VII.

The wind turbines are analysed based on the technical specifications of the turbine as well as the experience of the manufacturer. Based on the technical and operational parameters an evaluation criterion was developed and the turbines are analysed based on that criterion. The detailed description of technical parameters used, comparison of technical features between different makes, power curves and the ranking of turbines is given in Annex IX; the total scores of the turbines are shown below.

Table 6 Rating of turbines

Turbine manufacturer	Enercon	Suzlon	Suzlon	Vestas wind Technologies India Pvt. Ltd	Vestas Wind Technologies India Pvt. Ltd	Vestas RRB India Ltd.	Vestas RRB India Ltd.
Capacity (kW)	800	2100	1500	1650	750	500	600
Score	10.2875	10.25	10.19	10.2075	10.0875	10.04	10.05

Based on the evaluation, the following turbines were short listed for studying feasibility – Enercon 800kW, Suzlon 2100 kW (top 2), Vestas Wind technologies India Pvt. Ltd. 1650 and Suzlon 1500 kW, (middle 2) and Vestas RRB Ltd. 600 kW and Vestas Wind Technologies India Pvt. Ltd. 750 kW (lowest 2). Vestas RRB's 500 kW turbines will not be considered for the study. Among these turbines, currently the most widely offered turbines from the manufacturers in India are Suzlon 1500 kW, Vestas India's 1650 kW, Enercon's 800 kW and Vestas RRB's 600 kW turbines. Though we have considered turbine S2100 for our study to understand the aspects of wind energy generation and their impact in financial calculations, but it is found that Suzlon is currently not offering this turbine in India.

9. Energy generation analysis

The estimation of the generation has been undertaken for the three selected sites and for the six selected turbines. The monthly generation has been estimated based on the monthly wind data, wind rose data for each site. The monthly wind speeds along with the monthly power law index have been used. The power law index is used to estimate wind speed at a height different than the height of wind speed measurement.

Based on the monthly average wind speed and the shape factor 'k' the monthly frequency distribution curve can be plotted. Figure 4 shows the frequency distribution curve with turbine power curve superimposed on it. The area under both these curves is the monthly energy generating, shown as shaded area in figure.

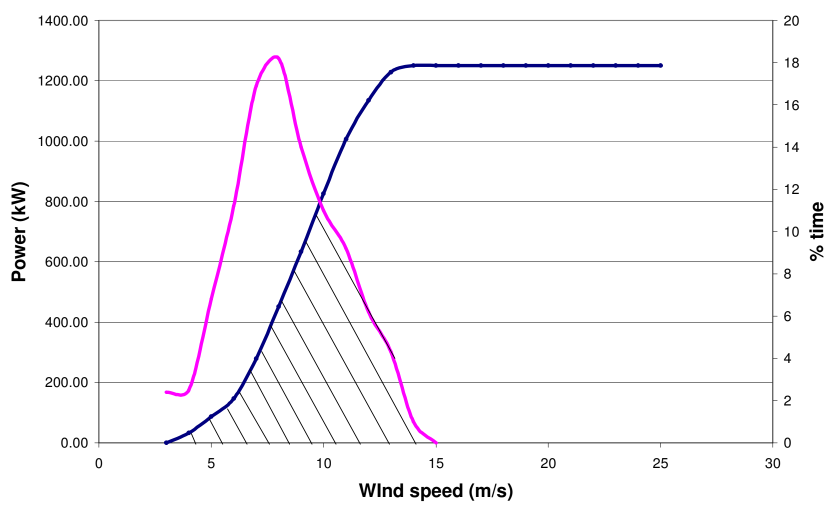


Figure 4 wind power generation

The above figure is monthly distribution for the month of June at Warshamendi with power curve of S1250 turbine. The area under the curve gives the monthly generation.

To get the monthly generation by above method, the monthly average wind speed with the shape factor and monthly power law index has been used along with the power curves of different turbines. A RETScreen model has been used to estimate the monthly Capacity Utilisation Factor (CUF) using above method, and based on the CUF, monthly energy generation is estimated. Different correction factors are considered for different losses. The correction factors are explained below.

1. Air density correction

The power curves are estimated at standard air density of 1.225kg/m^3. The energy generation has been corrected depending upon the air density at the selected site.

2. Array losses

The loss due to other wind turbines is called as array loss. Array loss is the range of 2-3%. The array loss of 3% has been considered for energy estimation.

3. Machine availability

The loss due to machine not available for generation is assumed 5% of total energy generation estimated. The manufacturers provide machine availability guarantee of about 95% to 97%.

4. Grid availability

The loss due to unavailability of grids is considered as 5% based on the general practise in the energy generation estimations.

5. Transmission losses

The metering of energy by the utility is done at the high-tension side of the step up transformer i.e. on the 66 kV side in case of Gujarat. The transformer losses and the transmission losses are considered at 5%.

6. Uncertainty

A correction factor of 5% is applied for uncertainty in the flow of wind.

The month-wise net generation of different turbines at different sites has been estimated after deducting above-mentioned losses from the estimated gross generation. For ease of comparison, the generation in terms of the net CUF is given below for all the turbines at three selected sites.

Table 7a Monthly CUF (in %) at Warshamendi

Month	Vestas RRB 600 kW	Vestas India 750 kW	Vestan India 1650 kW	Suzlon 1500 kW	Suzlon 2100 kW	Enercon 800 kW
January	18.91	16.64	27.24	22.70	31.02	28.75
Feb	16.64	14.37	24.21	19.67	27.24	24.97
March	21.94	17.40	27.24	26.48	30.26	28.75
Apr	37.07	32.53	43.88	39.34	46.15	45.39
May	49.93	47.66	53.71	52.96	52.96	54.47
June	43.88	39.34	49.93	48.42	51.44	50.69
July	49.17	46.15	53.71	52.96	52.96	53.71

Month	Vestas RRB 600 kW	Vestas India 750 kW	Vestan India 1650 kW	Suzlon 1500 kW	Suzlon 2100 kW	Enercon 800 kW
Aug	40.85	35.56	46.91	45.39	48.42	47.66
Sep	34.04	28.75	38.58	37.83	40.85	39.34
Oct	12.10	8.32	15.13	15.13	17.40	15.89
Nov	12.10	9.83	18.16	15.13	21.18	18.91
Dec	10.59	9.08	18.16	12.86	21.94	19.67
Annual	**28.94**	**25.47**	**34.74**	**32.40**	**36.82**	**35.68**

Annual average CUF at Warshamendi, based on all turbines, is 32.34%.

Table 7b Monthly CUF (in %) at Kalyanpur

Month	Vestas RRB 600 kW	Vestas India 750 kW	Vestan India 1650 kW	Suzlon 1500 kW	Suzlon 2100 kW	Enercon 800 kW
January	24.02	22.52	33.03	28.53	35.28	33.78
Feb	22.52	21.02	30.78	27.03	33.03	31.53
March	23.27	21.77	31.53	27.03	33.03	31.53
Apr	23.27	21.77	30.03	25.52	30.78	30.03
May	27.03	24.77	33.03	28.53	33.78	33.78
June	30.78	29.28	36.79	30.78	36.03	36.79
July	34.53	33.03	41.29	35.28	42.04	42.04
Aug	28.53	27.03	36.03	30.78	36.03	36.03
Sep	18.02	16.52	24.77	21.02	25.52	24.77
Oct	15.01	14.26	22.52	19.52	24.02	22.52
Nov	24.02	22.52	33.03	28.53	35.28	33.78
Dec	22.52	21.02	32.28	27.78	34.53	33.03
Annual	**24.46**	**22.96**	**32.09**	**27.53**	**33.28**	**32.47**

Annual average CUF at Kalyanpur based on all turbines is 28.80%.

Table 7c Monthly CUF (in %) at Poladia

Month	Vestas RRB 600 kW	Vestas India 750 kW	Vestan India 1650 kW	Suzlon 1500 kW	Suzlon 2100 kW	Enercon 800 kW
January	16.52	15.01	22.52	21.02	24.77	23.27
Feb	19.52	18.77	26.28	24.02	27.03	26.28
March	24.02	22.52	31.53	29.28	33.03	32.28
Apr	29.28	28.53	36.79	34.53	38.29	37.54
May	24.77	24.02	30.03	29.28	30.03	30.03
June	31.53	30.03	36.79	36.03	37.54	37.54
July	30.03	28.53	35.28	33.78	35.28	35.28
Aug	25.52	24.02	30.78	29.28	30.78	30.78
Sep	21.02	20.27	27.78	26.28	29.28	28.53
Oct	12.01	11.26	17.27	15.77	18.77	18.02
Nov	13.51	12.76	20.27	18.02	21.77	21.02
Dec	14.26	13.51	20.27	18.77	22.52	21.02
Annual	**21.83**	**20.77**	**27.96**	**26.34**	**29.09**	**28.47**

Annual average CUF at Poladia based on all turbines is 25.74%.

The CUFs are higher than the CUF assumed in the GERC tariff order. The CUF in tariff order is based on average of existing turbines, and Gujarat has large number of old turbines starting with individual capacity of 55kW to 600kW. The CUFs, as mentioned earlier are estimated based on the site wind resource measured over one year and there could be actual +/-10% variation in generation. This aspect has been covered in the sensitivity analysis.

Net monthly generation in kWh/MW estimated from each wind turbine at all three sites are given below in Table 8a, 8b and 8c. A sample sheet for this calculation is given in Annex XII

Table 8a Net monthly generation at Warshamendi site (kWh / MW)

			Warshamendi			
Month	RRB600	NM 750	NM 1650	S1500	S2100	E800
January	140715	123829	202630	168858	230773	213887
Feb	111846	96594	162685	132182	183021	167769
March	163230	129458	202630	197001	225144	213887
Apr	266905	234223	315928	283246	332269	326822
May	371488	354602	399631	394003	394003	405260
June	315928	283246	359505	348611	370399	364952
July	365860	343345	399631	394003	394003	399631
Aug	303945	264545	348974	337716	360231	354602
Sep	245117	206988	277799	272352	294140	283246
Oct	87153	59917	108941	108941	125282	114388
Nov	87153	70812	130729	108941	152517	136176
Dec	78801	67543	135087	95686	163230	146344
Total	2538139	2235102	3044169	2841539	3225011	3126964

Table8b Net monthly generation at Kalyanpur site (kWh / MW)

			Kalyanpur			
Month	RRB600	NM 750	NM 1650	S1500	S2100	E800
January	178734	167563	245759	212246	262515	251344
Feb	151347	141257	206841	181616	221975	211886
March	173148	161977	234588	201075	245759	234588
Apr	167563	156752	216210	183778	221615	216210
May	201075	184319	245759	212246	251344	251344
June	221615	210805	264857	221615	259452	264857
July	256929	245759	307198	262515	312784	312784
Aug	212246	201075	268100	229002	268100	268100
Sep	129726	118915	178373	151347	183778	178373
Oct	108105	102700	162157	140536	172968	162157
Nov	172968	162157	237831	205399	254047	243236
Dec	167563	156392	240173	206661	256929	245759
Total	2141018	2009671	2807846	2408038	2911266	2840637

Table8c Net monthly generation at Poladia Site (kWh / MW)

	Poladia					
Month	RRB600	NM 750	NM 1650	S1500	S2100	E800
January	122879	111708	167563	156392	184319	173148
Feb	131167	126122	176571	161437	181616	176571
March	178734	167563	234588	217831	245759	240173
Apr	210805	205399	264857	248641	275668	270262
May	184319	178734	223417	217831	223417	223417
June	227020	216210	264857	259452	270262	270262
July	223417	212246	262515	251344	262515	262515
Aug	189904	178734	229002	217831	229002	229002
Sep	151347	145942	199994	189184	210805	205399
Oct	86484	81079	124321	113510	135131	129726
Nov	97294	91889	145942	129726	156752	151347
Dec	106123	100538	150806	139636	167563	156392
Total	1909494	1816163	2444433	2302815	2542808	2488215

10. Project cost

10.1 Capital cost

The capital cost of wind project along with the break-up is provided in the Table 9 below. This cost is based on the present trends and actual project costs offered by different wind turbine manufacturers and developers for site locations in Gujarat for projects being developed presently. The broad cost components are described below.

Feasibility, tendering and contracting: this includes the costs for preparation of feasibility report, preparation and evaluation of bids and finalisation of contract.

Project monitoring cost: The proposed model for implementation of the project is through developers. Thus the project needs only monitoring and inspection by GSPC officials and/or project management consultants etc. The actual duration of implementation is expected to be six months.

Technical consultancy: The cost included here is for validation of the energy generation estimations for the proposed projects at about Rs.10.0 lakh per project through independent consultant.

The developer would offer the turnkey costs for the wind power project, which would include following broad elements.

Land: The land costs based on the quotations work out to be Rs 50,000/acre with requirement of 20 acres/MW for wind power project. The area of land required is calculated on the basis of arrangement of wind turbines in arrays. To minimise the loss of energy due to wake effect the wind turbines in a wind farm are arranged in arrays with spacing of 3Dx5D, 5Dx7D, or 4Dx8D etc. (D is the rotor diameter) to optimise the energy generation. Based on this array arrangement the area requirement is calculated approximately as 20 acre per MW.

Site development and civil work: This includes the costs for levelling of site, development of roads, civil amenities like control room/office/stores/rest rooms/water storage and foundation of wind turbines. This estimate, based on the quotation, is about Rs.45Lakh/MW.

Electrical equipments: This includes the transformers, switchgear etc. for the wind power projects, which is about Rs 49lakh/MW.

Wind turbines: This includes the wind turbine, tower, hub, and generator assembly. Based on the quotes, it is about Rs 490 Lakh/MW.

Erection and Commissioning: This includes the cost for erection of wind turbines and commissioning of the wind turbines. This cost is about Rs 20 Lakh/MW

Evacuation: This includes the cost of evacuation line, from the wind turbines till the substation. The actual cost varies from turbine to turbine depending upon the distance. However, the average cost for a group of turbines is Rs 30 Lakh/MW.

Project Registration cost including cost of application processing charges, PPA signing charges, and other processing charges is taken as Rs. 1.0 lakh per MW.

In the case of proposed wind power project, the implementation is suggested through wind project developer. In this case, the wind project developer undertakes all the activities and there will not be any additional contingency costs to the investor.

Table 9 Break-up of capital cost for wind power project

Cost Component	Cost for 100 MW in RS. Lakh
Feasibility, tendering, contract	15
Project monitoring cost	50
Technical consultancy	10
Registration	100
Land	1000
Site development, civil work	4500
Electrical equipment #	4900
Wind turbines	49000
Erection and commissioning	2000
Evacuation	3000
Total	64575
Cost of financing**	452
IDC	2940

Total project cost	67967

includes cost of SCADA equipment

** 70% debt @1. % of debt as processing charges

The insurance during construction is covered in above costs. Further, as the expected construction period is about 6 months (based on the offers given by the developers), for the projects, which the developer primarily implements, thus no working capital requirement has been considered in above costs. Though the commissioning time may vary depending on the situations and factors such as delay in land acquisition, delay in clearances and approvals, and some social issues like public opposition etc. but these will not be considered effective in the cost as there are no major problems of these kinds faced by the developers in Gujarat.

10.2 The operation and maintenance costs

The present model for O&M of wind projects is based on the annual maintenance contracts (AMC) offered by the wind turbine manufacturers. The O&M for the first year is sometimes offered free and for subsequent years the O&M is undertaken based on the AMC. There is about 5% increase in the AMC costs annually. The annual O&M costs, based on the AMCs, are about Rs.11.65 Lakh/MW. In addition, annual insurance of about Rs.1.5 Lakh/MW also has been considered. Along with this the recertification cost of Rs. 10,000.00 per MW will be included in the O&M cost per year.

11 Financial analysis

11.1 Assumptions

1. **80% accelerated depreciation considered**

In case of accelerated depreciation, it was assumed that GSPC has tax liability, which can absorb the depreciation benefit. The tax benefit as a result is shown as revenue inflow in the project. Further, the depreciation benefit can be different depending upon the date of commissioning of the project. If the project is commissioned before 30th September, full benefit of the accelerated depreciation can be availed. In case of project commissioning after 30th September, only 50% of eligible depreciation can accrue in that financial year. It is estimated that the project would be commissioned before September 2009 and full depreciation benefit in the first year has been considered for analysis.

2. **The tax benefit under Section 80IA of the Income Tax Act**

As per this section, the infrastructure projects can get tax holiday for 10 years. Wind power projects are eligible for Section 80IA benefit. Here, the Minimum Applicable Tax (MAT) that is applicable along with the surcharge (10%) and Education Cess during the period when Section 80IA benefit is taken are not considered in financial calculation as GSPC is already paying the MAT.

3. Costs

The capital cost and the O&M costs as given in the section on Project Cost have been used. Escalation in O&M has been assumed as 5%.

4. Energy generation

The analyses have been carried out with short listed 3 sites and six turbines and the generation in each case is used for the financial evaluation.

Norms Used for the financial evaluation:

5. Debt equity ratio: 70:30

6. Interest rate: 12.25%

7. Loan repayment period: 10 years including the moratorium period. Payment on quqrterly basis.

8. Moratorium: 1 year

9. Loan processing: 1 % of loan

10. Project life: 20 years

11. Reactive power compensation: Assuming 3% reactive power consumption of net generation @Rs0.10/unit.

11. 2 Financial analysis of the projects

As per norms specified

The financial analysis is carried out assuming total capacity of 100 MW; it is assumed that the complete generation is sold to the utility at the tariff Rs.3.37/unit.

The IRR and RoE have been estimated for a 100 MW total capacity with each of the six selected turbines and at each of the three sites. This is summarised in Tables 10a, 10b and 10c. Table 11 gives the debt service coverage ratio (DSCR) for each site.

Table 10 RoE , IRR(in %) and Payback Period with full 80% depreciation in first year

10a. Site: Warshamendi

Turbines	ROE (%)	IRR (%)	Payback (years)
S 2100	32.41	18.46	11
E 800	29.94	17.75	12
S1500	23.00	15.64	13
NM1650	27.89	17.15	12
Nm750	10.10	10.82	18
RRB600	16.20	13.30	15

10b. Site: Kalyanpur

Turbines	ROE (%)	IRR (%)	Payback (years)
S 2100	24.65	16.16	13
E 800	22.98	15.63	13
S1500	13.50	12.25	16
NM1650	22.21	15.39	13
Nm750	5.96	8.85	>20
RRB600	8.34	10.01	20

10c. Site: Poladia

Turbines	ROE (%)	IRR (%)	Payback (years)
S 2100	16.30	13.33	15
E 800	15.15	12.90	15
S1500	11.41	11.39	17
NM1650	14.24	12.55	16
Nm750	2.59	7.06	>20
RRB600	4.20	7.94	>20

The Debt Service Coverage Ratio (DSCR) has been calculated for different turbnes at each of the three sites and is presented in the table 11 below. The detailed calculation sheet is given in Annex XIII.

Table 11 DSCR at each site with all turbines

Site: Warshamendi

WTG	1	2	3	4	5	6	7	8	9	10	Average
S2100	2.83	1.36	1.14	1.10	1.17	1.26	1.35	1.47	1.61	1.79	**1.51**
S1500	2.70	1.23	1.00	0.95	1.01	1.08	1.17	1.26	1.38	1.53	**1.33**
E800	2.80	1.32	1.10	1.06	1.13	1.21	1.31	1.42	1.55	1.72	**1.46**
M1650	2.77	1.30	1.07	1.03	1.10	1.17	1.27	1.37	1.51	1.67	**1.42**
NM750	2.50	1.02	0.77	0.71	0.75	0.81	0.87	0.94	1.02	1.13	**1.05**
RRB600	2.60	1.12	0.88	0.83	0.88	0.94	1.02	1.10	1.20	1.33	**1.19**

Site: Kalyanpur

WTG	1	2	3	4	5	6	7	8	9	10	Average
S2100	2.73	1.25	1.02	0.98	1.04	1.11	1.20	1.30	1.43	1.58	**1.36**
S1500	2.56	1.08	0.84	0.78	0.83	0.88	0.95	1.03	1.13	1.24	**1.13**
E800	2.70	1.23	0.99	0.95	1.01	1.08	1.16	1.26	1.38	1.53	**1.33**
NM1650	2.69	1.21	0.98	0.93	1.00	1.07	1.15	1.25	1.36	1.51	**1.32**
NM750	2.43	0.94	0.69	0.62	0.66	0.70	0.75	0.82	0.89	0.98	**0.95**

RRB600	2.47	0.98	0.74	0.67	0.71	0.76	0.82	0.89	0.97	1.07	**1.01**

Site: Poladia

WTG	1	2	3	4	5	6	7	8	9	10	Average
S2100	2.61	1.12	0.89	0.83	0.88	0.95	1.02	1.10	1.21	1.33	**1.19**
S1500	2.53	1.04	0.80	0.74	0.78	0.84	0.90	0.97	1.06	1.17	**1.08**
E800	2.59	1.10	0.87	0.81	0.86	0.92	0.99	1.07	1.17	1.30	**1.17**
NM1650	2.57	1.09	0.85	0.79	0.84	0.90	0.97	1.05	1.15	1.27	**1.15**
NM750	2.37	0.87	0.62	0.55	0.58	0.62	0.66	0.71	0.77	0.85	**0.86**
RRB600	2.40	0.90	0.65	0.58	0.62	0.66	0.71	0.76	0.83	0.91	**0.90**

It is clear from above analyses that Poladia site has very low financial viability with the IRR below 13% for almost all the turbines except S2100. Further, the Debt Service Coverage Ratio at the Poladia site goes below 1 for some years for all the turbines and the average DSCR is below 1 for turbines NM750 and RRB600 and is just above 1 for turbines S1500/E800/S2100/NM1650. Thus, the sites with lower wind resource should not be considered for the wind power project.

The turbine NM750 is showing IRR below 13% at each of the three sites. The turbines RRB600 and S1500 are showing financial viability at Warshamendi whereas the IRRs are below 13% at Kalyanpur. The DSCR for turbine S1500 remains above 1 at Warshamendi site except for one year but goes below 1 for five years at Kalyanpur site. The DSCR for RRB 600 goes below 1 for all the sites. Thus, the viability for these turbines is dependent on site. The Enercon E800, NM1650 & S2100 are having higher returns than the above two turbines at all the three sites.

Based on he above analysis it can be inferred that the turbines such as NM750 (which shows the IRR below 13% for all the sites and gives payback period greater than 20 years for two sites Kalyanpur and Poladia) should not be considered for the wind power projects, also the sites wth lower wind resources may not be considered for the project. Turbines E800, S2100, S1500, NM1650, and RRB600 should be considered for the project. The wind farm developers may be asked to offer these turbines or even better turbine in the sites having higher wind resources in their bid during the tendering process.

Cost of generation

Using the straight-line depreciation, the average cost of generation was estimated for a period of 20 years (Life span of wind power project).

Table 12 Average cost of generation for 20 years

	WTG	S2100	S1500	E800	NM1650	NM750	RRB600
Cost of generation	Warshamendi	2.00	2.27	2.06	2.12	2.88	2.54
	Kalyanpur	2.21	2.68	2.27	2.29	3.20	3.01

Rs/kWh	Poladia	2.53	2.80	2.59	2.64	3.55	3.37

A standard methodology was followed for levelised cost estimation. It may be noted that once the investment is made, the cost of generation would remain as estimated without any escalation, as there are no cost components like fuel costs which can escalate. Thus the generation cost would remain as estimated for next 20 years. The same cannot be said for the present electricity costs in Gujarat, as the costs would escalate over the period of next 20 years. Further the cost of generation depends on the total amount of electricity generated. It is clear from the above table that the cost of generation is lower at Warshamendi site as this id the highest wind power density site an the estimated energy generation from all the turbines are higher for this site.

11.3 Sensitivity analysis

The energy generation may vary depending on the availability of the wind throughout the year, and also the cost of wind machine may be different at the time of project development depending on the raw material cost, equipment cost, site development cost etc. These variations in generation and cost is considered here and the sensitivity analyses were carried out at Kalyanpur site, taking into consideration two prominent parameters

a) Generation remaining constant and cost varying by +/- 5%

b) Cost remaining constant and generation varying by +/- 10%

Table 13a Scenario A: Cost of turbine up by +5%, generation remaining constant

Turbines	ROE (%)	IRR (%)
S 2100	21.99	15.32
E 800	20.45	14.81
S1500	11.73	11.52
NM1650	19.74	14.57
Nm750	4.74	8.22
RRB600	6.96	9.35

Table 13b Scenario B: Cost of turbine less by -5%, generation remaining constant

Turbines	ROE (%)	IRR (%)
S 2100	27.77	17.10
E 800	25.95	16.55
S1500	15.57	13.06
NM1650	25.11	16.29
Nm750	7.38	9.56
RRB600	9.95	10.75

Table 13c Scenario C: Cost of turbine constant, generation up by 10%

Turbines	ROE (%)	IRR (%)
S 2100	31.84	18.29
E 800	29.89	17.73
S1500	18.60	14.17
NM1650	28.99	17.47
Nm750	9.64	10.61
RRB600	12.44	11.82

Table 13d Scenario D: Cost of turbine constant, generation less by 10%

Turbines	ROE (%)	IRR (%)
S 2100	17.97	13.94
E 800	16.59	13.44
S1500	8.83	10.24
NM1650	15.96	13.21
Nm750	2.46	6.99
RRB600	4.50	8.10

It is clear from the above analysis that the cost of the turbine as well as the generation estimations has considerable impact on the financial viability of the project.

The IRR increases by approximately 1.0 % point with 5% increase in the cost and decreases about 1 % with 5% reduction in the cost. Similarly for reduction in generation of 10% there is an increase of approximately 2.0% in IRR and for increase in generation of 10%, there is a decrease in IRR of approximately 2.0%.

The issue of fluctuation in cost & generation and resultant lowering IRR is mitigated in project development with developer approach through tendering. The lump sum costs received in the tender would be firm and as the project has very short gestation period, the cost escalation would not arise.

In case of generation, which is function of wind turbine as well as location, the risk on wind turbine part is reduced by putting a requirement of on site power curve testing of the wind turbine and including it as a requirement in bid. Further, while evaluation the bids sites, which give IRR below a fixed value (specified by GSPC) would not be considered for further processing.

Thus through tendering, the best turbine/ site combination, which would meet the financial norms, would get selected; there by ensuring required returns even in worst case scenarios

11.4 Possibility of availing CDM benefits

India being a signatory of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), projects resulting in reduction of CO2 are eligible under the Clean Development Mechanism (CDM). The wind power projects producing clean power thus can result in to generation of additional revenue through sale of Certified Carbon Emissions

Reductions (CERs). The detailed procedure for registering the projects with the Executive Board of the UNFCCC and availing the CDM benefits is given in Annex XI.

12. Risk analysis

Payment security

In the tariff order of GERC for the payment of surplus energy sold to the distribution company, the Commission had directed the distribution company that "The Distribution Licensee shall make payment for any such excess generation in a given month, before the last day of the succeeding month". This means that the distribution licensee would make the payment for the surplus power within a month's time. The present track record of GUVNL, for payments, is good and there are no major overdue for wind power projects. There is provision for letter of credit (LC) for the payments; however this has not been used by present investors in Gujarat. The provision for LOC has been clearly mentioned in the model PPA.

There is no additional security mechanism in place for payments for wind energy projects. However, in case of long delays, the investors can approach the regulatory commission regarding delayed payments.

Entry Exit barriers

The wind energy projects are being developed on commercial scale in India as well as in Gujarat so there are no major entry barriers. In case of Gujarat, the wind tariff order has been issued on 11th August 2006 and is applicable for projects set up exclusively for selling power to utility. For projects for self-use the order is valid from 20th June 2007. Presently, there are no projects finalised with signed PPA for self-use under the new tariff order. The discussion with the utility indicates that the terms and conditions of the PPA would be same as earlier.

In the tariff order, it was mentioned that the PPA for self-use of wind power would include penalty if the investor winds up the projects before 20 years. However, the Commission would review this matter when it considers the model PPA issue. Thus, there is a possibility there would be some penalty for early exit. However, at present there is no clarity on the applicability and extent of this penalty.

Technology

The wind turbines presently being offered in India are state of the art for the individual turbine capacities. The individual turbine capacities are increasing world over and reaching the capacity of 5MW. However, these higher capacity turbines are developed a) for offshore wind projects or/and b) for high wind regimes. India being in medium to low wind regime, the maximum turbine capacities would remain about 2MW. The analysis carried out was based on turbines with C-WET certification, thus, reducing technology risk. In addition, while rating different turbines, the years a particular turbine has been operational was considered as one of the criteria.

Further, the 'on-site power curve testing' of turbines would be an essential condition for bidders ensuring the turbine quality.

Risk during construction

Risk during construction may be such as delay in land acquisition, delay in getting approvals and clearances for wind farm development, delay in procurement of materials, labour problem, etc. In Gujarat till now no major problems like above have been faced by the developers, which may couse delay in construction work. Generally the developers take all the clearances, well in time.

Other energy sources

There would not be any risk as far as other energy sources are concerned, as the project would have a long term PPA with the utility and would not enter into the open market for bidding, whenever it comes into force.

13. Environmental assessment

Pollution

Wind power is a clean source of energy and does not result into any liquid, land or air pollution. Thus wind projects are exempted from the requirement of carrying out Environmental Impact Assessment (EIA) prior to the project implementation.

There is some noise pollution in the vicinity of the wind projects. However, the wind projects are always in the remote locations away from settlements, making the noise pollution levels insignificant for general population.

Fire /Accident

Standard safety precautions are needed for the O&M personnel since the maintenance involves climbing to the hub of the turbine at 60-80m high. Standard industrial Injury and Illness Prevention Program and fire precaution are required to be followed at wind power project sites.

14. Steps involved in developing a wind energy farm

The implementation of the proposed wind farm could be done in two ways.

1. **Developer approach**

The developer/manufacturer carries out all the activities on behalf of the client. The project developer procures suitable land, develop the project with necessary permissions and approvals, install turbines, provide grid connection, gets the agreements signed, commission the project, hands over the same to the investor and if required carries out the O&M for contracted period etc.

The advantages of the developer approach are:

1 GSPC will not be required to undertake any of the processes for approvals, contracts, grid extension, site development as well as erection/ commissioning of the turbines etc.

2. Another advantage is the time required to commission the project. With the developer approach, the time required to commission the project is about a year since all the clearances, infrastructure development etc. is already planned/undertaken by the developer.

3. Further, if GSPC has a long-term interest in developing wind power projects, this initial project would provide experience in the wind projects, which could be used for independent project development subsequently.

The possible disadvantages of this approach are:

1. Limitation on choice of site depending on offers by developers
2. No option for opting Foreign based manufacturers turbines
3. Possible high cost as the developers may charge premium for the sites controlled by them.

2. Setting up of the project by the GSPC

The procedure to develop the wind farm in this node is as follows:

- Feasibility studies involving tendering and contract
- Wind resource assessment which requires more than 1years time
- Contour and land survey
- Micrositing study
- Hiring of a technical consultant for validation of micrositing
- Registration with GEDA
- Land procurement (18–20 acres/ MW): In case of Government land: Selection of land, Collectors approval, Tehsildar's approval, forest department approval, if necessary. In case of private land: Buying it from the villagers, approval of Tehsildar
- Approval from GEDA after filing an application.
- Assessment of power evacuation facilities
- Approval of GETCO after it conducts the load flow analysis
- Power purchase agreement with GETCO, GUVNL and GEDA
- Application of loan
- Site development and civil construction
- Preparation of bids for machine procurement and O&M arrangements
- Bid evaluation
- Finalization of contract
- Erection and commissioning
- Development of evacuation facilities

- Project commissioning

There are two agreements, one a PPA with GUVNL and another a wheeling agreement with GETCO, which are required to be entered into.

Advantage of this route:

1. Choice of site from all the declared windy sites. But with the present scenario of most of the high potential sites being captured by prospective developers, the choice can get restricted.
2. Choice of turbines from foreign manufacturers

Disadvantages:

1. Need to undertake all the activities on its own, with little experience, resulting in longer commissioning time.
2. Procurement of land without wind resource assessment can be risky.
3. Doing wind assessment without procurement of land can result in situation where some private developer might take possession of the same before our purchase.
4. The possibility of getting turbines from the manufacturers with the expected cost advantage is less given the current market situation.

Thus, the recommended approach for the development of the proposed wind project is through the developers.

The detailed pertchart for activities under both the implementation modes is given below.

Activity chart	MONTHS																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Activity chart for self development mode																						
Activity																						
Feasibility study	■	■																				
Selection of site and purchase of land with clearances		■	■	■	■	■	■															
Wind resource assessment			■	■	■	■	■	■	■	■	■	■	■	■								
Contour and land survey				■	■																	
Micrositing of wind turbines											■	■	■									
Assessment of evacuation facility with clearance												■	■									
Power purchase agreement														■								
Application for loan															■							
Site development, road development													■	■	■							
Preparation of Bids for supply and erection and commissioning of WTGs								■	■													
Bid evaluation									■	■												
Finalization of contract											■											
Erection and commissioning																■	■	■	■	■	■	
Evacuation facility																			■	■	■	
Commissioning of project																						■
Activity Chart for project at sites already being developed by Developers																						
Feasibility study	■	■																				

Activity chart	MONTHS																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Preparation of bids			■	■																		
Floating – closing of tender					■	■																
Bid evaluation, validation of micro-siting and contract signing							■	■	■	■												
Power purchase agreement										■												
Application for Loan										■												
Erection and commissioning										■	■	■	■	■	■							

It was noted that with the implementation through the developer mode, the project commissioning would be before September 2008, while as in the case of self-implementation by GSPC, it would take longer to commission the project.

Contractual agreements between wind farm/mill owners and GEB/power utilities

A model PPA has been developed by GUVNL for having agreements with the developer for sale of energy to utility. This PPA is signed only after the approval is accorded from GEDA. The obligations of the developer and GUVNL are given below:

Obligations of the developer

i. The developer shall obtain all statutory approvals, clearances and permits necessary for the project at his cost
ii. The developer shall construct, operate and maintain the project during the term of PPA at his cost and risk including the interconnection facilities and the substation.
iii. The developer shall sell all available capacity from identified wind farms to the extent of contracted capacity on first priority basis to GUVNL and not to sell to any third party.
iv. The developer shall seek approval of GETCO in respect of interconnection facilities and the sending station.
v. The developer shall undertake at its own cost construction/upgradation of (a) the interconnection facilities, (b) the transmission lines and (c) sending station as per the specifications and requirements of GETCO as notified to the developer.
vi. The developer shall undertake at its own cost maintenance of the interconnection facilities and the sending station excluding the transmission line beyond the sending station as per the specifications and requirements of GETCO as notified to the developer, in accordance with prudent utility practices.
vii. The developer shall operate and maintain the project in accordance with prudent utility practices.
viii. The developer shall be responsible for all payments on account of any taxes, cesses, duties or levies imposed by the government of Gujarat or its competent statutory authority on the land, equipment, material or works of the project or on the electricity generated or consumed by the project or by itself or on the income or assets owned by it.

ix. For evacuation facility and maintenance of the transmission, the developer shall enter into separate agreement with GETCO, if applicable.
x. To procure start up power required for the plant from respective discom.
xi. The developer cannot inject the power three months earlier to scheduled commercial operation date from wind turbine generator.

Obligations of GUVNL are:

i. To allow the developer to the extent possible, to operate the project as a base load generating station.
ii. To grant must run status to the project subject however to emergency conditions.

Billing and payment provisions:
The billing is done on monthly basis and payments will be made on the receipt of the tariff invoice raised by the developer.

The prevalent policies have been updated. However, since there are no new sites, which have been developed for self-use under the new policy regime, the nature of agreement and other formal agreements are still in an evolving stage. All the information collected is through discussions with GUVNL, GETCO officials and developers.

Technical parameters/limits for supply of power generated from wind farm

i. Nominal declared frequency to be 50 Hz
ii. Final voltage at delivery point to be 132 or 66kV
iii. Short circuit rating to be calculated by the developer and produced to GUVNL. The tolerances and electrical characteristics will be as per GUVNL/GETCO standards
iv. The developer will be responsible for delivery of energy conforming to GETCO/GUVNL standards
v. The PF of the power generated to be more than 0.8, or else the developer would attract penalty.

List of approvals required for project implementation

i. Consent from GETCO for the evacuation scheme for evacuation of the power generated by wind power projects.
ii. Approval of the electrical inspectorate, Government of Gujarat for commissioning of the transmission line and the wind energy converters installed at the project site.
iii. Certificate of commissioning of the wind farm project issued by GEDA.
iv. Permission from all other statutory and non-statutory bodies required for the project.
v. Clearance from the Airport Authority of India, if required.
vi. Clearance from the Department of Forest, Ecology and Environment, if required.

15. Conclusion and recommendation

Gujarat has the highest gross wind power potential in the country and only a limited number of projects have been commissioned so far. Thus, it has the highest untapped potential. With the GERC tariff order dated 11.8.2006 for wind power, the wind power projects in Gujarat have become financially viable.

Based on the financial analysis as well as the site conditions, the sites with low wind resource would provide lower returns as indicated by the lower ROE, and IRR. Thus, the wind belts to be focused are medium and high wind resource, with wind power density above 300W/m^2 at 50 m height, as indicated by the analysis of Warshamendi and Kalyanpur sites. These two wind sites, representative of high and medium wind resource, would provide good returns. as indicated by IRR above 13% and DSCR above 1.

The generation from the 750kW capacity turbine of Vestas Wind Technologies India Pvt. Ltd. is very less and yields very less returns and thus should not be considered for the proposed wind project. The turbines RRB600 and S1500 show financial viability depending upon the wind resource at the site and size of the project. Thus, these two turbines can be considered for inviting bids. The Enercon E800 and NM 1650 are viable at all the three sites and hence should be considered for inviting bids for the proposed wind power project. Thus, the turbines to be considered for the proposed wind project are Enercon 800kW, Suzlon and 1500kW, Vestas Wind Technologies India Pvt Ltd. 1650kW and RRB Energy Limited's 600kW. The turbines thus selected cover all the major wind turbine manufacturers operating in India. The recommendation for S2100 is notgiven here because of the fact that the Suzlon Energy Limited is currently not offering this wind turbine for Indian wind power projects. These four manufacturers have about 95% of the market share in India. The remaining turbine manufacturers, GE Wind and Pioneer Asia have turbines with more than 500 kW capacitiy. Though at present the GE1500kW and Pioneer 850kW turbines have not renewed the C-WET certification, these may also be considered while inviting bids with a condition that they should have C-WET certification when the bids are submitted.

In the case of implementation of the project through developer, it would not be sure that same sites, as analysed in this study, would be offered. In such a scenario, based on the typical site-wise analysis in the study, sites with wind power density above 300 W/m^2 at height of 50m, in the wind belt of coastal regions of Kutch /Jamnagar and/or wind belt in the bordering area of Rajkot and Surendranagar districts could be focused upon. These wind belts have high concentration of sites with good wind resource like Motisindholi, Mundra in Kutch district and Bamanbore, Warshamendi, Dhank etc. in Rajkot district.

The capital investment for the proposed wind power project would be about 679.67 cr, and the analysis shows that the IRR would be in the range of 10–16% with average wind site (Kalyanpur) and different turbines.

The developer approach with tendering would mitigate the possible fluctuations in cost and generation and would allow selection of best site and turbine combination offered which would make the project viable.

Considering the above, the investment in wind power project is feasible and recommended to GSPC.

Methodology for project development

As analysed in section 14, the recommended approach for the development of the proposed wind project is through the developers. With almost all the wind turbine manufacturers developing sites in Gujarat, there would be a choice of selecting sites within the available options. The short listed turbines based on the analysis, Suzlon 2100kW and 1500 kW, Enercon 800kW, Vestas India Wind technologies Pvt. Ltd. 1650kW and Vestas RRB India Ltd. 600 kW, cover all the major wind turbine manufacturers in India. In addition to the turbines evaluated for generation, there are two more manufacturers, GE Wind and Pioneer Asia which also manufacturer turbines with capacity more than 500kW. With these six manufacturers all the turbine manufacturers in India are covered. Thus, tenders for the proposed wind power project may be invited from these wind turbine manufacturers.

Annex I: Wind Policy, 2007

Wind Power Policy – 2007
Government of Gujarat
Energy and Petrochemicals Department
Government Resolution No.EDA-102001-3054-B
Sachivalaya, Gandhinagar

Dated the 13th June, 2007

The Government is keen on development of renewable energy sector, given the dwindling resources of fossil fuels, increased threat of global warming and the concern on environmental protection. The state is blessed with long coast line and good wind speeds for harnessing of the Wind Energy. The State of Gujarat is committed to have investment in Clean and Green Energy to reduce Carbon Dioxide emissions. To accelerate the investment in this sector, there is a need to extend Government support. In this context, it was under consideration of the government to review the present wind power policy. In order to further tap the potential of the Wind Energy, the State Government has decided to announce a New Wind Power Policy – 2007 as follows:

RESOLUTION:

1. Title:
This scheme shall be known as the "Wind Power Policy – 2007".

2. Operative Period:
This policy will come into force with effect from 20th June, 2007 and shall remain in operation upto 30th June 2012, which will be the operative period of the scheme. Wind Turbine Generators (WTGs) installed and commissioned during the operative period shall become eligible for the incentives declared under this policy, for a period of twenty years from the date of commissioning or for the life span of the WTGs , whichever is earlier.

3. Eligible Unit:
Any company or body corporate or association or body of individuals, whether incorporated or not, or artificial juridical person, will be eligible for setting up of WTGs, either for the purpose of captive use and /or for selling of electricity, in accordance with the Electricity Act -2003, as amended from time to time. Explanation:- The use of electricity for own consumption at his end use location/s by the owner of WTGs shall be considered as Captive use.

4. Eligible Sites:
The WTGs may be set up at sites notified by Gujarat Energy Development Agency (GEDA) and/ or any other sites identified as potential site, within the State by the Developer.

5. Wheeling of Electricity:
The wheeling of electricity generated from the WTGs, to the desired location/s within the State, shall be allowed at a wheeling charge of 4% of the energy fed to the grid, as per Gujarat Electricity Regulatory Commission (GERC) order, as amended from time to time.

6. Exemption from payment of Electricity Duty:
Except in case of Third Party Sale of electricity, the electricity generated from the WTGs shall be exempted from payment of Electricity Duty. The sale of electricity other than to GUVNL and/ or any Distribution Licensee in the State, shall be considered as Third Party Sale of Electricity. In case of Third Party Sale, the eligible unit shall have to recover the Electricity Duty from the purchaser, at such rates, as applicable under the Bombay Electricity Duty Act 1958.

7. Exemption from Demand Cut:
Exemption from demand cut to the extent of 30% of the installed capacity of WTGs, assigned for captive use purpose, shall be allowed.

8. Sale of Energy:
The electricity generated from the WTGs may be sold to GUVNL and/ or any Distribution Licensee within the state, at a rate of Rs.3.37 per unit of electricity as per GERC order, as amended from time to time. The requisite Power Purchase Agreement (PPA) shall be done between the purchaser of power and the eligible unit.

9. Third party sale of Energy:
The sale of electricity generated from the WTGs shall also be allowed to a third party, in accordance with the GERC order, as amended from time to time.

10. Land:
The WTGs may be set up on private land, or revenue wasteland / GEDA land, if available. The allotment of GEDA land on lease shall be done upon approval of the Co-ordination Committee consisting of the following members.
i. ACS/ PS/ Secretary (EPD) Chairman
ii. AS/ JS/ Deputy Secretary (EPD) Member
iii. Chief Electrical Inspector & Collector of Elect. Duty Member
iv. General Manager (Comm.), GUVNL Member
v. Respective District Collector Member
vi. Director, GEDA Member Secretary

11. Plant and Machinery:
Second hand WTGs shall not be eligible for installation under this Policy. Only such WTGs which are approved either by Ministry of New and Renewable Energy, Government of India, or by recognized international test houses, shall be eligible.

12. Metering of Electricity:
The electricity generated from the WTGs, shall be metered on a monthly basis jointly by GEDA/ GETCO at the sending sub-station of 66 kV or above, located at wind farm site.

13. Reactive Power Charges:
The drawl of reactive power shall be charged as per the GERC order, as amended from time to time.

14. Nodal Agency:
GEDA shall be the nodal agency for implementation of the Wind Power Policy – 2007. Notwithstanding anything contained in this resolution, the provisions of the
Electricity Act – 2003, and the GERC order, as issued from time to time, shall prevail, for the purpose of the implementation of this policy.

This issues with the concurrence of the Finance Department's note dated 27.12.2006 on this Department's file of even number.

By order and in the name of the Governor of Gujarat.
(Bipin Patel)
Under Secretary to the Government of Gujarat
Energy and Petrochemicals Department

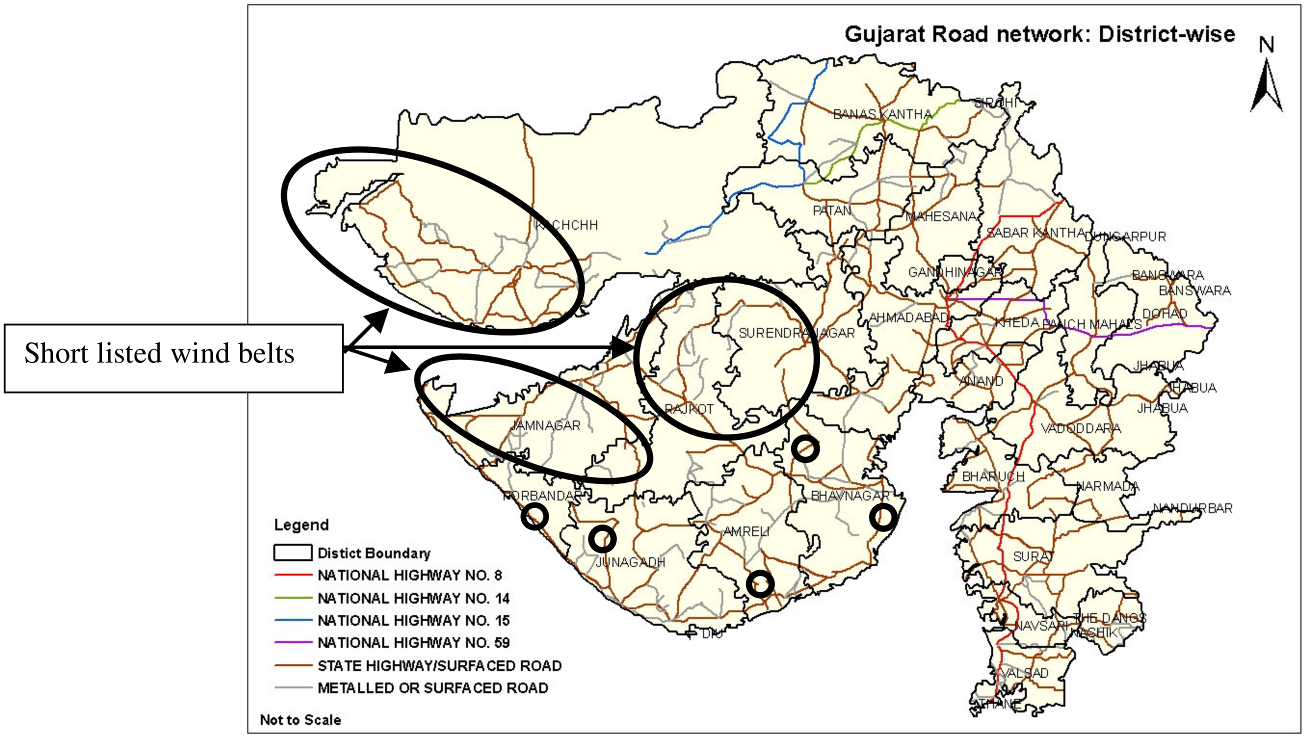
Copy to:

- The Principal Sec. to HE the Governor of Gujarat, Raj Bhavan, G'nagar (By Letter)
- The Principal Secretary to the Hon. CM, Sachivalaya, G'nagar
- The PS to Hon. MoS (EP&F), Sachivalaya, G'nagar.
- The PPS to the Chief Secretary, Sachivalaya , G'nagar
- The Additional Chief Secretary, Finance Department, Sachivalaya,G'nagar.
- The Principal Secretary, Revenue Department, Sachivalaya, G'nagar.
- The Principal Secretary, I&MD, Sachivalaya, G'nagar.
- The Secretary, Gujarat Electricity Regulatory Commission, Ahmedabad.
- The Industries Commissioner, Udyog Bhavan, G'nagar.
- All the District Collectors, Gujarat State.
- The Chairman, GUVNL, Vadodara
- The Chairman, GEDA, G'nagar
- The Chief Electrical Inspector & Collector of Elect. Duty, Udyog Bhavan,G'nagar.
- The Director, GEDA, G'nagar.
- The Managing Director, GUVNL/ GETCO/GSECL/ All DISCOMS
- The GM (Commerce), GUVNL, Vadodara.
- The Managing Director, Torrent Power Ltd. Ahmedabad.
- All Departments of Sachivalaya, G'nagar.
- All Branches of EPD
- The Select file
- The Personal file

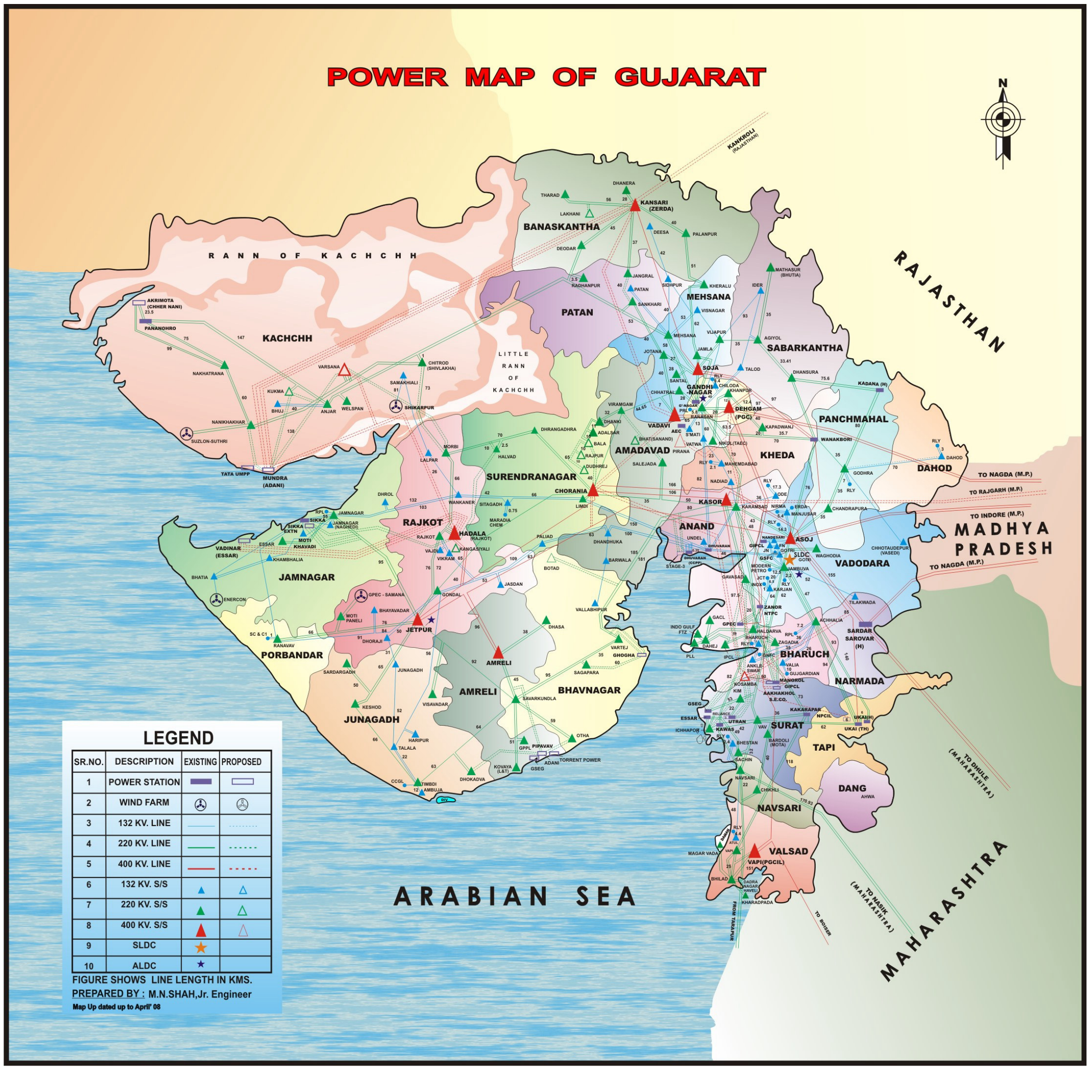
Annex II: Wind sites in Gujarat

Sl. No	Station	Tehasil	District	Measured at 20/25m	Extrapolated to 50m
	GUJARAT				
1	Adesar	Bachhau	Kutch	93	307
2	Amrapar (Gir)	Keshod	Junagarh	147	241
3	Amrapar (Seth)	Jamjodhpur	Jamnager	151	221
4	Bamanbore II	Chotila	Surendernagar	171	243
5	Bayath	Mandvi	Kutch	118	300
6	Bhandariya	Khambalia	Jamnager	162	208
7	Butavadar	Jamjodhpur	Jamnagar	98	240
8	Dhank I	Upleta	Rajkot	312	414
9	Dhank II	Upleta	Rajkot	327	367
10	Gala	Lalpur	Jamnager	175	254
11	Godladhar	Jasden	Porbander	144	345
12	Haripar	Khambalia	Jamnager	160	210
13	Harshad	Kalyanpur	Jamnager	164	239
14	Jafrabad	Rajula	Amreli	137	242
15	Jamanvada	Lakhpat	Kutch	149	299
16	Jasapar	Dhari	Amreli	104	214
17	Kagavad	Jetpur	Surat	141	212
18	Kalyanpur	Kalyanpur	Jamnager	208	327
19	Khambada	Babra	Amreli	126	204
20	Kukma	Bhuj	Kutch	150	239
21	Lamba	Kalyanpur	Jamnager	164	232
22	Limbara	Wankaner	Rajkot	166	227
23	Mahidad *	Chotila	Surendernagar	178	231
24	Motisindholi	Naliya	Kutch	118	311
25	Mundra	Mundra	Kutch	168	303
26	Navadra	Kalyanpur	Jamnager	183	297
27	Nani Kundal	Babra	Amreli	163	278
28	Navibander	Porbander	Porbander	153	213
29	Okha	Dwarka	Jamnager	150	260
30	Okhamadhi	Kalyanpur	Jamnager	129	209
31	Poladiya	Mandvi	Kutch	177	278
32	Ratabhe	Halvad	Surendernagar	123	212
33	Rojmal	Gadhada	Bhavnagar	129	317
34	Sanodar	Ghoga	Bhavnagar	197	373
35	Sinai	Anjar	Kutch	183	244
36	Suvarda	Jamnagar	Jamnager	166	243
37	Surajbari	Bhachau	Kutch	184	444
38	Warshamedi	Maliya	Rajkot	192	499

Annex III: Roadmap of Gujarat with the wind belts/sites



Annex IV: Power map of Gujarat



Source: Gujarat Energy Transmission Company Limited

Annex V: Short listing of wind sites

The parameters used for evaluation of sites are described below along with the details of scores under each of the parameter.

Land availability

It was observed that, based on the micro survey reports available for some of the sites the land pattern was mix of Government and private land. For the sites, which are under development, the wind project developers have procured some of the land. As the land availability is similar at almost all the sites this criteria was not used for scoring, but used as an information for the site

Road network

Based on the detailed roadmap of Gujarat and the micro survey data, it was observed that the road network at the sites in the selected wind belts is good and thus this criteria was not used for ranking of sites

Grid availability

The 66kV substations in the vicinity of the sites were identified. The sites, which have 2 substations in the vicinity of 10km radius, were given score of 10. The sites, which have one 66kV substation in the vicinity of 10 km, were given score of 7. In case of sites where the 66kV substation is more than 10 km away were given score of 2. The scores were based on the additional investment of grid infrastructure for additional distance of about 2.5 lakh/kilometre.

Wind power density at 50m height

The highest WPD of 499 W/m^2 was given highest score of 10 while as the lowest WPD of 200 was given score of 1. The sites with WPD in the range from 499-200W/m^2 were given relative scores. e.g. WPD of 327 W/m^2 in Kalyanpur is give score

$= 1 + (327-200)/(299/9) = 4.8$

Wind potential available

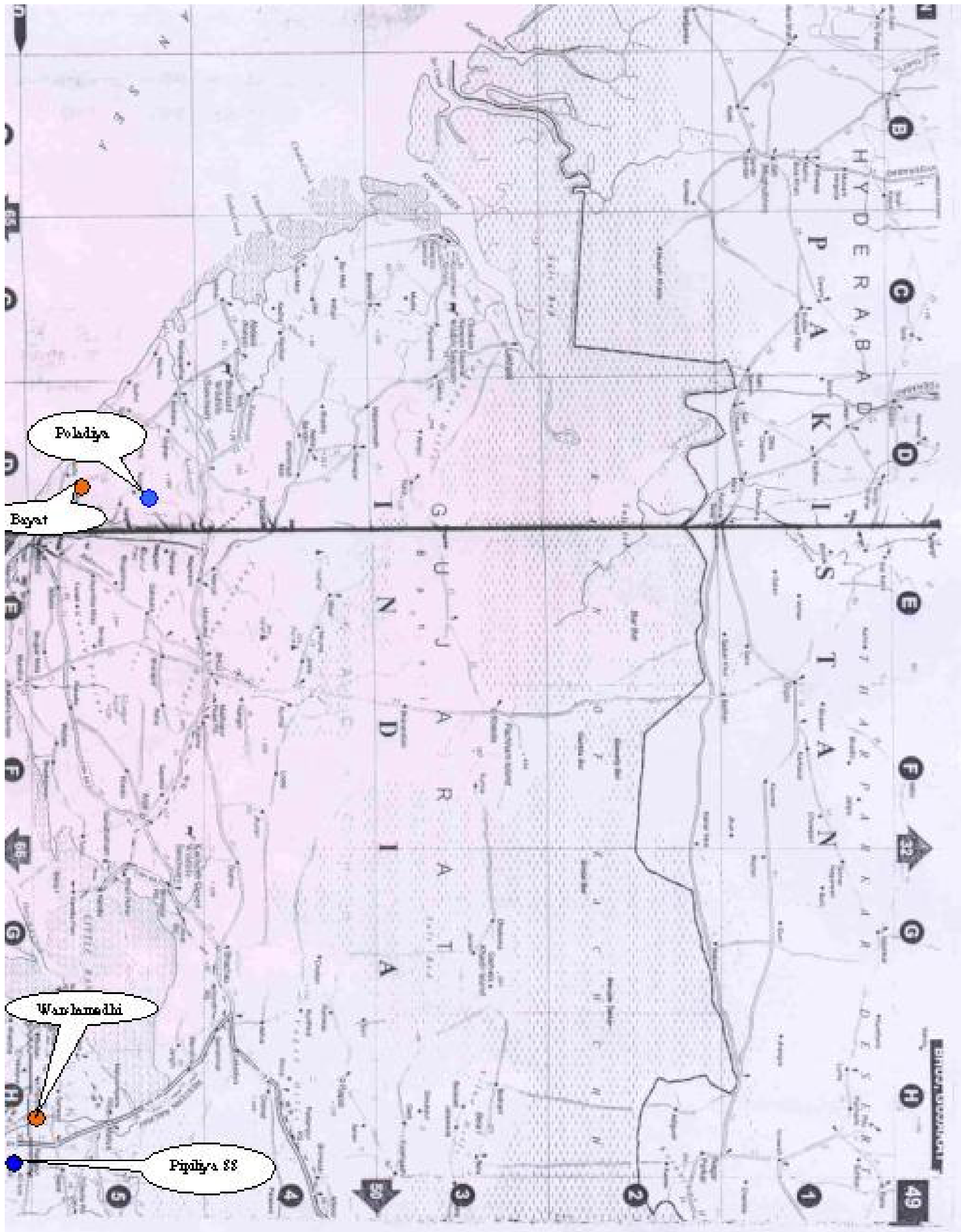
For the sites where micro survey has been conducted the data regarding potential at the site is available. The site with highest potential of 1100 MW is given score of 10 and other sites were given scores depending upon the potential available i.e. potential identified – installed capacity.

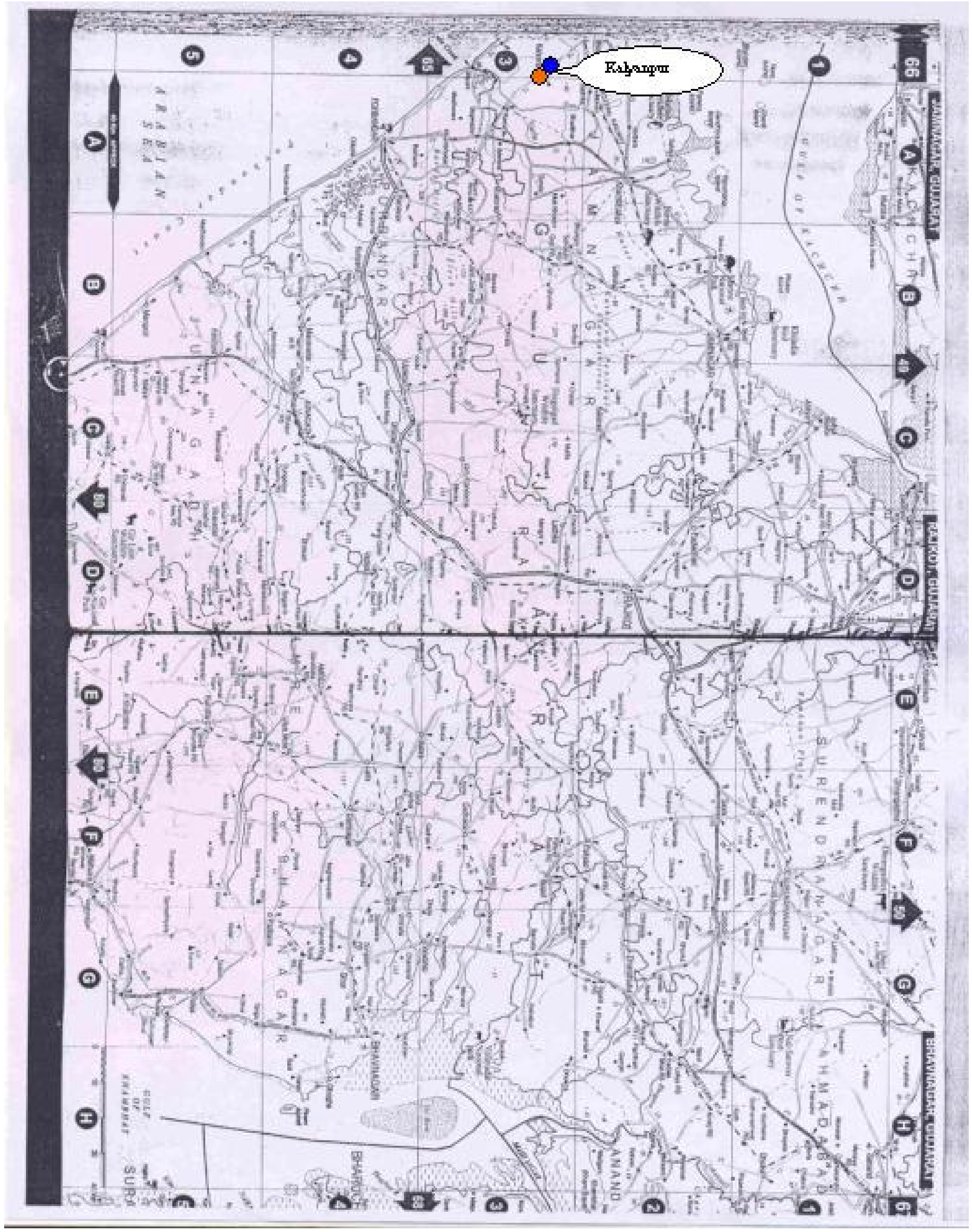
For the sites where the microsurvey was not undertaken and hence the potential is unknown a score was given based on the wind speed i.e. speed above 5m/s is given score of 4, sites with wind speed below 5m/s were given score of 2.

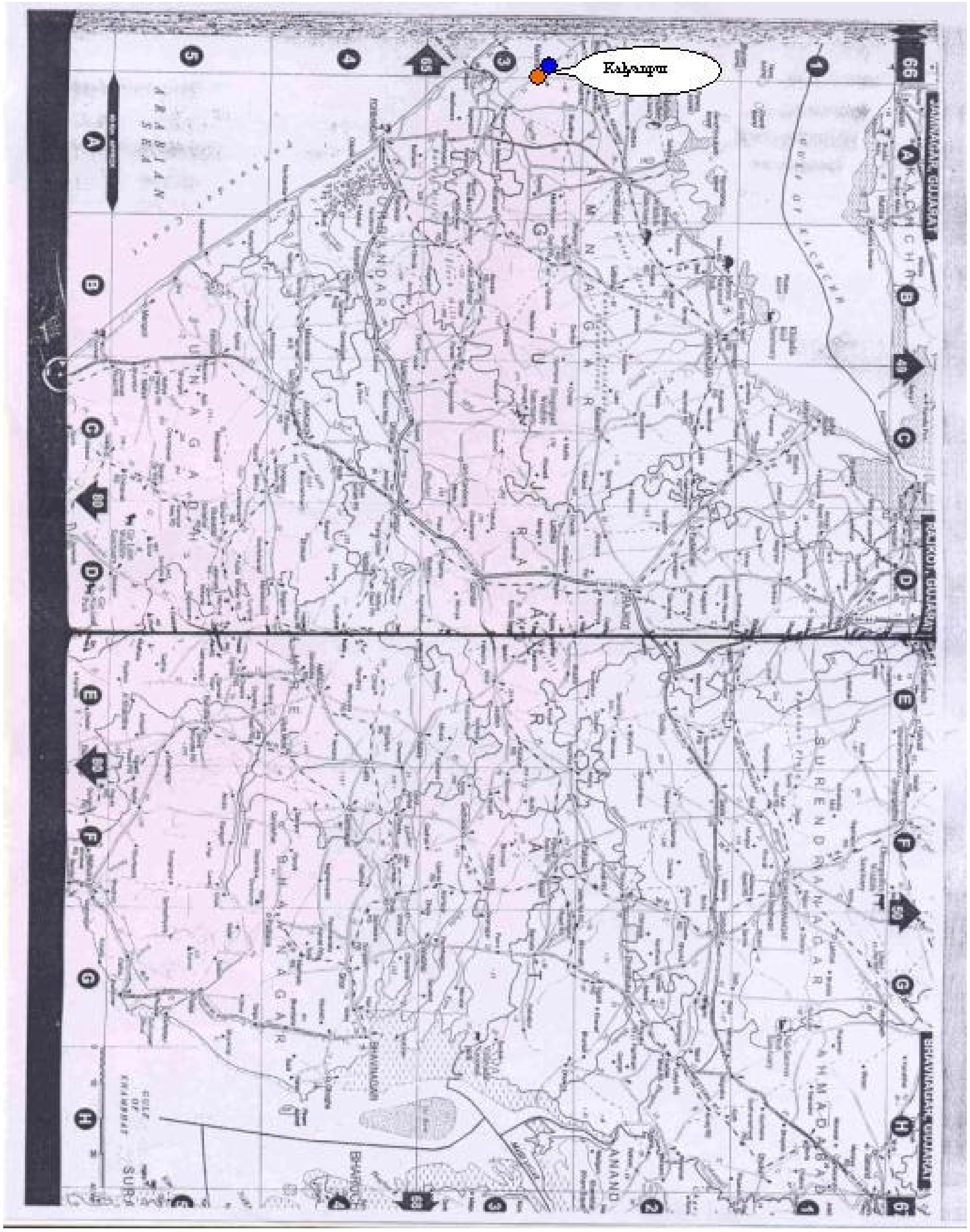
The site wise details of the parameters and the score are given in table below.

		District	WPD at 50m (W/m²)	Wind speed (m/s)	Potential (MW)	Tapped	Land	Road	Grid	Grid ranking	WPD score	Potential available	Total
Warshamedi	Maliya	Rajkot	**499**	**5.51**	NA		Govt/private	Good network	66 kV available (2)	10	10.0	4.0	24.0
Dhank I	Upleta	Rajkot	414	6.59	493.2		Mianly private + Govt	Fair network	66 kV available	7	7.4	4.5	18.9
Jamanvada	Lakhpat	Kutch	299	5.02	1100.2		Mainly government	Good network	66 kV not available near	2	4.0	10.0	16.0
Kalyanpur	Kalyanpur	Jamnager	**327**	**5.97**	418.5	5.17	75% private/rest govt	good network	66 kV available	7	4.8	3.8	15.6
Bamanbore II	Chotila	Surendernagar	243	5.48	688.9		75% private/rest govt	Not very high penetration	66 kV at bamanbore	7	2.3	6.3	15.6
Surajbari	Bhachau	Kutch	**444**	**5.27**	545.2	310	Govt/private + developer	Good network	66 kV near	2	8.3	5.0	15.3
Mundra	Mundra	Kutch	303	5.27	63.7		Govt/Pvt	Good network	66kV available (2)	10	4.1	0.6	14.7
Sinai	Anjar	Kutch	244	5.61	159.6		Govt/pvt	Good network	66kV available (2)	10	2.3	1.5	13.8
Butavadar	Jamjodhpur	Jamnagar	240	4.43	NA		Govt/Private	Good network	66 kV available (2)	10	2.2	2.0	14.2
Motisindholi	Naliya	Kutch	**311**	**4.73**	718.3	300	Govt/Private/Developer	Good network	66kV not available near	2	4.3	6.5	12.9
Bayath	Mandvi	Kutch	300	4.77	NA		Govt/Pvt	Good network	66kV available	7	4.0	2.0	13.0
Okha	Dwarka	Jamnager	260	5.24	156.6		75% private/rest govt	Good network	66 kV available	7	2.8	1.4	11.2
Dhank II	Upleta	Rajkot	367	6.78	NA	42.61	Mainly private	Fair network	66kV near	2	6.0	4.0	12.0
Suvarda	Jamnagar	Jamnager	243	5.45	NA	300	Govt / Private/ Developer	Good\	66 Available	7	2.3	4.0	13.3
Gala	Lalpur	Jamnager	254	5.34	60		Govt/private	Good network	66kV available	7	2.6	0.5	10.2
Adesar	Bachhau	Kutch	307	4.21	NA		Govt/Pvt	Good network	66kV near	2	4.2	2.0	8.2
Navadra	Kalyanpur	Jamnager	297	5.62	NA	43.1	75% private/rest govt	Good network	66kV near	2	3.9	4.0	9.9
Poladiya	Mandvi	Kutch	278	5.56	131.1	300*	Govt/Pvt	Good network	66 kV not near	2	3.3	1.2	6.5

Annex VI: Map showing wind sites and nearest sub-station




Kalyanpur


Kalyanpur

List of 66 kV Sub-Stations of GETCO

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
1	Navasari	Vapi	VAPI GIDC	66
2	Navasari	Vapi	UMERGAM	66
3	Navasari	Vapi	ATAKPARDI VALSAD	66
4	Navasari	Vapi	VAPI GIDC III	66
5	Navasari	Vapi	SARIGAM	66
6	Navasari	Vapi	DHARAMPUR	66
7	Navasari	Vapi	DAMANGANGA	66
8	Navasari	Vapi	MOTAPONDA(KAKAD KOPAR)	66
9	Navasari	Vapi	VALSAD CITY	66
10	Navasari	Vapi	VAPI GIDC IV	66
11	Navasari	Vapi	DUNGRI	66
12	Navasari	Vapi	KAPARADA	66
13	Navasari	Vapi	DUNGARKHADKI(PARDI)	66
14	Navasari	Vapi	SANJAN	66
15	Navasari	NAVSARI	EROO	66
16	Navasari	NAVSARI	GANDEVI	66
17	Navasari	NAVSARI	BILIMORA	66
18	Navasari	NAVSARI	WAGHAI	66
19	Navasari	NAVSARI	ANAVAL	66
20	Navasari	NAVSARI	CHIKHALI	66
21	Navasari	NAVSARI	CHHAPRA	66
22	Navasari	NAVSARI	MAROLI	66
23	Navasari	NAVSARI	DOLVAN	66
24	Navasari	NAVSARI	VANSDA	66
25	Navasari	NAVSARI	KHERGAM	66
26	Navasari	NAVSARI	AHWA	66
27	Navasari	NAVSARI	AMALSAD	66
28	Navasari	NAVSARI	TANKAL	66
29	Navasari	ICHHAPORE	ICHHAPORE	66
30	Navasari	ICHHAPORE	TAPI	66
31	Navasari	ICHHAPORE	UDHANA	66
32	Navasari	ICHHAPORE	OLPAD	66
33	Navasari	ICHHAPORE	GODADARA	66
34	Navasari	ICHHAPORE	VARIAV	66
35	Navasari	ICHHAPORE	VESU	66
36	Navasari	ICHHAPORE	GOVALAK(UDHANA'B')	66
37	Navasari	ICHHAPORE	SARTHANA	66
38	Navasari	ICHHAPORE	SACHIN GIDC - A	66
39	Navasari	ICHHAPORE	SACHIN B	66
40	Navasari	ICHHAPORE	PANDESARA-I	66
41	Navasari	ICHHAPORE	PAL	66
42	Navasari	ICHHAPORE	PUNA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
43	Navasari	ICHHAPORE	VANZ	66
44	Navasari	ICHHAPORE	PANDESARA-II	66
45	Navasari	VAV	VYARA	66
46	Navasari	VAV	UKAI	66
47	Navasari	VAV	NIZAR	66
48	Navasari	VAV	SONGADH	66
49	Navasari	VAV	MAHUVA	66
50	Navasari	VAV	UCHHAL	66
51	Navasari	VAV	VALOD	66
52	Navasari	VAV	BARDOLI	66
53	Navasari	VAV	PALSANA	66
54	Navasari	VAV	KAMREJ	66
55	Navasari	VAV	KADODARA	66
56	Navasari	VAV	LASKANA	66
57	Navasari	VAV	JOLWA	66
58	Navasari	VAV	KADOD	66
59	Navasari	VAV	MADHI	66
60	BHARUCH	BHARUCH	ANKLESHWAR GIDC-A	66
61	BHARUCH	BHARUCH	ANKLESHWAR GIDC-B	66
62	BHARUCH	BHARUCH	ANKLESHWAR (Urban)	66
63	BHARUCH	BHARUCH	DAHEJ	66
64	BHARUCH	BHARUCH	PANOLI GIDC	66
65	BHARUCH	BHARUCH	HANSOT	66
66	BHARUCH	BHARUCH	BHARUCH B	66
67	BHARUCH	ACHHALIA	JHAGADIA	66
68	BHARUCH	ACHHALIA	RAJPIPLA	66
69	BHARUCH	ACHHALIA	RAJPARDI	66
70	BHARUCH	ACHHALIA	DEDIYAPADA	66
71	BHARUCH	ACHHALIA	SAGBARA	66
72	BHARUCH	ACHHALIA	NETRANG	66
73	BHARUCH	ACHHALIA	PRATAPNAGAR	66
74	BHARUCH	ACHHALIA	RANDERI	66
75	BHARUCH	ACHHALIA	PANETHA	66
76	BHARUCH	HALDARVA	PALEJ	66
77	BHARUCH	HALDARVA	ZANOR(NABIPUR)	66
78	BHARUCH	HALDARVA	SARBHAN	66
79	BHARUCH	HALDARVA	WAGRA	66
80	BHARUCH	HALDARVA	JAMBUSAR	66
81	BHARUCH	HALDARVA	RAROD	66
82	BHARUCH	HALDARVA	CHHIDRA	66
83	BHARUCH	HALDARVA	AMOD	66
84	BHARUCH	HALDARVA	Muller	66
85	BHARUCH	KIM	PALOD(KIM)	66
86	BHARUCH	KIM	MOSALI (MANGROL)	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
87	BHARUCH	KIM	KARANJ	66
88	BHARUCH	KIM	VELANJA	66
89	BHARUCH	KIM	PIPODARA	66
90	BHARUCH	KIM	MOTA BORSARA	66
91	BHARUCH	KIM	MANDVI	66
92	BHARUCH	KIM	ZANKHVAV	66
93	BHARUCH	KIM	KOSAMBA	66
94	BHARUCH	KIM	KHARACH (TARSALI)	66
95	JAMBUVA	JAMBUVA	KHATAMBA	66
96	JAMBUVA	JAMBUVA	KARVAN	66
97	JAMBUVA	JAMBUVA	MAKARPURA	66
98	JAMBUVA	JAMBUVA	TARSALI	66
99	JAMBUVA	JAMBUVA	INDRAPURI	66
100	JAMBUVA	JAMBUVA	HARNI	66
101	JAMBUVA	JAMBUVA	DABHOI	66
102	JAMBUVA	JAMBUVA	MOTIBAUG	66
103	JAMBUVA	JAMBUVA	GAJRAWADI	66
104	JAMBUVA	GOTRI	VIDYUTNAGAR	66
105	JAMBUVA	GOTRI	SUBHANPURA 'B'	66
106	JAMBUVA	GOTRI	CHHANI 'A'	66
107	JAMBUVA	GOTRI	CHHANI 'B'	66
108	JAMBUVA	GOTRI	PADRA	66
109	JAMBUVA	GOTRI	MOBHA ROAD	66
110	JAMBUVA	GOTRI	KASHIPURA	66
111	JAMBUVA	GOTRI	MASAR ROAD	66
112	JAMBUVA	GOTRI	ATLADARA	66
113	JAMBUVA	GOTRI	KARAKHADI	66
114	JAMBUVA	GOTRI	GORWA	66
115	JAMBUVA	GOTRI	SAMIYALA	66
116	JAMBUVA	GOTRI	HANDOD	66
117	JAMBUVA	GODHRA	SANTROAD	66
118	JAMBUVA	GODHRA	LUNAWADA	66
119	JAMBUVA	GODHRA	LIMKHEDA	66
120	JAMBUVA	GODHRA	MOTAKHANPUR	66
121	JAMBUVA	GODHRA	SANTRAMPUR	66
122	JAMBUVA	GODHRA	DEVGADHBARIA	66
123	JAMBUVA	GODHRA	ZALOD	66
124	JAMBUVA	GODHRA	SHEHRA	66
125	JAMBUVA	GODHRA	TIMBA	66
126	JAMBUVA	GODHRA	JAFRABAD(GOVINDI)	66
127	JAMBUVA	GODHRA	VEJALPUR	66
128	JAMBUVA	GODHRA	KALOL(PMS)	66
129	JAMBUVA	GODHRA	HALOL GIDC	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
130	JAMBUVA	GODHRA	KHAKHARIA	66
131	JAMBUVA	GODHRA	KOTHAMBA	66
132	JAMBUVA	GODHRA	KHAREDI	66
133	JAMBUVA	BODELI	CHHOTAUDEPUR VASEDI	66
134	JAMBUVA	BODELI	KAWANT	66
135	JAMBUVA	BODELI	NAVAGAM	66
136	JAMBUVA	BODELI	CHANDOD	66
137	JAMBUVA	BODELI	SADHLI	66
138	JAMBUVA	BODELI	BODELI	66
139	JAMBUVA	BODELI	SANKHEDA	66
140	JAMBUVA	BODELI	PAVIJETPUR	66
141	JAMBUVA	BODELI	NASVADI	66
142	JAMBUVA	BODELI	SINOR	66
143	JAMBUVA	BODELI	SHIVRAJPUR	66
144	JAMBUVA	BODELI	GHOGHAMBA	66
145	JAMBUVA	BODELI	KOSHINDRA	66
146	JAMBUVA	KARAMSAD	VASAD	66
147	JAMBUVA	KARAMSAD	V. V. NAGAR	66
148	JAMBUVA	KARAMSAD	V. U. NAGAR	66
149	JAMBUVA	KARAMSAD	ANAND	66
150	JAMBUVA	KARAMSAD	GOPALPURA	66
151	JAMBUVA	KARAMSAD	MOGAR	66
152	JAMBUVA	KARAMSAD	BORSAD	66
153	JAMBUVA	KARAMSAD	ANKLAV	66
154	JAMBUVA	KARAMSAD	PETLAD	66
155	JAMBUVA	KARAMSAD	NAR	66
156	JAMBUVA	KARAMSAD	RAS	66
157	JAMBUVA	KARAMSAD	VIRSAD	66
158	JAMBUVA	KARAMSAD	CAMBAY	66
159	JAMBUVA	KARAMSAD	NEJA	66
160	JAMBUVA	KOYALI	KOYALI	66
161	JAMBUVA	KOYALI	SAVLI	66
162	JAMBUVA	KOYALI	NANDESARI	66
163	JAMBUVA	KOYALI	RANIA	66
164	JAMBUVA	KOYALI	DESAR	66
165	JAMBUVA	KOYALI	RANOLI	66
166	JAMBUVA	KOYALI	TUNDAV	66
167	JAMBUVA	KOYALI	JAROD	66
168	JAMBUVA	KOYALI	BASKA	66
169	NADIAD	NADIAD	KAPADVANJ	66
170	NADIAD	NADIAD	MAHUDHA	66
171	NADIAD	NADIAD	CHAKLASHI	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
172	NADIAD	NADIAD	UMRETH	66
173	NADIAD	NADIAD	SEVALIA	66
174	NADIAD	NADIAD	CHANGA	66
175	NADIAD	NADIAD	VASO	66
176	NADIAD	NADIAD	LIMBASI	66
177	NADIAD	NADIAD	UTTARSANDA	66
178	NADIAD	NADIAD	KAMLA(NADIADCITY)	66
179	NADIAD	NADIAD	THASRA	66
180	NADIAD	NADIAD	NIRMALI	66
181	NADIAD	NADIAD	ATTARSUMBA	66
182	NADIAD	NADIAD	KATHLAL	66
183	NADIAD	NADIAD	BALASINOR	66
184	NADIAD	NADIAD	TORNA	66
185	NADIAD	NADIAD	KHEDA	66
186	NADIAD	NADIAD	DEMAI	66
187	NADIAD	VATVA	BAREJADI	66
188	NADIAD	VATVA	NAVAGAM	66
189	NADIAD	VATVA	HALDARVAS	66
190	NADIAD	VATVA	KERALA	66
191	NADIAD	VATVA	KOTH	66
192	NADIAD	VATVA	CHANGODAR	66
193	NADIAD	VATVA	SANAND	66
194	NADIAD	VATVA	BAVLA	66
195	NADIAD	VATVA	DHOLKA	66
196	NADIAD	VATVA	JUVALRUPVATI	66
197	NADIAD	VATVA	DHOLKA GIDC	66
198	NADIAD	VATVA	SAMADARA	66
199	NADIAD	VATVA	JETALPUR	66
200	NADIAD	VATVA	MORAIYA	66
201	NADIAD	VATVA	SIMEJ	66
202	NADIAD	VATVA	ZAMP	66
203	NADIAD	RANASAN	DEHGAM	66
204	NADIAD	RANASAN	RAKHIAL	66
205	NADIAD	RANASAN	CHHALA	66
206	NADIAD	RANASAN	NARODA	66
207	NADIAD	RANASAN	VEHLAL	66
208	NADIAD	RANASAN	KANBHA	66
209	NADIAD	RANASAN	BAHIAL	66
210	NADIAD	RANASAN	HALISA	66
211	NADIAD	RANASAN	SADRA	66
212	NADIAD	RANASAN	BOPAL	66
213	NADIAD	RANASAN	MUTHIA(NANA-CHILODA)	66
214	NADIAD	RANASAN	KADJODARA	66
215	NADIAD	RANASAN	BHAT	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
216	NADIAD	RANASAN	BHADAJ	66
217	NADIAD	RANASAN	KUHA	66
218	NADIAD	LIMBDI	SURENDRANAGAR	66
219	NADIAD	LIMBDI	SAYLA	66
220	NADIAD	LIMBDI	DUDHREJ	66
221	NADIAD	LIMBDI	KHODU	66
222	NADIAD	LIMBDI	SADLA	66
223	NADIAD	LIMBDI	CHUDA	66
224	NADIAD	LIMBDI	RANPUR	66
225	NADIAD	LIMBDI	RAJSITAPUR	66
226	NADIAD	LIMBDI	MULI	66
227	NADIAD	LIMBDI	SUDAMADA	66
228	NADIAD	LIMBDI	WADHWAN	66
229	NADIAD	DHRANGADHRA	KONDH	66
230	NADIAD	DHRANGADHRA	SARA	66
231	NADIAD	DHRANGADHRA	DHRANGADHRA	66
232	NADIAD	DHRANGADHRA	KANKAVATI	66
233	NADIAD	DHRANGADHRA	VAVDI(HARIPUR)	66
234	NADIAD	DHRANGADHRA	HALVAD	66
235	NADIAD	DHRANGADHRA	GHANSHYAMGADH	66
236	NADIAD	DHRANGADHRA	BHALGAMDA	66
237	NADIAD	DHRANGADHRA	MALANIYAD	66
238	NADIAD	DHRANGADHRA	NARICHANA	66
239	NADIAD	DHRANGADHRA	CHULI	66
240	NADIAD	DHRANGADHRA	SARAMBHDA	66
241	NADIAD	DHRANGADHRA	METHAN	66
242	NADIAD	DHRANGADHRA	DUNGARPUR	66
243	NADIAD	DHRANGADHRA	RANAKPUR	66
244	NADIAD	DHRANGADHRA	TARNETAR	66
245	NADIAD	DHRANGADHRA	RAIGADH	66
246	NADIAD	VIRAMGAM	VIRAMGAM(FULWADI)	66
247	NADIAD	VIRAMGAM	MANDAL	66
248	NADIAD	VIRAMGAM	KHAVAD	66
249	NADIAD	VIRAMGAM	CHHARODI	66
250	NADIAD	VIRAMGAM	PATDI	66
251	NADIAD	VIRAMGAM	KANZ	66
252	NADIAD	VIRAMGAM	LAKHTAR	66
253	NADIAD	VIRAMGAM	VANOD	66
254	NADIAD	VIRAMGAM	VADGAM	66
255	NADIAD	VIRAMGAM	KAMALPUR	66
256	NADIAD	VIRAMGAM	JAKHWADA	66
257	MEHSANA	MEHSANA	BASNA	66
258	MEHSANA	MEHSANA	BHANDU	66
259	MEHSANA	MEHSANA	LINCH	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
260	MEHSANA	MEHSANA	BALOL	66
261	MEHSANA	MEHSANA	BECHRAJI	66
262	MEHSANA	MEHSANA	DHINOJ	66
263	MEHSANA	MEHSANA	MODHERA	66
264	MEHSANA	MEHSANA	PALAVASANA	66
265	MEHSANA	MEHSANA	KHERVA	66
266	MEHSANA	MEHSANA	MOTAP	66
267	MEHSANA	MEHSANA	KASALPUR (JOTANA)	66
268	MEHSANA	MEHSANA	NAGALPUR	66
269	MEHSANA	MEHSANA	UDALPUR	66
270	MEHSANA	MEHSANA	VALAM	66
271	MEHSANA	CHHATRAL	KALOL(NG)	66
272	MEHSANA	CHHATRAL	NARADIPUR	66
273	MEHSANA	CHHATRAL	KADI	66
274	MEHSANA	CHHATRAL	VADSAR	66
275	MEHSANA	CHHATRAL	NANDASAN	66
276	MEHSANA	CHHATRAL	KATOSAN ROAD	66
277	MEHSANA	CHHATRAL	LANGHNEJ	66
278	MEHSANA	CHHATRAL	RANDHEJA	66
279	MEHSANA	CHHATRAL	CHHATRAL GIDC	66
280	MEHSANA	CHHATRAL	ADALAJ	66
281	MEHSANA	CHHATRAL	BORISANA	66
282	MEHSANA	CHHATRAL	SOJA II	66
283	MEHSANA	CHHATRAL	KARAN NAGAR	66
284	MEHSANA	CHHATRAL	RAJPUR	66
285	MEHSANA	CHHATRAL	MEDA ADRAJ	66
286	MEHSANA	CHHATRAL	SANTEJ	66
287	MEHSANA	CHHATRAL	PANSAR	66
288	MEHSANA	CHHATRAL	MEDHA	66
289	MEHSANA	CHHATRAL	MANDALI	66
290	MEHSANA	CHHATRAL	SURAJ	66
291	MEHSANA	CHHATRAL	MOTI ADARAJ	66
292	MEHSANA	CHHATRAL	RANGPURDA	66
293	MEHSANA	CHHATRAL	VEDA	66
294	MEHSANA	VIJAPUR	MANSA	66
295	MEHSANA	VIJAPUR	LODRA	66
296	MEHSANA	VIJAPUR	TATOSAN	66
297	MEHSANA	VIJAPUR	SUNDERPUR	66
298	MEHSANA	VIJAPUR	GOZARIA	66
299	MEHSANA	VIJAPUR	VASAI	66
300	MEHSANA	VIJAPUR	JANTRAL	66
301	MEHSANA	VIJAPUR	VIHAR(KUKARWADA)	66
302	MEHSANA	VIJAPUR	GRAMBHARTI(M'PUR)	66
303	MEHSANA	VIJAPUR	KADA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
304	MEHSANA	VIJAPUR	LADOL	66
305	MEHSANA	VIJAPUR	RANASAN(GIDC)	66
306	MEHSANA	VIJAPUR	CHARADA	66
307	MEHSANA	VIJAPUR	BHALAK	66
308	MEHSANA	DHANSURA	PRANTIJ	66
309	MEHSANA	DHANSURA	TAJPUR	66
310	MEHSANA	DHANSURA	RANASAN(SK)	66
311	MEHSANA	DHANSURA	GAMBHOI	66
312	MEHSANA	DHANSURA	MODASA	66
313	MEHSANA	DHANSURA	MALPUR	66
314	MEHSANA	DHANSURA	MEGHRAJ	66
315	MEHSANA	DHANSURA	TINTOI	66
316	MEHSANA	DHANSURA	BAYAD	66
317	MEHSANA	DHANSURA	SATHAMBA	66
318	MEHSANA	DHANSURA	AMBALIYARA	66
319	MEHSANA	DHANSURA	AMODARA	66
320	MEHSANA	DHANSURA	ROZAD	66
321	MEHSANA	DHANSURA	GABAT	66
322	MEHSANA	DHANSURA	MEDHASAN	66
323	MEHSANA	DHANSURA	DALANI-MUVADI	66
324	MEHSANA	DHANSURA	BAYAL(DHANAKROL)	66
325	MEHSANA	DHANSURA	RELLAWADA	66
326	MEHSANA	DHANSURA	VIRPUR	66
327	MEHSANA	DHANSURA	SHINAWAD	66
328	MEHSANA	IDAR	VADALI	66
329	MEHSANA	IDAR	BADOLI	66
330	MEHSANA	IDAR	VIJAYNAGAR	66
331	MEHSANA	IDAR	HIMATNAGAR-I	66
332	MEHSANA	IDAR	HIMATNAGAR-II	66
333	MEHSANA	IDAR	BHILODA	66
334	MEHSANA	IDAR	KHEDBRAHMA	66
335	MEHSANA	IDAR	MAKADCHAMPA(Hadad)	66
336	MEHSANA	IDAR	JADAR	66
337	MEHSANA	IDAR	LAI-RANASAN	66
338	MEHSANA	IDAR	CHORIVAD	66
339	MEHSANA	IDAR	DEDHROTA	66
340	MEHSANA	IDAR	VASAI (M)	66
341	MEHSANA	IDAR	KANIYOL	66
342	MEHSANA	IDAR	KUNDLA	66
343	MEHSANA	IDAR	SUNDARPUR(Chhapi)	66
344	MEHSANA	IDAR	HAJIPUR	66
345	MEHSANA	IDAR	DANTOD (CHITHODA)	66
346	MEHSANA	IDAR	HANSALPUR	66
347	MEHSANA	IDAR	PANOL	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
348	MEHSANA	IDAR	NIKODA	66
349	MEHSANA	IDAR	PALLA (SHAMLAJI)	66
350	PALANPUR	PALANPUR	PALANPUR-I	66
351	PALANPUR	PALANPUR	GADH	66
352	PALANPUR	PALANPUR	VADGAM	66
353	PALANPUR	PALANPUR	DANTA	66
354	PALANPUR	PALANPUR	DANTIWADA	66
355	PALANPUR	PALANPUR	IQBALGADH	66
356	PALANPUR	PALANPUR	JALOTRA	66
357	PALANPUR	PALANPUR	CHANDISAR GIDC	66
358	PALANPUR	PALANPUR	AMBAJI	66
359	PALANPUR	PALANPUR	PALANPUR-II	66
360	PALANPUR	PALANPUR	KANODAR	66
361	PALANPUR	PALANPUR	MALAN	66
362	PALANPUR	PALANPUR	HEBATPUR(CHITRASANI)	66
363	PALANPUR	PALANPUR	LALAWADA	66
364	PALANPUR	PALANPUR	BASU	66
365	PALANPUR	PALANPUR	PANCHADA	66
366	PALANPUR	PALANPUR	AMIRGADH	66
367	PALANPUR	PALANPUR	JEGOL	66
368	PALANPUR	PATAN	BALISANA	66
369	PALANPUR	PATAN	CHANASMA	66
370	PALANPUR	PATAN	HARIJ	66
371	PALANPUR	PATAN	KANSA	66
372	PALANPUR	PATAN	MANUD	66
373	PALANPUR	PATAN	KAMBOI(CHANASMA)	66
374	PALANPUR	PATAN	ADIA	66
375	PALANPUR	PATAN	SAMI	66
376	PALANPUR	PATAN	SANKHESHWAR	66
377	PALANPUR	PATAN	ANAWADA(PATAN)	66
378	PALANPUR	PATAN	DUNAWADA	66
379	PALANPUR	PATAN	ANGANWADA	66
380	PALANPUR	PATAN	KIMBUVA	66
381	PALANPUR	PATAN	BHADRADA	66
382	PALANPUR	PATAN	KAMLIWADA	66
383	PALANPUR	PATAN	MUJPUR	66
384	PALANPUR	PATAN	KESHANI	66
385	PALANPUR	PATAN	RAJPUR(P)	66
386	PALANPUR	DEESA	JANGRAL	66
387	PALANPUR	DEESA	SAMAU	66
388	PALANPUR	DEESA	ZERDA	66
389	PALANPUR	DEESA	KHIMAT	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
390	PALANPUR	DEESA	MOTAKAPRA	66
391	PALANPUR	DEESA	NANAMEDA(RAVIA)	66
392	PALANPUR	DEESA	PANTHWADA	66
393	PALANPUR	DEESA	LORWADA	66
394	PALANPUR	DEESA	BAIWADA(MALGADH)	66
395	PALANPUR	DEESA	SHAMSHERPURA	66
396	PALANPUR	DEESA	SHERGADH	66
397	PALANPUR	DEESA	BHILDI	66
398	PALANPUR	DEESA	VITHODAR	66
399	PALANPUR	DEESA	RAMUN	66
400	PALANPUR	DEESA	MANEKPUR	66
401	PALANPUR	DEESA	RANPUR	66
402	PALANPUR	DEESA	DEVSARI	66
403	PALANPUR	DEESA	VAKTAPURA	66
404	PALANPUR	DEESA	SAMDHI	66
405	PALANPUR	DEODAR	DEODAR	66
406	PALANPUR	DEODAR	SHIHORI	66
407	PALANPUR	DEODAR	DUNGRASAN	66
408	PALANPUR	DEODAR	THARA	66
409	PALANPUR	DEODAR	KHODA	66
410	PALANPUR	DEODAR	VARAHI	66
411	PALANPUR	DEODAR	KOTDA(F)	66
412	PALANPUR	DEODAR	RADHANPUR	66
413	PALANPUR	DEODAR	PADARDI	66
414	PALANPUR	DEODAR	TERWADA	66
415	PALANPUR	DEODAR	SANTALPUR	66
416	PALANPUR	DEODAR	DAHISAR	66
417	PALANPUR	DEODAR	KAMBOI[F]	66
418	PALANPUR	DEODAR	UN	66
419	PALANPUR	DEODAR	ARNIWADA	66
420	PALANPUR	DEODAR	RAIYA	66
421	PALANPUR	DEODAR	VADIYA	66
422	PALANPUR	KHERALU	CHHAPI	66
423	PALANPUR	KHERALU	GIDASAN	66
424	PALANPUR	KHERALU	KAKOSI	66
425	PALANPUR	KHERALU	KAHODA	66
426	PALANPUR	KHERALU	KARLI	66
427	PALANPUR	KHERALU	KHALI	66
428	PALANPUR	KHERALU	KODRAM	66
429	PALANPUR	KHERALU	SATLASANA	66
430	PALANPUR	KHERALU	UNJHA	66
431	PALANPUR	KHERALU	VADNAGAR	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
432	PALANPUR	KHERALU	KHERALU	66
433	PALANPUR	KHERALU	UMTA	66
434	PALANPUR	KHERALU	KHANPUR	66
435	PALANPUR	KHERALU	VARETHA	66
436	PALANPUR	KHERALU	MANDALI	66
437	PALANPUR	KHERALU	DASAJ	66
438	PALANPUR	KHERALU	UNAVA	66
439	PALANPUR	THARAD	ASODAR	66
440	PALANPUR	THARAD	BHABHAR	66
441	PALANPUR	THARAD	MITHI PALDI	66
442	PALANPUR	THARAD	TITHGAM	66
443	PALANPUR	THARAD	DHANERA	66
444	PALANPUR	THARAD	LAKHANI	66
445	PALANPUR	THARAD	JADIA	66
446	PALANPUR	THARAD	RAH	66
447	PALANPUR	THARAD	KOTDA(DHUNSOL)	66
448	PALANPUR	THARAD	PILUDA	66
449	PALANPUR	THARAD	TADAV	66
450	PALANPUR	THARAD	KUVANA	66
451	PALANPUR	THARAD	MERA	66
452	PALANPUR	THARAD	THARAD	66
453	PALANPUR	THARAD	LAVARA	66
454	PALANPUR	THARAD	JALOYA	66
455	PALANPUR	THARAD	AGTHALA	66
456	PALANPUR	THARAD	MAKHANU	66
457	PALANPUR	THARAD	JADIYALI	66
458	PALANPUR	THARAD	DIDARDA	66
459	PALANPUR	THARAD	RUNI	66
460	GONDAL	GONDAL	KASHIVISHVANATH	66
461	GONDAL	GONDAL	JASDAN	66
462	GONDAL	GONDAL	VIRPUR	66
463	GONDAL	GONDAL	LODHIKA	66
464	GONDAL	GONDAL	VASAVAD	66
465	GONDAL	GONDAL	SARDHAR	66
466	GONDAL	GONDAL	KOTDA SANGANI	66
467	GONDAL	GONDAL	MOVIYA	66
468	GONDAL	GONDAL	KOLITHAD	66
469	GONDAL	GONDAL	LILAKHA	66
470	GONDAL	GONDAL	DERDI	66
471	GONDAL	GONDAL	KAMLAPUR	66
472	GONDAL	GONDAL	TRAMBA	66
473	GONDAL	RAJKOT	PUNITNAGAR	66
474	GONDAL	RAJKOT	LIARA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
475	GONDAL	RAJKOT	PADADHARI	66
476	GONDAL	RAJKOT	DUDHSAGAR	66
477	GONDAL	RAJKOT	SHAPAR	66
478	GONDAL	RAJKOT	AJI GIDC	66
479	GONDAL	RAJKOT	GHANTESHWAR	66
480	GONDAL	RAJKOT	NAVAGAM	66
481	GONDAL	RAJKOT	LAXMINAGAR	66
482	GONDAL	RAJKOT	SIDDHESWAR	66
483	GONDAL	RAJKOT	KOTHARIA	66
484	GONDAL	RAJKOT	TARAGHADI	66
485	GONDAL	RAJKOT	POPATPARA	66
486	GONDAL	RAJKOT	NIKAWA	66
487	GONDAL	RAJKOT	KAGDADI	66
488	GONDAL	RAJKOT	METODA	66
489	GONDAL	RAJKOT	RAIYADHAR	66
490	GONDAL	JAMNAGAR	SAT RASTA	66
491	GONDAL	JAMNAGAR	BEDESHWAR	66
492	GONDAL	JAMNAGAR	SIKKA	66
493	GONDAL	JAMNAGAR	DHROL	66
494	GONDAL	JAMNAGAR	KALAVAD	66
495	GONDAL	JAMNAGAR	LALPUR	66
496	GONDAL	JAMNAGAR	JAMNAGAR-B	66
497	GONDAL	JAMNAGAR	JAMDHUDHAI	66
498	GONDAL	JAMNAGAR	KHAREDI	66
499	GONDAL	JAMNAGAR	JAMVANTHALI	66
500	GONDAL	JAMNAGAR	HAPA	66
501	GONDAL	JAMNAGAR	MODPAR	66
502	GONDAL	JAMNAGAR	KESHIYA (JODIA)	66
503	GONDAL	JAMNAGAR	JAMNAGAR-C	66
504	GONDAL	JAMNAGAR	BANUGAR	66
505	GONDAL	JAMNAGAR	LATIPUR	66
506	GONDAL	JAMNAGAR	PIPALI	66
507	GONDAL	JAMNAGAR	PIPARTODA	66
508	GONDAL	KHAMBHALIA	VADINAR	66
509	GONDAL	KHAMBHALIA	VARVALA	66
510	GONDAL	KHAMBHALIA	ARAMBHADA	66
511	GONDAL	KHAMBHALIA	KALYANPUR	66
512	GONDAL	KHAMBHALIA	MEGHPAR	66
513	GONDAL	KHAMBHALIA	VADATARA	66
514	GONDAL	KHAMBHALIA	BHADTHAR	66
515	GONDAL	MORBI	MORBI ‘A’	66
516	GONDAL	MORBI	MORBI ’B’	66
517	GONDAL	MORBI	CHARAVDA	66
518	GONDAL	MORBI	TANKARA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
519	GONDAL	MORBI	CHUPANI	66
520	GONDAL	MORBI	DEVALIYA	66
521	GONDAL	MORBI	JETPAR	66
522	GONDAL	MORBI	PIPALIYA	66
523	GONDAL	MORBI	JEDESHWAR	66
524	GONDAL	MORBI	CHOTILA	66
525	GONDAL	MORBI	THAN	66
526	GONDAL	MORBI	BAMANBORE	66
527	GONDAL	MORBI	LUNSAR	66
528	GONDAL	MORBI	MORBI-C- LILAPAR	66
529	GONDAL	MORBI	DHUVA	66
530	GONDAL	MORBI	MAHIKA	66
531	GONDAL	MORBI	MAHENDRANAGAR	66
532	GONDAL	MORBI	KHAREDA	66
533	JUNAGADH	JUNAGADH	JUNAGADH(GIDC)	66
534	JUNAGADH	JUNAGADH	BHESAN	66
535	JUNAGADH	JUNAGADH	SHAPUR	66
536	JUNAGADH	JUNAGADH	MOTI MONPARI	66
537	JUNAGADH	JUNAGADH	KANZA	66
538	JUNAGADH	JUNAGADH	VADIA	66
539	JUNAGADH	JUNAGADH	CHOKI	66
540	JUNAGADH	JUNAGADH	DHEBAR	66
541	JUNAGADH	JUNAGADH	ZANZARDA	66
542	JUNAGADH	JUNAGADH	DEVKIGALOL	66
543	JUNAGADH	JUNAGADH	MOTAKOTDA	66
544	JUNAGADH	JUNAGADH	PRABHATPUR	66
545	JUNAGADH	JUNAGADH	VISAVADAR	66
546	JUNAGADH	JUNAGADH	CHUDA	66
547	JUNAGADH	JUNAGADH	MAJEVADI	66
548	JUNAGADH	JUNAGADH	BHALGAM	66
549	JUNAGADH	JUNAGADH	BILKHA	66
550	JUNAGADH	JUNAGADH	BARADIYA	66
551	JUNAGADH	KESHOD	VERAVAL	66
552	JUNAGADH	KESHOD	CHORVAD	66
553	JUNAGADH	KESHOD	MALIA-HATINA	66
554	JUNAGADH	KESHOD	KESHOD	66
555	JUNAGADH	KESHOD	MANGROL	66
556	JUNAGADH	KESHOD	MADHAVPUR	66
557	JUNAGADH	KESHOD	MENDARDA	66
558	JUNAGADH	KESHOD	PRABHAS PATAN	66
559	JUNAGADH	KESHOD	SHIL	66
560	JUNAGADH	KESHOD	KHIRASARA	66
561	JUNAGADH	KESHOD	AJAB	66
562	JUNAGADH	KESHOD	SUTRAPADA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
563	JUNAGADH	KESHOD	CHULDI	66
564	JUNAGADH	KESHOD	MORAJ	66
565	JUNAGADH	KESHOD	KOYLANA	66
566	JUNAGADH	KESHOD	NANI KHODIYAR	66
567	JUNAGADH	KESHOD	BUDHECHA	66
568	JUNAGADH	DHORAJI	PATANVAV	66
569	JUNAGADH	DHORAJI	SARDARGADH	66
570	JUNAGADH	DHORAJI	KHARCHIYA	66
571	JUNAGADH	DHORAJI	JAM JODHPUR	66
572	JUNAGADH	DHORAJI	SAMANA	66
573	JUNAGADH	DHORAJI	CHITRAVAD	66
574	JUNAGADH	DHORAJI	UPLETA	66
575	JUNAGADH	DHORAJI	TANSAVA	66
576	JUNAGADH	DHORAJI	JAM KANDORNA	66
577	JUNAGADH	DHORAJI	MOTI MARAD	66
578	JUNAGADH	DHORAJI	SUPEDI	66
579	JUNAGADH	DHORAJI	JETPUR \`B\`	66
580	JUNAGADH	DHORAJI	JETPUR \`A\`	66
581	JUNAGADH	RANAVAV	PORBANDAR COLONY	66
582	JUNAGADH	RANAVAV	BHANVAD	66
583	JUNAGADH	RANAVAV	VANSJALIA	66
584	JUNAGADH	RANAVAV	GOSA	66
585	JUNAGADH	RANAVAV	PORBANDAR (GIDC)	66
586	JUNAGADH	RANAVAV	BOKHIRA	66
587	JUNAGADH	RANAVAV	BAGVADAR	66
588	JUNAGADH	RANAVAV	VISAVADA	66
589	JUNAGADH	RANAVAV	ADVANA	66
590	JUNAGADH	RANAVAV	MANAVADAR	66
591	JUNAGADH	RANAVAV	PAJOD	66
592	JUNAGADH	RANAVAV	MANDODARA	66
593	JUNAGADH	RANAVAV	KUTIYANA	66
594	JUNAGADH	RANAVAV	RANA KANDORNA	66
595	JUNAGADH	RANAVAV	SONVADIA	66
596	JUNAGADH	RANAVAV	GUNDA	66
597	AMRELI	VARTEJ	BHAVNAGAR CITY	66
598	AMRELI	VARTEJ	NARIROAD	66
599	AMRELI	VARTEJ	BUNDER ROAD	66
600	AMRELI	VARTEJ	SONGADH	66
601	AMRELI	VARTEJ	PALITANA	66
602	AMRELI	VARTEJ	TALAJA	66
603	AMRELI	VARTEJ	SHIHOR	66
604	AMRELI	VARTEJ	DHOLA	66
605	AMRELI	VARTEJ	NAVAGAM	66
606	AMRELI	VARTEJ	SIDSAR	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
607	AMRELI	VARTEJ	TANSA	66
608	AMRELI	VARTEJ	BAGDANA(RAJPURA)	66
609	AMRELI	VARTEJ	TANA	66
610	AMRELI	VARTEJ	MAMSA	66
611	AMRELI	VARTEJ	GHANGHALI	66
612	AMRELI	VARTEJ	GHOGHA(BHUMLI)	66
613	AMRELI	VARTEJ	MANAR(ALANG)	66
614	AMRELI	VARTEJ	VARTEJ-II(CHITRA)	66
615	AMRELI	VARTEJ	PITHALPUR	66
616	AMRELI	VARTEJ	Thadach	66
617	AMRELI	Kodinar	Advi	66
618	AMRELI	Kodinar	Una	66
619	AMRELI	Kodinar	Dhokadava	66
620	AMRELI	Kodinar	Pranchi	66
621	AMRELI	Kodinar	Kodinar	66
622	AMRELI	Kodinar	Girgadhada	66
623	AMRELI	Kodinar	Ankolwadi	66
624	AMRELI	Kodinar	Ghatwad	66
625	AMRELI	Kodinar	Samter	66
626	AMRELI	Kodinar	Devli	66
627	AMRELI	Kodinar	Keshriya	66
628	AMRELI	Kodinar	Bhetali	66
629	AMRELI	Kodinar	Alidar	66
630	AMRELI	SAVARKUNDALA	Amreli	66
631	AMRELI	SAVARKUNDALA	Amreli-'B'	66
632	AMRELI	SAVARKUNDALA	Bagasara	66
633	AMRELI	SAVARKUNDALA	Bhader	66
634	AMRELI	SAVARKUNDALA	Chalala	66
635	AMRELI	SAVARKUNDALA	Dhari	66
636	AMRELI	SAVARKUNDALA	Dudhala	66
637	AMRELI	SAVARKUNDALA	Dunger	66
638	AMRELI	SAVARKUNDALA	Jafrabad	66
639	AMRELI	SAVARKUNDALA	Jesar	66
640	AMRELI	SAVARKUNDALA	Khambha	66
641	AMRELI	SAVARKUNDALA	Khuntawada	66
642	AMRELI	SAVARKUNDALA	Kukavav	66
643	AMRELI	SAVARKUNDALA	Liliya	66
644	AMRELI	SAVARKUNDALA	Mahuwa	66
645	AMRELI	SAVARKUNDALA	Mota-Barman	66
646	AMRELI	SAVARKUNDALA	Rajula	66
647	AMRELI	SAVARKUNDALA	Sarambhada	66
648	AMRELI	SAVARKUNDALA	Savarkundla	66
649	AMRELI	SAVARKUNDALA	Vadli	66
650	AMRELI	SAVARKUNDALA	Vanda	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
651	AMRELI	SAVARKUNDALA	Vijapadi	66
652	AMRELI	SAVARKUNDALA	Ambardi	66
653	AMRELI	SAVARKUNDALA	Dalkhaniya	66
654	AMRELI	SAVARKUNDALA	Mota Samadhiyala	66
655	AMRELI	DHASA	LATHI	66
656	AMRELI	DHASA	BOTAD	66
657	AMRELI	DHASA	GADHADA	66
658	AMRELI	DHASA	BABRA	66
659	AMRELI	DHASA	GARIYADHAR	66
660	AMRELI	DHASA	SARANGPUR	66
661	AMRELI	DHASA	LAKHENI	66
662	AMRELI	DHASA	VINCHIYA	66
663	AMRELI	DHASA	CHITAL	66
664	AMRELI	DHASA	DAMNAGAR	66
665	AMRELI	DHASA	SANOSARA	66
666	AMRELI	DHASA	TURKHA	66
667	AMRELI	DHASA	NONGHANVADAR	66
668	AMRELI	DHASA	LATHIDAD $	66
669	AMRELI	DHASA	Kotada Pitha $	66
670	AMRELI	DHASA	Kalatalav $	66
671	ANJAR	ANJAR	G'DHAM [FTZ]	66
672	ANJAR	ANJAR	BHACHAU	66
673	ANJAR	ANJAR	KHEDOI	66
674	ANJAR	ANJAR	KANDLA	66
675	ANJAR	ANJAR	DUDHAI	66
676	ANJAR	ANJAR	BHIMASAR	66
677	ANJAR	ANJAR	CHIRAI	66
678	ANJAR	ANJAR	RAPAR	66
679	ANJAR	ANJAR	VAJEPAR	66
680	ANJAR	ANJAR	CHOBARI	66
681	ANJAR	ANJAR	ADHOI	66
682	ANJAR	ANJAR	GANDHIDHAM `B'	66
683	ANJAR	ANJAR	BALASAR	66
684	ANJAR	ANJAR	AMARDI	66
685	ANJAR	ANJAR	RATNAL	66
686	ANJAR	ANJAR	PRAGPAR	66
687	ANJAR	ANJAR	MITHIROHAR	66
688	ANJAR	ANJAR	VARSANA	66
689	ANJAR	ANJAR	MOKHA	66
690	ANJAR	Nakhatrana	DESHALPAR	66
691	ANJAR	Nakhatrana	GADHSISA	66
692	ANJAR	Nakhatrana	KHIRSARA	66
693	ANJAR	Nakhatrana	NALIA	66
694	ANJAR	Nakhatrana	KOTHARA	66

Sr No	Name of Circle	Name of Div.	Name of Sub-Station	kV
695	ANJAR	Nakhatrana	NAKHATRANA	66
696	ANJAR	Nakhatrana	RAVAPAR	66
697	ANJAR	Nakhatrana	NETRA	66
698	ANJAR	Nakhatrana	KOTDA [J]	66
699	ANJAR	Nakhatrana	DAYAPAR	66
700	ANJAR	Nakhatrana	BAYATH	66
701	ANJAR	Nakhatrana	VITHON	66
702	ANJAR	Nakhatrana	DON	66
703	ANJAR	Nakhatrana	MOTHALA	66
704	ANJAR	Bhuj	DAHINSARA	66
705	ANJAR	Bhuj	MANDVI	66
706	ANJAR	Bhuj	NANIKHAKHAR	66
707	ANJAR	Bhuj	LORIA	66
708	ANJAR	Bhuj	KOTDA[CHAKAR]	66
709	ANJAR	Bhuj	MADHAPAR	66
710	ANJAR	Bhuj	BHUJ `B'	66
711	ANJAR	Bhuj	MANKUVA	66
712	ANJAR	Bhuj	KHAVDA	66
713	ANJAR	Bhuj	BALADIYA	66
714	ANJAR	Bhuj	KODAY	66
715	ANJAR	Bhuj	LAKHOND	66
716	ANJAR	Bhuj	MUNDRA	66
717	ANJAR	Bhuj	BHUJPAR	66
718	ANJAR	Bhuj	DARSADI	66
719	ANJAR	Bhuj	DHANETI	66
720	ANJAR	Bhuj	THARAWADA	66
721	ANJAR	Bhuj	MUNDRA IND.	66

Annex VII: List of C-WET Certified wind turbines

Sir,

Sub: Revised List of Models and Manufacturers of Wind Electric Generators / Wind Turbine Equipment.

The Ministry had issued guidelines vide Circular No.66/241/95-WE(PG) dated 13.06.1996 to streamline the development and facilitate healthy and orderly growth of the wind power sector in the country. The guidelines, inter-alia, include measures for the installation of duly tested and certified quality equipment which will optimize generation of energy from wind power projects. As per the revised guidelines No. 66/53/2000-WE(PG) dated 23.10.2000, para 3, point (i), on re-introduction of requirement of Certification by Independent testing and Certification agencies and MNRE letter No.66/53/2005-WE/PG(Part) dated 27.03.2008, the list of manufacturers has been drawn up by C-WET with models of wind turbines of unit capacity 225kW and above that have obtained type approval / certificate from designated certification agencies, as per the information received from the manufacturers. The list of wind turbine manufacturers and wind turbine models possessing valid type approval / Certificate is given below.

Table – A: The wind turbine models possessing valid Type Approvals / Certificates:

Sl. No.	Indian Manufacturers with address	Collaboration / Joint Venture	Model Rotor Dia (RD) (m) / Hub height (HH) (m)	Capacity	* Type Certifi -cate	Manufacturing System Certificate (ISO Certificate)
1.	M/s Enercon (India) Ltd. "Enercon Tower" A-9, Veera Industrial Estate Veera Desai Road Andheri (West) Mumbai - 400 053 **Phone : 022-66924848** **Fax : 022- 67040473**	Enercon GmbH, Germany	Enercon E - 48 RD : 48 m HH : 50/ 57/ 75 m Tower type: For HH 50/57/75 m–Tubular steel & 75 m - precast concrete	800 kW	Available	Yes
			E -53 RD : 53 m HH : 73 m / 75 m Tower type: For HH 73 m–Steel & 75 m - concrete tower	800 kW	Available	
2.	M/s Pioneer Wincon Private Ltd. 30/1A, Harrington Chambers, 2nd Floor, "B" Block Abdul Razaq, 1st Street, Saidapet Chennai- 600 015 **Phone : 044 - 24314790** **Fax : 044 - 24314789**	None	Pioneer P 250/29 RD : 29 m HH : 50 m Tower type: Lattice	250 kW	Available	Yes

*State Electricity Boards / TRANSCOs/ State Nodal Agencies/ developers shall refer complete type approval / certificate of the models listed above for verification of validity period, detailed specifications, power curve and other information.

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Sl. No.	Indian Manufacturers with address	Collaboration / Joint Venture	Model Rotor Dia (RD) (m) / Hub height (HH) (m)	Capacity	* Type Certifi -cate	Manufacturing System Certificate (ISO Certificate)
3	M/s Shriram EPC Limited No.5, T.V Street Chetput, Chennai – 600 031 **Phone: 044 – 28361817** **Fax : 044 - 28363518**	Under License Agreement with TTG Industries Ltd.	SEPC 250 T RD : 28.5 m HH : 41.2 m Tower type: Lattice	250 kW	Available	Yes
4.	M/s.Siva Windturbine India Private Limited 12A, Kandampalayam, Perundurai Erode- (DIS) Pin : 638052 **Phone : 04294 – 220017** **Fax : 04294 - 220137**	Under License agreement with Wind Technik Nord, Germany.	SIVA 250/50 RD : 30 m HH : 50 m Tower type: Lattice	250 kW	Available	Yes
4.	M/s. Southern Wind Farms Limited No.15, Soundarapandian Salai, Ashok nagar, Chennai – 600 083 **Phone : 044 – 39182618** **Fax : 044 – 39182636**	None	GWL 225 RD : 29.8 m HH : 45 m Tower type : Tubular	225 kW	Available	Yes
5.	M/s Suzlon Energy Ltd. 5th Floor, Godrej Millennium 9, Koregaon Park Road, Pune – 411 001 **Phone: 020- 4012 2000** **Fax : 020 - 4012 2100**	Suzlon Energy Gmbh, Germany (Subsidiary of Suzlon Energy Limited)	Suzlon S.52 / 600 kW RD : 52 m HH : 75 m Tower type: Lattice	600 kW	Available	Yes
			Suzlon S 64 - 1250 kW tubular towers 56 m, 65 m, 74m and lattice tower 65 m RD : 64 m HH : 57m, 65m, 75 m Tower type: For HH 57/65 /75 m–Tubular steel & 65 m– Lattice	1250 kW	Available	
			Suzlon S66-1250 kW, tubular tower 75 m and lattice tower 65m RD : 66 m HH : 65 m & 75 m Tower type: For HH 65 m- Lattice tower & 75 m Tubular Steel	1250 kW	Available	

*State Electricity Boards / TRANSCOs/ State Nodal Agencies/ developers shall refer complete type approval / certificate of the models listed above for verification of validity period, detailed specifications, power curve and other information.

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Sl. No.	Indian Manufacturers with address	Collaboration / Joint Venture	Model Rotor Dia (RD) (m) / Hub height (HH) (m)	Capacity	* Type Certifi -cate	Manufacturing System Certificate (ISO Certificate)
3	M/s Shriram EPC Limited No.5, T.V Street Chetput, Chennai – 600 031 **Phone: 044 – 28361817** **Fax : 044 - 28363518**	Under License Agreement with TTG Industries Ltd.	SEPC 250 T RD : 28.5 m HH : 41.2 m Tower type: Lattice	250 kW	Available	Yes
4.	M/s.Siva Windturbine India Private Limited 12A, Kandampalayam, Perundurai Erode- (DIS) Pin : 638052 **Phone : 04294 – 220017** **Fax : 04294 - 220137**	Under License agreement with Wind Technik Nord, Germany.	SIVA 250/50 RD : 30 m HH : 50 m Tower type: Lattice	250 kW	Available	Yes
4.	M/s. Southern Wind Farms Limited No.15, Soundarapandian Salai, Ashok nagar, Chennai – 600 083 **Phone : 044 – 39182618** **Fax : 044 – 39182636**	None	GWL 225 RD : 29.8 m HH : 45 m Tower type : Tubular	225 kW	Available	Yes
5.	M/s Suzlon Energy Ltd. 5th Floor, Godrej Millennium 9, Koregaon Park Road, Pune – 411 001 **Phone: 020- 4012 2000** **Fax : 020 - 4012 2100**	Suzlon Energy Gmbh, Germany (Subsidiary of Suzlon Energy Limited)	Suzlon S.52 / 600 kW RD : 52 m HH : 75 m Tower type: Lattice	600 kW	Available	Yes
			Suzlon S 64 - 1250 kW tubular towers 56 m, 65 m, 74m and lattice tower 65 m RD : 64 m HH : 57m, 65m, 75 m Tower type: For HH 57/65 /75 m–Tubular steel & 65 m– Lattice	1250 kW	Available	
			Suzlon S66-1250 kW, tubular tower 75 m and lattice tower 65m RD : 66 m HH : 65 m & 75 m Tower type: For HH 65 m- Lattice tower & 75 m Tubular Steel	1250 kW	Available	

*State Electricity Boards / TRANSCOs/ State Nodal Agencies/ developers shall refer complete type approval / certificate of the models listed above for verification of validity period, detailed specifications, power curve and other information.

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Annex VIII: Monthly wind speeds along with the monthly power law index for 3 selected wind sites

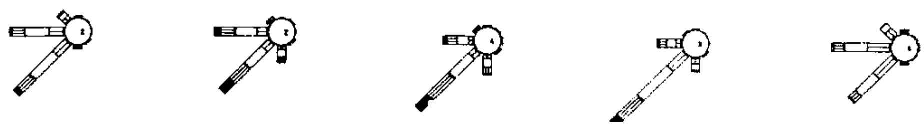
Warshamedi (20m mast height)		
Month	*Wind speed (m/s)*	*Power law index*
January	4.29	0.39
February	4.22	0.35
March	4.63	0.33
April	6.3	0.35
May	9.15	0.36
June	7.28	0.35
July	8.72	0.35
August	6.79	0.34
September	5.89	0.31
October	3.58	0.32
November	3.62	0.37
December	3.41	0.42
Kalyanpur		
Month	*Wind speed (m/s)*	*Power law index*
January	5.57	0.27
February	5.49	0.25
March	5.88	0.2
April	6.09	0.15
May	6.81	0.11
June	7.74	0.06
July	7.87	0.12
August	6.97	0.13
September	5.45	0.16
October	4.77	0.23
November	5.57	0.27
December	5.34	0.29
Poladia		
Month	*Wind speed (m/s)*	*Power law index*
January	4.64	0.25
February	5.31	0.2
March	5.69	0.24
April	6.57	0.22
May	6.74	0.08
June	7.73	0.1
July	7.37	0.1
August	6.59	0.11
September	5.48	0.21
October	4.07	0.25
November	4.29	0.26
December	4.35	0.26

Wind rose at sites

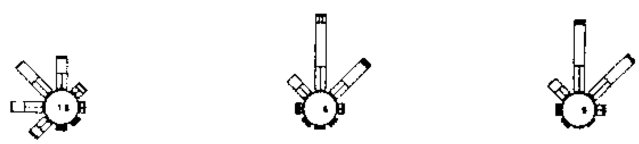
Kalyanpur

Jan Feb Mar Apr

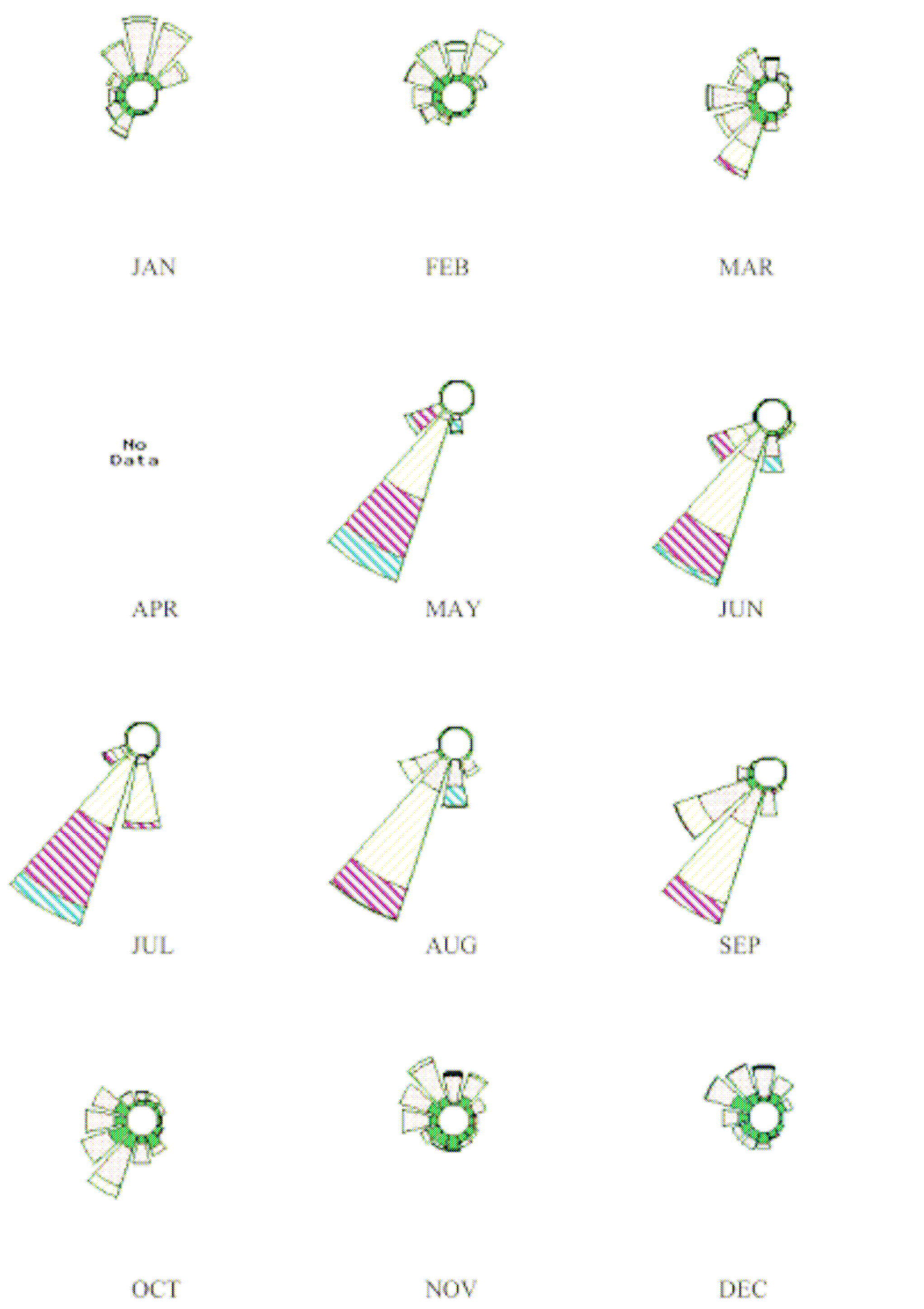
May Jun Jul Aug Sep



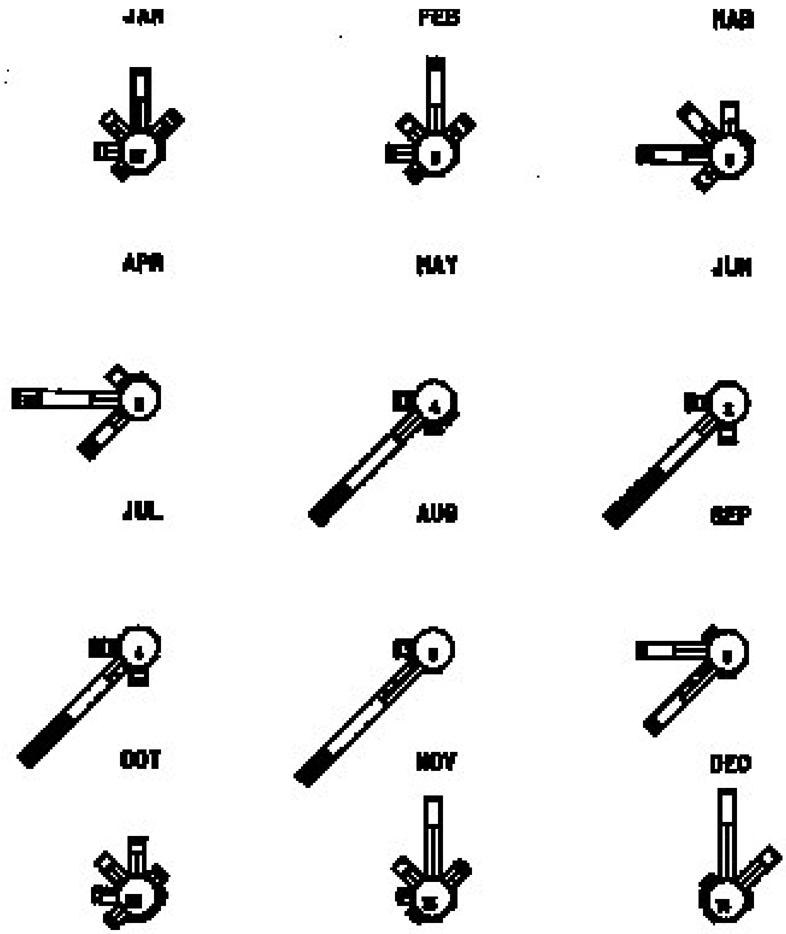
Oct Nov Dec



Warshamedi



Poladiya



Annex IX: Technical evaluation of wind turbines

The Turbine related parameters, which can be analyzed, are of two types, namely (i) those related to the experience of the offered turbine in India, its certification etc. and (ii) those related to salient features (electrical/ mechanical/safety etc) of the turbine. An evaluation matrix was generated to rate the turbines.

Turbine features

The turbine features, which were included in the evaluation matrix, are explained below.

Turbine size

Turbines with size 500 have been given minimum score of 1 and maximum size 2 MW was given score of 1.15. Different capacities in this range ware given score with increment of .005 for every 50kW increase above 500kW. The logic of scoring is based on the fact that there is about 15% reduction in land requirement with increase in size of turbines.

Generator type

The induction generator was give score 1. The synchronous generators have definite advantages like higher energy capture, and easier grid integration. The synchronous generators have about 5% higher energy capture thus were given score 5% higher than that of induction generator

Single speed/ variable speed

The variable speed machines have highest energy capture, about 5%, than the single speed machines and the variable speed turbines were given 5% higher score than singe speed machines. The double speed machines are have better energy capture than that of single speed and thus were given 2.5% higher score.

Geared/gearless

The gearless turbines have highest energy capture, about 2%, thus given higher score by 2% than the geared turbines. This is based on the fact that wind machines, which have synchronous generators, have no gearboxes since they could be designed for high speeds or for low speeds and have continuous variation according to the speed of the wind. These machines have an added advantage over induction machines because it is inherently variable speed and it has been proved that variable speed increases the energy capture and hence more energy could be generated. In this respect it has been found from various methods that there would be increase of 4-18% in energy capture by variable speed than the fixed speed machines.

Reactive power control

The turbines with the dynamically varying control systems were given score of 1.02since these systems have better reactive power control than the mechanically switched control systems. The intelligent switching systems, which basically have time delay with mechanical switching is given intermediate score of 1.01. The turbines with purely mechanical switching were given the lowest score of 1.

Cut in wind speed

The lower cut in wind speed results in higher energy capture, though the amount of energy capture depends on wind resource at the site. Thus the maximum cut in wind speed was given minimum score of 1, and lowest cut in wind speed of 4m/s was given score of 1.02. The other cut in wind speeds were given scores in the range of 1 to 1.02.

Rated wind speed

The rated wind speeds of turbines vary in the range from 11m/s to 17 m/s. The lower rated wind speeds, depending upon the sites and for similar rating of turbines, would lead to higher energy capture. Thus following scores were given to the different rated wind speeds

Rated speed	Score
11 m/s	1.06
12 m/s	1.05
13 m/s	1.04
14 m/s	1.03
15m/s	1.02
16 m/s	1.01
17 m/s	1

Class of turbine

The class of turbines is an indicator of whether the wind turbine is designed to operate in that class of wind regime. The definition of the wind turbine classes is given in IEC safety standards (IEC 61400). A wind turbine class in IEC 61400 is defined by its basic parameter of reference wind speed (Vref). Based on the reference wind speed a wind turbine is designed to withstand climate, for which the extreme ten minute average wind speeds, with a recurrence period of fifty years at a certain hub-height is lower than or equal to reference wind speed (Vref). From the table below, shows various wind turbine class, based on their reference wind speed. Al0ng with the other parameters the class is also defined by the annual average wind speed at the hub height as given in table below.

WTG class	I	II	III	IV
Reference wind speed (Vref) in m/s	50	42.5	37.5	30
Annual avg. wind speed (m/s)	10	8.5	7.5	6

Thus class I turbines were given score of 1.02, followed by class II with score of 1.01 and class III with score of 1.00.

Power regulation

The active pitch/stall has better control on output and was given highest score of 1.02 followed by the pitch control with score 1.01 and stall control with score 1.

Technical feature comparison of turbines

Features/ Turbine manufacturer	Suzlon	
Capacity (kW)	1500	2100
Score	10.19	10.25
Make	Suzlon	Suzlon
Model No.	S.82/1500*	S88/2100*
Rating in kW	1500	2100
Rotor Diameter (m)	82	88
Highest hub height (m)	78	80/100
Type of tower (Tubular/Lattice)	Tubular	Tubular
No. blades	3	3
Power regulation (Pitch/Stall)	Pitch	Pitch
Rotor speed (RPM)	16.3	15.71
Type of generator (Synchronous/Asynchronous)	Asyn.	Asyn.
Single speed/Dual speed/ Variable speed (Generator)	Single Speed	Dual Speed
AC/DC/AC system (Yes/No)	No	No
Protection/ insulation class	IP 54 class H	IP 54 class H
Rated Voltage	690V	690V/600V
Geared/Gearless	Geared	Geared
Cut-in-wind speed	4 m/s	4 m/s
Cut-out wind speed	20 m/s	25 m/s
Rated wind speed	14 m/s	14 m/s
Survival wind speed	52.5 m/s	59.5 m/s
Weight(In KG's)		
Tower	140390	
Nacelle	76400	
Rotor	11863	
Total (In KG's)	228653	265300

Technical feature/ Turbine manufacturer	**Enercon**
Capacity (kW)	800
Score	10.2875
Make	
Model No.	E-53*
Rating in kW	800
Rotor Diameter (m)	53
Highest hub height (m)	75
Type of tower (Tubular/Lattice)	Tubular/Concrete
No. blades	3
Power regulation (Pitch/Stall)	Pitch
Rotor speed (RPM)	12-29
Type of generator (Synchronous/Asynchronous)	Syn.
Single speed/Dual speed/ Variable speed (Generator)	Variable
Protection/ insulation class	IP 23 class F
AC/DC/AC system (Yes/No)	Yes
Rated Voltage	690V
Geared/Gearless	Gearless
Cut-in-wind speed	2.5 m/s
Cut-out wind speed	
Rated wind speed	12 m/s
Survival wind speed	
Weight (In KG's)	
Tower	
Nacelle	
Rotor	
Total (In KG's)	

Technical feature/ Turbine manufacturer	**Vestas wind technologies India Pvt Ltd**	
Capacity (kW)	750	1650
Score	10.0875	10.2075
Make		
Model No.	NM- 48/750*	NM-82/1650*
Rating in kW	750/200	1650
Rotor Diameter (m)	48.2	82.0
Highest hub height (m)	55	78.0
Type of tower (Tubular/Lattice)	Tubular	Tubular
No. blades	3	3
Power regulation (Pitch/Stall)	Stall	Active Stall
Rotor speed (RPM)	15/20	14.4
Type of generator (Synchronous/Asynchronous)	Asyn.	Asyn.
Protection/ insulation class	IP 56 class F	IP 56 class F
Single speed/Dual speed/ Variable speed (Generator)	Dual Speed	Single Speed
AC/DC/AC system (Yes/No)	No	No
Rated Voltage	690V	690V
Geared/Gearless	Geared	Geared
Cut-in-wind speed	<3.5 m/s	
Cut-out wind speed	25 m/s	20 m/s
Rated wind speed	17 m/s	14 m/s
Survival wind speed	60 m/s	52.5 m/s
Weight(In KG's)		
Tower	46000	
Nacelle	22000	
Rotor	13500	
Total (In KG's)	81500	

Feature/Turbine manufacturer	**Vestas RRB India Ltd**	**Vestas RRB India Ltd**
Capacity (kW)	500	600
Score	10.04	10.05
Make	Vestas RRB	Vestas RRB
Model No.	V39*	Pawan Shakti
Rating in kW	500	600
Rotor Diameter (m)	39/42	47
Highest hub height (m)	41.5	50
Type of tower (Tubular/Lattice)	Lattice	Lattice
No. blades	3	3
Power regulation (Pitch/Stall)	Pitch	Pitch
Rotor speed (RPM)	26	26.2
Type of generator (Synchronous/Asynchronous)	Asyn.	Asyn.
Single speed/Dual speed/ Variable speed (Generator)	Single Speed	Single Speed
AC/DC/AC system (Yes/No)	No	No
Protection/ insulation class	IP 56 class F	IP 54 class F
Rated Voltage	690V	690V
Geared/Gearless	Geared	Geared
Cut-in-wind speed	4.0 m/s	4.0 m/s
Cut-out wind speed	25 m/s	25 m/s
Rated wind speed	14 m/s	15 m/s
Survival wind speed	56 m/s	70 m/s
Weight(In KG's)		
Tower	19000	41446
Nacelle	18000	20600
Rotor	8200	7300
Total (In KG's)	45200	69346

Rating of Turbines

		Machine	Suzlon 1500		Suzlon 2100	
	Parameter	Score				
Machine size						
	500 kW	1	1500	1.1	2100	1.16
	2000 kW	1.15				
Generator type						
	Induction	1	Induction	1	Induction	1
	Synchronous	1.05				
Geared Gearless						
	Gearless	1.02	Geared	1	Geared	1
	Geared	1				
Singe speed/variable speed						
	Single speed	1	Single Speed	1.02	Dual speed	1.02
	Double speed	1.02				
	Variable speed	1.05				
Reactive power control						
	Mechanically switched	1	Intelligent	1.01	Intelligent	1.01
	Intelligent switching	1.01				
	Dynamically variable	1.02				
Cut in wind speed						
	2	1.05	4 m/s	1	4	1
	4	1				
Rated wind speed						
	11	1.06	14 m/s	1.03	14	1.03
	12	1.05				
	13	1.04				
	14	1.03				
	15	1.02				
	16	1.01				
	17	1				
Tower type						
	Lattice	1	tubular	1.01	tubular	1.01
	Tubular	1.01				
Class of machine						
	Class I	1.02	Class II	1.01	Class II	1.01
	Class II	1.01				
	Class III	1				
Power regulation						
	Active pitch/Active stall	1.02	pitch	1.01	pitch	1.01
	Pitch control	1.01				
	Stall	1				
Total score				**10.19**		**10.25**

		Machine	Vestas India pvt ltd 1650 kW		Vestas India pvt ltd 750 kW	
	Parameter	Score				
Machine size						
	500 kW	1	1650	1.115	750	1.025
	2000 kW	1.15				
Generator type						
	Induction	1	Induction	1	Induction	1
	Synchronous	1.05				
Geared Gearless						
	Gearless	1.02	Geared	1	Geared	1
	Geared	1				
Singe speed/variable speed						
	Single speed	1	Single speed	1	Duel speed	1.02
	Double speed	1.02				
	Variable speed	1.05				
Reactive power control						
	Mechanically switched	1	intelligent	1.01	intelligent	1.01
	Intelligent switching	1.01				
	Dynamically variable	1.02				
Cut in wind speed						
	2	1.05	3.5	1.0125	3.5	1.0125
	4	1				
Rated wind speed						
	11	1.06	14	1.03	17	1
	12	1.05				
	13	1.04				
	14	1.03				
	15	1.02				
	16	1.01				
	17	1				
Tower type						
	Lattice	1	Tubular	1.01	Tubular	1.01
	Tubular	1.01				
Class of machine						
	Class I	1.02	Class II	1.01	class II	1.01
	Class II	1.01				
	Class III	1				
Power regulation						
	Active pitch/Active stall	1.02	Active pitch	1.02	stall	1
	Pitch control	1.01				
	Stall	1				
Total score				**10.2075**		**10.0875**

		Machine	Enercon 800 kW	
	Parameter	Score		
Machine size				
	500 kW	1	800	1.03
	2000 kW	1.15		
Generator type				
	Induction	1	Synchronous	1.05
	Synchronous	1.05		
Geared Gearless				
	Gearless	1.02	Gearless	1.02
	Geared	1		
Singe speed/variable speed				
	Single speed	1	Variable speed	1.05
	Double speed	1.02		
	Variable speed	1.05		
Reactive power control				
	Mechanically switched	1	not required	1.02
	Intelligent switching	1.01		
	Dynamically variable	1.02		
Cut in wind speed				
	2	1.05	2.5 m/s	1.0375
	4	1		
Rated wind speed				
	11	1.06	12 m/s	1.05
	12	1.05		
	13	1.04		
	14	1.03		
	15	1.02		
	16	1.01		
	17	1		
Tower type				
	Lattice	1	Tubular	1.01
	Tubular	1.01		
Class of machine				
	Class I	1.02	Class II	1.01
	Class II	1.01		
	Class III	1		
Power regulation				
	Active pitch/Active stall	1.02	pitch	1.01
	Pitch control	1.01		
	Stall	1		
Total score				**10.2875**

Machine			Vestas RRB 500 kW		Vestas RRB 600 kW	
	Parameter	Score				
Machine size						
	500 kW	1	500	1	600	1.01
	2000 kW	1.15				
Generator type						
	Induction	1	Induction	1	Induction	1
	Synchronous	1.05				
Geared Gearless						
	Gearless	1.02	Geared	1	Geared	1
	Geared	1				
Singe speed/variable speed						
	Single speed	1	Single speed	1	Single speed	1
	Double speed	1.02				
	Variable speed	1.05				
Reactive power control						
	Mechanically switched	1	Mechanical	1	Mechanical	1
	Intelligent switching	1.01				
	Dynamically variable	1.02				
Cut in wind speed						
	2	1.05	4m/s	1	4m/s	1
	4	1				
Rated wind speed						
	11	1.06	15 m/s	1.02	15 m/s	1.02
	12	1.05				
	13	1.04				
	14	1.03				
	15	1.02				
	16	1.01				
	17	1				
Tower type						
	Lattice	1	Lattice	1	Lattice	1
	Tubular	1.01				
Class of machine						
	Class I	1.02	class II	1.01	class II	1.01
	Class II	1.01				
	Class III	1				
Power regulation						
	Active pitch/Active stall	1.02	Pitch	1.01	Pitch	1.01
	Pitch control	1.01				
	Stall	1				
Total score				**10.04**		**10.05**

Annex X: Guidelines for scheme on Generation Based Incentives (GBI) for Grid Interactive Wind Power Projects

The following are the broad guidelines for submission of proposals by the interested project developers, details of incentives and other related guidelines.

1. Eligibility

1.1 IPPs, NGOs, Trusts, Financial institutions, academic and research institutions, SNAs, central and state power generation companies and public/private sector wind power project developers who have set up or propose to set up a wind farm in India will be eligible for consideration of generation based incentive, provided they sell the power to State Electricity Board/DISCOMS/Eligible power trading companies (only those power trading companies are eligible who's tariff for sale of power is not exceeding the tariff specified by the concerned SERC).

1.2 The GBI scheme would be applicable only for those power producers who do not avail of the accelerated/enhanced depreciation benefits under the Income Tax Act. The power producers who avail of the benefits of the scheme will be required to furnish documentary proof to this effect.

1.3 The scheme will be applicable only for those independent power producers having minimum installed capacity of 5 MW and whose capacities are commissioned for sale of power to the grid after the announcement of the scheme on first commissioned, first served basis subject to fulfillment of all eligibility criteria. Any subsequent addition in the capacity will be eligible if the addition has prior approval from IREDA for the purpose.

1.4 The GBI scheme will not be applicable to those who set up capacities for captive consumption, third party sale, merchant plants etc.

2. Eligible Projects

2.1 Grid interactive wind Power Generation projects of a minimum installed capacity of five MW will be eligible for generation based incentive.

2.2 Any project developer, who fulfills the procedural requirements and the guidelines specified by the Ministry, will be eligible for consideration of generation based incentive.

2.3 The GBI would be available only for projects commissioned i.e. synchronized to the grid and certified by the concerned Utility as specified at para 1.1 above, after issuance of Administrative approval/Notification of scheme of Ministry.

2.4 Only those wind turbines listed in the RLM list issued by C-WET, Chennai shall be eligible for GBI.

2.5 This incentive is over and above the rates approved by the State Regulatory Commissions or the rates at which the power purchase agreement are signed with utilities.

2.6 In case any project developer is desirous of availing the accelerated depreciation benefit for the project under section 32 of the Income Tax Act 1961 read with rule 5 and appendix-1, they would not be eligible for generation-based incentive.

3.0 Procedures to be followed by Project developers for availing Generation base Incentive

3.1 The grid interactive wind power projects will be considered for generation based incentive on registration by IREDA as per procedure indicated in para-3.3 and in accordance with the guidelines of the Ministry and compliance of the procedural requirements for filing the applications/requests and requisite fees for incentive. Mere information to the Ministry and/or IREDA about the intention of the company/project developer to set up a grid interactive wind power plant will not be sufficient basis for this purpose.

3.2 Before submission of application, the interested wind power project developers are required to ensure compliance of all legal and procedural requirements, power purchase agreement (including initial PPA as per the procedure of concerned State) and obtain all necessary clearances from the concerned State Government/State Utility/State Nodal Agency/local bodies and other organizations, as specified by the concerned State Government and/or Central Government.

3.3 The applicants are required to submit complete application in prescribed format (Annexure-III) to the Ministry (one copy) with two copies to IREDA, from the date of issuance of Administrative approval/Notification of the scheme by the Ministry.

3.4 On receipt of application, which is complete in all respects, the eligibility for generation based incentive will be examined in accordance with the guidelines of the Ministry. On examination by the Committee, if a proposal is found to be eligible, the prospective developer will be informed. The investors will be asked to intimate the time frame for installation and commissioning of the plant.

3.5 All eligible projects will be inspected by a team consisting of officials from the Ministry, concerned State Nodal Agency, utility and IREDA after commissioning/synchronization to the grid before the GBI is disbursed. The GBI will be approved only after demonstration of satisfactory commissioning of the plant at the project site and its interfacing with the grid of the utility, evaluated by the committee.

3.6 Applications which are incomplete or do not provide firm and clear information, registration fees and necessary documents will not be considered for GBI.

3.7 GBI will be provided only for projects installed at wind potential site validated by C-WET.

3.8 Wind power project developers shall not avail accelerated depreciation benefit under Section 32 of the Income Tax Act 1961. The wind power project developers who submit their applications to the Ministry with a copy to IREDA are required to submit a declaration as per the prescribed format to this effect. At the end of each financial year, the developer shall file their acknowledged copy of I.T. Returns to establish that no accelerated depreciation has been availed. On approval of the project, IREDA will enter into an agreement with the project developer, among other matters, in this regard. If any violation of this condition is found, IREDA will immediately stop release of generation-based incentive to that project. The GBI already released would be liable for complete recovery with interest.

3.9 The project developers will maintain a record of power generation and other technical features of the power plant (wind turbines) for the entire period during which they will receive incentives. Along with documentation of its sale to the grid, a copy of the data should also be available in electronic form. This record will also be made available readily for verification / audit purposes, if required by the Ministry/IREDA.

3.10 The developer are required to submit the generation details as per payment receipt from the State Electricity Board/DISCOMS/Eligible power trading companies on half yearly basis together with a self declaration in the prescribed format about non-claiming of accelerated depreciation to IREDA and the submission of Income tax return at appropriate time.
The application format is available on the website of the Ministry (http://mnre.gov.in)

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Annex-XI: Procedure for registering the projects with the Executive Board of the UNFCCC and availing the CDM benefits

What is CDM?

Kyoto Protocol and CDM

The world community first came together to address the threat of climate change through the UNFCCC (Box 1). This treaty was opened for signatures in June 1992 at the Rio Earth Summit. The UNFCCC came into force on 21 March 1994, and had been ratified by 198 countries as of May 2004. While the UNFCCC did not lay down legally binding emissions reduction targets for countries, it recognized the need for an agreement with emissions reduction commitments with a specific timetable.

Box 1: Scientific evidence of climate change

Climate change was first recognized as a problem of global magnitude and of immediate concern in the 1980s with the occurrence of unusually warm summers in the United States. It became apparent that the atmospheric 'greenhouse' phenomenon studied by the Swedish scientist Svante Arrhenius a hundred years ago was actually changing climatic patterns across our planet. Severe storms, floods, and droughts in the last decade have served as a reminder that urgent action is required to control the increase in the concentrations of GHGs (greenhouse gases).

In order to better understand the processes by which we are altering the earth's climate system, the IPCC (Intergovernmental Panel on Climate Change) was established jointly by UNEP (United Nations Environment Programme) and WMO (World Meteorological Organization) in 1988. The scientific output of this body has helped to define more clearly the range of possible impacts, to determine which locations and systems may be most vulnerable, and to identify mitigation and adaptation measures. The IPCC, in its Third Assessment Report, has confirmed that the evidence of human interference in the climate is stronger than ever. Atmospheric concentrations of carbon dioxide, methane, and nitrous oxides have grown by about 31%, 151%, and 17%, respectively, over the period 1750–2000. Specifically, carbon dioxide concentrations have increased from about 280 PPMV (parts per million by volume) in pre-industrial times to 360 PPMV in 2000. At the same time, the mean global surface temperature has increased by 0.6 °C (+0.2 °C) over the twentieth century. Scenario-based projections reported in Third Assessment Report indicate a higher rate of warming (1.4 °C–5.8 °C)

over the period 1990–2100, while the sea level is projected to rise by 9–88 cm.
Changes in the surface air temperature and the sea level could change precipitation quantity and pattern, vegetation cover, and soil moisture. The impact on the natural and managed systems will depend critically on the rate of climate change. The predicted changes in global temperature are greater than any seen in the last 10 000 years. Further, regional temperature changes could be substantially different from the global average and the frequency, intensity, and duration of storms and other extreme weather events could increase.
The impacts of climate change could include the dieback of tropical forests and grasslands, tremendous reductions in the availability of water from rivers, decline in cereal yields, and increased incidence of heat stress, malaria, and other vectorborne and water-borne diseases.
Rise in the sea level could have a number of physical impacts on coastal areas, including loss of land due to inundation and erosion, increased flooding, and saltwater intrusion. These could adversely affect coastal agriculture, tourism, freshwater resources, fisheries and aquaculture, and human settlements and health.
Source IPCC (2001)

This was achieved in the form of the Kyoto Protocol in 1997. The Protocol covers the following six GHGs.

- CO_2 (carbon dioxide)
- CH_4 (methane)
- N_2O (nitrous oxide)
- HFC_s (hydrofluorocarbons)
- PFC_s (perfluorocarbons)
- SF_6 (sulphur hexafluoride)

Annex I Parties agreed to reduce their overall emissions of these six GHGs by an average of 5.2% below the 1990 levels by the first commitment period 2008–12. Among Annex I countries, the Protocol allowed for differentiated targets depending on the country's circumstances; for instance, Japan and the United States were required to reduce emissions by 6% and 7%, respectively, while Australia was allowed an increase of 8% over the 1990 levels. The condition for the coming into force of the Kyoto Protocol was ratification by 55 countries accounting for 55% of Annex I 1990 carbon dioxide emissions. Since the United States, responsible for about 35% of Annex I 1990 carbon dioxide emissions, refused to ratify the Kyoto Protocol in early 2001, the fulfilment of this condition became contingent on ratification by Russia (accounting for 17% of emissions). With this achieved, the Protocol has been ratified by 141 countries, as of 2 February 2005, including 37 Annex I countries accounting for 61.6% of 1990 carbon dioxide emissions (Figure 1).

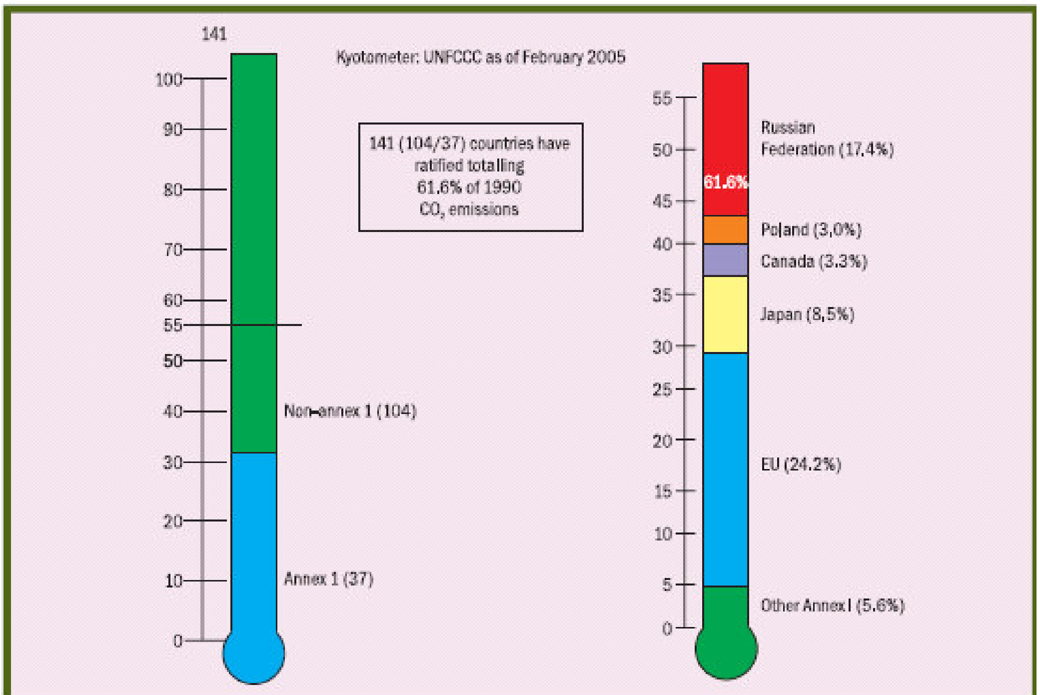

Figure 1 Kyoto Protocol ratification

To enable countries meet their reduction commitments in a flexible and cost-effective manner, the Protocol established three market-based mechanisms (ET, JI, and CDM). In particular, CDM allows Annex I countries to meet part of their Kyoto Protocol targets by using credits from projects that reduce GHG emissions in developing countries. The underlying rationale is that cutting GHG emissions in any part of the world can contribute towards reducing global atmospheric concentrations of GHGs. While the Annex I Parties benefit by obtaining reductions at costs lower than those in their own countries, the gains to the host Parties are in the form of finance, technology, and local sustainable development benefits.

Value of carbon

As a result of the Kyoto Protocol, carbon has become a tradable commodity with an associated value. One tonne of carbon dioxide reduced through a CDM project, when certified by a designated entity, is known as a CER (certified emission reduction), which can be traded. Revenue from CERs can form part of a project’s annual cash inflow, equity, or debt. There are varying estimates of the potential opportunities under CDM. Early studies of the demand for CDM had predicted impressive amounts of more than 4000 MTCO2eq per year. However, the refusal of the US and Australia to ratify the Kyoto Protocol citing adverse economic impacts has severely shrunk the carbon market. Also, instead of investing in CDM, Annex I countries can more cheaply buy the excess quota of countries like Russia and Ukraine.

Nevertheless, in recent years a small market for carbon has started to emerge. Even in the anticipation of the coming into force of the Kyoto Protocol, some European countries, multilateral

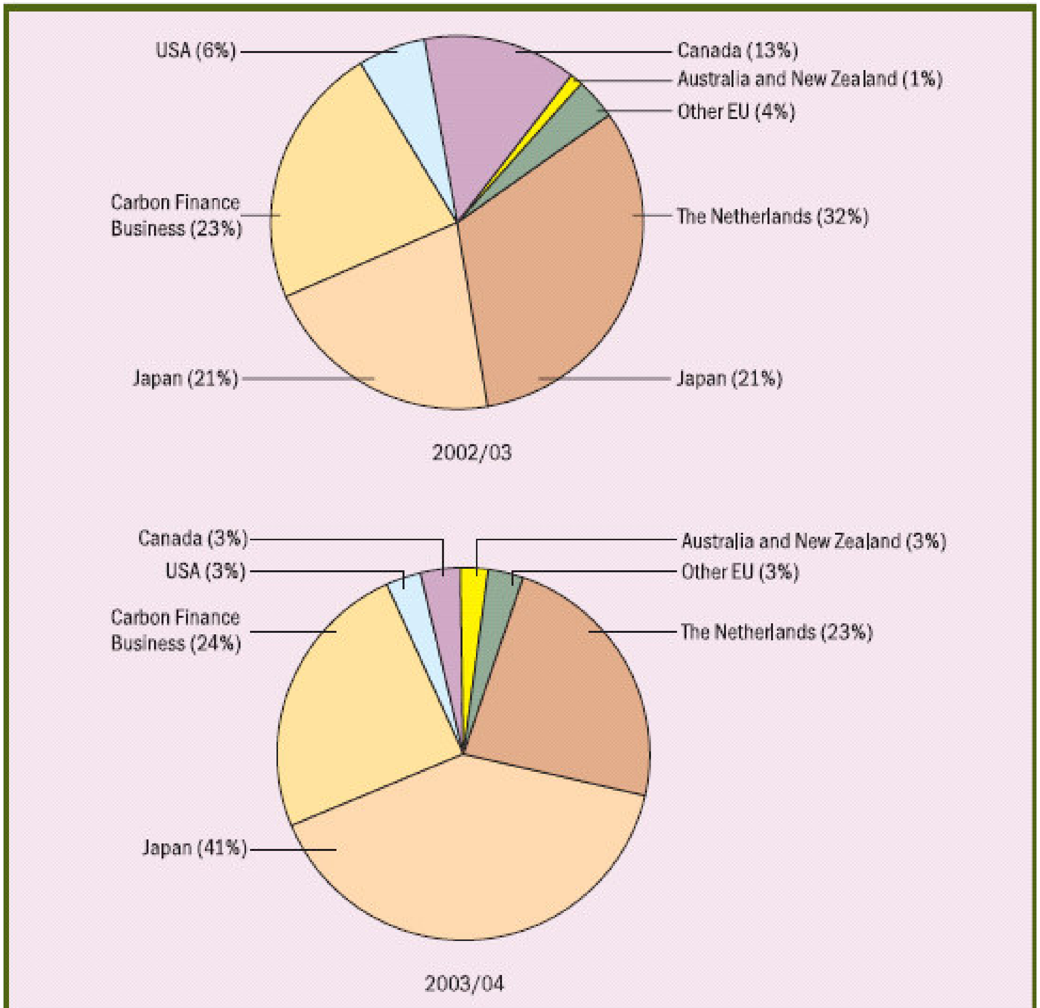

Figure 2 Share of market buyers (in terms of volume of emission reductions purchased)
Source Lecocq (2004)

Fast-tracking CDM in Indian States organizations, and corporates took the lead by launching CDM tenders, carbon funds, and emissions trading schemes (Box 2). Figure 2 shows the main buyers in the market. While the pioneers were the Prototype Carbon Fund of the World Bank and the CERUPT (Certified Emission Reduction Unit Procurement Tender) programme of the Netherlands, the year 2004 saw the emergence of Japan as the largest buyer, and the launch of the Japan Carbon Fund (jointly managed by the Japan Bank for International Cooperation and the Development Bank of Japan). In this evolving market, brokers and consultants are also playing matchmaking roles between buyers and sellers. Some of these initiatives are listed in Annexe 1. As a result of these activities, in 2004, 127.2 MTCO2eq were contracted, of which the share of CDM was 82 MTCO2eq at an average weighted price of 4.2 Euros/TCO2eq (Point Carbon 2005).

Box 2 Emissions trading

Despite the delay in entry of the Kyoto Protocol into force, many countries have started implementing regulations for reducing and trading GHG (greenhouse gas) emissions. Foremost among these is the European Union's Emissions Trading System (EU ETS), which in January 2005 commenced operation as the largest multi-country, multi-sector GHG emissions trading scheme worldwide. In addition to this regional trading system, some countries like the United Kingdom and Denmark have launched domestic trading schemes. Even in countries like the US and Australia, which have decided not to ratify the Kyoto Protocol, some policy initiatives are emerging at the state level. Massachusetts and New Hampshire have planned state cap-and-trade of carbon dioxide emissions starting in 2006, while Oregon already possesses a GHG emissions reduction procurement initiative. The New South Wales trading system covers electricity retailers and aims to reduce emissions by 5% in 2012. The corporate sector too is not far behind. Companies from seven US states, Canada, Brazil, and Mexico participated in CCX (Chicago Climate Exchange), and have committed to reduce their GHG emissions by 4% below their average 1998–2001 baseline by 2006. Companies like BP and Shell have also experimented with internal trading systems. In January 2005, the prices in the EU ETS were about ¤7.20 / TCO2eq for vintage 2005 allowances (Carbon Finance 2005).
Source Babu and Bhandari (2004) 1 Under the Kyoto Protocol, countries like Russia and Ukraine were set targets according to their 1990 emission levels.

Due to the ongoing economic slowdown, their emission levels were already 30% below their 1990 levels, giving rise to what has been termed as ‘hot air’.

The prevailing carbon prices are too low to excite large-scale CDM project development activity. However, the EU ETS (European Union Emissions Trading System), which became operational in January 2005, creates a significant new market for CDM as a result of its Linking Directive. Furthermore, prices can be expected to rise as the deadline for meeting the Kyoto Protocol targets draws nearer, and countries/companies save carbon credits to meet stricter targets in the future.

CDM Project Cycle

As defined in Article 12 of the Kyoto Protocol, CDM is defined as a mechanism to address the following objectives.

- Assist non-Annex I countries in achieving sustainable development

- Help Annex I countries comply with their emissions reduction commitments
- Contribute to the ultimate goal of the UNFCCC, i.e. stabilization of GHG concentrations in the atmosphere

Projects in developing countries are eligible under CDM if they help meet the above objectives by reducing GHG emissions relative to the 'baseline'. In other words, to qualify for credits, GHG emissions from a project activity must be reduced below those that would have occurred in the absence of the project. The project itself should not be part of the baseline scenario but should be 'additional' to what would have happened anyway. Without this 'additionality' requirement, there is no guarantee that CDM projects will create incremental environmental benefits, contribute toward sustainable development in the host country, or play a role in the ultimate objective of stabilizing atmospheric GHG concentrations. Some examples of CDM projects are listed below.

- Carbon dioxide displacement through utilization of renewable energy for power generation and thermal energy
- Carbon dioxide reduction through energy efficiency improvement
- Carbon dioxide sequestration through afforestation and reforestation
- Landfill gas capture and energy generation
- Hydrofluorocarbon decomposition

In December 2001, negotiators worked out the detailed modalities and procedures of the international climate change policy regime, including the rules and regulations of the CDM, which were formulated as the Marrakech Accords (Box 3).

The CDM Executive Board was established as part of the UNFCCC framework to oversee the CDM process. CDM projects have to undergo the series of steps illustrated in Figure 3. The glossary of CDM terms is given in Annexe 2.

Box 3 Clean development mechanism participation requirements as specified in Marrakech Accords

1 Participation in a CDM project activity is voluntary.
2 Parties participating in the CDM shall designate a national authority for the CDM.
3 A Party not included in Annex I may participate in a CDM project activity if it is a Party to the
Kyoto Protocol.
4 A Party included in Annex I* with a commitment inscribed in Annex B* is eligible to use CERs
(certified emissions reductions), issued in accordance with the relevant provisions, to contribute to compliance with part of its commitment under Article 3, paragraph 1, if it is in compliance with the following eligibility requirements.

(a) It is a Party to the Kyoto Protocol;
(b) Its assigned amount pursuant to Article 3, paragraphs 7 and 8, has been calculated and
recorded in accordance with decision -/CMP.1 (Modalities for the accounting of assigned amounts);
(c) It has in place a national system for the estimation of anthropogenic emissions by sources
and anthropogenic removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, in accordance with Article 5, paragraph 1, and the requirements in the guidelines decided thereunder;
(d) It has in place a national registry in accordance with Article 7, paragraph 4, and the requirements in the guidelines decided thereunder;
(e) It has submitted annually the most recent required inventory, in accordance with Article 5, paragraph 2, and Article 7, paragraph 1, and the requirements in the guidelines decided thereunder, including the national inventory report and the common reporting format. For the first commitment period, the quality assessment needed for the purpose of determining eligibility to use the mechanisms shall be limited to the parts of the inventory pertaining to emissions of greenhouse gases from sources/sector categories from Annex A* to the Kyoto Protocol and the submission of the annual inventory on sinks;
(f) It submits the supplementary information on assigned amount in accordance with Article 7,
paragraph 1, and the requirements in the guidelines decided thereunder and makes any additions to, and subtractions from, assigned amount pursuant to Article 3, paragraphs 7 and 8, including for the activities under Article 3, paragraphs 3 and 4, in accordance with Article 7, paragraph 4, and the requirements in the guidelines decided thereunder.

Refer Annexe 3

Source UNFCCC (2001)

Step 1: Project formulation

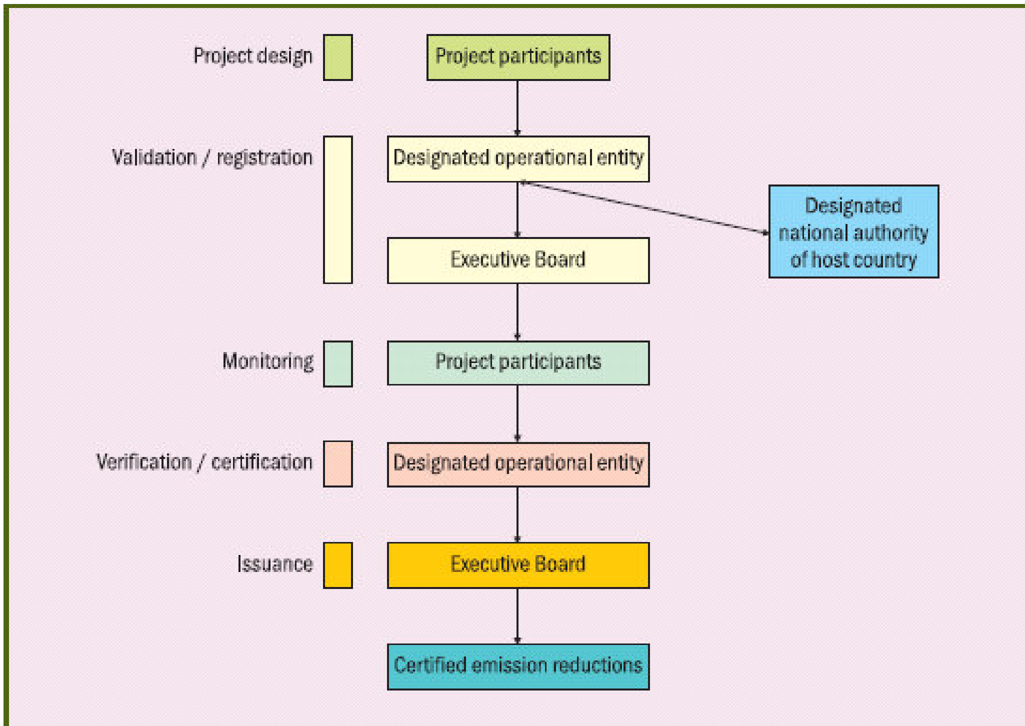

Figure 3 The CDM project cycle

Source UNFCCC (2005)

The first step in the CDM project cycle is identifying an eligible project. As per the Marrakech Accords, projects that reduce any of the six GHGs covered in the Kyoto Protocol are eligible for CDM if 'anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity'. Carbon sequestration projects in the forestry sector are limited to afforestation and reforestation. Nuclear energy projects have been deemed ineligible under CDM. Further, three types of small-scale project categories have been defined, which are entitled to simpler and faster procedures (Box 4).

Box 4 Small-scale clean development mechanism project categories

Renewable energy projects up to 15 MW (megawatt)
Energy efficiency projects reducing energy consumption by up to 15 GWh (gigawatt hour) annually
Other project activities that reduce emissions and directly emit less than 15 KTCO2eq (kilo tonnes)
Afforestation and reforestation project activities sequestering less than 8 KTCO2 annually

The project has to be formulated as a PDD (project design document), which has the following key elements.

- General description of project activity
- Baseline methodology (including boundary and leakage aspects)
- Duration of project activity / crediting period
- Monitoring methodology and plan
- Calculation of GHG emissions by sources
- Environmental impacts
- Stakeholder comments.

Probably the most important element is the establishment of the baseline and the calculation of
emissions reductions. The Marrakech Accords allow for the following three baseline approaches.
'Existing actual or historical emissions data.'
Emissions from a 'technology that represents an economically attractive course of action, taking into account barriers to investment.'

'The average emissions of similar project activities undertaken in the previous five years, in similar… circumstances, and whose performance is in the top 20% of their category.'

Details of PDD requirements are available at <http://cdm.unfccc.int>.

Step 2: Approval by designated national authority

Each participating country is required to set up a DNA (designated national authority) for CDM. Each project must get approval from the relevant DNA that it assists the host country in achieving sustainable development.

Step 3: Validation

Validation of the PDD is carried out by third-party agencies known as DOEs (designated operational entities) accredited by the Executive Board. As part of validation, the DOE checks the following points.

- The host and Annex I countries involved in the CDM project have ratified the Kyoto Protocol.
- Stakeholder comments have been accounted for.
- Environmental impact analysis/assessment has been done.
- GHG emissions reduction is additional.
- Approved baseline and monitoring methodologies have been used; or a new methodology has to be submitted to the Executive Board.

Step 4: Registration

After validation, the DOE forwards its report to the Executive Board, which normally registers the project as a CDM project within eight weeks. An administrative fee is charged, which differs according to the size of the project (Table 1).

Table 1 Administration fee for CDM projects

Volume of CERs generated annually (TCO_2)	Fee (US dollars)
<= 15 000	5 000
>15 000 and <=50 000	10 000
>50 000 and <=100 000	15 000
>100 000 and <=200 000	20 000
>200 000	30 000

CDM - clean development mechanism; CERs - certified emission reductions

Step 5: Monitoring

Monitoring is the systematic surveillance of project performance by the project participants. For this purpose, a transparent and reliable monitoring plan must be specified to collect and archive all data needed to estimate GHG emissions occurring within the project boundary, determine the baseline GHG emissions, and determine leakage.

Step 6: Verification

Verification is the periodic independent review and ex post determination by the DOE of the monitored emissions reductions resulting from the CDM project. The DOE which has performed the validation cannot normally perform verification for the same project.

Step 7: Certification

Certification is a written assurance by the DOE that the project has achieved emissions reductions as verified.

Step 8: Issuance of CERs

Project developers can choose between the following two options for the period of receiving credits.
1 Ten years without any revision to the baseline
2 Twenty one years with a reassessment of the baseline after every seven years.

Within 15 days of the DOE making its certification report public, the Executive Board issues the necessary CERs. The only exception is if there is an objection by a project participant or by three Executive Board members. A registry for the issuance and the tracking of CERs is under development by the Executive Board. Further, two per cent of the share of the proceeds from CDM projects is retained for the Adaptation Fund created under the Kyoto Protocol.

Table 2 summarizes the roles and responsibilities of the various agencies and stakeholders involved in the CDM project cycle.

Table 2 Roles and responsibilities in the CDM project cycle

Activity	Definition	Responsible entity
Project development	Developing a CDM project	Project promoter
Project design document	Developing a CDM PDD	Project promoter
Validation	Independent evaluation of PDD, including calculations of baseline emissions and estimated project emissions	DOE
Host country approval	Approval from host government is mandatory	Project promoter and host government
Registration	Formal acceptance of a validated PDD	Executive Board
Project implementation and monitoring	Commissioning and operation of the CDM project and measuring and recording project performance related indicators/parameters	Project promoter
Verification	Periodical independent review of monitored GHG reductions	DOE
Certification	Written assurance on the actual GHG reductions verified	DOE
Issuance of CERs	Issuance of CERs based on DOE's certification	Executive Board

CDM - clean development mechanism; PDD - project design document; DOE - designed operational entities; GHG - greenhouse gas; CERs - certified emission reductions.

Special consideration for small-scale projects

Recognizing the high sustainable development impacts of small projects, efforts have been made to encourage such projects by reducing the costs of going through the CDM project cycle. These measures include the following.

- Simplified baseline and monitoring methodologies approved by the Executive Board, which can be applied directly, thereby saving project development costs.
- PDD has simpler requirements related to sustainable development.
- The same DOE can undertake validation, verification, and certification for a small-scale project.
- Bundling of small projects is feasible, provided the bundle does not violate the small-scale project eligibility limit (e.g. 15 MW [megawatt] for renewable energy projects).
- A lower registration fee is charged.
- CERs are issued in four weeks, instead of the eight weeks taken for other projects.

Updated details are available at <http://cdm.unfccc.int/pac/howto/smallscalePA/index.html>.

Annex XII: Monthly CUF and energy generation calculation sheet

Energy Generation at warshmendi												100	MW	Sale rate	3.37	Rs/kWh
										0.756533						
Suzlon 1500		1500	0.96	0.97	0.95	0.95	95%	95%	**Net Gen (kWh/MW)**	Net CUF	Net CUF%		Total Generation from Plant			
	Gross generaton		air density correction	Arrey correction	machine avalibality	grid avaliability	transmission losses	Uncertainty					kWh	Revenue (Rs.)	Revenue (Rs.Lakh)	
January	30%	334800	320588.1	310970.4	295421.9	280650.8	266618.3	253287.3663	168858	0.22696	22.70		16885824.42	56905228.29	569.0523	
Feb	26%	262080	250955	243426.3	231255	219692.3	208707.6	198272.2609	132182	0.196699	19.67		13218150.73	44545167.95	445.4517	
March	35%	390600	374019.4	362798.8	344658.9	327426	311054.7	295501.9273	197001	0.264787	26.48		19700128.49	66389433.01	663.8943	
Apr	52%	561600	537760.7	521627.8	495546.4	470769.1	447230.7	424869.1305	283246	0.393397	39.34		28324608.7	95453931.33	954.5393	
May	70%	781200	748038.9	725597.7	689317.8	654851.9	622109.3	591003.8547	394003	0.529573	52.96		39400256.98	132778866	1327.789	
June	64%	691200	661859.3	642003.5	609903.3	579408.1	550437.7	522915.853	348611	0.484181	48.42		34861056.86	117481761.6	1174.818	
July	70%	781200	748038.9	725597.7	689317.8	654851.9	622109.3	591003.8547	394003	0.529573	52.96		39400256.98	132778866	1327.789	
Aug	60%	669600	641176.2	621940.9	590843.8	561301.6	533236.6	506574.7326	337716	0.45392	45.39		33771648.84	113810456.6	1138.105	
Sep	50%	540000	517077.6	501565.2	476487	452662.6	430029.5	408528.0101	272352	0.378267	37.83		27235200.68	91782626.28	917.8263	
Oct	20%	216000	206831	200626.1	190594.8	181065	172011.8	163411.2041	108941	0.151307	15.13		10894080.27	36713050.51	367.1305	
Nov	20%	216000	206831	200626.1	190594.8	181065	172011.8	163411.2041	108941	0.151307	15.13		10894080.27	36713050.51	367.1305	
Dec	17%	189720	181666.6	176216.6	167405.8	159035.5	151083.7	143529.5076	95686	0.128611	12.86		9568633.837	32246296.03	322.463	
		5634000					4486641		**2841539**	Avg.	**32.40**		**284153927**	**957598734.1**	**9575.987**	
		0.428767					0.341449									

Annex XIII: Detailed financial calculation sheets