ICI Pakistan Limited

50 MW ICI WIND POWER PLANT KALAR KAHAR, PAKISTAN

ENVIRONMENT IMPACT ASSESSMENT

GROUP A, SEMESTER VII, SDSC

Client: ICI Private Limited

Khewra

Pakistan

Consultant: Environ Consultants

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1. Introduction

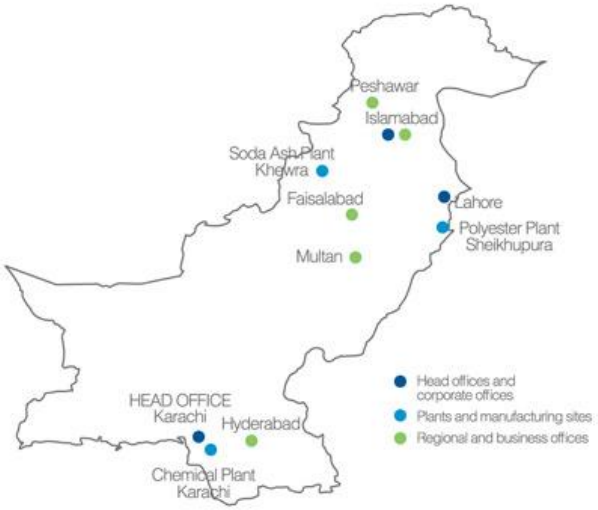
The Government of Pakistan has clearly articulated its support for the development of renewable energies. Due to the fact that the use of wind energy is actually the most economical one among the renewable energy production techniques, the focus is on supporting the development of wind farms.

ICI, one of the largest companies in Pakistan, is entering the wind energy market by developing a 50 MW wind farm. To prove the feasibility of the chosen site, ICI has engaged Environ Group as Consultant. Environ is elaborating the feasibility study, supervising the wind measurements initiated by ICI and preparing conceptual design of wind farm.

Within the range of this report, the environmental aspects of the Kalar Kahar project site are updated and elaborated. One main outcome of the study is the result that ICI Wind Power Project has no adverse impact on the environmental and social life of Kalar Kahar, Punjab. Instead it will be utilizing the wind potential of that unutilized barren land for electricity generation through renewable resources, thus helping in improving the environment.

Introduction to ICI Pakistan

With over 69 years of successful operations, ICI Pakistan is a leading manufacturing concern supplying products to almost every industry in the country. Its businesses are major players within their respective industries, bringing together outstanding knowledge of customer needs with leading edge technology platforms.



It is committed to reducing our impact on the planet and delivering more sustainable products and solutions to our customers. And it can only do this if sustainability is at the heart of everything we do. That is why we aim to integrate sustainability into every area of our business – for the benefit of our customers, shareholders, employees and the world around us.

Its business operations have an impact on the environment and we are working hard to reduce it. It aims to improve efficiency in the use of resources, employed for our operations and have defined this as "Operational Eco Efficiency" (OEE). It is measured in terms of carbon emissions impacting the environment and we call it the OEE footprint. The parameters that significantly impact OEE footprint are Carbon Oxygen Demand (COD), Volatile Organic Compounds (VOC), total NOx, total Sox, Carbon Dioxide (CO2), all types of waste, water consumption and energy usage.

As a part of its vision, ICI intends to diversify its business with a strong commitment in the renewable energy arena. To start with its journey in this avenue, ICI has embarked upon a 50 MW Wind Power Project at Kalar Kahar. ICI has engaged services of well known international consultant Environ Group for the project.

Following is the project brief:

Project Development Activities:

ICI has worked on fast track basis to complete the initial project development studies within 6 months of land acquiring. Results of the studies are briefly described below:

Wind Resource Assessment System:

ICI has installed a state of the art Sodar on the site. Additionally temperature, pressure & humidity are also recorded.

Topographical Survey:

A detailed topographical survey of the site has been carried out. Contour map, 3D digital elevation model and high resolution coloured Quickbird satellite imagery of the area is available.

Preliminary Geo-Technical Survey:

Preliminary Geotechnical investigation of the area has been carried out and detailed report is available.

Transportation Study:

A transportation study from port to site has been carried out by the consultant.

Electrical Grid Study:

The wind farm will be connected to the main electrical network of Pakistan through a local grid. The responsibility to evacuate power from the wind farm is the responsibility of Power Purchaser i.e. Transmission Line from Grid to Wind Farm will be on part of Power Purchaser. ICI has conducted a detailed Electrical Grid Studies like load flow, short circuit and stability analysis through an experienced consultant.

Introduction to Environ Group

Environ Group has a reputation for delivering expert knowledge and support across an extensive range of renewable technologies and infrastructure including;

- Biomass
- Carbon capture, transport & storage
- Cogeneration & trigeneration
- Geothermal & ground energy systems
- Grid connection and infrastructure
- Hydro power
- Solar power
- Wave and tidal energy
- Wind energy

Our dedicated renewables team has a real commitment to delivering the best level of advice and expertise, encompassing the complete lifecycle renewable and low carbon energy spectrum, specialising in the following;

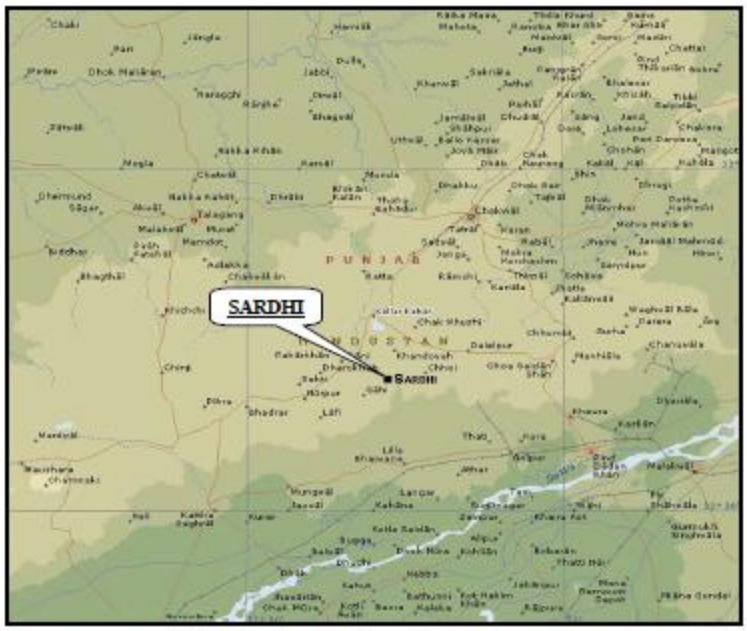
- Renewable energy capacity studies
- Site identification and project feasibility
- Meteorological data analysis and climate modelling
- Due diligence and economic appraisal; identifying and gaining energy grants
- Concept and detailed engineering design studies, plant sizing, specifications
- Project development including planning, permitting and compliance support

In addition, we provide leadership within the environmental consultancy sector and aspire to excellent corporate responsibility with respect to working with our clients as well as the communities and environment within which we work. To that end, we are committed to working sustainably with sustainability being at the top of our corporate agenda. We demonstrate our responsibilities by being an

excellent employer, through our work with our clients, by providing health and safety leadership and through our interactions with the communities and environments within which we work.

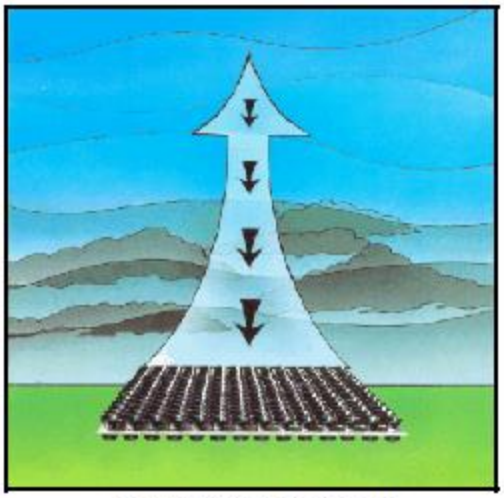
2. Site Description

SODAR (Sonic Detection and Ranging) was installed at village Sardhi, some 15 km towards south from Kallar Kahar (Motorway-2) in District Chakwal. Location parameters of the site are Latitude: 32.70ºN, Longitude: 72.73ºE.



Data Source:

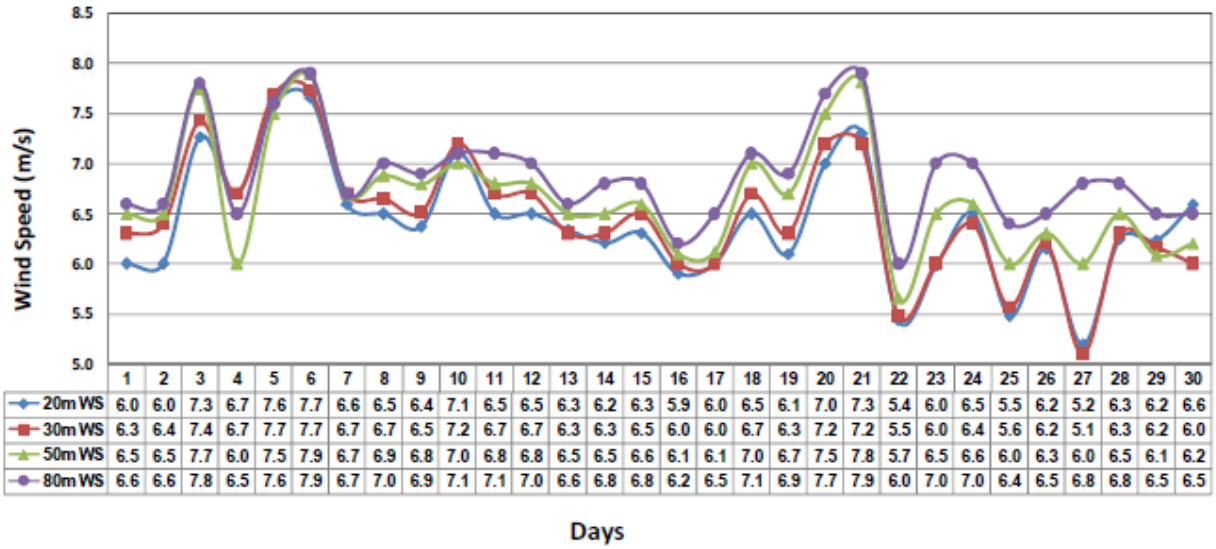
To undertake this study, SODAR (PA0) system is used. This SODAR System records average wind speed from 20 to 200 meters. It consists of two main components; data receiver and antenna. The SODAR processes the echo of an acoustic pulse, which is directed into the atmosphere. The frequency shift of the echo varies according to the wind speed (the Doppler Effect) while the echo intensity varies according to thermal turbulence and structure. SODAR uses a single, multicellular antenna whose beam is steered electronically. The basic antenna is composed of 52 elements. It is capable of measuring wind data up to 200m.



DOPLLER EFFECT OF SODAR

Average Wind Speed:

Figure shows the daily Average wind speeds for the month of September 2013.



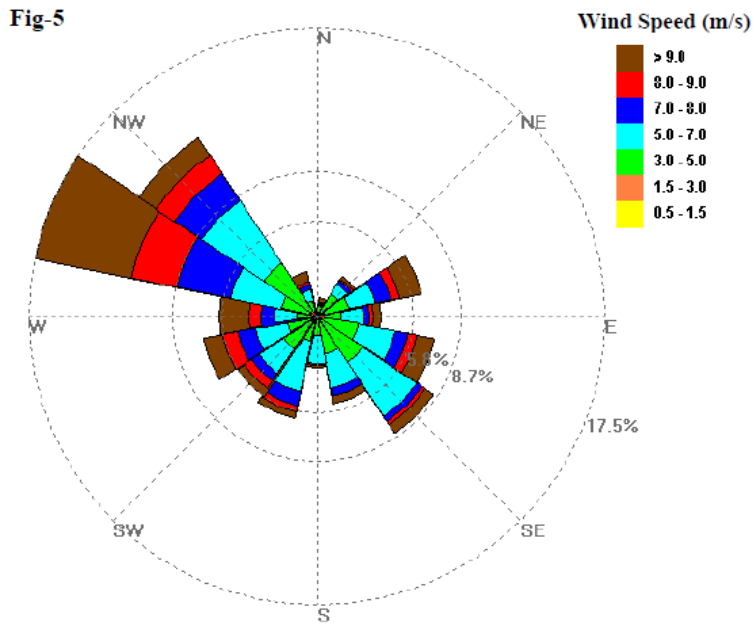
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
20m WS	6.0	6.0	7.3	6.7	7.6	7.7	6.6	6.5	6.4	7.1	6.5	6.5	6.3	6.2	6.3	5.9	6.0	6.5	6.1	7.0	7.3	5.4	6.0	6.5	5.5	6.2	5.2	6.3	6.2	6.6
30m WS	6.3	6.4	7.4	6.7	7.7	7.7	6.7	6.7	6.5	7.2	6.7	6.7	6.3	6.3	6.5	6.0	6.0	6.7	6.3	7.2	7.2	5.5	6.0	6.4	5.6	6.2	5.1	6.3	6.2	6.0
50m WS	6.5	6.5	7.7	6.0	7.5	7.9	6.7	6.9	6.8	7.0	6.8	6.8	6.5	6.5	6.6	6.1	6.1	7.0	6.7	7.5	7.8	5.7	6.5	6.6	6.0	6.3	6.0	6.5	6.1	6.2
80m WS	6.6	6.6	7.8	6.5	7.6	7.9	6.7	7.0	6.9	7.1	7.1	7.0	6.6	6.8	6.8	6.2	6.5	7.1	6.9	7.7	7.9	6.0	7.0	7.0	6.4	6.5	6.8	6.8	6.5	6.5

Average wind speed at Kallar Kahar for one month calculated at the heights of 20 meter, 30 meter, 50 meter and 80 meter is 6.41 m/s, 6.48 m/s, 6.66 m/s and 6.89 m/s respectively.

Wind Rose:

Figure shows the Wind Rose based on the data of June 2009 collected at 50 meters height. Wind Rose depicts that the prevailing wind direction during June is between West and North West and the average wind speed is 6.66 m/s.

Wind Rose at Kallar Kahar (50m height during 01 month)



Wind Power Classes:

To simplify the characterization of the wind power potential, it is common to assign areas to one of seven wind classes, each representing arrange of wind power density at the special height above the ground. The standard International wind power classifications are shown in Table.

Class	Resource Potential	30m Height		50m Height	
		Wind Speed m/s	Wind Power W/m²	Wind Speed m/s	Wind Power W/m²
1	Poor	0 – 5.1	0 – 160	0 – 5.6	0 – 200
2	Marginal	5.1 – 5.9	160 – 240	5.6 – 6.4	200 – 300
3	Moderate/Fair	5.9 – 6.5	240 – 320	6.4 – 7.0	300 – 400
4	Good	6.5 – 7.0	320 – 400	7.0 – 7.5	400 – 500
5	Excellent	7.0 – 7.4	400 – 480	7.5 – 8.0	500 – 600
6	Outstanding	7.4 – 8.2	480 – 640	8.0 – 8.8	600 – 800
7	Superb	8.2 – 11.0	640 – 1600	8.8 – 11.9	800 – 2000

By and large, the areas being developed today using large wind turbine are ranked as class 5 and above. Class 4 areas are also being considered for further development as wind turbines are adopted to run more efficiently a lower wind speeds.

Class 1 and class 2 areas are not being deemed suitable for large machines, although a smaller wind turbine may be economical in areas where the value of the energy produced is higher. The total power

density of Kallar Kahar at 50m height is 293 W/m^2. According to international wind classification, this power density categorizes Kallar Kahar as a marginal site for wind power generation.

3. Major Construction Activities

Contract for construction will be awarded to an Engineering Firm of repute to undertake the installation of turbines. The turbine supplier will have a supervising engineer onsite during the installation phase and the commissioning engineer during the start-up phase. Installation of the sub-station would be done by sub-contractors to the Engineering Firm. All other electrical work will be done by the contractor.

The roads within the project area shall be suitably compacted / strengthened to withstand the

onset of torrential surface flow and land submergence/inundation.

Siting The Wind Turbines

Design standards for siting the wind turbines include spatial configuration, lighting, density of turbines, tower visibility and tower design. Siting the wind turbines will, in taking account that each turbine unit will slow down the wind behind it as it pulls energy out of the wind and converts it to electricity, space the turbines as far apart as possible in the prevailing wind direction. As a rule of thumb, turbines in wind parks are spaced somewhere between 5 and 9 RD apart in the prevailing wind direction, and between 3 and 5 RD apart in the direction perpendicular to the prevailing winds. For the proposed Wind Farm, as an example comprising 1.5 MW each 33 WTG with ~70 m RD would be spaced 5 RD or 350 m apart in the prevailing wind direction, and 3 RD or 210 m apart in the direction perpendicular to the prevailing winds.

Electrical Collection System

Power from the wind turbines being negotiated by Wind Farm will generate about 600 volts in each phase. The power will run through a step-up transformer, which steps up the voltage to 11 kilovolts (kV). The power will then be fed into underground cables that will provide electrical connection among groups of wind turbines. The underground collection cables will feed the larger feeder lines that will run to the project substation. In locations where two or more sets of underground lines converge, pad-mounted junction panels will be utilized to tie the lines together into one or more sets of larger feeder conductors. At the Project substation, the electrical power from the entire wind power plant will be converted to 132 kV and will be delivered to the interconnection substation, for being stepped up to appropriate voltage level.

Substations

The main function of the substations is to step-up the voltage so that electricity can be reliably interconnected to the designated power grid. The basic elements of the substations are a control house, two main transformers, outdoor breakers, relaying equipment, high-voltage bus work steel support structures, and overhead lightning suppression conductors. These elements will be installed on concrete foundations. Each substation will consist of a graveled footprint area of approximately two to four acres, a chain link perimeter fence, and an outdoor lighting system.

Direct strike lightning protections will be provided by the use of overhead shield wires and lightning masts connected to the switchyard ground grid. Overhead shield wires will be high strength steel wires arranged to provide shield zones of protection.

Operations & Maintenance Center

Facility to house the operations and maintenance (O&M) section will be constructed as an integral part of the Project

Civil Construction

Civil works will include construction of the Sub-station and campsite preparation. The following steps will be taken in site preparation:

- Clearing of vegetation from identified areas
- Filling and compaction
- Construction of auxiliary facilities such as site camp, equipment and supplies storage areas, water tank and water pits, fuel storage areas and waste pits.
- Construction of turbine foundations and crane pad

The turbine foundation shall, where necessary, be built on pile foundations, with appropriate number of piles per location, built on detailed design, using standard piling practices. The construction at site will take into account that rotor assembly (blades and hub) weighing ~22 tons; the nacelle containing the generator component and weighing 52 tons, may need a concrete base for the tower whose construction may require 26 tons of reinforcing steel and contain 190 cubic meters of concrete. The base may be 15 m in diameter and 2.4 m thick near the center.

Campsite facilities will include supply of safe drinking water; drainage, sewerage, and septic tanks. Standard Operation Procedures will be followed to provide safe working environment compatible with human hygienic requirements and to maintain conditions necessary for storage of medicines, materials and equipment:

- The construction campsite will cover an area of about 10,000 m2 and will accommodate 4 construction trailers and 4 equipment storage trailers. There will also be vehicle parking and equipment staging areas.
- The water storage tank will be lined with an impervious liner to prevent seepage and loss of water.
- Sewage septic tanks will be lined. These will be periodically emptied into tankers for transporting the sewage to the nearest treatment facility. Gray water (from kitchen and washing areas) pits will not be lined, and water will be allowed to soak into the ground.
- The wastewater from campsite will be discharged as per standard practice into separate sewerage lines and from there to septic tanks and soak pit system. The quality of effluent discharged into soak pit system will be monitored for its BOD, and COD level.
- Camps for the construction crew will be established at a suitable site identified by Project Manager. The camps would accommodate around 400 to 500 personnel. The camp will be complete with living accommodation, mess and kitchen, prayer room, bathrooms and toilets, recreational facilities, fuel storage, water storage, etc. The camp will have its own power generation arrangements in the form of diesel generators.
- At all locations involving construction activity, appropriate water and sewage treatment systems will be provided and no liquid or solid effluent or waste will be allowed to leave the site without treatment to bring the effluents within the acceptable limits. The parking area and workshop at the campsite will have a slop tank system to minimize the spread of oily drips.
- Under normal operations there will be no gaseous emissions from the campsite, or operating areas. A small capacity, 2 MVA diesel generators, shall be installed for emergency power supply for the essential loads. Only when there is need for the diesel emergency generators would there be gaseous emissions from the sites, but such emissions would be well within limits as described in a subsequent section.
- Storm water runoff from the campsite will be suitably diverted through a storm water drainage system into an existing surface flow system.
- Storm water runoff from the wind farm will be harvested and ponded at a designated site for irrigating the surrounding open area.
- Onsite storage of fuel will be limited to daily requirements.
- The onsite delivery of fuel or lubricant will be at designated site that will have an impervious base, with a dyke around to contain spills in case an accidental spill occurs.
- The excavated earth, obtained during the piling procedure, will be used to construct the embankment for the road. The remaining material required for the road embankments will be

from the site. The top layer of the road, morum type material or gravel and clay, will be procured from the site.

- Installation of wind turbines, their accessories and equipment will start after completion of the above activities. Since all components will be prefabricated there would be need for assembly only. However, some fabrication will also take place at site.

Civil construction at site will involve the following components:

1. Turbine base that will be built on pile foundations, with about 14 piles per location, using reverse rotary drilling method for pile boring, and bentonite clay mixed with water during boring;

2. Sub-station and campsite preparation,

3. 11 km approach road, 15 km internal roads; culverts and the bridge, will involve the following three phases:

a) Designing and Pre-Construction,

b) Construction and

c) Post Construction including Operation.

The pre-construction phase has three components:

- Identification of land area and site;
- Topographic survey, and
- Design.

Construction activity as a major component of Wind Farm Project is currently at the Pre-Feasibility Stage. It will be followed by the pre-construction stage when:

The road and bridge construction design will be prepared

 No trees will be felled, except removal of dead wood of shrubs as part of land clearance

 Suitability of the site with respect to stability and seismicity has been determined through soil surveys by geo-technical investigations. The allowable bearing capacity of the soil will be adopted as 1.70 tsf, but this value will be verified before the start of construction.

- Topographic survey for the following will be undertaken and in the meantime area will provide the detailed design for:

- Construction of site roads, turn-around areas and crane pads at each wind turbine location;
- Construction of the turbine tower foundations and transformer pads;
- Installation of the electrical collection system – underground and some overhead lines;
- Assembly and erection of the wind turbines;
- Construction and installation of the substation.

The post-construction phase at the site will start after completion of the construction phase and will include:

- Provision of safe drinking water, and solid waste disposal system at campsites for the operation area
- Commissioning of the link roads and flyover (subject to final design) into the road network.
- Installation phase will start with the arrival and movement of machinery and equipment to site, and will involve the following activities:

Staff Requirement during Construction Phase

It is estimated that direct manpower required during the construction phase will be about 200, which might increase to 600 during the construction period. About 100 support staff will be present in addition to the above. Expatriate workers are not expected to be on site. Unskilled jobs will be offered mainly to the local people particularly during the construction phase.

Supplies during Construction Phase

All supplies, both for construction and for the camp, will be transported by trucks from Motorway. This will include all fuels and oils, drilling requirements, spare parts for construction machinery and food and supplies for construction camp. Fuels and oils will be unloaded in designated areas.

Electricity

The expected maximum requirement of electricity for construction and the campsite is estimated at 1500 KVA. Diesel generators will be used for power generation to operate the construction equipment and for the campsite.

Emissions and Discharges during Construction Phase

The daily estimated fuel requirement will be about 5,500 to 7,500 liters. This quantity of fuel will be responsible for daily emission of approximately 260 kg CO, 14 kg SO_2, 65 kg NOx, and 14 kg Particulate matter, besides 16 tons CO_2. These emissions will be dispersed into the airshed of area, which is thus far in the category of unpolluted sites. The small quantity of emissions will not raise their level by sub-microgram units and would not degrade the environment.

Emissions from the generators will be controlled by ensuring that the engines are always properly tuned and maintained, and the generators are so located that emissions are dispersed away from the camp and work areas.

Noise emission from the vehicles and equipments will exceed 85dB(A) but the same would be reduced to less than 85dB(A) at 7.5 m from the source. Workers will be provided PPE including ear plugs and other safety equipment as safeguard against occupational hazards.

The liquid effluents generated during the construction phase will include domestic sewage and grey water from camp operation.

The sewage will be treated in septic tanks and soaking pits.

The grey water from kitchens and washing areas will be directed to separate soaking pits.

The storm water will be collected in ponds and either disposed of after appropriate treatment, or diverted to fields for vegetation/rejuvenation of local flora.

The operation phase may generate a small quantity of oil/oily water during the maintenance of pumping stations. This will be treated in oil/water separators.

Waste Management

The solid waste generated by the project will consist of campsite waste, garage waste, metal scrap, and excess construction materials.

All efforts will be made to minimize waste generated during the construction period. The main types of waste that will be generated are:

- Fuels and oils
- Garage waste
- Sewage
- Campsite waste

The piling operation is not likely to generate any waste as only water based bentonite clay may be used during piling. As bulk concreting will be done using concrete, pump wastage of concrete will be minimal.

Fuels and oils will, if stored at site, despite security reasons, be stored in containers in areas with impervious floors and surrounded by dyke walls.

Recyclable materials will be periodically transported out of the site and sold / given to contractors. Non-recyclable material will be collected and disposed of by the contractor at designated landfill sites.

Most garage waste, such as used spare parts, is recycled in Pakistan. All such waste will be collected and sold / given to contractors for disposal off-site.

As part of the site preparation stage, a drainage and sewerage system will be constructed for the camp. The sewerage system will consist of soak pits for the collection of waste water from the camp kitchen and washing / ablution areas. Sewage from the toilets will go into lined septic tanks. Sewage and solid waste disposal trucks will be used to periodically remove the sludge, sewage and solid waste from the site.

All combustible domestic waste will be collected and burned in a garbage pit, suitably fenced to prevent from being blown away. Non-combustible and non-biodegradable waste, such as glass, metal and plastic, will be separated and transported for being sold or given to a contractor for suitable disposal.

Conservation of Water

The Wind Farm facility as well as campsite will keep the scarcity of water in the region in view, and adopt recommended methods to reduce the usage of water, and use recycled water as much as possible.

Health, Safety & Environment

Several cases have been reported to occur where the nacelle that houses the wind turbine caught fire. As it is normally out of the range of standard fire extinction equipment, it is nearly impossible to extinguish such fires. In several cases one or more blades were damaged or torn away. In 2010, a 70 MPH storm winds damaged some blades, prompting blade removal and inspection of all 25 wind turbines in Campo Indian Reservation in California, USA. Also several wind turbines collapsed catastrophically. Accordingly all the policy, procedures, and SOPs specific to HSE will be applicable to the contractors to be engaged for construction work. The contractors will be mandated to follow:

- HSE Policy of Wind Farm and the HSE Guidelines of the company
- Emergency rescue plan pertaining to safety and accidents including fall, will be established before start of construction activity according to the safety and protection rules of Pakistan.
- Trained persons will be appointed on the posts relating to implementation of emergency and rescue plan.
- Trained technicians and safety equipments will be installed for technical measures during construction and production.

Fire-Protection System

Appropriate fire detection and fire fighting system and equipment shall be designed and provided throughout the wind farm.

Fire Safety and Security

According to the regulations of the authorities in charge of public security and fire fighting and the rescue procedure of emergency treatment, the facilities of an independent rescue brigade at Area will be availed. A dedicated ambulance shall be stationed at site for emergency needs.

Employment

This project will bring in employment opportunities for the local inhabitants. Approximately 600 people will be working during the construction phase while approximately 40 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties.

Operational Activities

In-house as well as outsourced O&M activities will be carried out by trained staff for maintaining the availability of wind power and high performance.

Supplies

This will include all fuels and oils, spare parts required for maintenance and food and supplies for the site staff. Fuels and oils will be unloaded in designated areas, which will have above ground storage of adequate capacity to store fuel.

Water

850 liters per day of potable water will be required. This will be obtained from ICI Filter Plant and stored in a tank of 12,000 liter capacity. The storage tank will be fitted with treatment units to obtain decontaminated water. This treated water will be shared with the local population in the surrounding.

Waste Management

Fuels and oils will be stored in containers in areas with impervious floors and surrounded by dyke walls.

Recyclable materials, including garage waste, will periodically be transported out of the site and sold/given to contractors. Non-recyclable material will be collected and disposed of at designated landfill sites.

The drainage and sewerage system constructed during the construction phase will be used during the operations phase of the project i.e. soak pits for the collection of waste water from kitchen and washing / ablution areas and septic tanks for sewage from the toilets.

Sewage and solid waste disposal trucks will be used to remove the sludge, sewage and solid waste from the site.

Storm water drainage will be managed by controlled flow into the fields.

Noise

The desired noise level of 55 dB(A) would be achievable 1000 m from a turbine at 80 m hub height generating 100 – 105 dB(A).

Operation & Maintenance

O&M presents different challenges for utilities, including decisions on conducting activities with existing utility staff or outsourcing these activities or a blend of the two scenarios.

Operating costs are dependent upon many factors, but data indicate that operating costs for modern (<5-year old) wind projects run between $7 and $15/MWh of electricity produced. Wind turbines can provide large amounts of electricity, cleanly and reliably, at prices competitive with any other new electricity source, provided they are properly operated and maintained.

Decommissioning Activities

The wind farm site, after having remained in operation for the lifecycle, estimated at 25 years will not lose its value as a wind power generation system. Its performance would on the other hand enhance the value of the site as a wind farm. This would demand up-gradation rather than scrapping the plant and equipment or abandoning the site. What is anticipated is scrapping the existing steel structure and replacing it with a better system that may have developed in the mean time. Scrapping the site is therefore not envisaged. The towers and turbines may need replacement while the old ones will be sold as scrap to be appropriately disposed of. However, if the site is to be abandoned much before the designed plant life of 25 years, decommissioning will be initiated by dismantling of the turbines, supporting towers O&M building / sub-station, and transporting them out of the project area. It is expected that this activity will take approximately 6 months and will require about 300 heavy haul trucks (60-feet size) for the turbine components in addition to 600 truckloads of other materials. The turbine components will be sold as scrap. All scrap will, as per practice in Pakistan, be recycled to be refurbished.

The concrete will be broken up and removed to a landfill site. The stored fuel and oil, together with the containers, will be transported out of the site for sale / disposal at suitable landfill sites. The site road embankments, if any, will be leveled and the material spread evenly over the whole site. Chances are that the embankments may have become regularized and may have come into regular use. The site will, otherwise be restored as far as possible to its original condition. The access roads may be left intact, since local communities may have started to use them. If not, they too will be dismantled and the land returned to its original condition.

4. Impacts of Wind Power Plant on Physical Environment

Waste Disposal

The wind power plant does not generate any waste whether it is gaseous, liquid or solid hazardous chemicals during its construction & operation. The issue of disposing off the normal spent lubricants in very limited quantities is not of any significant concern. There are standard practices to dispose of these lubricants and we will follow the same. The packing material is largely re-usable. Modern technologies ensures majority of the packing material are from recycled sources.

Water Use and Quality

Wind power consumes no fuel and no water for continuing operation. The project requirement of water for drinking and domestic purposes and for foundation construction will not have any impact on groundwater resources. The roads within the wind farm will be developed such that the natural drainage pattern will not be impeded. It is in the betterment of the project that the natural drainage of the site will remain un-changed so that during rains, there should be good slope available for effective surface rain water flow.

Air Quality

Wind projects produce energy without generating many of the pollutants associated with fuel combustion. Wind power has no emissions directly related to electricity production. Wind turbines produce no carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen dioxide, mercury, radioactive waste, particulates, or any other type of air pollution, unlike fossil fuel sources and nuclear power plant fuel production. The Project involves power generation using wind energy—a completely clean source of energy i.e. no fuel burning. It is the beauty of wind power generation that till now more than 92,000 MW installed power generation is working not even with a puff of fuel burning.

Air pollution during construction due to truck / vehicle movement to the project site, earthwork, development of access roads, etc. will be controlled as much as possible and it is normal with every kind

of project. We have a very good knowledge and expertise to reduce this kind of temporary pollution to a minimum.

The nearest human habitat is about 3 - 4 km away from the project site. Thus the impact of the proposed construction activity on air pollution will be minor and temporary.

During operation, the wind farm will work as a pollution free power plant and contribute to power generation without emitting a single gram of GHG gases.

It may be seen that the average level of each parameter in ambient air is on lower side in comparison with National Environmental Quality Standards (NEQS).

- SO_2 level ranges between 7.0 ppb and 13.6 ppb which are much lower than 38 ppb recommended for the 24-hourly average by the NEQS.
- NOx level ranges between 8.2 ppb and 16.3 ppb which are much lower than 38 ppb recommended for the 24-hourly average by the NEQS.
- CO level ranges between 0.2 ppm and 1.9 ppm which is well within the NEQS standards.
- M10 concentration was between 114.0 $\mu g/m^3$ and 163 $\mu g/m^3$ with the average at 140.6 $\mu g/m^3$ which is below the level suggested by NEQS.
- Copy of NEQS for Air Quality has been included in this report as Annex.

Safety during operation

Operation of any utility-scale energy conversion system presents safety hazards. So if a turbine's brake fails, the turbine can spin freely until it disintegrates or catches fire. This is rare and the odds of a major turbine fire or disintegration is in the order of 0.001% over the 20-25 year lifespan of a modern wind turbine. Some turbine nacelle fires cannot be extinguished because of their height, and are sometimes left to burn themselves out. In such cases they generate toxic fumes and can cause secondary fires below. However, our wind turbines are built with automatic fire extinguishing systems similar to those provided for jet aircraft engines. These autonomous systems, which can be retrofitted to older wind turbines, automatically detect a fire, order the shutdown of the turbine unit and immediately extinguish the fires completely.

During winter ice may form on turbine blades and subsequently be thrown off during operation. This is a potential safety hazard, and has led to localized shut-downs of turbines. Our turbines can detect ice formation and excess vibration during operations, and are shut down automatically. Electronic controllers and safety sub-systems monitor many different aspects of the turbine, generator, tower, and environment to determine if the turbine is operating in a safe manner within prescribed limits. These systems can

temporarily shut down the turbine due to high wind, ice, electrical load imbalance, vibration, and other problems. Recurring or significant problems cause a system lockout and notify an engineer for inspection and repair. In addition, most systems include multiple passive safety systems that stop operation even if the electronic controller fails

Proximity to Roads and Railways

In general, turbines may distract motorists while they are under construction or when they are new. Over time, the turbines become part of the landscape and generally do not cause any significant distraction to motorists. Our project's wind turbines erected in accordance with standard engineering practice are stable structures, best practice indicates that it is advisable to achieve a safety set back from roads and railways of a distance equal to the height of the turbine and length of the blade.

Proximity to Power Lines

Adequate clearance between structures and overhead power lines will be provided as required by the competent electricity company and in line with the regulations. For example, in Ireland, there is a statutory obligation to notify the electricity distributor of proposed developments within 23 meters of any transmission or distribution line.

5. Impact on Infrastructure

Impact over industrial sector

No industrial sector is present in the village sardhi. 2 industries are present in Kalar kahar but these are out of the impact range of the wind power project. So this project seems to have no negative impact on industrial sector. Positive impact of wind power project is foreseen. As we know in Pakistan load shedding is a major issue both for industrial and domestic sector. Because we this project will become functional so the demand of electricity will also reduce so there are probability that industrial sector has less load shedding of electricity. So more power means more progress, productivity and prosperity by industrial sector.

Impact over telecommunication sector

Wind turbines, like all electrical equipment, produce electromagnetic radiation, which can interfere with broadcast communications. Some studies have proven that Electro Magnetic Interference (EMI) is caused by wind projects, these again are usually overstated. Residences or other nearby facilities likely to have a chance that their radio, television or other signals are impacted by potential. There are some concerns regarding EMI. So EMI can be overcome through the installation of deflector or repeaters. Competent authorities shall request the developer to procure the requirements from local and national broadcasters. The same apply to the mobile phone operators. Wind turbines must not create electromagnetic interference with the operation of telecommunication networks and must harmonize with the measures for the elimination of electromagnetic interference in the operation of telecommunication networks and signal reception, pursuant to the law on communication.

Noise Impact

There are two distinct noise sources associated with the operation of wind turbines:

Aerodynamic Noise

It is caused by blades passing through the air. Aerodynamic noise is a function of many interacting factors including blade design, rotational speed, wind speed and incoming air turbulence which can generate a specific sound.

Mechanical noise

It is created by the operation of mechanical elements in the nacelle- the generator, gearbox and other parts of the drivetrain. Mechanical noise from a turbine is tonal in nature.

The purpose of the noise assessment is to investigate the potential noise impact of the wind turbine operation on sensitive areas in the vicinity of the wind farm. The advisable distances between residences and the proposed wind turbine sites depend on a variety of factors including local topography, possible background noise and the size of wind farm itself. Official demands with regard to noise limit values for the operation of a wind farm in Pakistan are not too much specified.

Advances in technology and design resulted in reduced noise emissions. Aerodynamic refinements that have been combined to make turbines quieter include the replacement of lattice with tubular towers, the use of variable speed operations and the switch to three blade turbine designs. Improvements in gearbox design and the use of anti-vibration

The results of the calculations show no conflict in terms of noise emissions. The boundary levels for the noise emission points are not exceeded.

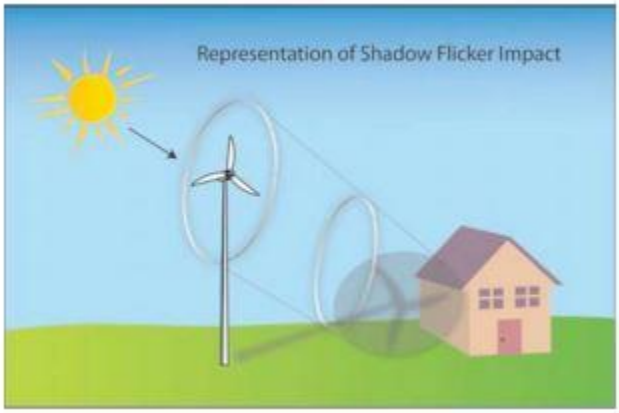
Visual Impact

Today's wind turbines are much larger and much more powerful than just a few years ago. The reason for today's size is that bigger is often better, it turns out that the amount of energy a wind turbine can extract from the wind is proportional to the size of the swept area the blades cover. As the radius of the blades increases one meter the swept area increases even more dramatically. The turbines anticipated to be installed on this project may be as tall as 100m to the nacelle and each blade may be as long as 50m-60m, so total tip height of the turbine may be as tall as 160m. Intelligently siting turbines this big away from people is important, that is why in almost all cases the turbines are at least as far away from places where people typically are such as homes and

businesses (these locations are sometimes called receptors) as the turbines are tall. In many cases the turbines are multiple times their height away from potential receptors.

Shadow Flicker

As the today's turbines have grown so have their shadows. Where these shadows fall is also a key element developers consider when placing turbines. The longest shadows from wind turbines occur in the early morning and late afternoon/early evening. At these times shadows may fall as far as 450m from the base of the turbine. The effect of shadows cast by the large blades turning is sometimes called "shadow flicker." This shadow could move across a house (window) for a short period of time. If this happens frequently for longer periods, it causes stress to the inhabitants. We have selected the project site because of the limited number of hours a year that the turbines are likely to cast any shadow on houses or other permanent receptors.



Shadow flicker occurs when the sun is low in the sky and a wind turbine creates a shadow on a building. As the turbine blades pass in front of the sun, a shadow moves across the landscape, appearing to flick on and off as the turbine rotates. The location of the turbine shadow varies by time of day and season and usually only falls on a single building for a few minutes of a day. Shadows that fall on a home may be disruptive. Shadow flicker has been a concern in Northern Europe where the high latitude and low sun angle exacerbate the effect. However, flicker has rarely been cited as a problem in Asia.

The exact position and time period of a shadow can be calculated very accurately for each location, taking into account the structure of topography as well as angle above the horizon and movement during the day of the sun. Official boundary levels do not exist for the shadow flicker

effect. A commonly accepted value is the maximum of 30 hours shadow caused by the wind turbines per year, and 30 minutes shadow per day.

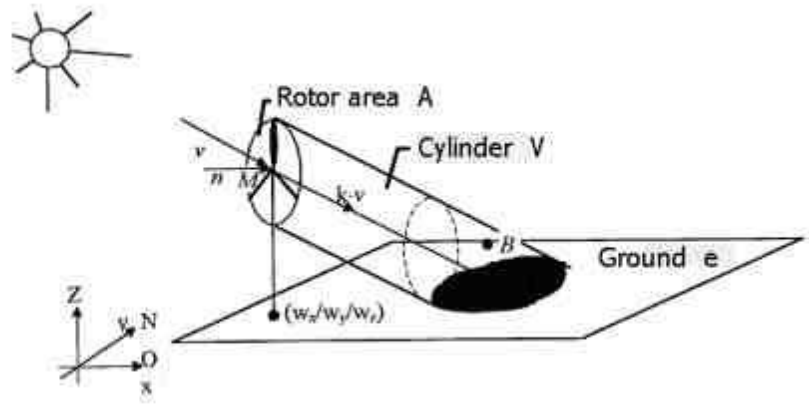


Fig. Shadow calculation model

We used WindPro for the calculation of the shadow impact. No exceedances of the limits have been found considering different layouts of turbine models.

6. Social Impact

Land Ownership and Resettlement Actions

Since the land which is considered for the proposed wind farm is uninhabited owned by Government of punjab, no resettlement of inhabitants is required. Government of Punjab has allocated the land on lease basis for the development of Wind Energy Projects in that particular area and has already reviewed the land situation thoroughly from multidimensional aspects. The necessary area for the proposed wind farm site is approximately 1,283 acres in total. However, the net used area for foundations, roads, crane places, etc. will be around 2-3%, which is much less then the gross area.

LI has been informed by AEDB that the whole land which is foreseen for the wind farm is owned by the Government of Punjab which is already leased to AEDB through a “Master Land Lease Agreement”. Thus a compensation of land owners is not required. The foreseen land will be sub-leased to FFC by AEDB for up to 30 years. The land lease / sub-lease agreements are in progress.

Socioeconomic Environment

Archaeological Sites

There are formally few registered sites of historic or historic archaeological significance at kallar kahar Site. During geo-technical investigations no other archaeological findings were observed. The nearest ones, which are far away from project site, so these few sites, have no much impacts.

Resettlement

No resettlement is required as the Project is located on Government-owned barren land. Settlements and individual dwellings in the local area are located at least 3 - 4 km away, thus the development will not require any rehabilitation or resettlement. Moreover, the project will not cause any negative effect on the population as there will be no emissions; there is no need of re-settlement at all.

Aviation Hazard

No aviation hazard will be created by the Project as it is installed at village Sardhi, some 15km towards south from KallarKahar (Motorway-2) in District Chakwal. Moreover, the hub height of the wind turbine will be only around 80m, not posing any hazard to the aircrafts. AEDB (Alternative Energy Development Board) has issued the NOC for installation of Wind Mast up to a height of 90m at the proposed site. Another NOC will be issued by AEDB prior to installation erection of turbine towers & rotors.

To minimise the visual impact on the environment, obstacle lights may be partially shielded, pro vided it does not compromise their operational effectiveness. Where obstacle lighting isprovide d, lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind f arm should be turned on simultaneously and off simultaneously. The towers will be provided with air traffic warning lights to make the structure more visible / detectable at night also.


During the day, large wind turbines are sufficiently conspicuous due to their shape and size, pro vided the colour of the turbine is of a contrasting colour to the background. Rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study. Other colours are also acceptable, unless the colo urof the turbine is likely to blend in with the background. This project is also safe for birds and stop during there flight season (especially for migratory birds) for a seconds when they pas they will start again.

Traffic Management

The aim of this project also is to identify and manage traffic impacts and road safety concerns that may occur during the construction of the Kalar kahar Wind Farm project.

Specific objectives are to:

- Provide a safe environment for all road users.
- Provide protection to workers, visitors, agents of the principal and general public:
  - From traffic hazards
  - From the potential congestion and disruption of construction
  - By ensuring works meet the requirements of relevant road authorities

The site is located away from the regular traffic routes. At a maximum, there can be a minor temporary impact on traffic due to trucks carrying construction material and WTG components and that too on motorway where trucking is a normal routine. However, transportation will be planned, coordinated and managed effectively to avoid any inconvenience.


Labour Welfare and Safety

Due to largely mechanised construction, few labours will be deployed during construction. Facilities will be provided with proper water supply / sanitation to avoid any public health hazard. The industrial safety rules will be practised during construction of the project like proper handling of electrical devices, tools, equipment, construction materials and use of safety gear to prevent accidents to pers onnel.Some of the on site safety rules which should be follow are as:

Safety Rules

- Hard hats and safety glasses required at all times
- Stretch and Bend required daily with full PPE
- 100% fall protection required above 6 feet
- Ropes on site for high work
- On-site speed limit is 15 MPH
- County Road / State Road speed limits must be obeyed
- Construction vehicles must yield to traffic on public roads
- GFCI on all temporary power
- All power cords and ladders will be inspected quarterly and marked for identification
- **Safety permits:** Hot Work, Confined Space, Critical Lift, Scaffold, Dig, Blast
- Fire extinguishers required for all work trucks
- Daily inspection on rigging
- No work inside towers alone
- No riding in back of pickup trucks
- Injuries / Incidents reported IMMEDIATELY
- Near Miss and Hazard Recognition reported daily
- Hazard Communication Program available to you at all times
- Project site Safety Committee participation
- Post accident investigations
- Daily safety audits
- Operator certifications: Forklifts, Aerial Lifts

- Trained CPR/First aid individuals on site



7. Screening of potential environmental impacts & proposed mitigation measures

This presents the screening of potential environmental and social impacts of different activities of Wind Farm Project during its different stages of designing, construction and operation. Using the general guidelines as well as professional judgment it evaluates the positive and negative impact of emissions and waste discharges on the aesthetics, airshed, watershed, fauna, flora and the living environment at the site. The screening process, besides identifying significant environmental impacts and the existence of residual impact suggests mitigation measures that may have to be adopted in order to reduce minimize or compensate for the impact.

Screening of Alternatives

The Wind Farm Project aims at harnessing wind energy the renewable energy source potential in the Kalar kahar Corridoras an alternative to the conventional system that depends on fossil fuel, and thus meet the shortfall in the current energy production system. The alternatives available are:

- No Action, continuation with the existing condition.

- No renewable energy alternative; No New system alternative that involves renewable energy but continuation with the use of fossil fuel.
- Harnessing Wind Energy Potential of the region

Selection of Preferred Alternative Site

Selection of the preferred alternative system and site for establishment of wind farm needs to be based on:

- Current status of energy production system,
- Strategic needs of energy production, conservation and environmental protection,
- Urgent need to provide better level of service in power production to meet the current and future demand.

Alternative # 1: No Action Alternative

The "No Action Alternative" does not offer the advantages sought by the Alternative Energy Development Project. It does not respond to:

- The urgent and strategic needs of enhanced power production to meet the demand of industry, agriculture as well as commercial and domestic consumers of the country; nor does it propose better level of service for improvement of quality of life.
- The need to increase the current power production capacity despite the shortfall in energy availability resulting in load shedding of 6 to 8 hours every day.
- The requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting its resources.
- In view of the above shortcomings the "No Action Alternative" cannot be considered.

Mitigation Measures: No mitigation measures are needed with respect to existing land use and land tenure since:

- Likewise there are no issues on loss of land, or loss of business. No involuntary resettlement is consequently required and no business can be considered lost on the acquired land.
- The wind turbines would be suitably landscaped so as to make them visually attractive and
- also matt-finished to make the rotors less glossy.

Alternative # 2: No New Renewable Energy Alternative

Alternative#2 also does not respond to:

- The need to increase the current power production capacity despite the shortfall in energy availability resulting in load shedding of 6 to 8 hours every day.
- The requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting the resources.

Alternative # 3: Harnessing Wind Energy Potential of Kalar Kahar Corridor

It offers the following advantages over the others:

- The screening process finds the site of the Project in the Wind Corridor suitable for power generation.
- It is the only alternative site for establishment of the ICI Wind Farm Project.
- It suits to the requirement of accessibility to infrastructure facilities for the establishment of Wind Farm and for providing energy to WAPDA when it goes into operation.

Alternative 3 has, in view of the above findings, been found to be the preferred alternative.

Screening of Potential Environmental Impacts at different stages of project development

Exploitation of wind energy potential at site will require the following environmental constraints to be addressed:

- Land Use.
- Visual Effects.
- Noise Effect.
- EMI Assessment.
- Flicker Effects.
- Cultural Heritage and Archaeological Issues.
- Flora.
- Fauna (Wildlife, Birds).
- Wind Farm Development Advantages (positive effects).
- Recreational and Tourism Issues.
- Impact during Construction phase.
- Impact during Operational phase.

Land Use

The 600- hectare land comprising the microenvironment is arid stony wasteland with rock, sand and gravel removal besides tree/dead wood/shrubs removal activities leading to impoverishment of resources and further degradation. There is one residential Colony and one hamlet (small village) with 70 to 80 and 10 to 15 households respectively. The site is not located under the flyway of commercial aircrafts. The wind turbines would be at the hub height of 80 m (to be confirmed at design stage), which would necessitate adequate provision of warning lights and signals necessary for elevated structures. This would require obtaining clearance from the Civil Aviation Authority and Telecommunication Authority, which has since been obtained.

Seismic Hazard

The seismic hazard, in view of the historical data as well as proximity to fault has been estimated as "moderate to major". This suggests the "possibility" of earthquakes of intensity V to VII on (MM) scale and "probability" of those above VII. The Wind Farm site should be placed between Zone 2 and Zone 3 i.e. Zone 2A.

Such Seismic Zoning would correspond to Magnitude between 5.0 and 6.5 on Richter Scale and Intensity between VII and IX on Modified Mercallis Scale. This suggests that Ground Force in terms of Assumed Approximate Acceleration equivalent of 0.3 g should be adopted for the site.

A seismic risk factor of 0.3 g is recommended for the design for constructions and installations at the site in view of the installations involving large towers with hub heights reaching 80 meters, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM scale VII to IX).

Moreover in view of the Rock Quality Designation (RQD) values being lower than 30% and showing poor Rock Quality and low load bearing capacity, the risk of liquefaction during major (> 7 on Richter Scale) earthquakes will have to be taken into account.

Mitigation Measures

- Seismic risk factor of 0.3 g should be incorporated in the design factor for the construction of Wind Towers and Turbines.
- Bored reinforced concrete piles shall be provided to minimize the risk of liquefaction threat during major (> 7 on Richter scale) earthquake.

Visual Effects

Visual impact depends on the visual contrast between turbine structures and visual character against the skyline and landscape, both of which result from color, form and scale. Visual effects are so far a non-issue

in the construction of large structures. They have so far not appeared as a major constraint to development of high-rise apartments, towers, minarets and chimneys. There are also no regulations for visual effects while siting wind turbines.

Noise Impact

Noise created by the wind turbines would range between 90 and 105 dB(A) at a height of about 70 m. This level would attenuate at the ground level to perceptible range of 55 to 65 dB(A), which is almost the same as noted when the surface wind is blowing. With the rotation of blades by class 3-4 winds at 12 to 15 rotations, the noise emission would be at the lower level of 55 to 60 dB(A). At a distance of over 1.5 km, where the three villages are located, the noise emission would be just perceptible. The average background noise level recorded at site during the reconnaissance survey was 38.0 to 46.5 dB(A), while it ranged between 41 and 54 dB(A) during 24-hour monitoring at the site. The noise level as a result of exposure to wind was 65.0 to 76.0 dB (A).

Performance of WTGs at a recently installed wind farm in the Corridor has been observed by the residents. The blades were found rotating at 12 to 15 rounds per minute and were not causing sound disturbance or roaring effect. The residents were of the opinion that the wind was at times noisier than the WTGs all put together.

Mitigation Measures: In case the wind turbines are noisier than just stated, the impact will be largely on the operators working at the wind farm or the security personnel resident in the accommodation provided to them. It will be mandatory for the workers and officials to wear ear mufflers or earplugs while in the operations area and for the management to adopt mitigation measures during construction to minimize the environmental impact of the wind farm. Regulations/standards relevant to wind farm have not been framed. National Environmental Quality Standards have only been stated for transport vehicles which suggests that the level should not exceed 85 dB(A) when measured at a distance of 7.5 m from the edge of the road.

The standards will be applied if the level exceeds the limits for Industrial and commercial sites set at 70 dB(A) at the boundary of the wind farm. Simulation studies indicate that this level would be achieved at the ground level of the wind farm. These studies also show that the noise level would be reduced at the Filter Plant and its residential area at a distance of over 2.5 km to acceptable levels of 55 dB(A) during the day and 45 dB(A) during the night, as required by the World Bank Guidelines.

The detailed design shall nevertheless take the noise aspect into consideration and site the WTG nearest to the Colony at a distance exceeding 1.5 km.

EMI Impact

Electro-magnetic Interference (EMI) caused by the development of wind farm is not expected to be significant. Electro-magnetic Interference produced from either WTG placement in the direct line of sight of point-to-point communications, or too close to omni- (all) directional communications or radar equipment, is the main point of interest for communications and radar operators.

Mitigation Measures: Contact with the Pakistan Telecommunication Authority will be made to establish licensed communications operators in the area. Although no major impact is anticipated, communications operators may need to be contacted, during the initial stages of development. In some cases before and after surveys of signal strength and interference may be required. Typically the following types of owners/operators are contacted.

- Television (Some interference to Television signals close to and within the wind farm is possible, however this would probably be possible by rectification with relatively inexpensive aerials or repeaters.)
- Radar Systems (Considered an issue on Super Highway for security reasons).
- Public Communications Systems (Pakistan Telecommunication Authority)
- Private Communications Systems: Mobile phone coverage is present in the Project site.

Flicker Shadow Effect

Turbines that are east or west of houses can impose fluctuating shadow effects at morning or evening hours when the sun is behind the rotor blades and the alternating shadow flicker is cause for annoyance to residents within one km.

Mitigation Measures: This issue will be analyzed in more detail at the designing and siting stage for the final layout.

Screening of Potential Environmental Impacts at Construction Stage

Construction activities will include the following main elements:

- Location of campsite and field construction office
- Construction of access road, site roads, turn-around areas and crane pads at each wind turbine location;

- Construction of the turbine tower foundations and transformer pads;
- Installation of electrical collection system – underground and some overhead lines;
- Assembly and erection of the wind turbines;
- Construction and installation of the substation;
- Plant commissioning and energizing, and
- Decommissioning.

The above activities will entail the following construction related issues that may have impact on the environment and will require mitigation measures to be adopted during the implementation phase:

- Heavy weight and/or long trucks haulage
- Surface sealing (foundations, roads)
- Topsoil removal
- Compressing of topsoil
- Protection of (natural) drainage of agricultural lands
- Fuel storage
- Concrete production
- Ground water levels and watercourses, erosion minimization
- Waste disposal
- Dust emission and control
- Construction related noise
- General conditions of construction site (visual)
- Disturbance of fauna
- Impact on flora
- Emergency response
- Site rehabilitation.

Impact Assessment

Construction at the proposed site of Wind Farm would not involve extensive land preparation since the stony wasteland at Wind Farm Project site is almost flat. The impact of land preparation on the microenvironment i.e. land with no value addition to its land use, and the living area 1.5 km outside the allotted area, will be minor and not significant.

Site preparation activities would include clearing, excavation, earth and fill movement and transportation of wind turbine sets and associated equipment to the site. The said activities will not lead to extensive soil erosion resulting from removal of topsoil at the site, but to improvement of its quality.

Mitigation Measures: The fugitive dust emission would be controlled by spraying water to keep the soil moist. Dust emission due to other materials of construction will be controlled through appropriate measures to reduce the level of impact to be of minor significance.

- Temporary disturbance to the landscape that will occur during construction of site roads, turn-around areas and crane pads at each wind turbine location; construction of the turbine tower foundations and transformer pads; installation of the electrical collection system, including underground and some overhead lines; assembly and erection of the wind turbines, and construction and installation of the substation, will be limited to the microenvironment.
- Domestic solid waste from the construction camp will be disposed in a manner that does not cause soil contamination. The waste disposal plan submitted by the contractor(s) will also address the solid waste.
- The construction camp will not be established close to the storm water channels and the living areas in particular the villages.
- Formation of internal access tracks, foundation excavations, electrical trenching and other site works will not be visible to the public commuting on Motorway

Blocked Access

- There are no settlements at or in the immediate vicinity of the proposed site. Hence the construction activities at the site will not cause any inconvenience to the nearby population by blocking their access routes. The movement of extra heavy plant equipment along the roads leading to the site may require temporary adjustment and would not block the insignificant local traffic even for short periods of time.

Mitigation Measures

- The ICI EHS Guidelines will be strictly followed
- Movement of extra heavy loads will be carefully planned, in consultation with the communities in the surrounding and relevant authorities.
- Co-habitation issues with existing wind farm operations will not require negotiations with the community who are settled in the villages on unsurveyed land outside the sub-leased area.
- Diesel and other petroleum products used for the operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.

- 40,000 liters water required daily for numerous construction activities would be transported in tanker trucks and will not have significant impact on other beneficial water uses or its reduced availability.
- Conservation practices would nevertheless be adopted during the entire course of construction.
- Noise and visual impact will be limited to the microenvironment comprising the ecosystem. No major operational impact is envisaged at the construction stage from the Wind Farm Project.

Air Quality Deterioration

Construction machinery, diesel generators and project vehicles will release exhaust emissions, containing carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NOx), and particulate matter (PM), which can deteriorate the ambient air quality in the immediate vicinity of the project site and along the road leading to it. Furthermore, construction activities such as excavation, leveling, filling and vehicular movement on unpaved tracks may cause fugitive dust emissions.

The deteriorated air quality at the project site is unlikely to impact the communities, since the nearest community/settled area is 1.5 to 2.5 kilometers away. However the construction crew and other site staff can be impacted by this air quality deterioration. In addition, the exhaust and dust emissions caused by project related vehicular traffic may impact the communities living along the dirt track leading to the site. The daily *estimated* fuel requirement will be about 5,500 to 7,500 liters. This quantity of fuel will be responsible for daily emission of approximately 260 kg CO, 14 kg SO_2, 65 kg NOx, and 14 kg Particulate matter, besides 16 tons CO_2. These emissions will be dispersed into the unpolluted environment at land area. Their dispersal will not degrade the quality of airshed of the Project site.

Mitigation Measures

- Environmental Management Plan (EMP) will be effectively implemented to keep the interventions in the ecosystem well within prescribed limits while ICI's HSE Guidelines will be strictly followed and Contractors will be mandated to adopt the EMP in letter and spirit.
- Emissions from the generators will be monitored to ensure that the engines are properly tuned and maintained, and generators are so located that emissions are dispersed away from the camp and work areas.
- Noise emission from the vehicles and equipments will exceed 85 dB (A) but the same would be reduced to less than 85 dB (A) at 7.5 m from the source. Workers will be provided ear plugs and other safety equipment as safeguard against the hazards in the 'high noise zones', which will be clearly defined.

- The liquid effluents generated during the construction phase will include domestic sewage and grey water from the camp operation.
- The sewage will be treated in septic tanks and soaking pits.
- The grey water from kitchens and washing areas will be directed to separate soaking pits.
- The storm water will be collected in ponds and either disposed of after appropriate treatment, or diverted to fields for vegetation, and rejuvenation of local flora.

Gender and Social Issues

The construction site and construction camp will be located well outside the community, thus eliminating any impact on the women of the area. The vehicular traffic on the local roads can potentially pose low level of adverse impact on the women of the area.

Mitigation Measures

- Construction crew will avoid entering villages and settlements.
- Local norms will be respected
- Communities will be informed and consulted before commencing the site works.
- Environmental monitoring during the project execution will ensure compliance with the above mitigation measures and their adequacy, as well as significance of any residual impacts.

Child Labor

Although the use of child labor is not prevalent in the construction works such as those involved in the proposed project, yet the provisions of the Child Labor Act will be made part of the construction contracts, in order to ensure that no child labor is employed at the project sites or campsites.

Cultural Heritage and Archaeological Issues

There is no prominent cultural or archaeological feature in or around the Wind

Farm Project site.

Mitigation Measures: The recommended procedure will be followed during site excavation for construction at the site, which requires that if artifacts of significance are found, the finding will be immediately reported to the Department of Archaeology, Punjab.

Recreational Value & Tourism

At present the Wind Farm site has a great tourism value. Establishment of the wind farm and its operation in the area may induce further curiosity and encourage tourism

Screening of potential environmental impacts at operation stage

Operation of Wind Farm at the proposed site would start as soon as the wind turbines and switchyard are in place, and the system starts to produce power. Environmental problems identified at the Operations stage relate to the following aspects:

Air quality and noise level changes due to operation of fleet of trucks, container trucks and operation of mechanical equipment.

- Visual Effects
- Noise Effect
- EMI Effects
- Flicker Effects
- Cultural Heritage and Archaeological Issues
- Flora
- Fauna (Wildlife, Birds)
- Recreational and Tourism Issues
- Operation of Wind Farm would not release air pollutants into the airshed, and wastewater will be discharged into soak pits after treatment.
- Diesel and other petroleum products used for the operation of mechanical equipment and transportation vehicles would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.
- Visual effect, Noise effect, EMI effect, Flicker effect induced by operation of the wind turbines will have no significant impact on the living area

Mitigation Measures: The induced impact on operation of the appropriately sited wind turbines on the microenvironment will be monitored through Environmental Management Plan (EMP) and ICI's HSE Guidelines, and mitigated, if necessary by adoption of suitable measures to minimize the impact of Visual effect, Noise effect and Flicker effect on the microenvironment as well as macroenvironment.

Noise Effect

The rotor blades of the wind turbines are the main source of noise during the operation phase of the wind power plants.

The study of noise data for a wind power generation plant of similar size and using the same turbines in the same microenvironment shows that the noise levels generated by the wind farm drop down to 35-40

dB(A) range within a distance of about one kilometer from the plant. This noise level is much lower than the background noise that exists in the living environment i.e. the villages which will be at a distance of over 1.5 km from the nearest turbine.

The emergency generator, if installed at the site, will also generate some noise. However, much like the noise generated by the wind farm, its impact on the communities will be negligible, in view of the large distance.

Advances in turbine technology and design have resulted in reduced noise emissions. Aerodynamic refinements that have combined to make turbines quieter include the change from lattice to tubular towers, the use of variable speed operations, and the switch to 3 blade turbine designs. Improvements in gearbox design and the use of anti-vibration techniques in the past ten years have resulted in significant reductions in mechanical noise.

The most recent direct drive machines have no high-speed mechanical components and therefore do not produce mechanical noise.

Mitigation Measure

- No mitigation measure is necessary. The staff will be provided with the personnel protective equipment (PPE).
- In general, noise is unlikely to be a significant problem where the distance from the nearest turbine to any noise sensitive property is more than 1000 metres. The proponent may seek evidence that the type(s) of turbines proposed will use best current engineering practice in terms of noise creation and suppression.
- Noise mapping study is recommended at the detailed design stage.

Shadow Flicker and Blade Glint

Shadow flicker occurs when the sun passes behind the wind turbine and casts a shadow on the immediate neighborhood. As the rotor blades rotate, shadows pass over the same point causing an effect termed shadow flicker. Shadow flicker may become a problem when residences are located near, or have a specific orientation to, the wind farm. Similar to shadow flicker, blade or tower glint occurs when the sun strikes a rotor blade or the tower at a particular orientation. This can impact a community, as the reflection of sunlight off the rotor blade may be angled toward nearby residences. Blade glint is not a concern for new turbines as matt finish paint is now being used which does not produce the glint effect. However, the nearest WTG will be sited in the detailed design at about 1.5 km away from the living area in the hamlets. Hence the flicker or glint from the proposed project will not cause any significant adverse impact.

According to the report of Chief Medical Officer of Ontario in May 2010: Shadow flicker occurs when the blades of a turbine rotate in sunny conditions, casting moving shadows on the ground that result in alternating changes in light intensity appearing to flick on and off. About 3 per cent of people with epilepsy are photosensitive, generally to flicker frequencies between 5- 30Hz. Most industrial turbines rotate at a speed below these flicker frequencies. Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. It is recommended that shadow flicker at neighboring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day.[1] At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

Mitigation Measures

Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. Proponent will provide calculations (application of Windpro Software) to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times.

Wildlife

The project site and its immediate vicinity do not provide habitat to any terrestrial or avian faunal species, nor is it located along or under the route of migratory birds. The endangered Houbara bustard found in the macro environment, and the highflying falcons are only few in number. The number of the few that visit the site and also their mortality will be recorded during the pre-construction period. High noise levels scare these noise sensitive bird species and the falcons, eagles and high flying birds would be scared off by the scores of WTGs lined up.

Regarding the chances of avian collision with turbines, no such instances have been reported so far. There is a need to study bird behavior and characteristic in these areas which makes it necessary to undertake periodic bird counting and maintaining of records.

[1] The shadow flicker recommendations are based on research by Predac, a European Union sponsored organization promoting best practice in energy use and supply which draws on experience from Belgium, Denmark, France, the Netherlands and Germany.

Mitigation measures

- Environmental Management Plan (EMP) will be effectively implemented to keep the interventions in the ecosystem well within prescribed limits.
- The project staff will not be allowed to indulge in any hunting, trapping or harassment activities.
- Configure turbine arrays to avoid potential avian mortality (e.g. group turbines rather than spread them widely or orient rows of turbines parallel to known bird movements);
- Increase the visibility of towers and rotor blades to birds by using uniform colors and flashing rotor lights especially during migration;
- Mitigation measures such as positioning of sharp shooters can be in place not to kill but stupefy the high-flying stray birds before they reach the turbines. Such birds would be rehabilitated subsequently into safe environment such as a Biodiversity Park. This is already one of the conservation practices to safe the wildlife in India. In order to implement the proposed mechanism Punjab Wildlife Department will be taken onboard so that appropriate steps are taken to save the wildlife from extinction.
- A record of bird casualties will be maintained and reviewed at the end of every month.
- The environmental monitoring and strictly following ICI's EHS Guidelines during the project execution will further ensure compliance with the above mitigation measures and their adequacy in dealing with significant residual impacts.

Habitat Modification

The establishment and operation of a series of wind power plants will potentially modify the natural habitat of the ecosystem of the site. However the macroenvironment of these wind farms is not located in an area which is known for high bird concentration/habitat, or bird migration route. Such a route is at least 15 to 20 km from this site.

The aridity of the land and removal of topsoil has rendered the land unproductive and unattractive for the birds and wildlife to move in. The series of wind turbines would be a deterrent for the high flying migratory birds to make a landing in this barren land. As a result of the proponent's O&M activities on the wind farm in a row, the site will not remain available to the wild birds as landing area and not the least as feeding ground.

8. Economic Assessment Of Environmental Impacts

Environmental Benefits Of Wind Farm Development

Significant environmental benefits will be gained by installing the Wind Farm.

Developing the renewable energy resource would, besides proportionately lessening the need to use fossil fuels such as imported fuel oil, or gas, complement the GoP efforts in increasing the power production capacity. Substantial reduction in gaseous emissions from fuel-fired generation will be achieved, although the amount would depend on the wind farm installed capacity.

Saving on Emissions

Utilizing wind power is among the cheapest methods of reducing CO_2 emissions in electricity production. According to a Danish study, a 100 MW offshore wind farm will reduce CO_2 emissions by almost 0.3 million tons per year, when substituting power from conventional coal fired power plants. The costs will be approximately US$ 5 per ton of CO_2 for offshore wind farms situated near the coast.

CO_2 emission is not the only gas of concern in terms of global warming. Others including NOx, VOCs and humidity also contribute to retaining the thermal component of solar energy. The following indicative figures are based on the estimates that a 100 MW installed capacity power plant using fossil fuel produces 1 kg of CO_2 for generation of each 1 kWh of electricity. Accordingly the 50 MW capacity power plant based on fossil fuel would produce:

- CO_2 (a major contributor to the "greenhouse effect"): 155,000 tonnes/year
- SO_2 (Sulphur Dioxide a constituent of acid rain): 2,375 tonnes/year
- NOx (Nitrous Oxides a constituent of acid rain): 1,150 tonnes/year

Thus Wind Power Generation Complex will

- Prevent emission of an amount equivalent to 155,000 tonnes CO_2, 2,375 tonnes SO_2, and 1150 tonnes NOx annually
- Add as much value as the saving on CO_2 to the wind whose potential has so far remained neglected in the country.

Help the government environmental initiatives in:

- Augmenting the power production capacity in the country, and
- Lowering the emission of greenhouse gases.

9. Environmental Management Plan

This presents an environmental management plan (EMP) as the implementation mechanism to manage environmental and social issues and mitigation measures identified in last section on screening potential environmental impacts and mitigation measures.

Objectives of Environmental Management Plan

The EMP will help the Proponent in addressing the adverse environmental impact of the project, enhance project benefits, and introduce standards of good environmental practice. The primary objectives of the EMP are to:

Facilitate Owner/project sponsors corporate policy on environment

Define the responsibilities of project coordinators, contractors and other role players and effectively communicate environmental issues among them.

Facilitate the implementation of mitigation measures identified in the EIA by providing the technical details of each project impact, and providing an implementation schedule.

Define a monitoring mechanism and identify monitoring parameters to ensure that all mitigation measures are completely and effectively implemented.

Ensure that after completion of Project, restoration of site and rehabilitation work will be carried out

Required equipment and human resources for environmental monitoring and meeting contingency plan objectives are in place and personnel are trained to meet accidents and emergencies

Scope of EMP

This Environmental Management Plan has provided detailed strategy to be implemented for achieving improved environmental performance in the following areas:

1. Environmental Management
2. Water Usages and Disposal
3. Recycling and Waste Management
4. Storm Water Management
5. Pollution Prevention/Environmental Risk Assessment
6. Bio-Diversity
7. Energy Management
8. Transport
9. Community Awareness

Components of EMP

The EMP consists of the following components:

1. Legislation and Guidelines
2. Organizational Structure and Responsibilities
3. Mitigation Plan
4. Environmental Monitoring Plan
5. Emergency Response and Contingency Plan
6. Communication and Documentation
7. Change Management

Legislation and Guidelines

The EIA for Wind Power Generation has discussed national and international legislation and guidelines that are relevant to the project. ICI (Pvt.) Ltd will ensure that the key project management officials and staff and all its assigned and associated consultants and contractors are aware of these legislations and guidelines prior to the start of the project activities.

EIA Regulation: The project will be conducted in conformance with EIA regulation and relevant international conventions and that guidance is sought from national and international guidelines. An independent monitoring consultant will be appointed for the project.

NEQS Requirements: The NEQS for industrial gaseous emissions, Motor Vehicle Emissions and Noise levels, and Industrial and Municipal effluents will be followed throughout the project activities and operation.

World Bank Guidelines: The World Bank guidelines will be followed in all such cases where National guidelines have not been proposed. The project designers need to know applicable bank requirements and the environmental implications of their design choices.

Organizational Roles and Responsibilities

ICI (Pvt.) Ltd shall have its own Environmental Management System EMS to ensure the implementation of EMP and Health and Safety Issues during construction and maintenance.

The environmental management responsibilities will be assumed by its Project Manager and his team members during construction and operations phase to:

- Coordinate with relevant government departments
- Identify and report changes in activities and services that may create new environmental aspects

- Collect and coordinate information regarding environmental aspects, and maintain records related to environmental aspects and their impacts
- Ensure construction work is carried out in an environmentally sound manner by the Contractor by incorporating environmental compliance by appropriate provision in the construction contract
- Contractor will ensure compliance with the environmental management plan by way of training of construction crews in all aspects of implementation of EMP.

Environmentally Sound & Safe Working Procedures

Contractors, sub-contractors and contract workers will be made aware of environmental aspects and Emergency Response Plan prior to commencing the work. Prior to leaving the site contractors, sub-contractors and contract workers will ensure that their work area is in safe position. On emergency call they will report in assembly area. Written procedures or standards will be prepared for all activities, where the absence of such procedures and standards could result in not following HSE policy, the law or the contract.

Safe Working Procedures will be based on the following four aspects of job safety:

Safe Place: Work site will be designed and controls set up to ensure that working environment provides no significant risk to personnel, property and the environment.

Safe Equipment: All equipment for any job, including tools, machinery and protective equipment will be specified and/or designed to ensure that it poses no significant risk to personnel, property or the environment. All equipment will comply with legislative standards for conformity and test.

Safe Procedure: Procedures will be designed for all aspects of the job to facilitate safe use of equipment at the work site to complete tasks with no significant risk to personnel, property or the environment. Design of procedure will be based on step-by-step analysis of the tasks involved (Job Safety Analysis), identification of associated hazards and elimination of control of those hazards. Procedures should allow for work in ideal conditions as well as under aggravating conditions e.g. adverse weather.

Trained Personnel: Suitable job-specific, safety skills and supervision training will be provided to personnel involved in construction and operation activities so that they are able to use the procedure and equipment at the worksite with no significant risk to personnel, property and environment.

Safe Working Procedures will be available to contractors and sub-contractors, who will adopt the relevant labor laws of the country.

Identification of Environmentally Safe Aspects

- EMS will identify Environmental aspects at the initiation of activities at the site with regard to:

- Emissions of fugitive dust and gaseous pollutants from vehicles and equipment,
- Discharges of liquid effluent including oily waste and seepage to land, and water
- Disposal of excavated material and solid waste to land, water and air
- Noise
- Consumption of natural resources and energy
- Emergency releases
- Fauna including high flying/straying birds, and Flora.

Environmental Assessment of Safe Procedures

After identifying the environmental aspects, the related impacts will be assessed and the significance of each issue will be evaluated. Following aspects will be identified for evaluating the impacts:

- Parts of microenvironment impacted
- Parts of macroenvironment impacted
- Whether the impact is beneficial or damaging
- Severity of impact
- Frequency or likelihood of impact
- Existing mitigation measures
- Adequacy of mitigation measures
- Concerns of stakeholders/interested parties
- Regulatory requirements and their compliance

Impact rating

Impact rating will be assessed for each identified aspect to determine the significance as small, medium and high intensity or non-significant.

Pre-Construction Phase

Following are likely to be the main activities at pre-construction phase:

- Photographs of the project area will be taken for recording current status of environment to compare with alterations introduced by the Project
- Monitoring disturbance or alterations in the natural drainage of Wind Farm land, and soil erosion, if any
- Number of approach routes to different facilities over the Wind farm and the powerhouse will be minimized

- Use of horns will be avoided
- Soaking pits for waste water from campsites will be constructed and hazardous waste from these pits will be treated during rehabilitation and restoration phase
- Leakages and drips from operating vehicles and equipment will be attended to immediately; vehicles with leaks will be restrained from operation at the site. All vehicles will carry fire extinguishers

Training and Exercises

To ensure effective implementation of the Emergency Response plan, training programs for Disaster response personnel will be organized regularly in collaboration with wind farms in the neighborhood. The training program will aim at:

Maintaining the plan and working document to be fully operational.

Inform the Response Team members and other relevant personnel of their respective duties and procedures to be followed.

Familiarize all relevant personnel with the use of equipments.

The training program will be structured according to the level of responsibility of the participants:

Classroom instructions as well as field demonstration will be conducted.

Regular operational exercise/drills will be conducted to ensure that the response organization and other components detailed in the plan function effectively and

Response Team members and other relevant personnel assigned specific responsibilities become fully familiar.

9. Environmental Monitoring Program

Monitoring of different activities will be required to assess the impacts of activities during construction and operation on the environment. For this purpose EMS will establish its own unit to:

Coordinate with other units

- Record all non-conformities observed and report them along with actions to Project
- Manager for further action.
- Report any impact anticipated along with recommendations for further action.
- Contractor shall take note of the recommendations relating to issues arising during monitoring of construction activities. The following Tables show the checklist of actions for monitoring different environmental Aspect during the Construction and Operations Phases of the Project:

Stage	Monitoring areas	Location of monitoring	Parameters to monitor	Documentation & Monitoring Frequency
Construction	Water	Sampling points at campsite, powerhouse;	Water analysis for following parameters: pH Dissolved Oxygen Total suspended solids Common ions Oil & grease Coliform count	Quarterly
Construction	Wastewater	Outlet of the wastewater treatment system	Wastewater analysis for the following parameters: pH Total suspended solids DO BOD Oil & grease	Quarterly
Construction	Solid Waste (Kitchen)	Collection, handling and disposal to designated areas/borrow pits	Observations on solid waste type, quantity and disposal arrangement	Quarterly
	Solid Waste			Quarterly
Construction	Air quality	15 meters distance from activity area	Parameters to monitor include: CO SPM SO_2 NO_x	i. Before beginning of construction ii. Monthly during construction iii. Quarterly during operations

Construction	Air quality	15 meters distance from activity area	Parameters to monitor include: CO SPM SO_2 NO_x	i. Before beginning of construction ii. Monthly during construction iii. Quarterly during operations
End of Construction	Restoration of sites	All excavation sites & Borrow pits	Visual Observations	Status Report for Completion of Construction
Operations	Accidental risk at site		Visual Observations Recording accidents during operation of WTG & equipment	Quarterly
Operations	Noise	▪ Activity areas ▪ Wind Farm ▪ Powerhouse ▪ Filter Plant ▪ Access Road	Noise intensity measurement	Quarterly
Construction & Operations	Occupational Safety	Installation of Machinery and equipment Operations areas	Visual observations and Recording hazard/accident	Quarterly

10. Recommendations

EIA of the Wind Farm has identified the key environmental aspects that need to be attended to. Mitigation measures for the likely impact have been suggested. General specification/details have been worked out in respect of type of structures, grade of concrete, and all other materials of construction for the Construction Phase of Wind Farm.

It is recommended that:

- The structures and materials conform to recommended standards and follow standard practice of civil works.
- Environmentally sound materials and goods are selected, with priority being accorded to products meeting national and international standards.
- Traditionally well-tried materials are chosen for provision of utilities services in the Project.
- Temporary inconveniences due to construction works are minimized through planning and coordination with local population and organizations in the neighborhood.

- The foundations of the wind turbine towers are of concrete on bearing soil. Bearing capacity, settlement, static and dynamic loading conditions are determined while seismic conditions pertain to placement of the site in zone 2A (Moderate to High hazards) and taken into account in the working designs that will submitted for approval.
- The stability of soil is verified before laying the foundations of the wind turbines.
- Environmental Performance Monitoring will be an integral part of the Project to ensure environmental safeguards.

11. Conclusions

Review of Guidelines for classification of polluted and unpolluted sites with respect to their airshed, watershed, soil, sensitivity of ecosystem including fauna, flora, wildlife, aquatic life, historical and archaeological sites and their values, along with assessment of impact by using the "Checklist of actions affecting environment and significance of their impact" has been usedin this EIA Study for assessment of impact of different activities for establishment of Wind Farm. The review process finds that:

- The impacts from Wind Farm Project during construction, and installation of machinery and the resulting emission of noise and gaseous effluent, and wastewater discharges during siting, construction and operation of the Wind Farm Project would be of small order and would be of little significance at the site or microenvironment and none in the macroenvironment.
- Estimates on net saving in terms of air pollutants clearly suggest that operation of the Wind Farm would be economically viable and environment friendly.
- No untreated wastewater would be discharged from the Wind Farm.
- Initiatives will be taken to harvest rainwater by channelizing it into dyked ponds for subsequent use in plantation.
- Noise emissions from the wind turbines at Wind Farm site will have a high level at the top and will attenuate with distance. The noise level at the living areas at more than 1.5 km or three times the required distance of one rotor diameter equivalents will be within acceptable limits of the World Bank Guidelines and the limits recently proposed by Federal EPA.
- The level of emissions and discharges suggests that Wind Farm operations will have no significant impact either on its microenvironment that includes the proposed site for Wind Farm, or on its macroenvironment that includes the small cluster of settlement.

Annex 1: Checklist for Impact Scoring

Checklist of actions affecting environment and their significant impacts

Actions affecting environment resources and values	Damage to environment	Recommended mitigation measures	Significance of Impact			
A. Environmental Problems due to Siting/Location of Project			**None**	**Small**	**Medium**	**Major**
Change in hydrology affecting existing land values	Damage to land by erosion and/or accretion	Careful design and planning to minimize problem	√			
Change in drainage pattern	Damage due to change in flooding, accretion, erosion hazard	Careful design to minimize the problem	√			
Obstruction in Water flow	Conflicts with other beneficial water uses	Appropriate sharing of water	√			
Change in land uses	Possible lives in overall regional welfare	Careful planning and implementation of ICI HSE Guidelines		√		
Encroachment into precious ecological zones	Loss of precious ecology	Careful planning and implementation of ICI HSE Guidelines		√		
Resettlement	Displacement of local population	Adequate attention to local problems	√			
Historical/monuments/cultural values	Loss of precious values	Careful planning to minimize/offset problem	√			
Environmental aesthetics	Loss of environmental aesthetics	Careful planning		√		
B. Environmental Problems due to Inadequate Design						
Unrealistic assumptions on available O & M skills	Unnecessary damages because O&M requirements too high	Realistic O&M assumptions & Implementation of ICI's HSE Guidelines	√			
Pollution Control Equipment Selection	Assumed pollution removals not realized	Appropriate equipment selection	√			
Environmental pollution control operations	Possible loss in overall regional welfare	Careful planning/ designing / monitoring and use of appropriate standards	√			
Surface water	Impairment of downstream beneficial water uses	Careful Management of Resources	√			
Groundwater	Impairment of beneficial water uses	Careful Management of Resources	√			
Air	Impairment of air quality	Careful Management & Monitoring	√			
Noise	Environmental Degradation & Health hazard	Careful planning & monitoring		√		

Impacts on adjacent land economic users including recreation/tourism	Impairment of land uses	Careful planning/O&M		√		
Occupational health & Safety hazards	Hazards to workers health & safety	Effective implementation of EMP		√		
Hazards due to Spills/fires/explosions	Hazards to workers health & safety	Effective implementation of EMP		√		
Area sanitation	Sanitation/disease hazards	Careful planning/design	√			
Hauling routes in/out areas	Traffic congestion and nuisances along routes	Effective implementation of EMP		√		
C. Environmental Problems During Construction Stage						
Problems due to uncontrolled construction practices	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
runoff erosion	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
worker accidents	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
sanitation disease hazards	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
insect vector disease hazards	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
hazardous material handling	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
dust/odors/fume	Problems of Environmental Degradation	Careful Planning and Implementation of EMP			√	
explosion/fire hazards/hazardous materials spills	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
noise/vibration hazards	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
traffic congestion	Problems of Environmental Degradation	Careful Planning and Implementation of EMP		√		
water pollution hazards	Problems of Environmental Degradation	Careful Planning and Implementation		√		

		of EMP				
blockage of wildlife/birds passageways	Problems of Environmental Degradation	Careful Planning and Implementation of EMP			√	
Uncovered cut & fill areas	Soil erosion & consequent damage to properties & environment	Careful Planning and Implementation of EMP		√		
Inadequate construction monitoring	Encourages poor construction practices	Adequate monitoring during construction and Implementation of EMP		√		
D. Environmental Hazards Relating to Operations (assuming proper design assumptions on O&M)						
Inadequate O & M	Variety of environmental degradation similar to items B.1 to 8	Adequate monitoring during Operation and Implementation of EMP		√		
Inadequate operations phase/environmental monitoring	Opportunity loss for feedback connections to project design and O&M	Adequate monitoring during Operation and Implementation of EMP		√		
Occupational Health & Safety Programmes including Accidents	Hazards to workers health & safety	Adequate monitoring during Operation and Implementation of EMP		√		
Nuisance from handling & Transportation of fuels on access roads	oil drips, spills, dust & noise hazards	Adequate monitoring during Operation and Implementation of EMP		√		
Surface run off from plant yard	leakage of fuel on ground & oil drips	Adequate monitoring during Operation and Implementation of EMP		√		
E. Critical Environmental Review Criteria						
Loss of irreplaceable Resources	Long-term national environmental and economic losses	Planning to be consistent with polices		√		
Accelerated use of resources for short term gain	Long-term national environmental and economic losses	Planning to be consistent with polices		√		
Endangering of species	Long-term national	Planning to be consistent		√		

	environmental and economic losses	with polices				
Promoting undesirable rural-urban migration	Intensification of urban socioeconomic problems	Planning to be consistent with polices	√			
Increase in affluence/poor income gap	Intensification of national socioeconomic imbalances	Planning to be consistent with polices		√		
F. Potential Environmental Problems During Operation						
Removal or damage to vegetative growth	Problem at preparation of site & during operation	Careful implementation of EMP		√		
Land Use Changes	Problem at preparation of site & during operation	Careful implementation of EMP		√		
Micro level changes in the human settlements	Problem at siting & Operation stage	Careful implementation of EMP		√		
Industrial & Transportation Activities	Problem at Operation Stage	Careful implementation of EMP	√			
Emergence of Slums & Wayside Commercial Activity	Problem at Construction & Operation Stage	Careful implementation of EMP	√			
G. Impacts from power Transmission facilities						
Environmental health hazard due to electromagnetic radiation	Unnecessary exposure of workers to environmental hazards	Careful planning, training of workers		√		
Depreciation of environmental aesthetics	Loss of values	Careful planning & implementation of EMP		√		
Encroachment on Ecosystem	Loss of precious ecology	Careful planning & implementation of EMP		√		
Overall Significance of Impact: Not Significant						

Annex 2: National Environment Quality Standards

National Environmental Quality Standards for Industrial Gaseous Emissions (mg/Nm^3, Unless Otherwise Defined)

S.No.	Parameter	Source of emission	Standards	Revised Standards
1.	Smoke	Smoke opacity not to exceed:-	40% or 2 (Ringlemann Scale).	40% or 2 Ringlemann Scale or equivalent smoke number
2.	Particulate Matter[1]	(a) Boilers and furnaces:		
		(I) Oil fired.	300	300
		(ii) Coal fired.	500	500
		(iii) Cement Kilns.	200	300
		(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, convertors, blast furnaces and cupolas.	500	500
3.	Hydrogen Chloride[2]	Any.	400	400
4.	Chlorine[2]	Any.	150	150
5.	Hydrogen Fluoride[2]	Any.	150	150
6.	Hydrogen Sulphide[2]	Any.	10	10
7.	Sulphur Oxides	Sulfuric Acid / Sulfuric Acid Plants. Others Plants. [3]	400 400	5000 1700
8.	Carbon Monoxide[4]	Any.	800	800

National Environmental Quality Standards for Industrial Gaseous Emissions (mg/Nm^3, Unless Otherwise Defined) (Contd..)

S.No.	Parameter	Source of emission	Standards	Revised Standards
9.	Lead [2]	Any.	50	50
10.	Mercury [2]	Any.	10	10
11.	Cadmium [2]	Any.	20	20
12.	Arsenic [2]	Any.	20	20
13.	Copper [2]	Any.	50	50
14.	Antimony [2]	Any.	20	20
15.	Zinc [2]	Any.	200	200
16.	Oxides of Nitrogen (NOx) [4]	(i) Nitric Acid manufacturing unit. (ii) Gas fired (iii) Oil fired (iv) Coal fired	400 400 - -	3000 400 600 1200

Explanations :

1. Based on the assumption that the size of the particles is 10 microns or more.
2. Any source.
3. Based on 1% sulphure content in fuel oil. Higher content of sulphure will cause standards to be pro-rated.
4. In respect of emissions of sulphure dioxide and nitrogen oxides, the power plants operating on oil or coal as fuel shall, in addition to National Environmental Quality Standards (NEQS) specified above, comply with the following standards.

Sulphur Dioxide

Sulphur Dioxide Background Levels (ug/m3)			Standards	
			Criterion I	Criterion II
Background Air Quality	**Annual Average**	**Max. 24 hours**	**Max. SO_2 Emission**	**Max. allowable ground level**
($S0^2$ Basis)		Interval	(Tons per day per Plant)	Increment to ambient (ug//m^3) (One year average)
Unpolluted	< 50	< 200	500	50
Moderately Polluted *				
Low	50	200	500	50
High	100	400	100	10
Very Polluted **	> 100	> 400	100	10

* For intermediate values between 50 and 100 ug/m3 linear interpolations should be used.
** No project with sulphure dioxide emissions will be recommended.

Nitrogen Oxide

Ambient air concentrations of nitrogen oxides, expressed as NO2, should not exceed the follow

Annual Arithmetic Mean	100 ug/m3 (0.05 ppm)

Emission levels for stationary sources discharges, before mixing with the atmosphere, should be maintained as follows:-

For fuel fired steam generations, as nanogram (10E-9 gram) per joule of heat input:

Liquid fossil fuel	130
Solid fossil fuel	300
Lignite fossil fuel	260

National Environmental Quality Standards for Motor Vehicle Exhaust and Noise

S.No	Parameter	Standards (maximum permissible limit)	Measuring method
1.	Smoke	40% or 2 on the Ringlemann Scale or equivalent smoke number at end of exhaust pipe during engine acceleration mode.	To be compared with Ringlemann Chart at a distance of 6 meters or more.
2.	Carbon Monoxide.	Emission Standards : New Vehicles. 4.5 % Used* Vehicles. 6 %	Under idling conditions. Non dispersive infrared detection through gas analyzer.
3.	Noise.	85 db (A).	Sound-meter at 7.5 meters from the source.

* 10 year or older model.