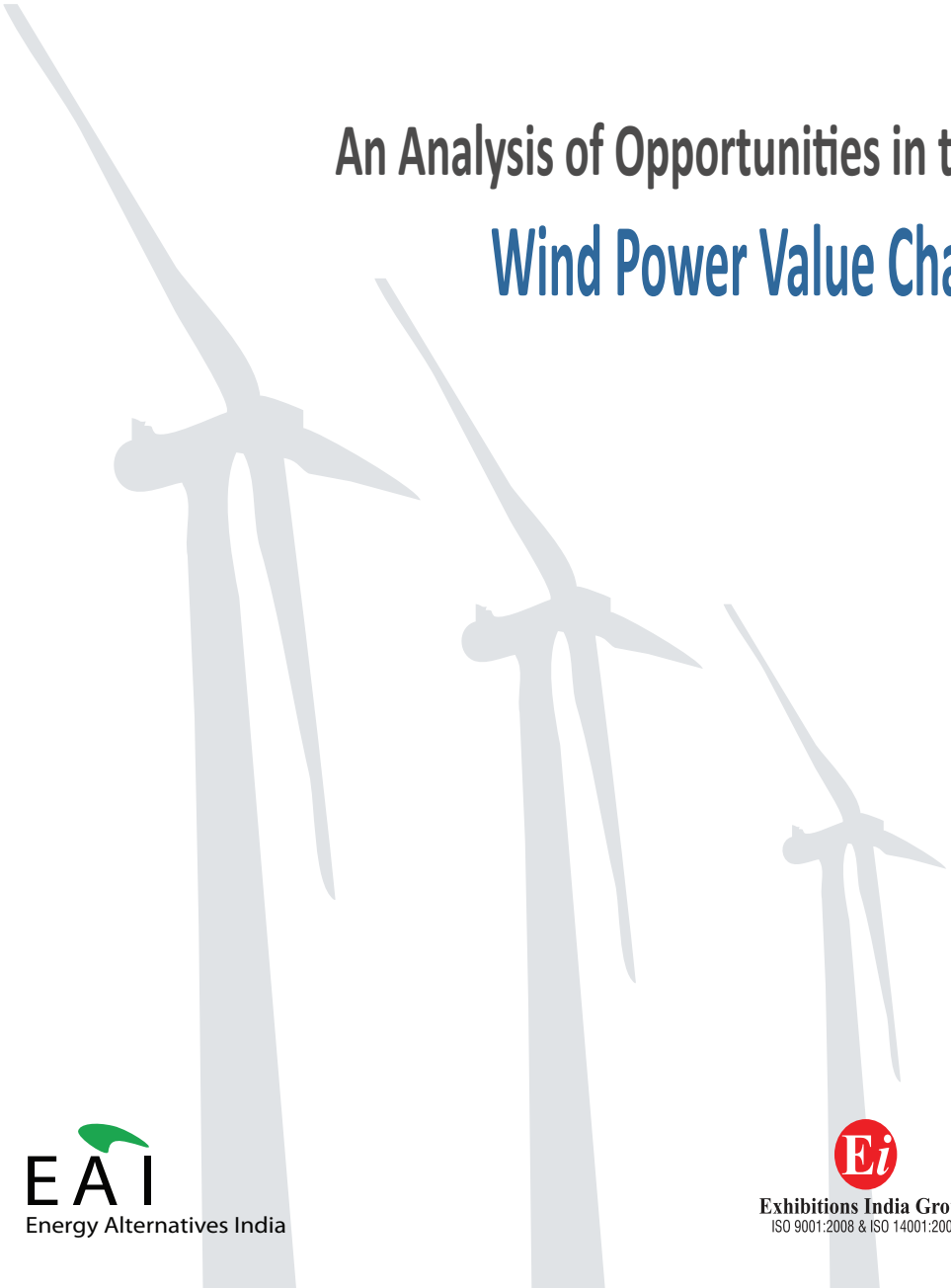
An Analysis of Opportunities in the

Wind Power Value Chain



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Foreword

These are exciting times for Indian renewable energy, and especially so for solar and wind energy.

Investments in renewable energy industry in India have increased from a meager $94.58 million in 2001 to $3.7 billion in 2008, and about $7.2 billion by 2009 - at a CAGR of 72%. A significant part of these investments were in wind energy.

For the past few years China has been doubling its cumulative wind energy installed capacity, and by end of 2009, the country had a cumulative installed capacity of 25.1 GW, from 12.1 GW for end-2008 - over 100% growth! During the same year, India added a modest 1.27 GW, raising its total installed capacity from 9.65 GW to 10.92 GW.

The comparative data for India and China show the potential the Indian wind energy sector has. With the government of India keen on promoting renewables with attractive incentives, the wind energy sector is expected to created thousands of jobs and a number of business opportunities for the private sector.

EAI is glad to be part of the The Renewable Energy Chennai 2010 Conference which has a focus on the exciting wind energy sector. We hope that this white paper on the opportunities present in the wind energy sector will assist entrepreneurs and businesses in their efforts at exploring this sector.

EAI thanks Exhibitions India/Comnet Conferences for providing the opportunity to present this white paper as part of the conference, and wishes the very best for the success of the conference.

Narasimhan Santhanam
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1. Overview of the Wind Energy Industry in India

The development of wind power in India began in the 1990s, and has progressed steadily in the last few years. The short gestation periods for installing wind turbines, and the increasing reliability and performance of wind energy machines have made wind power a favored choice for capacity addition in India. Currently, India has the fifth largest[1] installed wind power capacity in the world. Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power[2]. It is estimated that 6,000 MW[3] of additional wind power capacity will be installed in India between 2010 and 2012, taking the total installed capacity beyond 15,000 MW.

In addition to the progress made in wind turbine installed capacities, the progress of the overall wind energy ecosystem has been encouraging as well. Pointers to this are the increasing number of component manufacturers and the rapid utilization of India's land for wind energy. While the growth of wind power in India was largely driven by tax incentives until recently, it is expected that more IPPs (independent power producers) will be interested in investing in this segment with the recent announcement of generation-based incentives.

1.1 Status and Trends

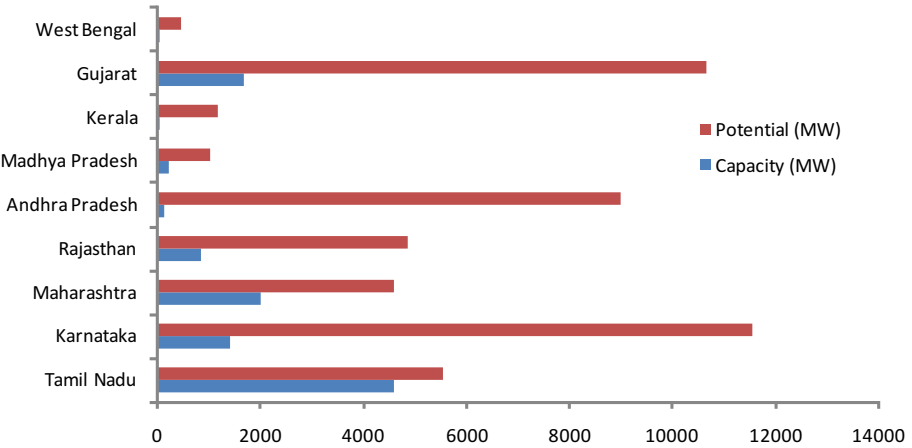
The growth in wind energy in India has been spurred by only a handful of states so far, with Tamilnadu being by far the leader.

[1] Indian wind Energy Association, www.inwea.org

[2] India Wind Turbine Manufacturers Association, www.indianwindpower.com/

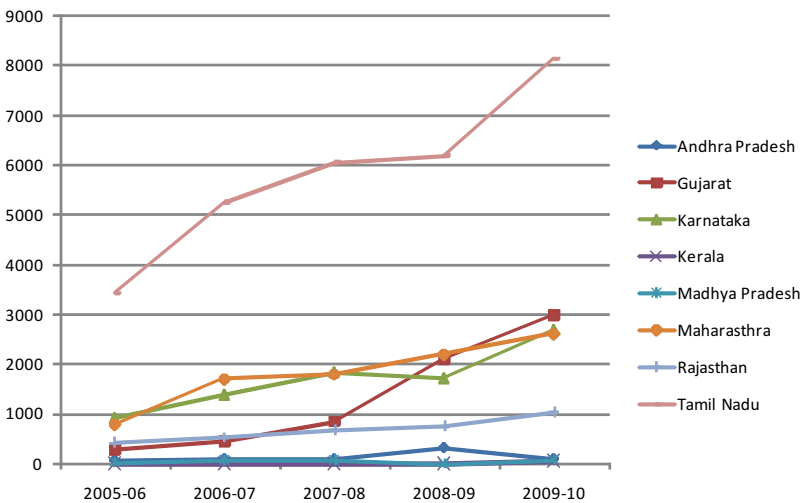
[3] ProjectsToday, www.projectstoday.com

Potential vs. Installed Capacity (as on 30.09.2009)



Sources: www.indianwindpower.com , GWEC – India Wind Energy Outlook 2009

Installed Capacity Trends in Different States



Source: www.windpowerindia.com

It can be observed from the two charts that while Tamilnadu garners the most limelight currently owing to its leading position in installed wind capacity, attention will quickly be shifting to states such as Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Rajasthan where the gap between the available potential and installed capacities are much higher than those for Tamilnadu. However, it should also be noted that many of the locations in these zones might not be as efficient as those in Tamilnadu, owing to lower wind speeds.

1.2 Future Potential

The total potential for wind power in India was first estimated by the Centre for Wind Energy Technology[4] at 45 GW, and was recently increased to 48.5 GW. This figure was also adopted by the government as the official estimate.

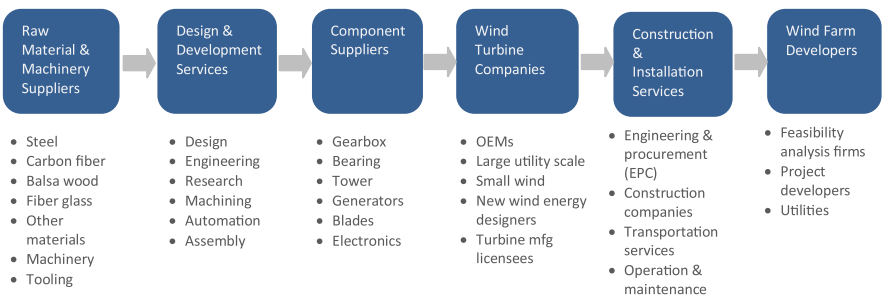
At heights of 55-65 meters, the Indian Wind Turbine Manufacturers Association (IWTMA) estimates that the potential for wind development in India is around 65-70 GW. The World Institute for Sustainable Energy (WISE) estimates that with larger turbines, greater land availability and expanded resource exploration, the potential could be as high as 100 GW.

A 100 GW potential for wind energy significantly widens the attractiveness of the Indian wind energy segment, given that the total installed capacity for electricity is India is about 160 GW.

[4] C-WET - www.cwet.tn.nic.in

2. Industry Value Chain

The wind energy value chain consists of a number of specific and distinct steps - from the supply of raw materials to the transmission of electricity. These steps, along with the prominent supporting products and services for each, are given below. The illustration below also provides a bird's-eye view of the opportunities available along the entire wind energy value chain.



Source: www.nextenergy.org

A detailed analysis of the various stages presented above and the products and services applicable for each stage will also show how opportunities exist for a range of entrepreneurs at each stage. Except for the “wind turbine companies” stage, which is a relatively concentrated OEM market with the top ten players cornering a large share of the market (over 80% of capacity installed during 2009), the rest of the stages could present ample opportunities for small and medium players.

A trend in the wind energy industry that entrepreneurs should be aware of is the move by incumbents towards vertical integration along this value chain. And there is a reason for the vertical integration efforts.

Turbines have been doubling in size every four years, and technology has been developing at excellent speed, but the suppliers that had the right expertise, facilities and capacity to deliver on increasingly challenging orders have been thin on the ground.

With supply chain bottlenecks a constant threat, many of the large wind firms have responded by buying out suppliers of critical components such as blades, generators, and gearboxes. By bringing suppliers in house, they could ensure they would get the products they needed on time, and at an acceptable price.

Vertical integration of the supply chain has been a gradual process over the last decade. Today, most turbine manufacturers make their own blades, after a rush to bring them in-house four or five years ago.

OEMs including Vestas, GE, Gamesa, and Suzlon also have in-house supply of generators and controllers, although they also still source some of these components from other suppliers.

Vertical integration has not always been a smooth process, however. An example is Suzlon's acquisition of Hansen Transmissions (a gearbox manufacturer) in 2006 and its subsequent divestment of a large portion of its stake in the company.

2.1 Key Players in the Wind Power Development

Key players with a role to play in wind energy development include: wind turbine manufacturers, dealers and distributors; wind project developers; consultants and contractors; electric utilities, government agencies; and landowners.

Wind Turbine Manufacturers: Large wind turbines are either sold directly by the manufacturer or by the manufacturer's regional dealers and distributors.

Wind Developers: Wind developers buy or lease windy land, finance the installation of wind turbines and operate and maintain the turbines for an extended period. After a project is constructed, the wind developer's role varies. The developer may own and operate the wind farm, or merely operate the project for a different owner.

Private Consultants and Contractors: Private consultants and contractors provide specialized skills or knowledge. A consulting meteorologist can independently

evaluate the wind resources at a site. Engineering consultants can offer technical comparisons among competing wind turbines or provide “due diligence” reports to banks considering loans for proposed wind projects. Contractors are often needed for the construction phase of wind projects for tasks such as pouring concrete and erecting the turbines.

Electric Utilities: The cooperation of electric utilities (typically state electricity boards) is required to interconnect wind turbines with the power grid. Selling electricity to a utility involves negotiations between the power generator and the electric utility. These negotiations generally result in a contract binding both parties to an agreement for a fixed amount of time. In India, state electricity boards represent the main market for wind-generated electricity, whether they are interested in wind power for their own purposes or are under obligations/ mandates to invest in wind energy (examples of such mandates include RPS or renewable portfolio standards that mandate a certain % of electricity to be derived from renewable sources).

Landowners: As the suppliers of windy land, landowners – especially in rural areas - can have substantial influence over how wind energy develops. As the industry has grown, windy landowners and their communities are gaining an understanding of the tremendous value of their wind resource and are finding ways to keep more of the benefits in the local community. These methods range from farmers negotiating better land leases with developers to local and community investments in wind projects.

2.2 Business Opportunities

Business opportunities in wind energy industry are available in manufacturing, services and trading. Among these sectors, the widest range of opportunities is present in the manufacturing sector, followed by services.

The analysis of business opportunities presented in this section is, to a large extent, not country specific, but we have provided some notes in the Indian context.

2.2.1 Manufacturing Opportunities

Manufacturing opportunities in wind exist in:

1. Raw materials production

2. Original equipment manufacturing

3. Component manufacturing

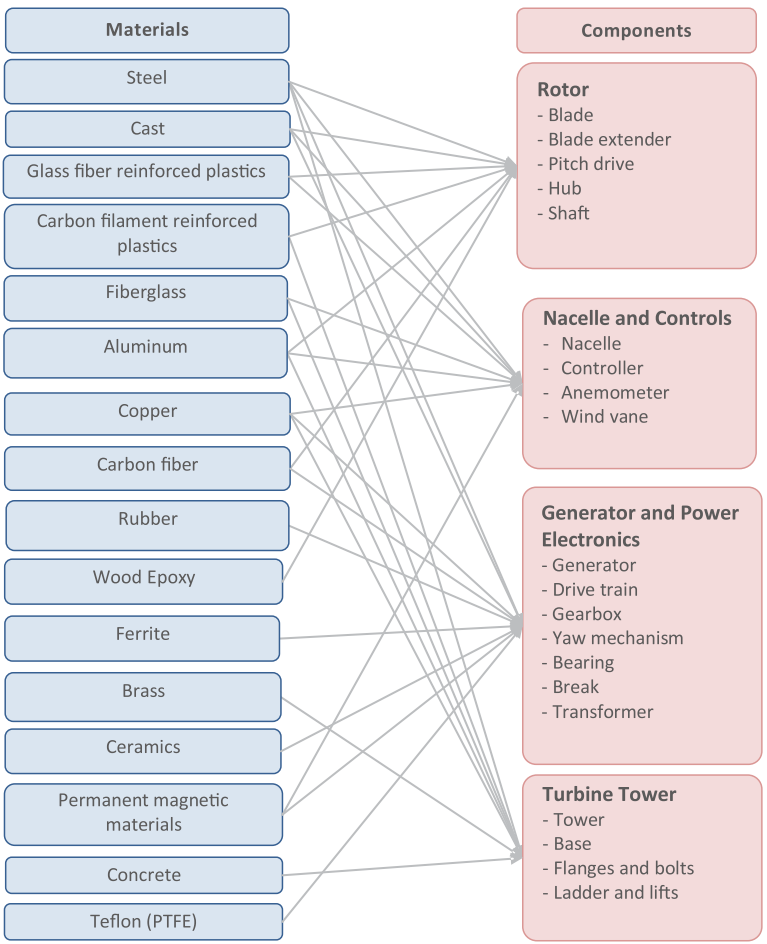
Raw Materials Production

A wide range of materials are used for wind turbine construction. Steel is one of the most important materials because of its strength and durability. Turbines are primarily made of steel, which accounts for 90% of the machine by weight. A single 1 MW utility scale wind turbine tower is constructed from an estimated 100 tons of steel, and larger turbines use a significantly greater amount of steel. The rotor is constructed from approximately 45% steel, with the hub being made of 100% steel, and the blades being made up of 2% steel and a combination of fiberglass (78%) and adhesive (15%). Steel accounts for between 87% and 92% of nacelle components (American Wind Energy Association, 2009).

While steel is perhaps the most important material in this context, a diverse list of raw materials are required to produce the vast number of components that comprise a wind farm. The following illustration provides a detailed review of the materials and components used in the production of wind turbines.

There is a move in India to indigenize wind turbine component production; this could lead to significant opportunities for suppliers of raw materials that go into the production of these components. Indian producers of the above raw materials should hence explore how they can become suppliers to this sector.

Raw Materials Required for Wind Turbine Components



Source: CGGC, based on industry sources and company websites.

Original Equipment Manufacturing

In the wind energy sector, turbine manufacturers represent the predominant OEM segment. The top 10 OEMs in the wind energy industry (by total installed capacity) are: Vestas, Enercon, Gamesa, GE Energy, Siemens, Suzlon, Nordex, Acciona, REpower (owned by Suzlon) and Goldwind.

OEMs usually manufacture some of the critical components such as the nacelle in-house, and blades and towers are produced either by the OEM or fabricated to the OEM's specifications by a supplier. Typically, the wind project developer's contract with the OEMs for the delivery of the complete wind turbines include the nacelle, blades, and turbine tower, which are transported from the manufacturing facility directly to the wind farm construction site.

Competition among wind turbine OEMs has increased substantially as the wind power industry has expanded. In addition, as noted earlier, there has been a significant trend towards vertical integration in the wind energy industry and this could see OEMs producing more of the components themselves.

While opportunities do exist for new OEMs in India with the projected continuous growth in the wind industry, it should be noted that this is an area that faces intense competition from large global companies, and entering the OEM domain will require significant capital and marketing investments.

Acquisitions could be one of the ways for a medium or large business group to enter the OEM market. An example of this is the acquisition of controlling stake in WinWind Oy, a Finnish manufacturer of wind turbines, by Siva Group of India.

Component Manufacturing

Component manufacturers produce a wide range of mechanical and electrical components, including generators, hydraulics, sensors, hardware, drives, power distribution, composites, cabling, castings, forgings, bearings, gearboxes.

The primary components in a wind energy generating system are:

- Rotors and Blades
- Nacelle and Controls
- Generator and Power Electronics
- Tower Components

Sub-components for each of these components are provided in the earlier illustration.

A modern wind turbine consists of about 8000 unique components. Such components and related services are supplied by an estimated 25 to 30 highly specialized companies in India in addition to a large number of international suppliers. Companies involved in component manufacturing for the wind power industry range from OEMs such as Vestas, Suzlon, and GE Energy to smaller firms.

Many of the components used in wind turbines are "generic" components – examples of such "generic" components include brakes, ladders, bearings, shafts etc. For Indian firms that are already producing components that could be supplied to the wind energy industry with minor customizations, component manufacturing could be a very attractive avenue, as these firms will able to use their existing skills and assets to quickly diversify to become suppliers for the wind sector. The interest shown towards higher indigenization for wind turbine components also makes the component manufacturing segment an attractive one for Indian businesses.

2.2.2 Services & Support Opportunities

While manufacturing opportunities are the most prominent in the wind energy industry, a range of service opportunities are available as well.

Broadly, the services opportunities could be categorized into:

- Feasibility studies and project development
- Geotechnical services
- Logistics support for wind farm

- Construction opportunities
- Operations and maintenance

Feasibility Studies and Project Development

Wind farm developers are responsible for developing the wind project from concept to commissioning, and they undertake all the planning, design and project development work in this regard. Some developers perform services beyond the commissioning stage as well, such as operations and maintenance support.

As part of their role, wind power project developers also take up the role of establishing access to capital for investment. In addition, they also assist in the construction of roads and related infrastructure that can accommodate the transport of heavy industrial equipment and components.

Owners of wind farms (many times distinct from wind farm developers) could be private companies that have an interest in power generation, or power production utility companies.

Depending on the nature of contract, the wind project developer sometimes has a managing interest in the project when it is complete, but in most cases the real ownership lies with the wind farm owner.

Wind power feasibility studies and project development for commercial-scale wind farms is a multifaceted, lengthy process, often requiring collaborative efforts among several companies. Project developers perform the following:

- Wind power feasibility analysis,
- Site selection,
- Wind farm design and layout,
- Wind turbine selection and acquisition,
- Obtaining state permits,

- Construction contracting,
- Acquiring wind rights and leases,
- Energy production estimates, and
- Project financing

All the above present opportunities for Indian entrepreneurs keen on benefitting from the wind energy sector. While some integrated wind energy companies such as Suzlon provide most of the above-mentioned services, opportunities are available for other businesses to be sub-contractors to such companies for some of the services.

Geotechnical Services

Geotechnical services deals with the geological analysis and examines the suitability of a certain location for the proposed wind farm infrastructure. These services mainly include the analysis of the stability of the subsoil and foundation advice.

While geotechnical services are a part of project development, owing to the specific importance that these services carry in the context of wind farms, this has been mentioned as a separate section.

For onshore wind farms, geotechnical services include:

- Geotechnical and geo hazards aspects of site selection, master planning and environmental impact assessment and management
- Geotechnical and geo-environmental site investigation, including terrain evaluation and contaminated land assessment
- Foundation and ground improvement design for static and dynamic load conditions
- Access road and cable routes - selection, investigation and design
- Geo hazard assessment and mitigation – unstable slopes, surface and groundwater, seismic hazards.
- Site reinstatement and restoration, including erosion control and planting regimes

- Construction supervision
- Due diligence and expert witness services

As mentioned earlier, integrated wind energy companies provide the above services as part of their development portfolio, but opportunities exist for Indian construction and civil engineering companies to be sub-contractors for specific services.

Offshore wind farms could require a few more geotechnical services, in addition to most of what are required for the onshore wind farms:

- Foundation and design assessment
- Subsea cabling
- Sea bed geotechnical service

Currently, offshore wind is in its infancy in India and is more relevant to countries in north Europe and to a certain extent, for the United States. It is however expected that the offshore wind industry could start gaining momentum during the next few years, so entrepreneurs will do well to watch that space.

Logistics Support for Wind Power

Transporting wind turbines presents unique challenges and opportunities. Transporting these machines involves handling components that have an unusual weight, length and shape; thus companies that serve the industry must have equipment to transport very large and heavy cargo. The nacelles, blades, and turbine towers must be transported from the manufacturing facility to the wind farm location. The wind turbine industry needs to rely on collaborative transportation management processes, whereby manufacturers, logistics companies, transportation companies, and shipping ports share information and integrate their functions to achieve an effective delivery process (Tremwell & Ozment, 2007). Modes of transportation for the wind industry include trucking, shipping and rail freight.

There are considerable opportunities for transportation providers in all sectors to

serve the industry. A single wind turbine can require up to eight hauls, and for a large project of 150 MW, transportation requirements could be as much as 689 truckloads, 140 railcars, and eight ships (Tremwell & Ozment, 2007). As the wind power industry continues to grow, demand increases for companies that are capable of transporting heavy and large loads. This could lead to the emergence of a specialized sector in the transportation industry.

Construction Opportunities

Companies involved in large scale wind project construction generally offer turnkey arrangements, according to criteria specified in the contract. Turnkey construction contractors provide engineering, procurement and construction services, including civil works, laying cables for electrical infrastructure, and installing wind turbines.

Over the past decade, a number of construction companies in India have contributed to and benefitted from the wind energy sector growth, and this trend is expected to continue in future as well.

Operation and Maintenance

The reliability of the turbine system is essential to a wind power project; thus, operation and maintenance (O&M) services are critical. Operations include scheduling site personnel, observing turbine operation, dealing with equipment failure, and coordinating with the utility to respond to curtailments or outages (Walford, 2006). Maintenance includes both scheduled (preventive) services, such as periodic equipment inspections, oil and filter changes, calibration of electronic sensors, blade cleaning, and unscheduled services to repair component malfunctions.

When wind turbines are installed and the wind farm is in use, routine maintenance is important to ensure maximum efficiency and lifespan of the machines. Generally, wind turbine manufacturers' service turbines during the first 2-5 years while the wind turbines are still under warranty. Thereafter, wind farm operators may perform maintenance on their own, or subcontract the service to independent service companies (Wittholz & Pan, 2004).

Some companies in India are focused on offering only repair and maintenance services to existing wind farms, as they see a potential to add significant value owing to their focus.

2.2.3 Trading Opportunities

Trading opportunities for wind energy components and parts are presently limited owing to the way the industry supply chain is structured – most of the parts procured are business-to-business transactions with the OEMs directly procuring from the component manufacturers. Should a market for micro-wind turbines emerge in future, opportunities could arise for traders and small system integrators, similar to what is happening in the solar PV industry in India where rooftop solar systems are set to take off soon.

Opportunities to trade in the power produced are however likely to expand significantly. Currently, it is possible for wind power producers to sell electricity to the grid, use it for captive consumption or sell it to third parties. With the emergence of independent power exchanges and with the likely liberalization and streamlining of power distribution across states, the opportunities to trade in power are likely to increase and become more lucrative.

2.2.4 Opportunities in R&D

Relative to solar photovoltaic, which has seen tremendous and disruptive innovations in the last two decades – in the form of thin film, concentrated PV, dye-sensitized solar cells, etc – the innovations in the wind industry have been more incremental in nature.

This is not to infer that there have been no significant innovations. Tremendous progress have been made in the context of gearless wind turbines, original concepts such as the FloDesign's Jet Engine-inspired Wind Turbine, attempts at vertical axis wind turbines for utility scale, innovation in wind towers resulting in significant reduction in amount of materials used, innovations that are attempting to increase the efficiency of generators (ex: ExRo), and interesting innovations in wind turbine blades (ex: shape-shifting blades designed by Purdue University and Sandia National Laboratories).

The above inputs on innovations point to the range of opportunities that exists for R&D within the wind energy sector. Large wind energy companies have their own dedicated R&D teams, but research opportunities also exist for Indian entrepreneurs and businesses that have research in their business DNA.

2.2.5 Other Opportunities

Some of the other opportunities along the value chain include:

Leasing Land

When you lease your land to a wind energy developer, you receive compensation for the commercial-scale project on your land.

Training

Opportunities exist in wind energy training and education, hands-on workshops in renewable energy system design and installation

Software Tools

Opportunities exist for developing information and tools for evaluating wind energy contracts, landowner options, and economic development impacts of wind energy.

Financial Services

There are companies which provide financial services and business tools for wind industry. They assist investors and others in financing renewable electric power generation projects.

Legal Services

Legal service providers play a role in development, financing, and acquisition of wind power projects.

Insurance Services

Companies specializing in underwriting, loss adjusting and risk engineering wind power projects provide insurance services. These include:

- Insurance Cost Estimating
- Insurance Brokerage/ Risk Management
- Contract Review/ Analysis/ Document Drafting
- Underwriting/ Marketing
- Fire Protection/ Property Preservation
- Risk Assessments
- Life/ Safety Risk Control
- Claims Consulting

2.3 Summary

India is already a leading player in wind energy. Estimates suggest that the potential for wind energy in India could be much higher than current estimates, with larger turbines operating at increased heights. This is likely to ensure an even faster growth for the wind energy sector in India.

The growth in wind energy sector is expected to bring forth a whole range of opportunities for Indian entrepreneurs and businesses, and these opportunities are present along the entire wind energy business value chain. Significant opportunities are expected to open up in the manufacturing segment, especially for the manufacture of wind turbine components, with a move towards greater indigenization in the wind industry. Attractive opportunities – some of which are niche in nature – are available in the services sector as well, and these opportunities are available for diverse entities such as small businesses, landowners and entrepreneurs. Trading opportunities for products are limited currently owing to the current structuring of the industry supply chain, but with the opening up of the Indian electricity sector, wind power producers can expect more options available for the trading of the power produced by them.

about EAI
Energy Alternatives India

EAI is the Foremost Research and Consulting Company for the Indian Renewable Energy Industry

We have a dedicated focus on the Indian renewable energy sector

We are unique in our focus on market and strategy research for renewable energy

Our team has assisted businesses large and small on a variety of renewable energy projects.

Our expertise has been sought by Fortune 100 companies

Our team comprises professionals from premier institutes such as the IITs and IIMs

The cumulative wisdom of our team, derived from extensive research and hands-on consulting, has provided us with deep insights about the industry which few, if any, have.

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