CREATING GREEN JOBS: EMPLOYMENT GENERATION BY GAMESA-RENEW POWER'S 85 MEGAWATT WIND PROJECT IN JATH, MAHARASHTRA

Facing rising fuel prices, threats to energy security, and the need to manage economic growth with pragmatic consideration of climate change, renewable energy offers a critical solution to India's burgeoning energy demand challenges. Further, renewable energy technologies are more labor-intensive than more mechanized fossil fuel technologies, as demonstrated in more mature markets, and can provide a tremendous opportunity to create domestic jobs.[1] Wind power, constituting the largest share of India's installed renewable capacity at 68 percent, is price competitive with conventional thermal power in India. This robust, 30 year old market is expected to be vital to realizing India's goal of doubling renewable energy capacity in the country by 2017, as outlined in India's 12th Five Year Plan. This maturing sector also presents an added opportunity to generate significant employment in the country.

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Currently, the economic and social benefits of employment generated by the wind market remain largely unknown to potential market investors and the broader Indian public who stand to benefit from the growth of this industry. Evaluating this opportunity can provide a much-needed impetus for strong policy to promote the wind market in India. Existing studies and anecdotal evidence from the industry, however, fail to provide consistent and adequately in-depth analysis of the jobs created in the market. Further, there is a dearth of analyses to shed light on the nature of employment generated during phases of a wind power project execution.

To capture the existing scenario of wind employment in India and estimate actual wind job numbers, NRDC and CEEW conducted a survey of wind companies. To get a clearer picture, we also evaluated the jobs created by a specific project: an 85 megawatt (MW) wind project developed by Gamesa in Jath, Maharashtra.

Key findings from our analysis included:

1. Only in-depth and continuous interaction with the market players will allow an accurate and reliable estimation of employment in the Indian wind market.
2. In the business development phase, most jobs generated are skilled in nature.
3. The majority of employment is generated during construction and commissioning and the number of FTE employees required during this phase increases with project size.
4. Job creation across wind firms vary depending on nature of activities undertaken.
5. The 85 MW wind power project in Jath created a total of 438 FTE jobs in the first year of operations, including 102.5 annual FTE jobs post-commissioning over the 20-year lifespan of the project.

Conversations with wind companies and insights from the in-depth job profile of the 85 MW Jath-ReNew project commissioned by Gamesa show that maximum employment opportunities exist in construction and commissioning and in operations and maintenance, particularly for members of the local community in semiskilled and unskilled roles. Employment generated during construction, commissioning, and O&M phases of a wind project increase as project capacity increases. Manufacturing of wind components also enables skilled workers to be hired as engineers, managers, executives, and technicians. Growth in wind projects presents a significant opportunity for the sizeable number of civil and electrical engineers in India's workforce.

Looking ahead, the wind industry should maintain transparency and a willingness to share data to lend credibility to the sector and build confidence among policymakers, enabling them to continue with stable, long-term policies and incentives promoting further growth of the industry.

Prior Wind Employment Studies

The Ministry of New and Renewable Energy (MNRE) and the Confederation of Indian Industry (CII), first to approximate renewable energy employment in India, estimated that with an installed capacity of 10,900 MW, the Indian wind market employed 42,000 people as of October 2009.[2] The report projected that the market would employ 46,500 workers by end of 2015 and 80,000 by 2020, assuming a 10 percent annual rate of growth.

In 2012, the Global Wind Energy Council (GWEC) published a report that pegged employment in the Indian wind market at 47,500 jobs. The analysis estimates that employment would increase to more than 98,000 by 2020.[3] The 2013 annual reports of REN 21 and the International Renewable Energy Agency (IRENA) estimate Indian wind employment at 48,000 as of 2012.[4]

Interestingly, MNRE's 2013 Report on Developmental Impacts of Renewable Energy is unclear on jobs generated in the wind sector. It estimates the wind market to have employed a total of 2,000 people as of 2009.[5] Further, significant variations exist among the estimates reported in studies and the figures quoted by manufacturers. For example, some reports estimate that wind generates about 15 jobs per MW of wind capacity installed.[6] This translates to roughly 315,000 jobs for India's installed wind capacity of 21 GW (as of March 2014), which is well beyond the employment figures projected in existing literature. Additionally, industry estimates suggest that one extra job is generated for operations and maintenance (O&M) for every 3 MW of wind capacity installed.[7] However, no studies substantiate this claim.

WIND JOBS SURVEY ANALYSIS

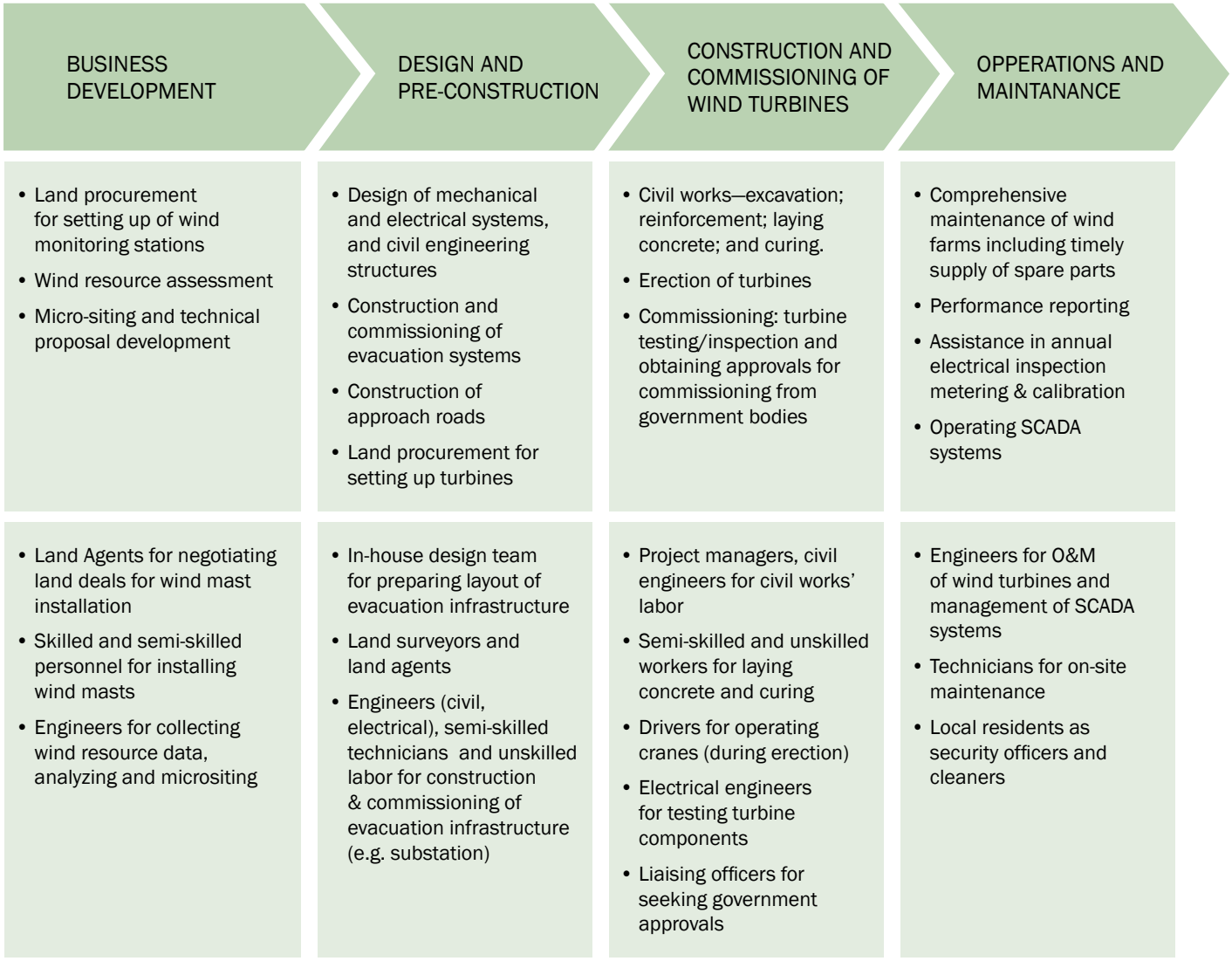
INTERPRETATION OF RESULTS

A diverse set of players operating in the wind industry are represented through the limited questionnaire responses we received:

- Respondent A: Wind Consultancy (Project Capacity: 47.6 MW)
- Respondent B: IPP (Project Capacity: 43.5 MW)
- Respondent C: IPP (Project Capacity: 37.5 MW)
- Respondent D: Developer & Turnkey Solutions Provider (Project Capacity: 50 MW)
- Respondent E: Turnkey Solutions Provider (Project Capacity: 85 MW)

We used the numbers we received as part of the complete responses to estimate the full-time-equivalent (FTE) employment generated by the five respondents. Figure 2 illustrates the FTE of employment generated by each respondent across the four stages of a wind power project.

Figure 1: Wind Project Execution Process



KEY FINDINGS AND DISCUSSION

1. Only in-depth and continuous interaction with the market players will allow an accurate and reliable estimation of employment in the Indian wind market.

A lack of the estimated size of contractor crews deployed during various phases of the project limits the full picture of job creation. Obtaining a broad set of jobs data for the projects would have required numerous interactions with various contractors hired for development of evacuation systems, construction, commissioning, and operations and maintenance of wind turbines. The incomplete nature of the information obtained through survey responses underlines the need for a detailed assessment of FTE jobs from a project-based point of view.

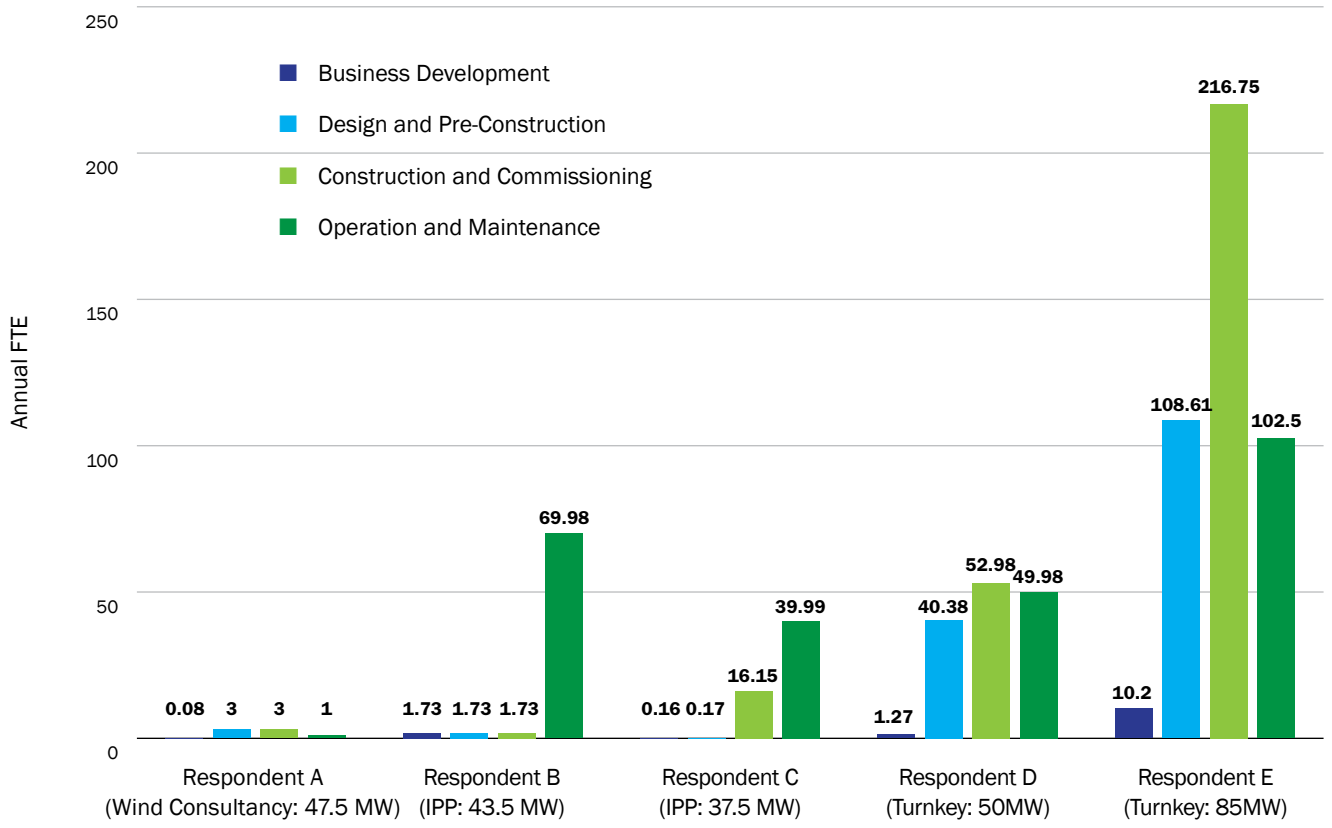
2. In the business development phase, most jobs generated are skilled in nature.

All five respondents deployed only skilled workers in the business development phase (100 percent share of the total deployed). However, it is important to note that in this stage, respondent E, the turnkey solutions provider deployed the most workers. This variation could be attributed to the diverse nature of business development activities by the respondents. For example, a turnkey solutions provider undertakes crucial activities such as wind resource assessment and land procurement, whereas an IPP player may focus primarily on financing.

3. The majority of employment is generated during construction and commissioning and the number of FTE employees required during this phase increases with project size.

The analysis shows that as project size increases, there is an increase in FTE workers employed for construction and commissioning. Respondents deployed a blend of skilled and unskilled labor in the construction and commissioning phase. Both turnkey solutions providers deployed a higher proportion of unskilled workers. The IPP respondent was found to deploy solely contractor's staff (both skilled and unskilled) in the construction and commissioning phase,

Figure 2: Survey Responses—Overview of employment generated across the project lifecycle



Source: CEEW and NRDC Analysis, August 2014.[8]

highlighting the fact that IPPs subcontract construction and commissioning activities. The survey responses also suggest that the number of unskilled personnel outweighs the skilled workforce in the construction and commissioning phase irrespective of whether they are outsourced.

4. Job creation across wind firms vary depending on nature of activities undertaken.

After analyzing responses from a mix of wind companies, it was observed that employment generation is dependant on the roles and activities undertaken by a particular wind company during wind project execution. For example, turnkey solutions providers (respondents D and E) create maximum jobs by virtue of of undertaking wide range of activities ranging from wind resource assessment, land procurement, designing, building evacuation infrastructure and roads, construction of wind farms and overseeing operations and maintenance. On the other hand, respondent A (Wind Consultancy) reported least number of FTE staff which is attributable to the limited nature of their involvement in a wind energy project. They were active only in wind resource assessment, technical due diligence, finance facilitation, and facilitating PPA agreements. Independent Power Producers (IPPs) finance wind projects and employ turnkey solutions providers for project implementation and to track progress of wind projects.

Methodology

To determine actual job market numbers, NRDC and CEEW developed a questionnaire to survey companies in the Indian wind market and capture the existing scenario of wind employment in India. First the survey was conducted through online tools and direct telephone interviews, with limited results. To enhance the results, Dexter Consultancy was retained to seek responses on the questionnaire through additional telephone interviews. Through a set of 16 questions, the survey solicited project- and policy-specific information to assess how many jobs have been created in India. Project-specific questions were categorized according to the stages in the project execution process.

The questionnaire was presented to 19 wind companies—a mix of manufacturers, turnkey solutions providers, independent power producers (IPPs), and wind consultancies. The questionnaire was also shared with industry associations such as the Indian Wind Turbine Manufacturers Association (IWTMA) and the Indian Wind Power Association (IWPA) to promote wider dissemination and to build confidence about the project among member companies. Of the nineteen companies that received the questionnaire, only eight responded and only five of those responses were complete and usable. This result is telling of the general culture in the Indian market regarding disclosure of employment numbers.

A CLOSER LOOK: EMPLOYMENT GENERATION FROM THE GAMESA-RENEW POWER WIND PROJECT IN JATH, MAHARASHTRA

PROJECT PROFILE

Our analysis estimates the skilled, semiskilled, and unskilled jobs generated by the 85 MW wind power project commissioned by Gamesa in Jath, located in the Sangli district of the state of Maharashtra. The project was financed by ReNew Power. The project was commissioned in phases, with 22 MW commissioned in September 2012, 4 MW in January 2013, and the remaining 59 MW in July 2013.

The project uses 30 G97-2MW turbines and 29 G58-850 kW turbines and is estimated to generate 205 million units (MU) of power annually (1 unit = 1 kWh).

ReNew Power signed a power purchase agreement (PPA) with the Maharashtra State Electricity Distribution Company Ltd. for a period of 13 years. The tariff rate applicable under the PPA for fiscal year 2012–13 was Rs 5.67 per kWh ($0.105); in March this increased to Rs 5.81 per kWh ($0.108).

While no single template for the number of jobs created for a wind power project exists. Jobs are driven by a number of variables, including time frame, skill level of the resources available, and financial factors. Gamesa volunteered information to help define employment characteristics across a wind project's phases for purposes of this profile.

The analysis examined employment generation at the Gamesa-ReNew Wind Farm during the following phases:

- early-stage measurement of wind resources;
- construction of evacuation systems and land procurement for wind farm;
- in-house manufacturing of wind turbine components;
- construction and commissioning of the wind power project; and
- annual operations and maintenance.

ABOUT GAMESA

Gamesa operates in India as a wind manufacturer and turnkey solutions provider. The Spanish company has installed projects with a total capacity of 1,000 MW in India thus far and is currently in the process of commissioning another 1,500 MW there. The company has around 850 employees in India. Gamesa makes blades in its manufacturing facility in Vadodara, Gujarat, producing 142 blades per year. It also operates a nacelle assembly plant in Chennai having a manufacturing capacity of 1,000 MW. In addition, Gamesa has a second plant in Chennai that was originally set up for assembly of nacelles but is currently being used as a service center. Furthermore, the company has discontinued operations of its India-based research and development center, which previously supported the global R&D team.

ABOUT RENEW POWER

ReNew Power was founded in 2011 as an independent power producer (IPP). It has commissioned 370 MW of wind power so far and aims to reach 1 GW by the end of 2015. In 2013, ReNew secured an equity investment of Rs 763 crore ($135 million) from the private equity arm of Goldman Sachs, the world's largest investment bank, marking the single largest investment in India's renewable energy market so far.

Project Details	
Item	**Description**
Project Name	Jath–ReNew
Location	Jath, Sangli district, Maharashtra
Capacity	85 MW
Financing	ReNew Power (IPP)
Turnkey solutions provider	Gamesa
Power purchaser	Maharashtra State Electricity Distribution Company Ltd.
Duration of PPA	13 years
Turbine models used	G97 (2 MW) and G58 (850 kW)
Plant load factor (PLF)	27 percent
Estimated annual power generation	205 MU
Blades supplier	LM Glassfibre, Gamesa
Nacelles supplier	Gamesa
Towers supplier	Anand Engineering, Welspun, DN Wind
Other component suppliers	ABB (Generators), Winergy (gearboxes), L&T (hubs), Gamesa Electric (control systems)
Other key service providers for the project	Shri Maruti Infrastructure Developers Pvt. Ltd., PRDC, third-party validation of wind assessment
Estimated lifespan of project	20 years
Jobs supported per year	438 total full-time equivalent (FTE) during first year of operation, with 102.5 FTE jobs per year post-commissioning for lifespan of project • Skilled: 67 FTE (15%) • Semiskilled: 268 FTE (61%) • Unskilled: 103 FTE (23%)

ESTIMATES OF EMPLOYMENT GENERATED ACROSS EACH PHASE

BUSINESS DEVELOPMENT

Business development entails two key activities that can generate employment:

Wind resource assessment: Construction of a wind farm rests on this strong foundational step. Wind resource assessment requires setting up tubular wind monitoring masts (equipped with anemometers, wind vanes, and data loggers) to record wind speed, direction, density, and other climatic conditions for two years. The two-year data on local wind conditions are crucial to a feasibility analysis of the selected site.

Gamesa hired skilled external agents to negotiate land deals, frame lease agreements, and facilitate the final purchase of land required to set up three wind monitoring masts. The company deployed two in-house skilled supervisors and four semiskilled staff to install the wind masts. It also engaged local people as security personnel to oversee the masts for two years, two for each mast. Two additional Gamesa employees were involved full-time in recording wind resource data for two years on a continual basis.

Micro-siting and technical feasibility analysis: Data collected as part of the wind resource assessment were analyzed to calculate wind direction, annual average wind speed, and turbulence. These data, in conjunction with information on site landscape and meteorological conditions, were used to select the appropriate turbine type, the tower height, and optimum wind farm layout for maximum energy output. This process, called micro-siting or siting of turbines, was carried out by three in-house engineers over a span of 15 days.

Table 1: Business Development - Resource Requirements

Activity	Key Resource	Duration
Wind Resource Assessment	*Skilled:* 2 external land agents, 2 external supervisors (engineers) for wind mast installation, 2 engineers from Gamesa recording on-site wind and weather data for 4 months every year for 2 years. *Semiskilled:* Contractor's 4-member team performing wind mast installation, 6 security guards for wind masts throughout 2-year period.	2 Years
Data Analysis, Micro-siting, and Technical Feasibility Report	*Skilled:* In-house managers and engineers analyzing 2 years' worth of wind data, wind resource assessment team of 3 engineers conducting technical assessment and micro-siting.	15 days

DESIGN AND PRE-CONSTRUCTION

Design and pre-construction entails preparation of layouts of the required evacuation infrastructure, construction and commissioning of the evacuation systems, and procuring land for erecting the wind turbines.

For this particular project, the evacuation infrastructure included:

(a) a pooling substation of 170 MW capacity: 85 MW x 2 to support future expansion (if any)

(b) 132 kilovolt (kV) extra-high-voltage (EHV) overhead transmission lines, 52 kilometers long

Design of evacuation infrastructure: A three-person in-house team was involved in designing the evacuation infrastructure, a task that took six months. Each member of the team contributed 30 to 35 percent of his or her working time to complete the design.

Construction and commissioning of evacuation infrastructure: Gamesa outsourced a mix of skilled, semiskilled, and unskilled employees to construct and commission the 170MW pooling substation over a period of 18 months. Gamesa further employed unskilled labor from the local vicinity for a period of six months to carry out construction of access roads leading to the substation.

Skilled, semiskilled, and unskilled staff were outsourced to undertake construction, erection, and stringing of the 132-kV high-voltage overhead transmission lines. This process took 14 months and was carried out in parallel to the construction of the substation. Permanent skilled employees were involved largely in a supervisory capacity.

Gamesa's in-house project management team was responsible for supervision of all activities related to building and erection of the evacuation infrastructure.

Land procurement: Gamesa needed 1.4 hectares of land to install a single 2 MW turbine and 1 hectare of land for a single 850 kW turbine. The process of procuring land took skilled and semiskilled personnel six to seven months to complete this activity. Further, Gamesa used two in-house lawyers (skilled) to fulfill legal requirements. Gamesa hired external agents including two land surveyors, five negotiators, two legal advisers, three skilled and two semiskilled aides who were responsible for registration and legal documentation. Gamesa hired local land agents to leverage their familiarity with the local government departments and legal procedures.

Table 2: Design and Pre-construction—Resource Requirements		
Activity	**Key Resource**	**Duration**
Design of Evacuation Infrastructure	In-house technical design team for preparing layout of evacuation infrastructure.	6 months
Construction and Commissioning of Evacuation Infrastructure	*Skilled:* 2 full-time Gamesa staff for oversight of overall work related to development of evacuation infrastructure; engineers and executives from contractor involved in materials procurement and substation civil construction and electrical erection; around 20 people subcontracted for building, erection, and stringing of 132-kV high-voltage transmission lines; team of 3 technicians and 1 engineer for cable termination. *Semiskilled and unskilled:* 25 technicians from contractor involved in construction and erection of substation; 90 contractor's staff (skilled and semiskilled) involved in building, erecting, and stringing of 132-kV lines, aided by 70 unskilled laborers. Contractor was also involved in right-of-way clearance by engaging with locals. Clearing the right-of-way (by removing obstructions such as bushes and trees) provides the necessary access for construction equipment and a safe work area for crews involved in construction, erection, and wire-stringing (installing conductors after construction of steel poles) for the 132-kV transmission lines.	15 months
Land Procurement	*Skilled:* 2 lawyers from Gamesa (working on several projects simultaneously) to take care of legal requirements, 2 land surveyors hired by Gamesa. *Semiskilled:* External agents helping lawyers with registration and legal documentation.	6 months

CONSTRUCTION AND COMMISSIONING

This phase of the project cycle is implemented simultaneously with development of the evacuation infrastructure.

Civil works: The civil works for this project took six to seven months to complete. Gamesa hired contractors to carry out all activities related to civil construction such as excavation for building wind turbine foundations, installation of the foundations' steel reinforcing structures, and the pouring and curing of concrete.

Placement of steel reinforcement structures was outsourced to five skilled, fifteen semiskilled, and five unskilled staff. Around two skilled, sixteen semiskilled, and sixteen unskilled personnel were deployed by contractors for construction of the foundation. This also required semiskilled drivers and helpers to operate ready-mix trucks, conveyor trucks, and equipment to pour concrete over turbine foundations.

Gamesa hired ten people from the local community to cure the concrete. Construction workers from the community were hired to build internal roads on the wind farm, including 59 gravel roads to access each turbine.

A two-member in-house project management team was responsible for supervising all activities during the entire phase. Gamesa deployed an in-house project management team consisting of civil engineers to oversee civil works, erection of turbines, and electrical termination.

Erection of turbines: After the curing period, the wind turbines were erected. Gamesa contracted staff including five highly skilled engineers and technicians, ten semiskilled technicians, and five unskilled staff for a period of three months. Skilled crane operators stacked the tower segments atop one another before adding the nacelle and blades to the top of the turbine. Around five skilled engineers and technicians were deployed for wind turbine cable terminations.

Construction of electrical yard and 33-kV lines: The power generated from the wind turbines passes through a network of transformers, isolators, and meters housed in the electrical yard and then fed to the 33-kV transmission lines that transmit the power to the on-site substation and act as electrical connections between the turbines. Gamesa outsourced work associated with building this infrastructure, which was supervised by its in-house technical project team.

Commissioning: Toward the end of erection of wind turbines, officials from the Maharashtra Energy Development Agency (MEDA) visited the site for inspection prior to commissioning. Gamesa deployed two in-house liaison officers and 4 semiskilled external agents to interact with government bodies for necessary permits and approvals. Commissioning took about three months. During this period, all systems, infrastructure, and wind farm equipment—such as motors and gearboxes—were thoroughly tested for efficiency and proper functioning, for which Gamesa deployed a team of highly skilled in-house engineers.

Around sixty security guard jobs were filled from the local community during the construction and commissioning phase to prevent theft of equipment and components such as the cable wires used in 33-kV transmission lines.

Table 3: Construction and Commissioning – Resource Requirement		
Activity	**Key Resource**	**Duration**
Civil Works (including road construction)	*Skilled:* 2-member project management team of civil engineers from Gamesa, contractor's staff for steel reinforcement and concreting of turbine foundations, 2 in-house employees to supervise construction of roads to towers. *Semiskilled and unskilled:* 15 semiskilled and 5 helpers/unskilled staff from contractors involved in steel reinforcement, 16 semiskilled drivers and operators of ready-mix trucks, 10 people from the local community for curing of concrete foundations.	7 months
Erection of Turbines	*Skilled:* 3-member Gamesa project management team to supervise erection activities and maintain site schedule, skilled crane operators (contractor's staff) for turbine installation, 5 skilled engineers and technicians as part of the erection crew, 2 technicians for cable termination. *Semiskilled and unskilled:* 10 semiskilled personnel and 5 helpers/unskilled laborers for turbine erection; 3 semiskilled contractor staffers for cable termination.	3 months
Construction of DP Yard and 33-kV Transmission Line	30 skilled technicians/engineers, 50 semiskilled personnel, and 45 helpers/unskilled laborers sourced from contractor for construction of electrical yard and 33-kV transmission lines.	6 months
Commissioning	*Skilled:* 2 in-house technical liaison officers to secure government approvals and permits, electrical engineers for testing turbines, 2 Gamesa employees to facilitate signing of PPA (involved for 3 months). *Semiskilled:* Subcontracted staff for interacting with government bodies; 60 local security guards stationed throughout construction and commissioning period.	3 months

OPERATIONS AND MAINTENANCE (O&M)

Over the 20-year lifetime of the project, wind turbine O&M includes regular monitoring and analysis of turbine performance, preventive mechanical and electrical checks and maintenance, and replacement or repair of turbines and other components of the wind farm.

Gamesa has staffed a dedicated on-site O&M team of 10 skilled technicians and engineers. The on-site O&M team is also responsible for annual inspections of access roads and minor repairs. The wind farm also employs local workers for maintenance and repair work.

Gamesa also engages around 20 in-house engineers to manage supervisory control and data acquisition (SCADA) systems. This staff simultaneously works across different projects. O&M also opens up opportunities for local employment.

Table 4: Job creation – Lifetime Operation and Maintenance		
Activity	**Key Resource**	**Duration**
On-site O&M	Around 10 full-time skilled employees (engineers and technicians) from Gamesa, responsible for regular electrical and mechanical checks, preventive maintenance of turbines, and road inspections. Around 20 employees from an O&M contractor are also involved in on-site maintenance.	20 Years
Operation of SCADA systems	20 in-house engineers stationed at Gamesa's head office, responsible for operating SCADA systems. This staff invests around 25% of its time on this project.	
Security of wind turbines	People from the local community deployed as security guards.	

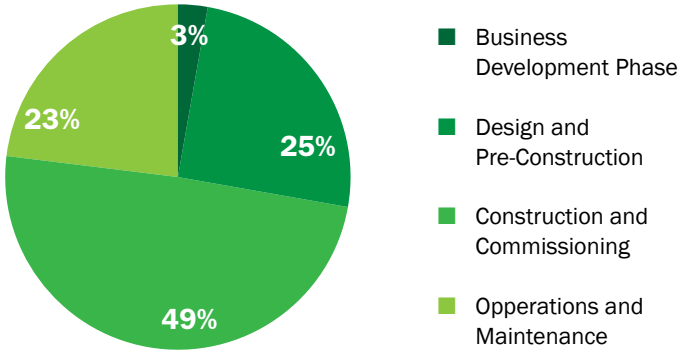
MANUFACTURING

Gamesa designs and manufactures its own blades, nacelles and towers and assembles the wind turbines itself. Rotors and nacelles for the 85 MW Jath-ReNew wind power project were sourced from Gamesa's blade manufacturing facility at Vadodara and its nacelle assembly plant in Chennai. Towers were sourced from a local supplier to avoid logistical difficulties related to transportation. The project used several additional components, such as gearboxes and hubs that were supplied by external manufacturers such as Welspun and DN Wind. Jobs associated with these components have not been estimated as part of this report.

On the basis of the numbers of employees at Gamesa's manufacturing facilities, we have estimated the employment generated by the manufacture of rotors and nacelles required for this 85 MW project. For manufacturing blades, 30 percent of employees were highly skilled managers and shift engineers and the remaining 70 percent were semiskilled technicians. The nacelle assembly employed 20 percent highly skilled personnel and 80 percent semiskilled technicians.

The figure shows both one-time jobs created during various phases of the pre-commissioning project cycle, and post-commissioning annual O&M jobs that will last for a duration of 20 to 25 years (the lifetime of the project).

Figure 3: Overview of full-time equivalent employees deployed during various phases of the project cycle

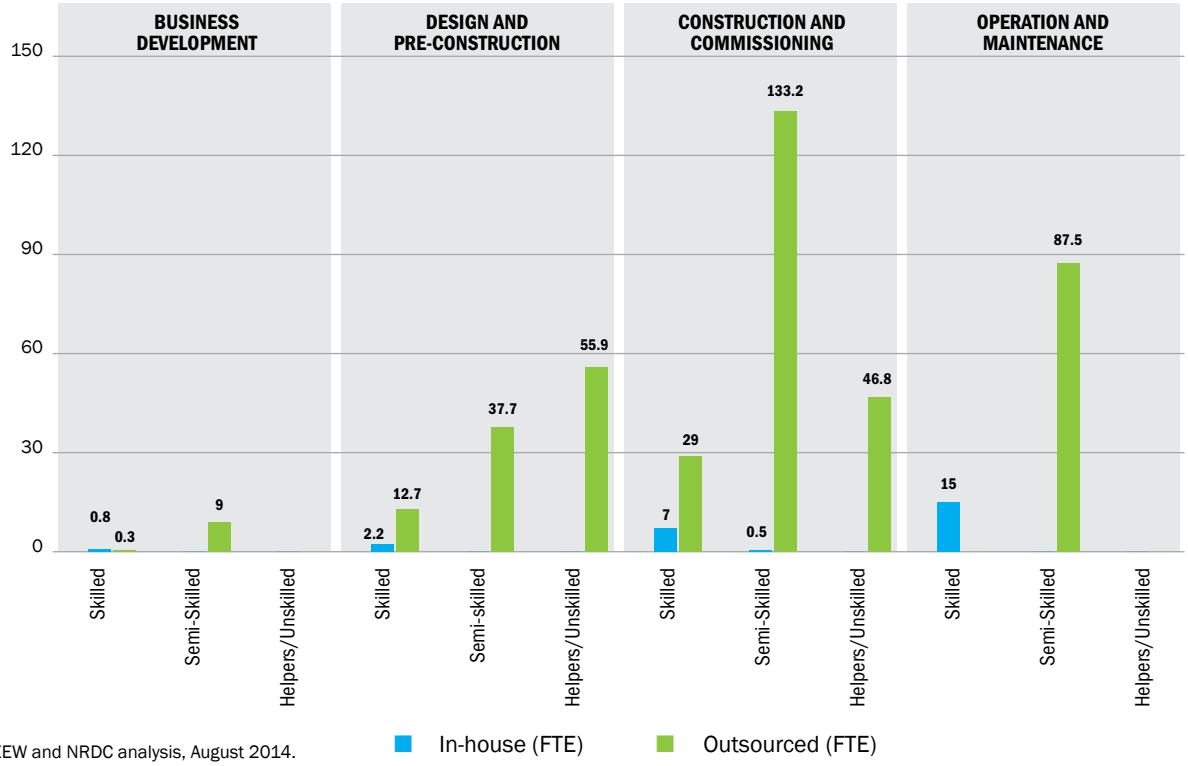


Source: CEEW and NRDC analysis, August 2014.

Table 5: Job Creation: Manufacturing

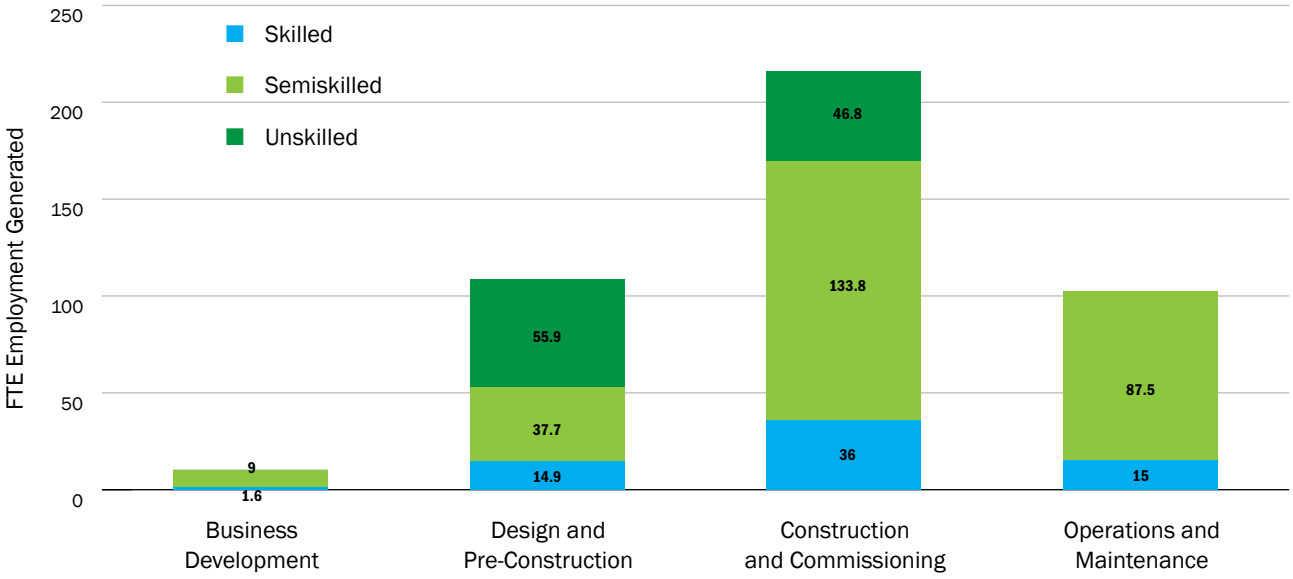
Activity	Key Resource	Duration
Manufacturing of Rotors	Personnel including managers, shift engineers, senior executives, and technicians	Approximately 6-7 months
Manufacturing of Blades	Highly skilled personnel including engineers, managers, executives, and production technicians	Approximately 6-7 months

Figure 4: Deployment of In-House and Contractor's Staff Across Project Cycle



Source: CEEW and NRDC analysis, August 2014.

Figure 5: Skilled, semiskilled, and unskilled employees (FTE) deployed during the project cycle



Source: CEEW and NRDC analysis, August 2014.

KEY FINDINGS OF THE PROFILED WIND ENERGY PROJECT

Based on the employment estimates shared by the Gamesa project team, we have estimated full-time equivalent (FTE) employees deployed in skilled, semiskilled and unskilled roles across the project cycle.

- **The 85 MW wind power project installed in Jath created a total of 438 FTE jobs in the first year of operations.** Of these, 3 percent were in the business development phase, 25 percent were for design and pre-construction, 49 percent for construction and commissioning of wind turbines, and 23 percent for operations and maintenance.
- Manufacturing: Gamesa's blade manufacturing and nacelles assembly facilities hold significant job potential for skilled workforce technicians including managers, engineers, executives, and technicians. However, these manufacturing FTE were not included in the total 438 FTE jobs.
- Business development created a total of 10.2 FTE of employment. This stage requires highly skilled and semiskilled personnel for wind resource assessment and micro-siting.
- Activities carried out during project development, such as design and pre-construction, created a total of 108 FTE jobs of employment. All jobs involving semiskilled and unskilled workforce were subcontracted or outsourced. Additionally, construction and commissioning activity created a total of 216 full-time-equivalent jobs.
- **The operations & maintenance phase of the project created 102.5 annual FTE jobs post-commissioning over the 20-year lifespan of the project.** Importantly, this phase generated approximately 67.5 full-time security jobs for local, semiskilled employees.

CONCLUSION

A strong and stable wind industry is crucial if India is to achieve energy security and reach its goal of a 15 percent share of renewables in the energy mix by 2020. Further, with expansion in installed capacity, the wind industry can emerge as an important driver of jobs for a skilled and unskilled Indian workforce.

This study demonstrated the difficulty of acquiring job estimates from the wind sector. The wind project cycle involves a wide variety of actors (including financiers, independent power producers, turnkey solutions providers, and contractors), and sourcing data from these players requires repeated inquiries and the building of trust. Further efforts should follow this report to gather comprehensive job estimates from wind industry players. Looking ahead, to showcase the employment potential of the sector and therefore an additional reason to support the renewable energy market, wind companies should maintain openness and transparency in sharing employment data.

ENDNOTES

1 Union of Concerned Scientists, *Benefits of Renewable Energy Use*, April 8, 2013, www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/public-benefits-of-renewable.html#jobs (accessed March 29, 2014).

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5 Ministry of New and Renewable Energy, *Developmental Impacts and Sustainable Governance Aspects of Renewable Energy Projects*, September 2013, http://mnre.gov.in/file-manager/UserFiles/report-on-developmental-impacts-of-RE.pdf (accessed August 8, 2014).

6 Global Wind Energy Council, *India Wind Energy Outlook 2009*, http://www.gwec.net/wp-content/uploads/2012/10/Ind_Wind-ENergy-Outlook_2009_GWEC.pdf (accessed August 8, 2014).

7 Suzlon, *Wind Matters: Making the Case for Wind in India*, June 2011, www.suzlon.com/pdf/case-for-wind.pdf (accessed November 11, 2013).

8 The height of the bars for Respondent E (85 MW project) is a result of more detailed job estimates obtained through repeated interviews, site visits, and interaction with the project team of the Jath project (profiled in detail in Section 3). The figure shows both one-time jobs created during various phases of the pre-commissioning project cycle, and post-commissioning annual O&M jobs that will last for a duration of 20 to 25 years (the lifetime of the project).

9 5.2 MU generated per 2 MW turbine (5.2 x 30 turbines); 1.7 MU of power generated by each 850 kW turbine (1.7 x 29 turbines).

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