

GREENING INDIA'S WORKFORCE

Gearing up for Expansion
of Solar and Wind Power
in India



SKILL COUNCIL FOR
GREEN JOBS

ABOUT THIS REPORT

About Council on Energy, Environment and Water

The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading not-for-profit policy research institutions. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public. In 2017, CEEW has once again been featured extensively across nine categories in the '2016 Global Go To Think Tank Index Report', including being ranked as South Asia's top think tank (14th globally) with an annual operating budget of less than \$5 million for the fourth year running. In 2016, CEEW was also ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings. In 2013 and 2014, CEEW was rated as India's top climate change think tank as per the ICCG standardised rankings. (<http://ceew.in/>) Twitter @CEEWIndia

About Natural Resources Defense Council

The Natural Resources Defense Council (NRDC) is an international non-profit environmental organization with more than 2 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC's India Initiative on Climate Change and Clean Energy, launched in 2009, works with partners in India to help build a low-carbon, sustainable economy. (www.nrdc.org) Twitter @NRDC_India

Authors and Investigators

CEEW Team: Neeraj Kuldeep, Kanika Chawla, Arunabha Ghosh

NRDC Team: Anjali Jaiswal, Nehmat Kaur, Sameer Kwatra, Karan Chouksey

Acknowledgements

The authors of this report thank officials from India's Ministry of New & Renewable Energy (MNRE) and the Skills Council for Green Jobs (SCGJ). We are further, grateful to the solar developers, wind developers and solar manufacturers, who shared their feedback and helped inform the findings of this report. We would also like to thank the following peer reviewers for their valuable comments: Dr. Praveen Saxena, Tanmay Bishnoi, Akhilesh Magal and Zach Amittay. We sincerely appreciate the valuable contributions by the following NRDC staff: Laasya Bhagavatula, Sayantan Sarkar, Kriti Sehgal, Christina Swanson and Leslie Jones. We thank Dexter Consultancy and Maction Consulting for their assistance in data collection for the jobs surveys. We also thank Boond Engineering & Development, Refex Energy, Indosolar, Gautam Solar, Jackson Power, Minda NexGen Tech, GSES India Sustainable Energy, Sterling and Wilson, Sun Edison, Vikram Solar, Rays Power Experts, Gensol, Azure Power, PLG Power, Welspun Energies, First Solar, Moser Baer Solar, Alpex Solar, Hero Future Energies, Cirus Solar, Clean Max, Aplussolar, Focal Energy, Mahindra EPC, Tata Power Solar, L&T Construction, Solaire Direct, Astonfield Renewables, Belectric, Renew Power, National Institute of Solar Energy, Claro Energy, Su-Kam, PLG Power, Nature Tech Infra, Sunsource Energy, EMC, Gamesa Renewables, Kshema Power Infrastructure, Pioneer Wincon, Enerfra, and Wind World India for participating in our surveys.

The authors would like to thank the funders of our work for their generous support.

Table of Contents

Executive Summary	4
1. Introduction	5
2. Scope of the Report: Direct Project-Related Jobs and Manufacturing Jobs	5
3. Methodology and Data Sample: Primary Market Surveys	6
3.1 Methodology	6
3.2 Survey Sample	8
3.2.1 Solar Developers	8
3.2.2 Wind Developers	9
3.2.3 Solar Module Manufacturers	9
4. Analysis: Estimating Job-Years Per MW for Solar and Wind Projects and Solar Manufacturing	10
4.1 Ground-Mounted Solar Projects	10
4.2 Rooftop Solar Projects	11
4.3 Wind Power Projects	11
4.4 Solar Manufacturing	11
5. Discussion and Findings	12
6. Key Policy Recommendations and Conclusion	15

EXECUTIVE SUMMARY

Job creation and skill development are key priorities for the Indian government. Jobs created from renewable energy offer a significant opportunity to meet the government's objectives on employment generation. However, credible information on the number of jobs that have been created so far, and those that can be created in future to achieve India's renewable energy goal of 175 gigawatts (GW) by 2022, has been lacking.¹

In an effort to fill this information gap, NRDC and CEEW conduct annual surveys of India's solar and wind companies, developers, and manufacturers to collect accurate, market-based information on jobs created, workforce employed, and the skills required to achieve India's renewable energy goals. This analysis builds on our previous reports on clean energy jobs in India. Our earlier analyses focused on renewable energy job creation, short-term and long-term. This report updates and translates those figures into actual full-time employment and workforce requirements.

The **key findings** of our 2017 analysis are:

1) Over 300,000 workers will be employed in the next 5 years, to achieve India's solar and wind energy targets, mostly in the rooftop solar sector.

2) A strong domestic solar module manufacturing industry has the potential to provide employment for an additional 45,000 people in India.

3) Solar and wind energy employed more than 21,000 people in India in 2016-2017, and are expected to employ an estimated 25,000 people or more in the following year.

4) Solar jobs will be well distributed across the country, while wind jobs will be concentrated in a few states.

5) Rooftop solar is more labour-intensive than other renewables, providing 24.72 job-years per megawatt (MW) in comparison to 3.45 job-years per MW for ground-mounted solar and 1.27 job-years per MW for wind power

National and state governments should promote reporting of employment generation from renewable energy companies; provide a greater policy priority to rooftop solar to create renewable energy jobs; support development of localized private sector-led training centres for solar construction jobs and wind power training centres in the 8 states with wind targets; and, promote a strong domestic solar module manufacturing industry to provide additional employment.


Over 300,000

workers will be employed for **more than 1 million jobs** to achieve India's solar and wind energy targets.


45,000
people in India

A **strong domestic solar module manufacturing** industry could provide employment for an additional

Solar and wind energy employed more than

21,000

people in India

in **2016-2017**, and are expected to employ an estimated

25,000

people or more in the following year



Solar jobs will be well distributed across the country, while wind jobs will be concentrated in a few states



Rooftop solar is more labour-intensive than other renewables, providing

24.72 job-years per MW

in comparison to **3.45 job-years per MW** for ground-mounted solar and

1.27 job-years per MW

for wind power



¹ Ministry of New & Renewable Energy, Jawaharlal Nehru National Solar Mission: Towards Building Solar India, http://www.mnre.gov.in/file-manager/UserFiles/mission_document_JNNSM.pdf (Accessed 3rd May 2017)

1. Introduction

Major economies around the world, are expanding the share of increasingly cost-competitive renewable energy technologies in their energy mix. These technologies generate critical energy for growth, add new jobs to the economy, and provide livelihoods for millions. The International Renewable Energy Agency estimates that renewable energy, excluding large hydropower, employed 8.3 million people globally, in 2016.²

Renewable energy job creation and skill development is one of the Indian government's foremost objectives. However, credible information on the number of jobs that have been created so far, and those that can be created in the future to achieve India's renewable energy goal of 175 GW by 2022, has been lacking.^{3,4}

In an effort to fill this information gap, every year for the past three years, NRDC and CEEW have surveyed India's solar and wind companies, developers, and manufacturers to collect accurate, market-based information on jobs created, workforce employed, and the skills required to achieve India's renewable energy goals.

We have used market information to estimate the workforce that would be required in India at any given time to meet the 2017 – 2022 national goals for annual capacity addition of solar and wind (160 GW), including ground-mounted and rooftop solar. We also estimate the number of jobs created by solar module manufacturing, as well as those that can be created if India meets its demand for solar modules domestically.

By estimating the employment impact from clean energy growth, our analysis offers actionable information to support and strengthen national and state-level policy and build support for renewable energy expansion in India.

Estimating Renewable Jobs and Skills Since 2014

Although common practice internationally, companies in India do not always self-report the number of jobs created with each new solar or wind project. Our analyses strive to bridge this information gap. Every year since 2014, NRDC and CEEW have surveyed solar and wind companies to estimate numbers of job created, identify skills required, and make policy recommendations that create conditions favourable for growth of clean energy in India.

This report builds on our previous analyses on job creation, *Clean Energy Powers Local Job Growth in India*, and *Filling the Skill Gap in India's Clean Energy Market*, with an enhanced scope that includes solar rooftop developers and solar module manufacturing companies⁵. Our previous research estimated that expanding solar and wind energy would add about 1 million cumulative jobs for solar installers, maintenance workers, engineers, technicians, and performance data monitors while addressing growing energy demands and global climate change.

2. Scope of Analysis: Direct Solar & Wind Project-Related Jobs and Solar Manufacturing Jobs

Employment in any industry, including renewables, can be broadly classified in three categories: direct, indirect and induced. For this analysis, we estimate the direct jobs as well as portion of the indirect jobs (manufacturing) created from solar and wind projects in India. This analysis does not include induced jobs and some of the indirect jobs, for example, those in the financing and banking sectors, or those created for data analytics or meter readers in distribution companies, since those jobs may not be specific to the solar or wind sectors.

2 International Renewable Energy Agency, 2017, Renewable Energy Jobs – Annual Review 2017, http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2017.pdf (Accessed 30th May 2017)

3 Ministry of New & Renewable Energy, Jawaharlal Nehru National Solar Mission: Towards Building Solar India, http://www.mnre.gov.in/file-manager/UserFiles/mission_document_JNNSM.pdf (Accessed 3rd May 2017)

4 The renewable energy target of 175 GW includes 100 GW of solar, 60 GW of wind, 10 GW of biomass and 5 GW of small hydro-power. For the purpose of this report, we have considered jobs created by solar and wind power, corresponding to a cumulative target of 160 GW by 2022.

5 NRDC - CEEW, Renewable Energy in India: Employment Potential and Financing Solutions for Solar and Wind Energy, <https://www.nrdc.org/resources/renewable-energy-india-employment-potential-and-financing-solutions-solar-and-wind-energy> (Accessed 3rd May 2017)

For solar manufacturing, we have only considered module manufacturing jobs and not included other components such as inverters, cables and other balance of system components in order to calculate jobs created on account the solar power sector. Specific examples defining direct, indirect and induced jobs are described in the text box below.

Difference Between Direct Jobs, Indirect Jobs and Induced Jobs⁷

Direct jobs, earnings, and output are the jobs associated with the design, development, management, construction/installation, and maintenance of projects and project facilities. For example, in installing a PV or large wind system, the direct impacts include the jobs for specialty contractors, construction workers, clean-up crews, truck drivers, and other specialists hired to permit, design, and install the system. It also includes management, business development and support staff.

Indirect jobs are the jobs associated with the manufacturing of equipment and materials used for the facility, the supply chain that provides raw materials and services to these manufacturers, and the finance and banking sectors that provide services for the construction and operation of a facility. For example, for a wind facility, this would include jobs at

wind turbine manufacturing plants and jobs at other manufacturing facilities that fabricate structural hardware, foundations, and electrical components for the wind facility's systems. It also includes the banker who finances the construction contractor, the accountant who keeps the contractor's books, and the jobs at steel mills and other suppliers that provide the necessary materials.

Induced jobs refer to the jobs created due to the spending of earnings by persons directly and indirectly employed by the projects (workers in the first two categories). For example, during the construction phase of a facility, jobs are induced when the workers hired to install a PV system spend their earnings to purchase food at grocery stores and restaurants, pay rent, and purchase clothes or other goods to meet their needs.

Tasks performed during the project lifecycle are classified as per the following phases of project deployment: business development, design and pre-construction, construction and commissioning and operations and maintenance, as described in figure 1.⁶ Each project development phase creates direct, indirect and induced employment.

6 NRDC - CEEW, 2014, Solar Power Jobs: Exploring the Employment Potential In India's Grid-Connected Solar Market, <http://ceew.in/pdf/ceew-nrdc-india-solar-jobs-report-25aug14.pdf> (Accessed 3rd June 2017)

7 National Renewable Energy Laboratory, 2012, Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the 1603 Treasury Grant Program, <http://www.nrel.gov/docs/fy12osti/52739.pdf> (Accessed on 25th April, 2017)

3. Methodology and Data Sample: Primary Market Surveys

3.1 Methodology

The study estimates workforce required for deployment of ground-mounted and rooftop solar photovoltaic projects, solar photovoltaic module manufacturing and wind projects in India. These estimates represent direct employment in the respective sectors. The estimates are based on primary data collected from multiple organisations engaging in project deployment activities. This includes, solar module and windmill manufacturers, project developers, engineering, procurement and construction (EPC) companies and turnkey solution providers.

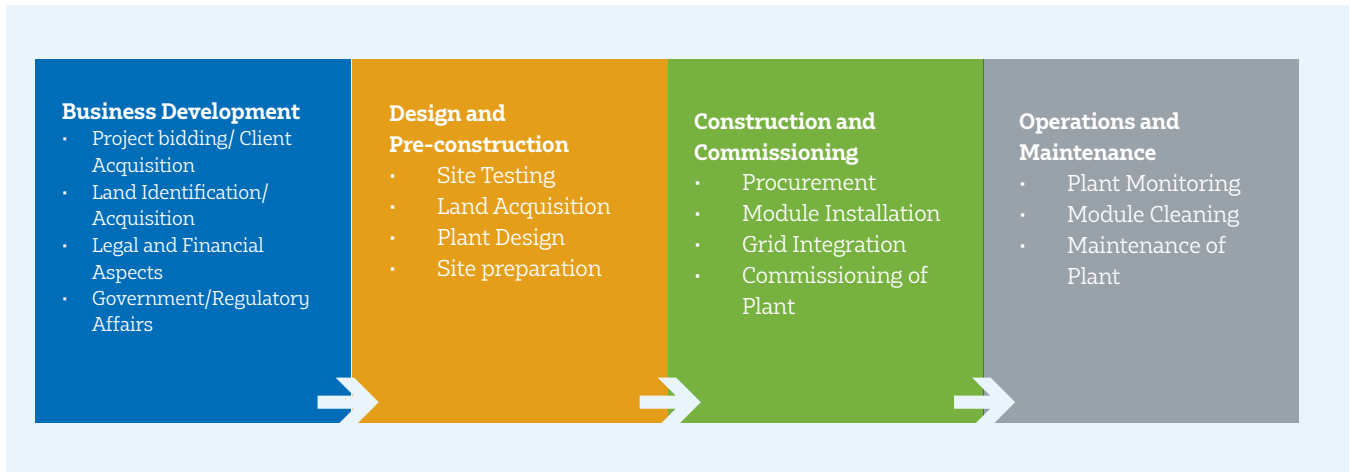
Jobs vs. Workforce/Manpower: An Explainer

In our 2015 analysis, *Clean Energy Powers Local Job Growth in India*, we estimated that scaling up grid-connected solar and wind energy would add a cumulative 1 million jobs for solar construction workers, installers, maintenance works, engineers, technicians, and plant operators between 2015 and 2022. These jobs include short-term jobs for business development, design and pre-commissioning, and construction and commissioning, as well as long-term jobs for operation and maintenance and performance monitoring.

Jobs created, however, is different from workforce needed. One worker can perform more than one job because some of the jobs are short-term. As a hypothetical example, assume the country has an installed capacity of 5 GW that has been deployed with a workforce of 1,500 people. In order to deploy an additional 15 GW in the following year, we would need those 1,500 people who have already been trained to deploy 5 of 15 GW as well as an additional 3,000 people to deploy the remaining 10 GW. The workforce required, therefore, is only the new 3,000 people that would need training. However, the jobs created totals 4,500 for the entire 15 GW of deployment.

In this analysis, we estimate the workforce required, i.e., number of workers needed to perform these 1 million jobs based on the planned capacity addition of grid-connected solar and wind energy between 2017 and 2022.

Figure 1: Solar and wind project deployment cycle



Source: CEEW – NRDC, 2014, *Solar Power Jobs: Exploring the Employment Potential in India's Grid-Connected Solar Market*

To determine solar and wind workforce numbers, we developed a detailed survey questionnaire, aimed at capturing key employment information for each of the four phases of ground-mounted solar, rooftop solar and wind project deployment. We developed a second questionnaire focused on solar manufacturing to tabulate the number of jobs created in this sector. The survey questionnaires also capture information related to employment potential at organisation level and distribution of skilled, semi-skilled and unskilled manpower in each stage of project deployment.

We used the data collected from the survey to calculate the workforce numbers and job-years per megawatt (MW) or the **full time equivalent (FTE)** per MW. We calculated FTE per MW numbers separately for each phase of solar and wind project deployment. We used these FTE numbers as coefficients to estimate the total workforce expected to be employed in the solar and wind energy project deployment process based on excess capacity to be added every year between now and 2022.

One-time vs. Full-time Employment

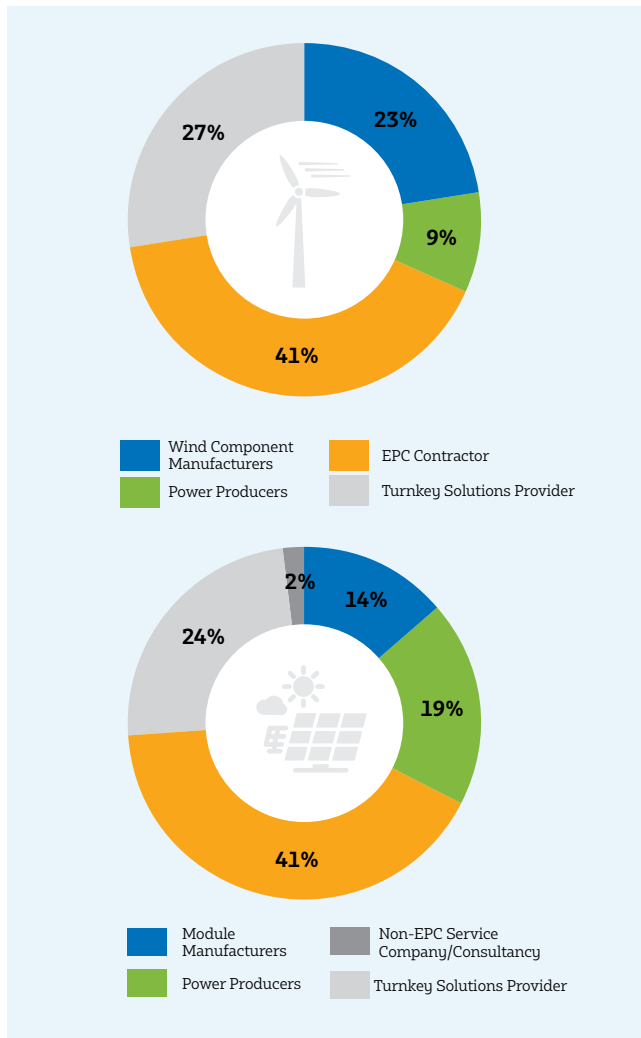
The first three phases of project deployment (i.e. business development, design and pre-construction, as well as construction and pre-commissioning) create one-time jobs. For example, once the project is designed or constructed, the employment generated from those functions is terminated and the workforce employed for those functions moves on to the next project. For the last phase of the project (i.e. operations and maintenance), the employment generated lasts for the lifetime of the project.

The *full time equivalent (FTE)* coefficient or job-year is simply a ratio of the time spent by an employee on a particular project/task in a given year to the standard total working hours in that particular year. The FTE formula translates short-term or one-time employment into a full-time equivalent or job-year. Therefore, all numbers in this report correspond to full-time equivalent employment.

3.2 Survey Sample

The survey respondents included 37 solar companies, 8 solar manufacturers, and 9 wind companies from the industry representing the complete value chain of the project deployment cycle, including contractors, power producers and turnkey solution providers. The survey responses represent diversity in terms of geographical distribution of respondents; small, mid and large-scale companies based on number of employees and their portfolio of solar and wind projects; individual project size; and consumer segment to represent a good range from the entire spectrum of renewable companies in India.

Figure 2: Distribution of solar and wind companies surveyed based on company function

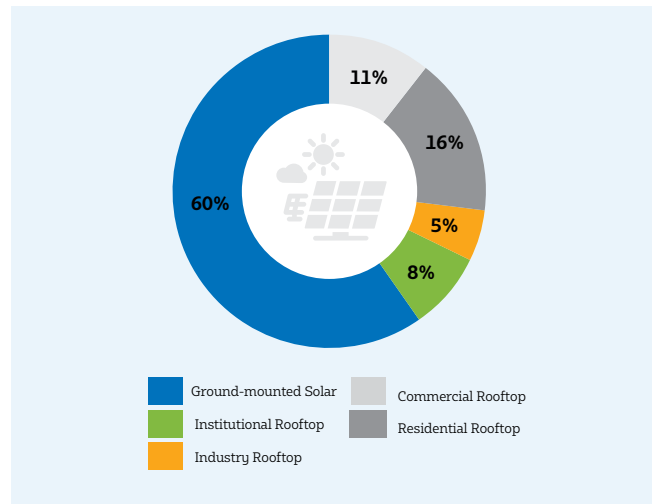


Source: CEEW-NRDC Analysis

3.2.1 SOLAR DEVELOPERS

For solar, both ground-mounted and rooftop, a total of 37 companies responded to the survey, with 60 percent of the companies developing ground-mounted plants and 40 percent developing rooftop solar projects. The rooftop solar respondents represent those that develop residential, commercial, industrial and institutional projects.

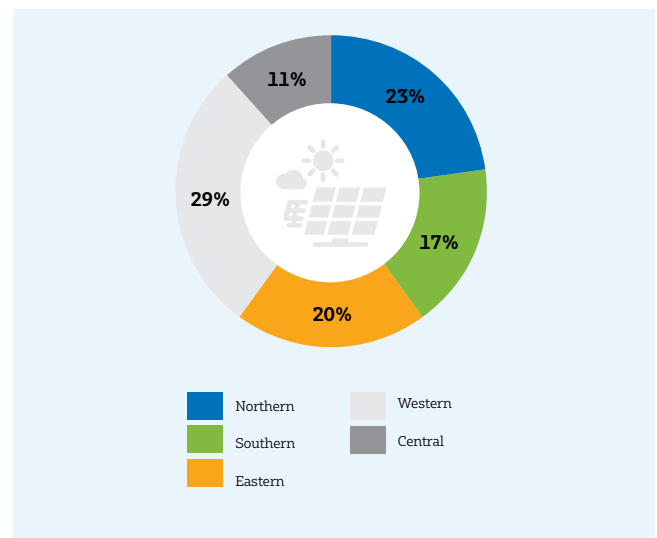
Figure 3: Distribution of solar respondents by market segment



Source: CEEW – NRDC analysis

Solar respondents are well distributed across India to capture the diversity in employment generated based on geographic location.

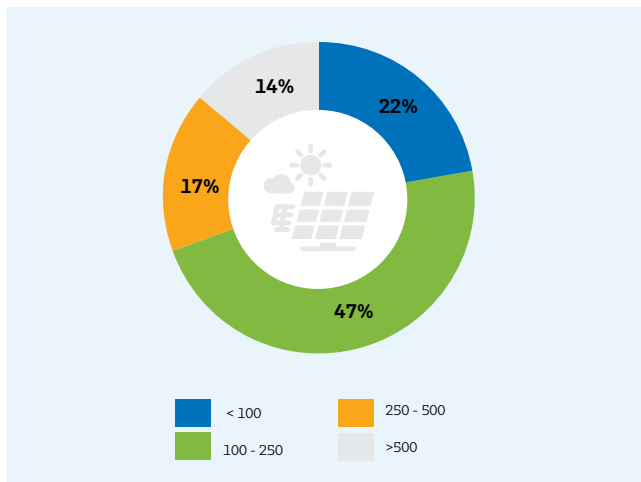
Figure 4: Distribution of solar survey respondents by region in India



Source: CEEW – NRDC analysis

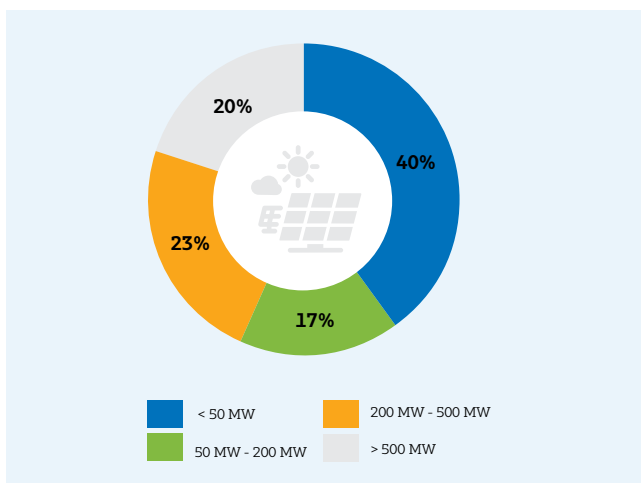
The solar respondents represent, small, mid and large-scale companies, based on number of employees and operational solar capacity. For solar power, both ground-mounted and rooftop, about 47 percent of the companies surveyed have between 100 to 250 employees representing a good range of small to large companies. Of the respondents, about 40 percent of the companies have deployed more than 200 MW of solar capacity each and about 40 percent control capacities of less than 50 MW. This highlights the participation of early stage companies in our survey.

Figure 5: Distribution of solar companies surveyed based on number of employees



Source: CEEW – NRDC analysis

Figure 6: Distribution of companies surveyed by operational installed capacity



Source: CEEW-NRDC Analysis

3.2.2 WIND DEVELOPERS

For wind, respondents represent close to 15,000 MW of installed wind capacity – about half the total installed capacity in the country. Respondents reflect a fair share of wind

companies involved in different functions throughout the entire lifecycle of a wind energy project, including component manufacturers, power producers, installers and turnkey solutions providers.

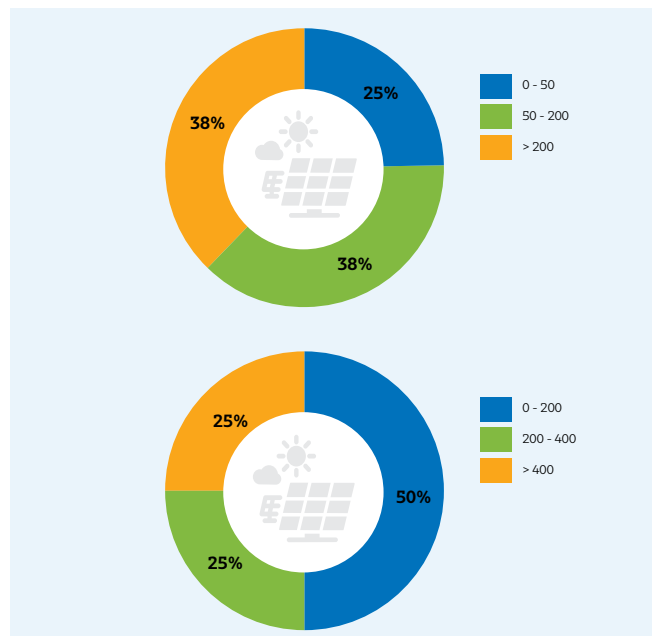
However, the survey data for wind manufacturing companies is not as granular as that for solar companies. Because of the nature of the wind industry, with many companies taking on multiple functions, segregation by phase and job type to estimate job-years or FTE per MW in the wind manufacturing industry is challenging and complex. Companies perform different tasks, both in terms of project deployment as well as component manufacturing. For example, it becomes difficult to estimate job-years per MW for a company that manufactures different wind equipment in different quantities and also does project deployment.

3.2.3 SOLAR MODULE MANUFACTURERS

Representatives of eight of India’s leading solar module manufacturing companies, eight companies with cumulative production of more than 1,500 MW, responded to our surveys. Respondents include smaller companies with a manufacturing capacity of about 5 MW per year as well as some of the larger manufactures with upwards of 500 MW of annual production capacity.

Respondents from the solar module manufacturing segment represents small, mid and large-scale companies, based on annual production capacity and total employee strength.

Figure 7: Distribution of companies by annual production capacity and number of employees



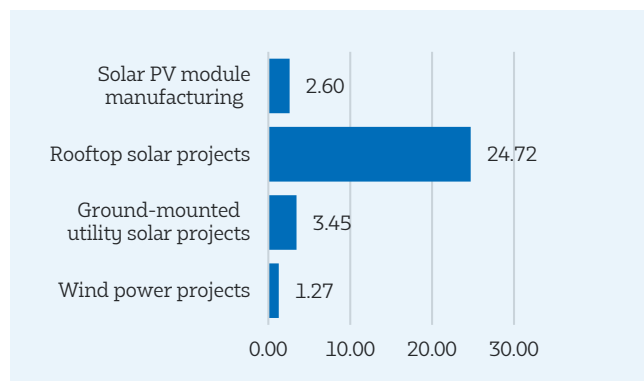
Source: CEEW-NRDC Analysis

4. Analysis: Estimating Job-Years Per MW for Solar and Wind Projects; and Solar Module Manufacturing

This section includes estimates of full-time equivalent (FTE) or job-year per MW for each phase of ground-mounted solar, rooftop solar and wind project deployment from business development, design and pre-construction, construction and commissioning as well as operations and maintenance. Similarly, FTE or job-year per MW estimates are also calculated for solar PV module manufacturing in India.

According to the analysis, rooftop solar projects create the maximum job-years per MW: 24.72 job-years per MW. This sector is followed first by ground-mounted solar projects, which create around 3.45 job-years per MW, and then by wind projects, which create 1.27 job-year per MW. Solar photovoltaic module manufacturing also creates employment of 2.60 job-years per MW of modules manufactured. Employment generation potential in each phase of solar and wind project deployment from business development to operations and maintenance is discussed in the following sub sections.

Figure 8: Employment coefficient (job-years per MW) for solar and wind sector



Source: CEEW – NRDC analysis

4.1 Ground-Mounted Solar Projects

Business development related activities create about 0.05 job-year per MW (FTE) from ground-mounted solar PV plant installations. Employment in this phase primarily requires skilled manpower. Some companies, however, also mentioned engaging semi-skilled manpower to facilitate land procurement and coordination with local organisations at the location of the project.

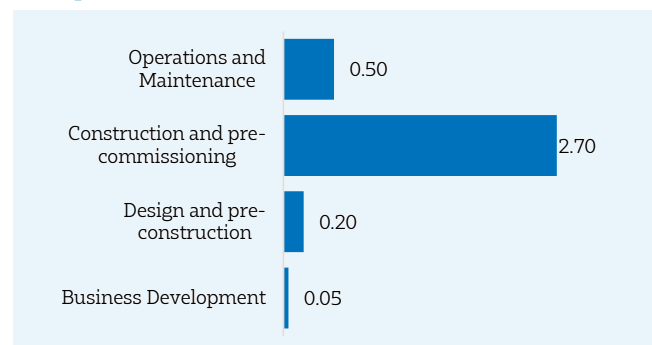
During **design and pre-construction phase**, about 0.20 job-years per MW are created from ground-mounted solar PV plant installations. About 60 percent of total manpower engaged in

this phase of project deployment are skilled. About 30 percent are semi-skilled and a small portion of manpower (about 10 percent) is unskilled, associated primarily with site survey and pre-feasibility related activities in this phase.

The **construction and pre-commissioning phase** creates the maximum employment for ground-mounted solar power, generating 2.70 job-years per MW. This also includes contract labourers deployed for the construction of entire plant. More than 50 percent of the jobs created in construction and pre-commissioning phase employ unskilled manpower.

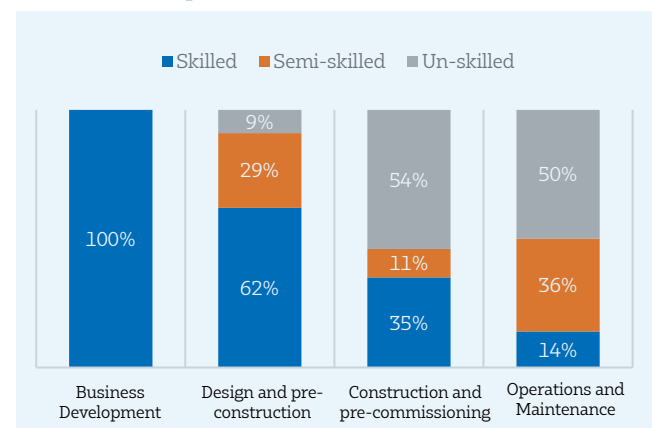
The **operations and maintenance** phase requires full-time permanent employees to ensure continuous operation of the ground-mounted solar PV plant. Operation and maintenance activities for a ground-mounted solar plant create employment equivalent to 0.50 job-years per MW. Most of these jobs are semi-skilled and unskilled in nature.

Figure 9 : FTE or job-year per MW for a ground-mounted solar plant



Source: CEEW – NRDC analysis

Figure 10: Distribution of skilled, semi-skilled and unskilled employment during each phase of a ground-mounted solar plant



Source: CEEW – NRDC analysis

4.2 Rooftop Solar Projects

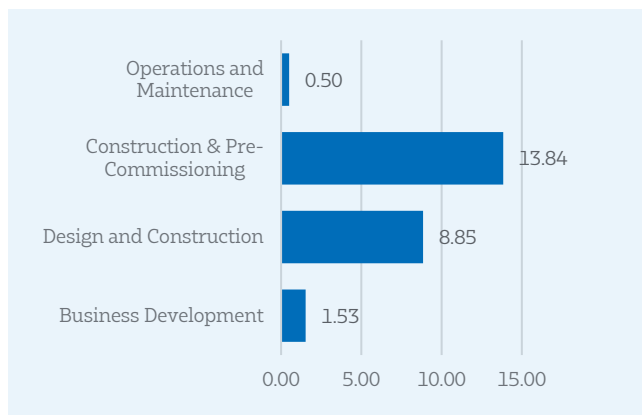
Business development related activities in the rooftop solar sector creates more jobs than the same activities for the ground-mounted utility scale solar sector. Rooftop installation of a solar PV project create about 1.53 job-years per MW. This relatively high job creation is primarily due to the small size of individual projects and the necessity of reaching out to a large consumer base.

For the rooftop projects, **design and construction phase** can be categorised as a single phase since design teams themselves oversee construction and commissioning of a solar PV project at consumer sites. In this phase, about 8.85 job-years per MW are created, with most of them requiring skilled (72 percent) and semi-skilled (20 percent) manpower.

The solar rooftop companies still require additional construction workers to undertake activities, which they either outsource to contractors or hire construction workers independently for a particular project. This leads to employment generation of 13.84 job-years per MW during the **construction and pre-commissioning phase**.

Some smaller companies that operate on the capital expenditure (CAPEX) model, in which the rooftop owners invest equity in the plant, do not have dedicated operations and maintenance teams. In such cases, the rooftop owners themselves do the regular cleaning and maintenance-related work. However, even relatively larger companies such as Cleanmax and Azure Power or other smaller companies that operate on the operating expenditure (OPEX) models outsource the operations and maintenance of their plants. The employment generated from rooftop **operation and maintenance** activities is about 0.50 job-years per MW in either scenario.

Figure 11: FTE or job-year per MW for a rooftop solar plant



Source: CEEW – NRDC analysis

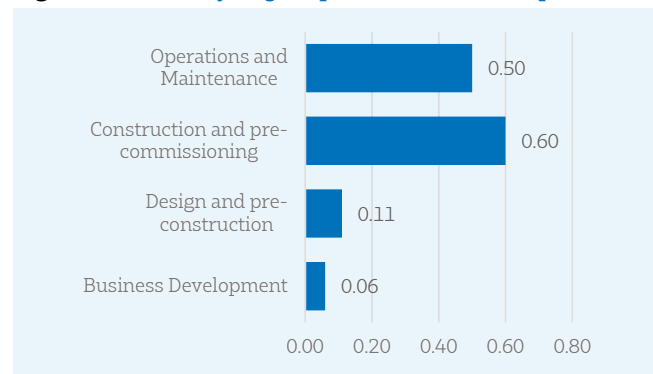
4.3 Wind Power Projects

About 0.06 job-years per MW are created during the **business development phase** of wind power projects. These jobs are primarily skilled in nature.

Wind project **design and pre-construction** related activities create 0.11 job-years per MW. **Construction and commissioning** of a wind plant creates 0.6 job-years per MW and **operation and maintenance** creates 0.5 job-years per MW.

In total, the wind industry creates about 1.27 job-years per MW from wind project deployment in India. This is lower than total employment generated from solar project deployment.

Figure 12: FTE or job-year per MW for a wind plant



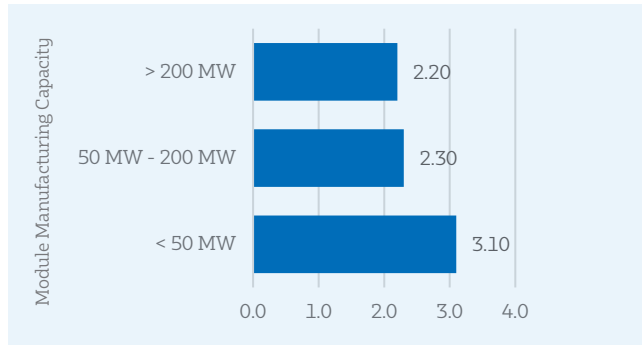
Source: CEEW – NRDC analysis

About 70 percent of the respondents mentioned that the average employee works on at least two projects simultaneously during the business development phase. The remaining 30 percent stated that their employees work on at least three or more projects simultaneously. About 60 percent of respondents indicated that an individual employee works on at least two projects simultaneously during the design phase. During the construction and operations and maintenance phases, however, each employee is assigned to only one specific project at a time.

4.4 Solar Manufacturing

Our analysis estimates that the solar module manufacturing sector generates an average of 2.60 job-years per MW. Companies with an annual production capacity of below 50 MW require about 35 percent more personnel than companies with higher capacities. The employment generation factor or the job-years per MW vary marginally with an increase in production capacity of above 200 MW.

Figure 13: FTE or job-years per MW for solar module manufacturing



Source: CEEW – NRDC analysis

In the solar module manufacturing sector, all the jobs are continuous in nature. According to the analysis, in a typical solar module manufacturing facility, more than 70 percent of the employees are engaged in production activities. This is followed by senior management, administration and accounts staff at 14 percent.

5. Discussion and Key Findings

Finding 1: Over 300,000 workers will be employed in the next 5 years, to achieve India’s solar and wind targets

Our analysis estimates that achieving India’s solar and wind energy goals by 2022 will provide full-time-equivalent new employment to 331,210 people in the country.⁸ These workers will need to be trained to undertake over 1 million employment opportunities (short-term and long-term cumulatively) that will be created in achieving India’s clean energy targets.⁹

Of the more than 300,000 workers, 237,980, or about two-thirds, will work in rooftop solar and the rest in ground-mounted solar and wind industries.

8 Note this is the number of people that need to be employed to meet the solar and wind targets. Our previous analysis had calculated the number of full-time equivalent (FTE) yearly jobs. For example, a project that requires a person working for three years counts as 3 FTE jobs.

9 NRDC - CEEW, Renewable Energy in India: Employment Potential and Financing Solutions for Solar and Wind Energy, <https://www.nrdc.org/resources/renewable-energy-india-employment-potential-and-financing-solutions-solar-and-wind-energy> (Accessed 3rd May 2017)

Table 1: Total employment generation in solar and wind industry by 2022

Jobs by 2022	Ground-mounted Solar (60 GW)	Rooftop Solar (40 GW)	Wind Power (60 GW)	Total (160 GW)
Business Development	500	13,770	360	14,630
Design and Pre - Construction	2,000	79,650	660	82,310
Construction and Commissioning	27,000	124,560	3,600	155,160
Operations and Maintenance	29,147	20,000	29,963	79,110
Total Jobs	58,647	237,980	34,583	331,210

Source: CEEW – NRDC analysis

Further, for ground-mounted solar projects, the employment coefficients are higher for smaller projects, sized between 1 – 5 MW, in comparison to large projects sized above 50 MW. This implies that if the deployment of 60 GW of ground-mounted solar constitutes more small-sized projects, this would result in greater employment generation or a higher workforce requirement to deploy the same capacity in bigger sized projects.¹⁰

Table 2: FTE and expected workforce requirement from rooftop solar

Rooftop Solar Jobs	Job-Years Per MW	Jobs - Total
Business Development	1.53	13,770
Design and Construction	8.85	79,650
Construction & Commissioning	13.84	124,560
Operation and Maintenance	0.50	20,000
Total	24.72	237,980

Source: CEEW – NRDC analysis

In total, the wind industry creates about 1.27 job-years per MW, lower than the total employment generated during solar project deployment.

Table 3: FTE and expected workforce requirement from wind

Wind Jobs	Job-Years per MW	Jobs - Total
Business Development	0.06	360
Design	0.11	660
Construction and Commissioning	0.60	3,600
Operations and Maintenance	0.50	29,963
Total	1.27	34,583

Source: CEEW – NRDC analysis

10 The Skills Council for Green Jobs estimates about 635,208 jobs in solar sector by 2022, considering smaller projects will have higher share of total deployment in the sector. This indicates the likely maximum employment in the sector by 2022.

Finding 2: In 2016-2017, solar and wind energy projects in India added more than 21,000 new jobs for the economy. In 2017-2018, most solar and wind companies expect to increase their workforce by at least 10 percent and employ an estimated 25,000-plus people.

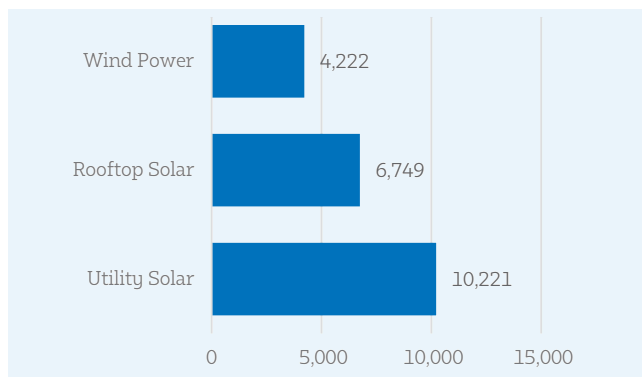
Based on our analysis of job-year per MW of employment generated from ground-mounted solar, rooftop solar and wind project deployment, 21,192 additional workers were employed in the financial year (FY) 2016 – 2017. An excess capacity addition of 2.5 GW of ground-mounted solar, 500 MW of rooftop solar and about 2 GW of wind power supported more than 600 business development personnel, more than 3,000 design and pre-construction personnel, more than 11,000 people for constructing and commissioning these projects and more than 5,000 people to operate and maintain these plants.¹¹

Table 4: Additional workforce employed in 2016 - 2017

New jobs in 2016-17	Ground-Mounted Solar	Rooftop Solar	Wind Power	Total
Business Development	125	418	119	662
Design	501	2,416	217	3,134
Construction and Commissioning	6,769	3,778	1,186	11,733
Operations and Maintenance	2,826	137	2,700	5,663
Total Jobs	10,221	6,749	4,222	21,192

Source: CEEW – NRDC analysis

Figure 14: New jobs created in solar and wind industry, in 2016-17



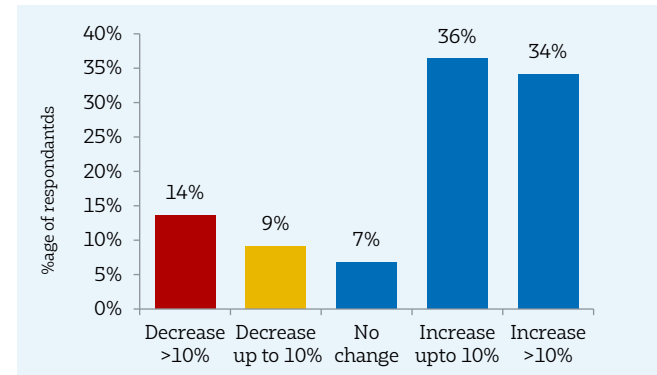
Source: CEEW – NRDC analysis

For the coming year, two thirds of the ground-mounted solar respondents expect to increase their workforce in 2017 – 2018. Of the 60 percent respondents, half (about 34 percent) expect that increase to exceed 10 percent. About 36 percent

¹¹ In 2016 – 2017, a total of 5.5 GW of solar capacity and 5.4 GW of wind capacity was added in the country. This equals to an excess capacity of 2.5 GW of solar (over and above the 3 GW that was added in the previous year) and an excess capacity addition of 2 GW of wind (over and above the 3.4 GW) added in the previous year.

of the respondents expect an increase in the number of employees by up to 10 percent, while 7 percent expect no change. This growth is linked to the growing footprint of Indian companies in domestic and international markets. About one-fifth (23 percent) of respondents, most of which are large engineering, procurement, and construction (EPC) companies, expect some decline in workforce. The expected decrease could be linked to growing competition in the sector and the improving efficiency of available manpower per project.

Figure 15: Expected change in workforce for ground-mounted solar



Source: CEEW – NRDC analysis

Similarly, all the wind power companies surveyed plan to increase their workforce in FY18 by at least 10 percent.

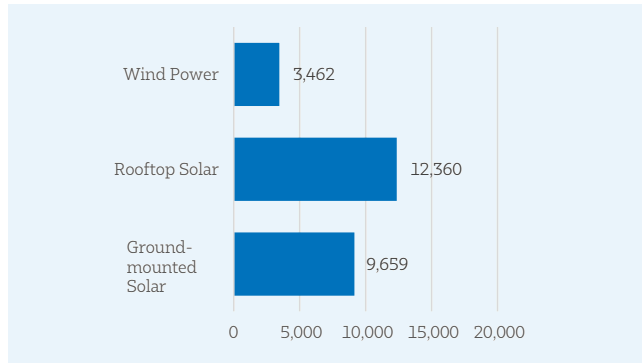
In the coming year, 2017 - 2018, we estimate that new ground-mounted solar, rooftop solar, and wind power capacity additions will employ an additional 25,481 people. This includes more than 1,000 people for business development, more than 5,000 people for design and pre-construction, and almost 20,000 people for construction and commissioning. Annual additional employment generation in solar sector, both ground-mounted and rooftop is expected to increase by almost 80 percent, whereas for wind sector it will come down by about 18 percent.

Table 5: Estimated additional workforce required in 2017 - 2018

New jobs in 2017-18	Ground-Mounted Solar	Rooftop Solar	Wind Power	Total
Business Development	99	765	36	900
Design and Pre-Construction	395	4,425	66	4,886
Construction and Commissioning	5,330	6,920	360	12,610
Operations and Maintenance	3,835	250	3,000	7,085
Total Jobs	9,659	12,360	3,462	25,481

Source: CEEW – NRDC analysis

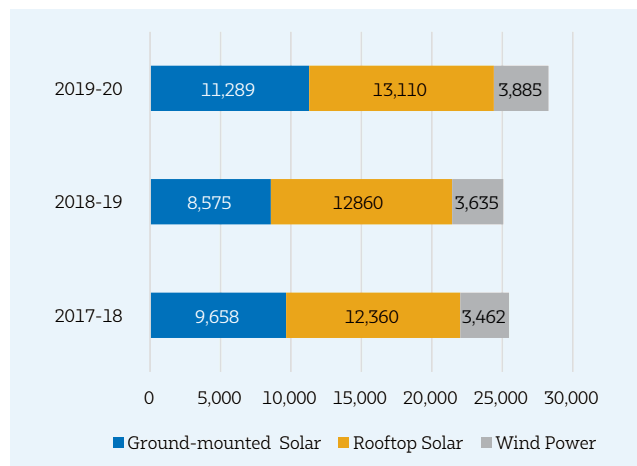
Figure 16: New jobs that are estimated in the solar and wind industry, in 2017-2018



Source: CEEW – NRDC analysis

In total, over the next three years from 2017 to 2020, employment for about 80,000 additional people will be generated in India.

Figure 17: Estimated additional workforce in the solar and wind industry required in the next three years from 2017 to 2020



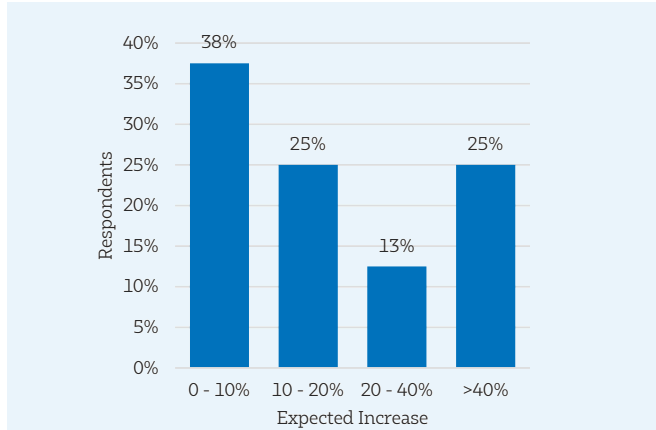
Source: CEEW – NRDC analysis

Finding 3: Solar module manufacturing could employ about 45,000 people if demand for modules is met domestically in India

We estimate that solar module manufacturing currently employs close to 2,900 people. With India’s reported plan to announce a policy for competitive domestic solar module manufacturing, all solar manufacturing companies surveyed expect to increase their workforce in FY 2017-2018. In fact, one fourth of them expect an increase in excess of 40 percent.

Further, we estimate that the domestic solar module manufacturing industry in India could employ an additional 45,000 people if the demand for solar modules is met domestically in India.

Figure 18: Expected change in solar manufacturing workforce in 2017 - 2018



Source: CEEW – NRDC analysis

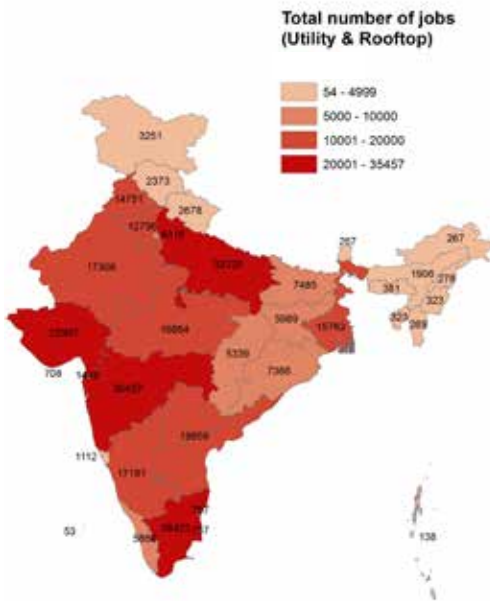
Finding 4: Solar power jobs will be well distributed across the country, while wind power jobs will be concentrated in a few states

Solar resources in India are well distributed across the country¹². State-wise installation targets for ground-mounted solar projects and rooftop solar projects set by the Ministry of New and Renewable Energy also reflect the same geographical diversity. Based on the Ministry targets, we estimated state workforce requirements. Based on our analysis, Maharashtra and Uttar Pradesh are estimated to have the most number of solar jobs in the country.

Wind jobs, however, are likely to be concentrated in the states that have high wind potential. According to the Ministry of New & Renewable Energy, 8 states have wind installation targets between 2017 and 2022.¹³ These include Rajasthan in the north, Gujarat, Madhya Pradesh, and Maharashtra in the west, and Andhra Pradesh, Telangana, Tamil Nadu, and Karnataka in the South.

12 National Institute of Solar Energy, Solar Energy Potential Map of India, <http://mnre.gov.in/file-manager/UserFiles/Statewise-Solar-Potential-NISE.pdf> (Accessed 3rd May 2017)
 13 Ministry of New & Renewable Energy, Tentative State Wise Break Up of Renewable Power Targets to be Achieved by 2022, <http://mnre.gov.in/file-manager/UserFiles/Tentative-State-wise-break-up-of-Renewable-Power-by-2022.pdf> (Accessed on 26th May 2017)

Figure 19: State-wise employment potential for solar in India

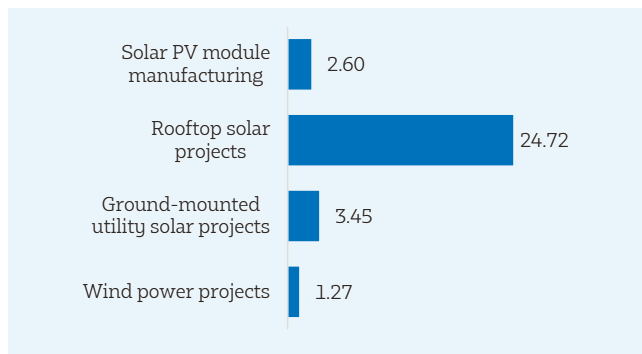


Source: CEEW – NRDC analysis

Finding 5: Rooftop solar is more workforce-intensive than other renewables, providing 24.72 job-years per MW in comparison to 3.45 job-years per MW for ground-mounted solar and 1.27 job-years per MW for wind power

Compared to ground-mounted solar (3.45 job-years per MW) and wind (1.27 job-years per MW), rooftop solar has the most workforce intensive project deployment at 24.72 job-years per MW. This is due to the smaller project sizes compared to ground-mounted solar or wind, which means that more people are required for installations.

Figure 20: Full Time Equivalent (FTE) for ground-mounted solar, rooftop solar, solar manufacturing and wind power projects



Source: CEEW – NRDC analysis

6. Key Policy Recommendations and Conclusion

Our analysis serves to further illustrate wind and solar employment opportunities in India as the nation moves toward its 2022 renewable energy targets, and can be used to design and implement clean energy policies at the state and national levels. The solar manufacturing employment potential highlighted here can serve to help the industry prepare.

Based on our analysis, national and state governments should focus on job-creation as a key policy area for solar and wind sectors in the country. Specifically, governments can:

- Encourage reporting of employment generation from renewable energy companies;
- Provide a greater impetus and policy priority to rooftop solar to create renewable energy jobs and meet the government's employment objectives;
- Support development of localized training centres led by the private sector to source construction jobs locally since solar jobs are well distributed among states;
- Develop wind power training centres on the basis of state-specific wind targets in 8 states; and
- Promote a strong domestic solar module manufacturing industry to provide employment to an additional 45,000 people in India.

For more information please visit:
www.nrdc.org | www.ceew.in



Reenergizing India's Solar Energy Market Through Financing



Creating Green Jobs: Employment Created by Kiran Energy's 20 Megawatt Solar Plant in Rajasthan, India



A Second Wind for India's Energy Market: Financing Mechanisms to Support India's National Wind Mission



Making Use of the Roof: Employment Generation from Hero MotoCorp's 80 kW Rooftop Solar Project in Haryana India



Solar Power Jobs: Exploring the Employment Potential in India's Grid-Connected Solar Market



Creating Green Jobs: Employment Generation from Wind Energy in India



Surging Ahead: Scaling India's Clean Energy Market Through Jobs and Financing



Natural Resources Defense Council

40 West 20th Street
New York, NY 10011
212 727-2700
Fax 212 727-1773
www.nrdc.org



Council on Energy, Environment and Water

Thapar House
124 Janpath
New Delhi 110001
+91 11 40733300
Fax: +91 11 40733399
www.ceew.in

Copyright © 2017 Natural Resources Defense Council and Council on Energy, Environment and Water

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior permission.