POWERING JOBS GROWTH
WITH GREEN ENERGY

CEEW THE COUNCIL

NRDC NATURAL RESOURCES DEFENSE COUNCIL

SCGJ SKILL COUNCIL FOR GREEN JOBS ISO 9001 : 2015 CERTIFIED

About this Issue Brief
This issue brief is a part of series of issue briefs, reports, case studies, and fact sheets on clean energy in India. This employment discussion builds on two earlier issue briefs on clean energy jobs, *Greening India's Workforce* (2017) and *Clean Energy Powers Local Job Growth in India* (2015).

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LIST OF ABBREVIATIONS

BD	Business Development
B. Voc.	Bachelors in Vocation Education
BESS	Battery Energy Storage System
CAD	Computer Aided Design
CEEW	Council on Energy, Environment and Water
CMS	Conditional Monitoring System
DDU-GKY	Deendayal Upadhyaya Grameen Kaushalya Yojayan
DRE	Decentralized Renewable Energy
E&C	Engineering and Construction
EPC	Engineering, Procurement and Construction
FTE	Full Time Equivalent
FY	Financial Year
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GST	Goods and Services Tax
GW	Gigawatts
HSE	Health, Safety and Environment
IPP	Independent Power Producer
JNNSM	Jawaharlal Nehru National Solar Mission
KUSUM	Kisan Urja Suraksha evam Utthaan Mahabhiyan
MNRE	Ministry of New and Renewable Energy
MSDE	Ministry of Skill Development and Entrepreneurship
MW	Megawatt
NOS	National Occupational Standards
NRDC	Natural Resources Defense Council
NSQF	National Skills Qualifications Framework
O&M	Operations and Maintenance
OEM	Orginal Equipment Manufacturers
PMKVY	Pradhan Mantri Kaushal Vikas Yojana
PV	Photovoltaic
QA	Quality Assurance
QP	Qualification Pack
RE	Renewable Energy
RPL	Recognition of Prior Learning

EXECUTIVE SUMMARY

Job creation and skill development are key priorities for the Indian government. Jobs created in the renewable energy market offer a significant opportunity to meet the government's multiple goals of employment generation, clean energy expansion, and economic development.

India's installed renewable energy capacity, which includes solar, wind, small hydro, and biomass power, has increased nearly five-fold in the last nine years from almost 17 gigawatts (GW) in financial year (FY) 2009-2010 (FY10) to over 80 GW in FY19.[1] Renewables now account for 22% of India's installed electricity capacity.[2]

The renewable energy sector deployed 21.2 GW capacity in just the last two years – 11.8 GW in FY18 and 9.3 GW in FY19 (Figure 1).[3] In FY18, India added more of solar and wind capacity (at 11.2 GW), than coal-fired and hydro put together at 9.5 GW.[4] Moreover, investments in the renewable energy sector outnumbered those in fossil-fuel-based projects in 2017 further signaling a transition towards clean energy.[5] This remarkable growth in renewable energy also creates thousands of jobs in India.

This issue brief provides an updated analysis on direct jobs created from solar and wind in FY18 and FY19, building on earlier analysis by the Skill Council for Green Jobs (SCGJ), the Council on Energy, Environment and Water (CEEW), and the Natural Resources Defense Council (NRDC). For this analysis, we use the workforce numbers and job-years per megawatt (MW) or the full time equivalent (FTE) coefficients calculated in earlier reports that are based on primary data collected from multiple companies active in India's renewable energy market.[6] This issue brief also provides updated findings and recommendations geared toward India's goal of 175 GW of installed renewable energy by 2022.

KEY FINDINGS

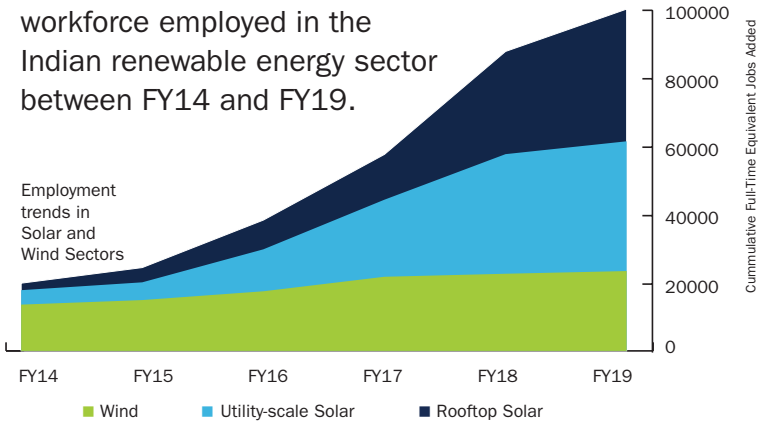
1. **The workforce employed in the Indian renewable energy sector grew nearly five-fold in the past five years**, rising from nearly 19,800 workers in FY14 to nearly 99,900 workers in FY19.
2. **The largest renewable energy employment growth occurred in FY18 with over 30,000 new workers** added in utility-scale ground mounted solar (referred to as utility-scale solar in the issue brief), rooftop solar, and wind energy. In FY19 this number dropped to nearly 12,400 newly-added workers given the limited renewable energy capacity added that year.
3. **Rooftop solar and other decentralized renewable energy technologies continue to employ far more workers than utility-scale solar and wind energy** – nearly 38,640 workers were employed for just 3.8 GW of total cumulative installed rooftop solar capacity until FY19, as compared to over 37,910 workers for 26.2 GW of total utility-scale solar and nearly 23,340 workers for 35.6 GW of total cumulative wind energy capacity installed in India until FY19.
4. **Stronger government programs and market investments are needed to meet India's clean energy targets of 175 GW and employment potential of over 330,000 workers creating nearly 1 million job opportunities (short-term and long-term) in the wind and solar sectors by 2022**, especially given the recent market slowdown in FY19.
5. **Training programs by SCGJ trained over 58,000 workers between FY16 and FY19**, demonstrating that training centers in smaller town and rural areas can help develop the skills needed in the local workforce and help expand the renewable energy market across India.

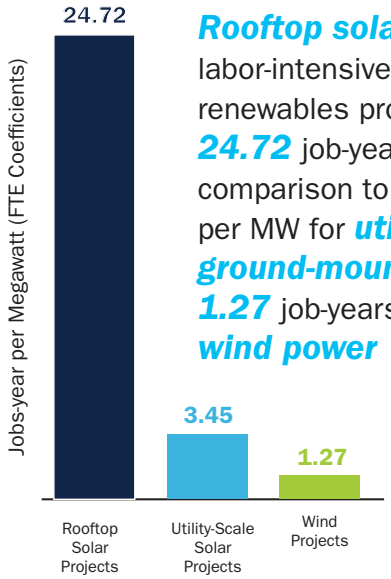
KEY RECOMMENDATIONS

As India works toward meeting these goals, there is significant opportunity to combine the government's job creation and energy transition goals. The following recommendations can help:

1. **Strengthen support for decentralized renewable energy projects such as solar rooftops** since decentralized renewable energy (DRE) has the maximum job creating potential and the mix of utility-scale RE and DRE projects India choses will be pivotal in employment trends in this sector.
2. **Expand government programs and market investment to ensure steady renewable energy growth** to support clean energy job-creation to achieve India's clean energy potential of at least 330,000 workers and 1 million short-term and long-term job opportunities in the wind and solar sectors by 2022.
3. **Support local training centers collaborating with industry, particularly in the rural areas**, to provide a specialized workforce needed by developers, to expand clean energy jobs across India, and to spur local green entrepreneurs.
4. **Increase reporting of employment generation from renewable energy companies** by encouraging companies to report the number of jobs created at every stage of the value chain and the kind of skills required to ensure market growth and political support over time.
5. **Promote domestic solar module manufacturing industry to boost employment** since meeting the demand for solar modules required for 100 GW of solar capacity domestically, can employ an additional 45,000 workers.

5-fold increase in the workforce employed in the Indian renewable energy sector between FY14 and FY19.

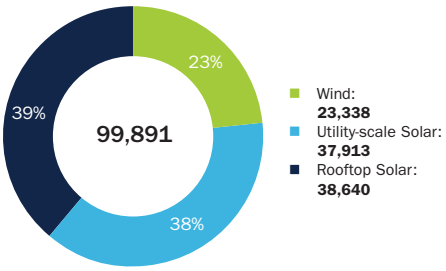




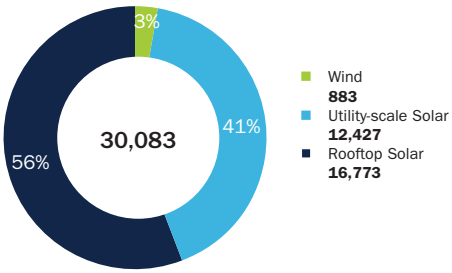
Rooftop solar is more labor-intensive than other renewables providing ***24.72*** job-years per MW in comparison to ***3.45*** job-years per MW for ***utility-scale ground-mounted solar*** ***1.27*** job-years per MW for ***wind power***

Nearly ***99,900 workers employed*** in solar and wind projects until FY19

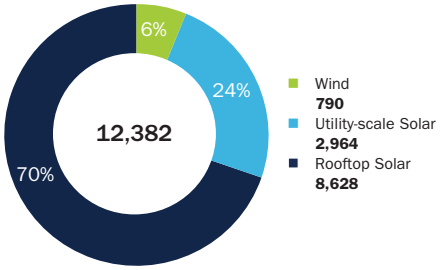
Cumulative Jobs Created in the Solar and Wind Sectors for 65.7 GW of Installed Capacity Until FY19



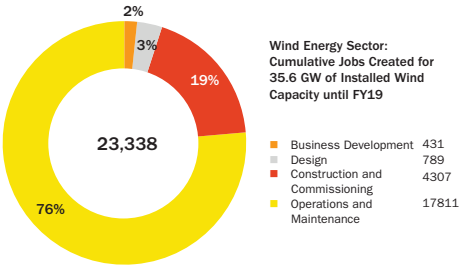
Solar and Wind Sector Jobs Added in FY18



Solar and Wind Sector Jobs Added in FY19

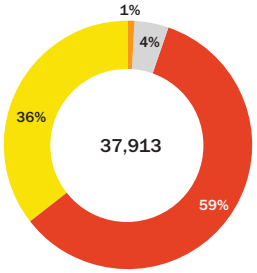


Over ***30,000*** new workers added to solar & wind energy workforce ***in FY18*** but workforce growth in solar & wind energy reduced to nearly ***12,400*** workers in ***FY19***



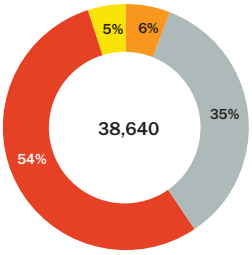
Wind Energy Sector: Cumulative Jobs Created for 35.6 GW of Installed Wind Capacity until FY19

Business Development	431
Design	789
Construction and Commissioning	4307
Operations and Maintenance	17811



Utility-Scale Solar Sector: Cumulative Jobs Created for 26.2 GW of Installed Utility-Scale Solar Capacity until FY19

Business Development	415
Design	1660
Construction and Commissioning	22,407
Operations and Maintenance	13,431



Rooftop Solar Sector: Cumulative Jobs Created for 3.8 GW of Installed Rooftop Solar Capacity until FY19

Business Development	2319
Design	13417
Construction and Commissioning	20981
Operations and Maintenance	1923

Over 58,000 workers trained by SCGJ between ***FY16 and FY19***

Over ***330,000*** workers will be employed to take up nearly 1 million job opportunities (short-term & long-term) if India achieves its solar and wind energy targets ***by 2022.***

INTRODUCTION

India has an ambitious renewable energy capacity target of 175 gigawatts (GW) by 2022, and the National Electricity Plan 2018 projects even greater growth to 275 GW by 2027. Supported by strong government policies, the renewable energy (RE) market has experienced unprecedented growth in the last decade. India's installed RE capacity, which includes solar, wind, small hydro, and biomass power, has increased nearly five-fold in the last nine years from almost 17 gigawatts (GW) in financial year (FY) 2009-2010 (FY10) to over 80 GW in FY19.[7] Renewables now account for 22% of India's installed electricity capacity.[8]

The renewable energy sector deployed 21.2 GW capacity in just the last two years – 11.8 GW in FY18 and 9.3 GW in FY19 (Figure 1).[9] In FY18, India added more of solar and wind capacity (at 11.2 GW), than coal-fired and hydro put together at 9.5 GW.[10] Moreover, investments in the renewable energy sector outnumbered those in fossil-fuel-based projects in 2017 further signaling a transition towards clean energy.[11]

This remarkable growth in renewable energy also creates thousands of jobs in India. According to our analysis, the total workforce employed in the solar and wind sectors, excluding manufacturing, grew from around 19,790 in FY14 to 99,891 by March 2019 – a five-fold increase.[12] In addition, if the 175 GW target is met, the solar and wind energy industries have the potential of employing over 330,000 workers by 2022.[13]

The success of the renewable energy market is crucial to achieving India's Paris Climate Agreement targets and to transition to a clean economy.[15] India has committed to reducing greenhouse gas (GHG) emissions intensity of its GDP by 33% to 35% below 2005 levels by 2030, and to achieving 40% of installed electric power capacity from non-fossil sources by the same year.[16] India's emission intensity has reduced by 21% over the period 2005-2014, while India's grid connected non-fossil fuel (including renewables, large scale hydro power, and nuclear energy) installed capacity stands at 38% by May 2019.[17] India has made remarkable progress towards achieving this target (Figure 1) but a lot more needs to be done. Accelerating renewables deployment is a central solution to also achieve India's multiple goals of economic development, energy access and security, improved air quality, reduced climate pollution, and importantly, job creation.

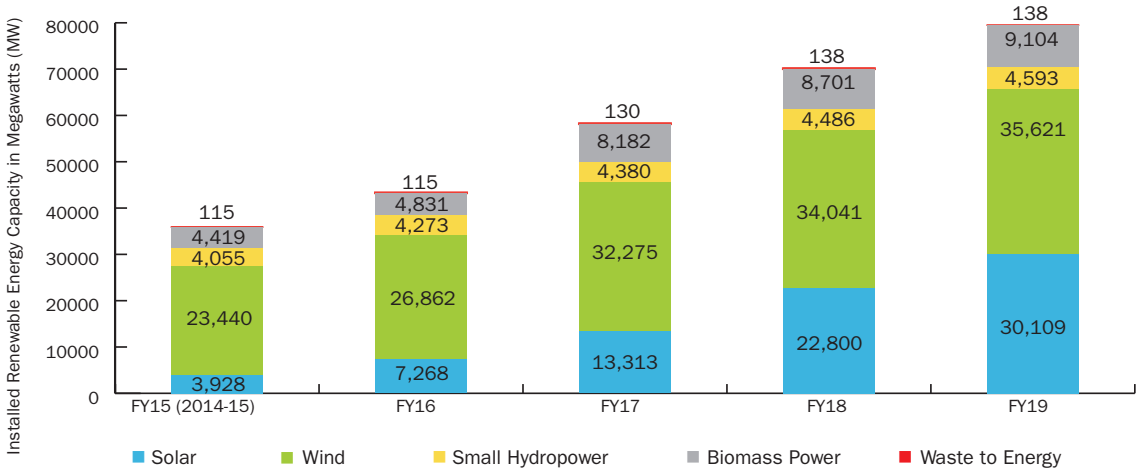
RENEWABLE ENERGY AND JOBS

India's employment needs are large as almost 64 percent of India's population falls between the age of 15 and 59 years.[18] India's total labor force in 2018, as per World Bank's World Development Indicators, is about 38% of the total population, totaling to nearly 510 million people.[19] On an average, around 4.75 million people are added to the labor force in India per year.[20] Generating employment to meet the needs of a growing workforce is a key priority of the government.[21]

While the forecast on jobs in the Indian economy has been mixed in 2019, growth in renewable energy has proven to boost jobs around the world.[22] Globally, renewable energy provided jobs to 11 million people in 2018.[23] According to CEEW-NRDC-SCGJ analysis, in FY18, an additional 30,083 workers were employed in India over 11.2 GW of capacity addition in the solar and wind sector.

The analysis in this issue brief highlights that the job creation potential of the decentralized renewable energy (DRE) projects is higher than utility-scale ground mounted solar (referred to as utility-scale solar from hereon) projects

Figure 1 Installed Grid-Connected Renewable Energy Capacity, Including Rooftop Solar, from FY15 (2014-15) to FY19 in Megawatts (MW)



Source: Compiled by CEEW-NRDC using multiple sources.[14]

**The figures on top of the bar-graph represent waste to energy capacity.*

projects. For instance, in FY18, the rooftop solar segment with just 1.1 GW of installed capacity created employment for 16,773 workers — the highest among the different renewable energy technologies. Meanwhile, utility-scale solar and wind sector created employment for about 12,427 and 883 workers respectively.

RENEWABLE ENERGY MARKET GROWTH

While renewable energy is reshaping India's energy sector, growth within the renewable energy sector is uneven. For example, new capacity additions in solar (utility-scale and rooftop) at 27.4 GW between FY15 to FY19 have outpaced the wind sector at 14.4 GW during the same time.[24] Within the solar market, the vast majority of India's total solar capacity until FY19 comes from utility-scale projects at 26.2 GW with only 3.8 GW of total rooftop solar. Utility-scale solar has achieved 43% of its 60 GW target, while rooftop solar is at only 9.5% of its target of 40 GW by 2022.[25]

The year-on-year capacity additions have also been inconsistent. For instance, only 5.7 GW of utility-scale solar energy was added in FY19, as compared to 8.2 GW in FY18.[26] Capacity growth in the wind sector slowed from 5.4 GW in FY17 to multi-year lows in the last two years – 1.7 GW in FY18 and 1.5 GW in FY19.[27] These developments also have a direct impact on employment with additional workforce for utility-scale solar, rooftop solar, and wind dropping to 12,382 workers in FY19 from 30,083 additional workers in FY18.

Evaluating policy and market choices regarding the share of clean energy projects – large utility-scale or decentralized renewable energy – and ensuring continuous growth in the sector can help in maximizing the jobs created in the renewable energy sector.

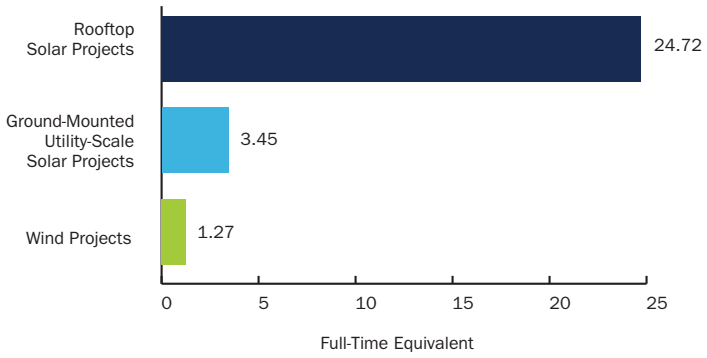
SCOPE AND METHODOLOGY

This issue brief analyzes the workforce required, i.e., the number of workers needed to perform the multiple tasks based on rooftop solar, utility-scale solar, and wind capacity added to grid in FY18 and FY19. The scope of this issue brief is to provide an update of the estimated number of solar and wind jobs, building on earlier analysis in 2017 and 2015. The analyses in this issue brief are limited to direct jobs created through installation and maintenance of the additional solar or wind capacity. This issue brief does not include indirect jobs for example, those in the manufacturing, financing, and distribution companies, or induced jobs, such as jobs created by earnings of workers employed in the renewable energy sector (Appendix 1).

This issue brief explores the impact of lower solar and wind capacity additions on employment; discusses the missed opportunities and emerging opportunities to bolster employment in the sector; and highlights the skill development activities in India. The issue brief also includes key findings and policy recommendations aimed toward improving the job creation potential of the renewable energy sector as India works towards achieving its clean energy targets.

To estimate the direct jobs created by grid-connected solar and wind capacity additions in FY18 and FY19, this issue brief relies on the workforce numbers and job-years per megawatt (MW) or the full time equivalent (FTE) coefficients calculated in the CEEW-NRDC 2017 study to estimate the jobs added in the market (Figure 2).[28] The 2017 estimates are based on primary data collected from multiple organizations engaging in project deployment activities. This includes solar module and windmill manufacturers, project developers, engineering, procurement and construction (EPC) companies and turnkey solution providers.

Figure 2 FTE Coefficients (Job-Years per Megawatt)



Source: CEEW, NRDC, and SCGJ 2017, Greening India's Workforce

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 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 issue brief correspond to full-time equivalent employment.

The jobs figures for each sector – solar rooftop, utility-scale ground mounted solar (referred to as utility-scale solar), and wind – account for the differences in the number of workers employed across various stages of project development (business development; design and pre-construction; construction and commissioning; and operations and maintenance) (Appendix 2). Each stage creates direct, indirect, and induced jobs. This issue brief captures direct jobs only.[29] To capture progress in the renewable energy market, the capacity addition figures are from government and market reports.

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-construction, and construction and commissioning, as well as long-term jobs for operations and maintenance and performance monitoring.

Jobs created, however, are different from the 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 in Year 1 with a workforce of 1,500 workers. In order to deploy an additional 15 GW in Year 2, we would need those 1,500 workers who have already been trained to deploy 5 of 15 GW as well as an additional 3,000 workers to deploy the remaining 10 GW. The workforce required in Year 2, therefore, is only the new 3,000 workers that would need training. However, the jobs created totals 4,500 for the entire 15 GW of deployment.

EMPLOYMENT IN THE SOLAR AND WIND SECTORS

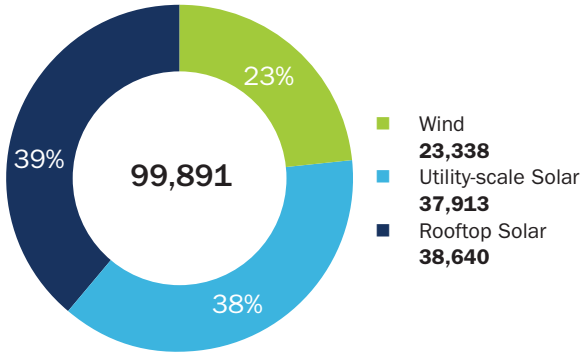
Renewable energy generation grew at almost 6% in FY19 against a mere 1% growth in conventional energy generation, indicating India's progress in transitioning to cleaner and sustainable energy sources compared to FY18.[30] Further, of the 9.3 GW new RE capacity added in FY19, solar energy (including rooftop solar) dominated with almost 77% share translating to 7.3 GW.[31]

Progressive addition of renewable energy capacity increases employment prospects as well. Most conventional energy technologies have matured and are largely automated. In comparison, the RE technologies are still at the development stage and are more workforce-intensive and provide more employment opportunities.[32] The government has provided several financial incentives to tap into the employment opportunities in the renewable energy sector and promote local manufacturing of solar and wind equipment and plant development. But with mixed results.[33]

CUMULATIVE EMPLOYMENT

As of FY19, India's cumulative solar and wind energy capacity is 65.7 GW. Together, these two sectors employed 99,891 workers across project phases, namely, business development, design and pre-construction, construction and commissioning, and operations and maintenance (O&M) (Appendix 3). Further, the solar sector, which includes rooftop and utility-scale solar, led to more employment (76,553 workers) than the wind sector (23,338 workers) (Figure 3). Since rooftop solar is more labor intensive, its share in employment created is high despite lower installed capacity.

Figure 3 **Cumulative Jobs Created in the Solar and Wind Sectors for 65.7 GW of Installed Capacity Until FY19**



Source: CEEW-NRDC analysis 2019.

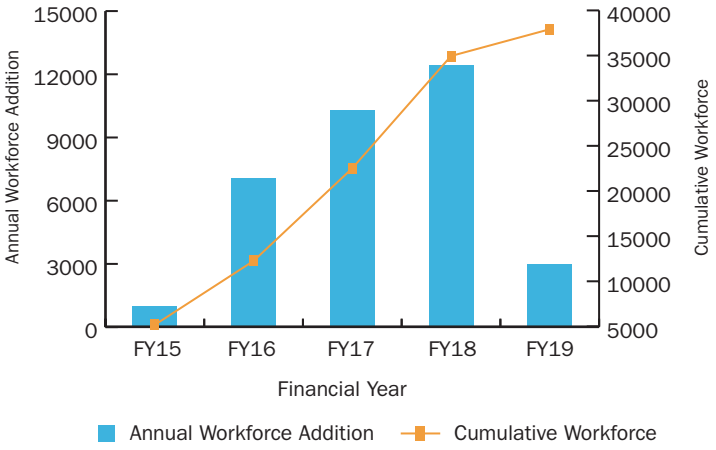
SOLAR ENERGY

The flagship Jawaharlal Nehru National Solar Mission (JNNSM), which originally aimed to install 20 GW of solar power capacity by 2022, was revised in 2015 and targets 100 GW of solar by 2022. Supported by the various incentives, installed solar capacity (including rooftop solar) has increased from nearly 4 GW in FY15 to more than 30 GW in FY19. This is also reflected in the growth in the employment sector and the annual work force addition.

Utility-Scale Solar

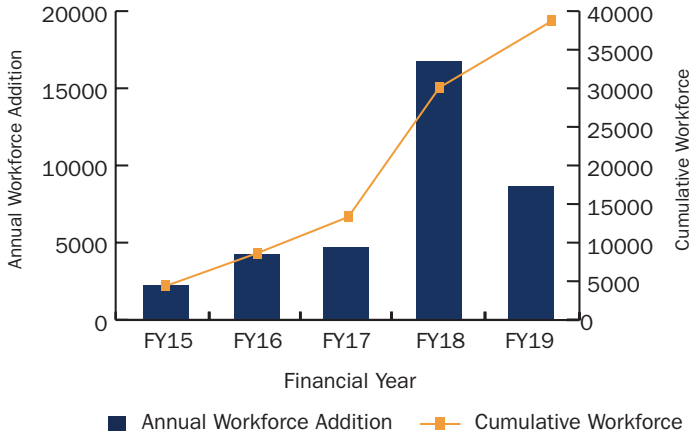
Annual workforce addition in utility-scale solar progressively increased from around 969 workers in FY15 to 12,427 workers by FY18 (Figure 4). Most of this workforce was employed in the construction and commissioning, followed by O&M, and project design.

Figure 4 Annual Employment Addition Trends in Utility-Scale Solar



Source: CEEW-NRDC analysis 2019

Figure 5 Annual Employment Addition Trends in Rooftop Solar



Source: CEEW-NRDC analysis 2019

After years of accelerated growth, various fiscal and operational issues like the introduction of the Goods and Services Tax (GST), financing issues, payment delays by distribution companies, and infrastructure constraints, led to a slow-down in capacity additions in the sector in FY19. Imposition of duties on imported solar panels, while undertaken to promote domestic manufacturing, also impacted capacity growth.[34] As a result, the capacity addition dropped to 5,796 MW in FY19 compared to 8,299 MW in FY18 – a 30% decrease.

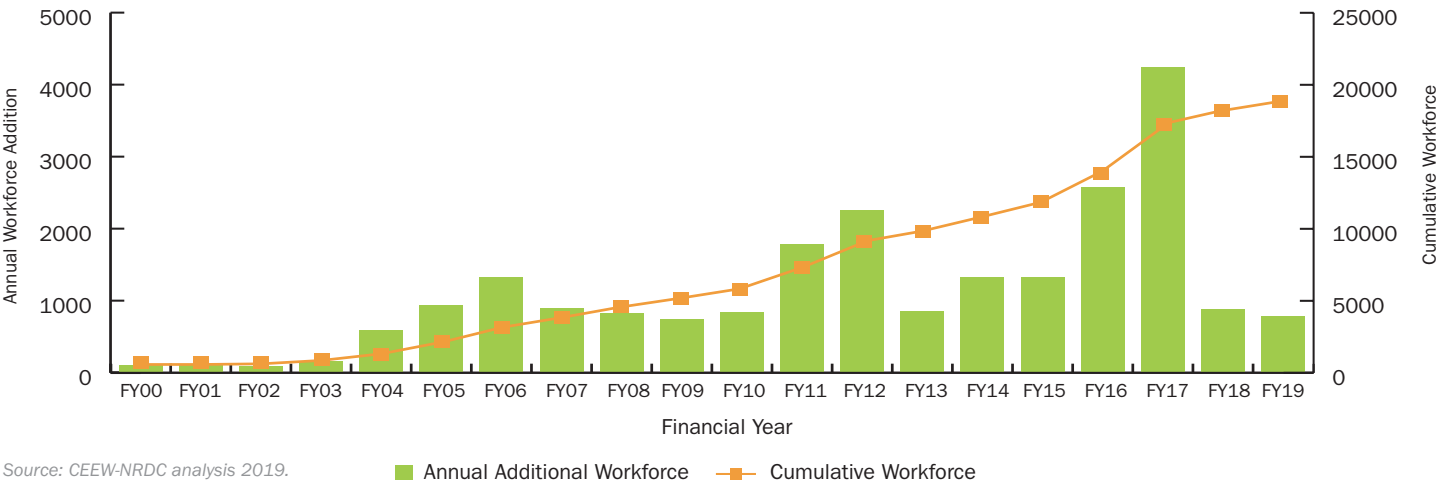
The slowdown in capacity addition impacted employment, and the workforce used decreased significantly in FY19. Most of the contractual workforce were let go, and the sector required 2,964 additional workforce for the O&M of plants in FY19. No new recruitment was done for construction, design, or commissioning of the projects. If the sector had met its annual targeted capacity addition of 10 GW in FY19, it would have employed a total workforce of 10,132 workers, or 7,168 additional workers.

Rooftop Solar

Rooftop solar employs a significant number of people in the solar power sector. Due to its distributed nature, rooftop solar is more labor intensive than utility-scale solar. Over the years, the annual workforce requirement has progressively increased with capacity additions (Figure 5). A large share of this workforce is involved in the construction and commissioning of the project, followed by design and business development, whereas O&M of rooftop solar requires smaller workforce than utility solar.

Annual rooftop solar installations grew at 128% in FY18 over FY17 adding 1,188 MW. The number of new workforce employed for rooftop solar was 16,773. Capacity installations increased to 1,513 MW but the growth rate reduced to 27% in FY19 over FY18. Due the reduction in growth rate, the new jobs created in FY19 are 8,628 (Figure 5). In FY19 the maximum number of workers were employed in the construction and commissioning of the projects, followed by plant design, O&M, and business development.

Figure 6 Annual Employment Addition Trends in Wind Energy



Source: CEEW-NRDC analysis 2019.

WIND ENERGY

Wind energy is one of the more mature and well-developed RE technology in India. Over the years, the sector has undergone several ups and downs to reach a cumulative capacity of 35.6 GW in FY19. Beginning with small demonstration farms in the 1990s, the capacity augmented rapidly in the mid- and late 2000s.

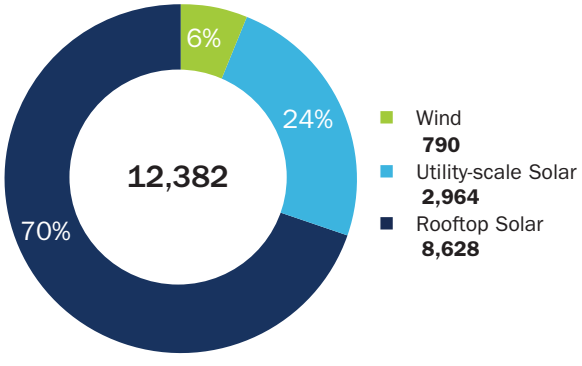
Similar growth occurred in the employment sector to meet the workforce demand (Figure 6). Majority of the workforce was required for plants' O&M, followed by project construction and commissioning. Recent policy changes, land availability challenges, tariff-ceilings, and power evacuation issues have seized the sector which has led to a decline in the capacity additions. Consequently, the wind developers have had to let go a significant fraction of its workforce in FY18 and FY19.

The annual wind capacity added in the FY19 was 1,580 MW, which is 186 MW less than the previous year. Annual workforce addition also reduced 10% in FY19 to 790 workers over 883 in FY18. The main reductions have come from the construction phase, which are often temporary or contractual in nature. Thus, according to our estimates the workforce employed in FY19 belonged to the O&M stage.

EMPLOYMENT ADDITION IN THE SOLAR AND WIND SECTOR IN FY19

Overall, the wind, utility-scale solar, and rooftop solar projects created employment for 12,382 new workers in the FY19 (Figure 7). Rooftop solar employed the highest number of workers at 8,628. Utility-scale solar was the second largest employer in FY19 with 2,964 new workers, followed by the wind sector with 790 workers.

Figure 7 Solar and Wind Sector Jobs Added in India in FY19



Source: CEEW-NRDC analysis 2019.

The slowdown in capacity deployment has been detrimental to the RE job sector. The following section discusses factors that can increase employment in the RE sector.

MISSED OPPORTUNITIES – STEADY GROWTH IN INSTALLED RENEWABLE ENERGY CAPACITY

The number of jobs created in the RE sector is greatly dependent on the annual renewable energy capacity additions. The analysis in this issue brief highlights that lower capacity additions than previous years can lead to a slowdown in job growth. For instance, in the wind sector due to several policy and technical issues, out of the 10 GW capacity auctioned since FY18, less than 4 GW has been commissioned so far.[35] As a result, companies have had to reduce their workforce because of low growth year-on-year.[36] To prevent a slowdown in job growth, the level of capacity addition in a year should be equal to or greater than previous years. But ensuring new jobs requires an annual increase above the previous year in actual installed energy.

Job creation by a RE technology also depends on the evolution of its value chain. For example, in the solar energy sector, most of the modules are imported and only assembling is done in India. On the other hand, there are many well established original equipment manufacturers (OEMs) in wind energy, partly due to the early evolution of this sector and the prevalence of appropriate policies. As the workforce required for manufacturing and assembling is different, an underdeveloped manufacturing industry reduces potential employment opportunities in solar energy sector. Thus, to achieve the full job creation potential in a RE technology, local manufacturing is crucial.

NEW OPPORTUNITIES AHEAD

Market signals show indicators of a stronger solar sector in FY20. The Indian government has indicated concerted efforts to address challenges in the renewable energy sector and has reiterated its commitment to meet the targets. In addition, there are also emerging technologies that hold the potential for providing employment. Some prominent ones are floating solar, wind-solar hybrid projects, solar photovoltaic (PV) plants with battery energy storage system (BESS), and agro-photovoltaics such as solar pumps.[37]

The wind-solar hybrid plants integrate photovoltaics and wind turbine generators to increase efficiency and reduce variability of power generated. The main advantage of these systems is that the reliability of the system is enhanced. In May 2018, the government announced a policy for wind-solar hybrid plants, under which it plans to develop 10 GW of wind-solar hybrid capacity by 2022.[38] Floating solar is another emerging technology that uses water bodies and reservoirs to set up solar power plants. With growing land availability issues, floating solar can be a good alternative to ground mounted solar. For instance, the Solar Energy

Corporation of India has issued several tenders under these technologies like 20 MW floating solar PV plant with BESS at Lakshadweep and 14 MW battery storage supported solar PV plant in Leh and Kargil.

Power reliability is also gaining importance with the rapid expansion of RE technologies. This has opened up the field of RE power systems with BESS backed by government support.[39] While the actual workforce required for wind-solar hybrid, floating solar, and BESS projects still needs to be understood, their development promises new employment opportunities besides improving energy access and security.

Agro-photovoltaics, i.e. combining solar generation and agriculture to increase land use efficiency, also have the potential to create direct and indirect jobs.[40] For instance, the *Kisan Urja Suraksha evam Utthaan Mahabhiyan* (KUSUM) scheme aims to promote around 10 GW of ground mounted grid-connected decentralized renewable energy plants by 2022.[41] In addition, it aims to enable install over 1.75 million standalone and around 1 million grid-connect solar powered agriculture pumps. If the targets of the scheme are met, 25.5 GW of solar capacity can be added by 2022. Decentralized renewable energy schemes such as KUSUM or solar agriculture feeders are likely to create more jobs.

Encouraging solar entrepreneurs is another opportunity for encouraging jobs. For instance, establishing local technical solar entrepreneurs for solar rooftop systems can not only help in outsourcing installation and O&M activities but also enable a greater penetration of the technology. Based on consultations with solar organizations, SCGJ's 2016 study estimates the need for at least 6,500 new solar rooftop entrepreneurs spread across the districts in India.[42] Promoting local skill development can help in tapping the employment potential of existing and emerging opportunities in the renewable energy sector.

SKILL DEVELOPMENT IN THE RENEWABLE ENERGY SECTOR IN INDIA

Skill development is critical for the success of the renewable energy sector – both in accelerating its growth and enabling people to benefit from it. Developing a skilled workforce requires clear focus and commitment by government, industry, and key stakeholders. In 2015, the Government of India created the Skill Council for Green Jobs under the National Skill Development Mission.[43]

The objectives of this Skill Council are to identify training needs of the green businesses sector, institute dedicate training centers, develop technical courses, and address the skill development needs of manufacturers and service providers within the sector. SCGJ also aims to implement nationwide industry-led skill collaborative skills development initiatives that will support in meeting India's potential for "green businesses."

NATIONAL SKILLS QUALIFICATIONS FRAMEWORK

The government of India aims to catalyze skill development initiatives that can potentially have a multiplier effect in the economy. It also aims to involve the industry in these skill development initiatives. The "standards and research" teams at National Skills Development Corporation, a not-for-profit public sector company responsible for implementing the National Skill Policy, and the Sector Skill Councils focus on enabling standardized structure and consistency across the skilling endeavors in the country.

The National Skills Qualifications Framework (NSQF) is a competency-based framework that organizes all qualifications according to a series of levels of knowledge, skills and aptitude. The NSQF is a quality assurance framework. Under NSQF, the learner can acquire the certification for competency needed at any level through formal or informal learning. Presently, more than 100 countries have, or are in the process of developing national qualification frameworks. All skill training programs must adhere to the National Occupational Standards (NOS) as per the constitution of the targeted Qualification Pack (QP), to assure quality and consistency of skill development courses across the training initiatives for the varied job roles across the country.

To cater to the requirements of new-comers and working professional, SCGJ has developed 39 National Standards in the renewable energy domain (Appendix 4).

PROGRESS ON SKILL DEVELOPMENT

Occupational Maps - Developing occupational maps for the sector (Appendix 5 & 6) helps in highlighting the career progression for multiple employment opportunities. They also help identify the types of jobs created and understand the trainings required to service them. These maps also need to be updated frequently to capture the changing nature of the industry and to update the competency levels required. The occupational maps are utilized for horizontal and vertical mobility of skilled workforce within the sector. These maps are also being utilized by many organizations in defining their organization structure. For the Renewable energy sector in India, occupational maps are developed by Skill Council for Green Jobs in consultation with industry and experts (Appendix 5 & 6).

Training Programs - There are multiple programs instituted for skill development by the government of India such as *Pradhan Mantri Kaushal Vikas Yojana* (PMKVY) to encourage the youth to take up training programs; *Deendayal Upadhayaya Grameen Kaushalya Yojayan* (DDU-GKY) for placement linked skill development for low-income rural youth; Bachelors in Vocation Education (B.Voc) offered as a part of college/university education; and Recognition of Prior Learning (RPL) to assess a person's existing experience and knowledge.

SKILL COUNCIL ACTIVITIES

The skill development ecosystem needs to be addressed holistically, starting with basics such as ensuring that the training institutions have the necessary lab equipment to ensuring regular training of trainers and assessors. SCGJ is expanding the reach of its activities to address the challenges of low penetration of training centers in rural areas and smaller cities, and to encourage solar entrepreneurs.

SCGJ's skill development strategy is highlighted in Appendix 7. It aims at working in close collaboration with the industry for skill development around solar parks, wind farms, and bio-energy projects. This will also help support local economic development and employment. As the renewable energy sector grows, corporate trainings and upskilling courses will be required to upgrade the skills of existing employees to keep up with the technological advancements in the sector. These trainings courses can be delivered under the Recognition of Prior Learning scheme for working professionals and employees in the industry.

Progress on activities undertaken by SCGJ since its inception are summarized in Table 1. Through the skill development programs of the government around 58,896 people have been trained as of May 2019 (Table 2). In addition, private solar and wind developers also carry out trainings for their staff.

Table 1 Activities of SCGJ from FY16 to FY19

Parameter	Figures in Numbers
Trainers Certified	2,413
Assessors Certified	713
Total Qualification Packs / National Standards Developed Specific to Clean Energy	47*
Total Curriculums developed	47*
Content- Participant Handbooks developed	14

Source: Skill Council for Green Jobs, 2019.

**This includes all qualification packs and occupational standards developed by SCGJ.*

Skill Development Schemes in India

Pradhan Mantri Kaushal Vikas Yojana (PMKVY) – The objective of this scheme is to encourage skill development for the youth by providing monetary rewards for successful completion of approved training programs. Specifically, the scheme aims to: encourage standardization in the certification process and initiate a process of creating a registry of skills; enable and mobilize a large number of Indian youths to take up skill training and become employable and earn their livelihood; and increase productivity of the existing workforce and align the training and certification to the needs of the country.

Deen Dayal Upadhayaya Grameen Kaushalya Yojana (DDU- GKY) – This scheme is a placement linked skill development scheme for low-income rural youth. This initiative is part of the National Rural Livelihood Mission (NRLM). The skill development program for rural youths has now been refocused and reprioritized to build the capacity of poor rural youth to address the needs of global skill requirements.

Bachelor of Vocation Education (B.Voc.) – The University Grants Commission (UGC) has launched a scheme on skills development based higher education as part of college/university education, leading to Bachelor of Vocation (B.Voc.) degree with multiple exits such as Diploma/Advanced Diploma under the NSQF. The B.Voc. program is focused on universities and colleges providing undergraduate studies which would also incorporate specific job roles and their NOSs along with broad based general education. This would enable the graduates completing B.Voc. to improve their skills and knowledge-base and enable to them gain employment or become entrepreneurs.

Recognition of Prior Learning (RPL) – This scheme refers to an assessment process used to evaluate a person's existing skill sets, knowledge and experience gained either by formal, non-formal or informal learning given that a huge section of India's unorganized workforce is unskilled and semi-skilled. This is where RPL can help them get assessed and certified on their current competencies as per NSQF levels. RPL shows a path to bridge the current knowledge and skill levels to reach a competency level or go for higher skills for professional growth. This is applicable for anyone who is working in the sector and have gained the knowledge and skills by doing, but there is no proof of those skills. By getting the workforce certified under RPL, any organization gets the dual advantage – first, a formally recognized skill levels mapped with QPs and job roles and second, it opens up different paths for workers to upskill and grow through short term training and bridge courses.

Source: Multiple sources.[44]

Table 2 Current Status of Skilled Workforce in Solar Energy Sector

Job Role	Total Number of Certified Candidates between FY16 and FY19
Solar PV Installer (Suryamitra)	46,416
Solar PV Installer – Electrical	7,205
Solar Lighting Technician Options: Home Lighting System Street Lights	1,133
Rooftop Solar Photovoltaic Entrepreneur	1,105
Solar PV Installer – Civil	1,183
Rooftop Solar Grid Engineer	920
Solar Proposal Evaluation Specialist	335
Improved Cookstove Installer	243
Solar PV Maintenance Technician - Electrical (Ground Mount)	103
Solar PV O&M Engineer	70
Solar Domestic Water Heater Technician	63
Solar Off Grid Entrepreneur	40
Solar PV Business Development Executive	40
Solar PV Engineer	40
Grand Total	**58,896.00**

Source: Skill Council for Green Jobs, 2019.

REALIZING THE MARKET POTENTIAL FOR EMPLOYMENT IN THE RENEWABLE ENERGY SECTOR

Despite the numerous government programs and focus on skill development challenges exist in increasing the reach of these programs. High costs of setting up skill development centers, scarcity of skilled trainers, insufficient penetration of training institutes in smaller cities, and insufficient consumer awareness are some of the challenges in enhancing the number of people trained.

Often such training programs are sought as an alternative to formal education and not as complementary, hence catering to people with different levels of technical knowledge through a single curriculum is difficult. In addition, companies often treat skilled and unskilled candidates similarly, which deter candidates to take up skilled courses. In the informal sector where most workers are daily-wagers, time spent on skill development competes with their earnings.

Addressing these challenges by incentivizing the establishment of training institutes, tying up with schools and colleges to offer specialized trainings as a part of their curriculum, developing courses designed for differing levels of experiences can help in developing a larger skilled workforce. Tying-up with industry on skill development can help in developing incentives for skilled professionals to provide trainings and improve training quality. Similarly, renewable energy developers can undertake skill development activities in areas where they operate and use local workforce for installation and O&M activities. Closer collaboration and feedback from the industry on the types of jobs created, the skills required, and the number of people employed can help in developing relevant training programs.

CONCLUSION AND RECOMMENDATIONS

The renewable energy sector in the past two years has seen some phenomenal highs such as record capacity additions (FY18), dramatic increase in the total installed renewable energy capacity, more investments in renewables than conventional energy (FY17), and more renewables installed than thermal and large-hydro combined.[45] These are robust developments backed by strong policy support which have helped in employment opportunities for over 99,900 people as of FY19. New technologies on the horizon also have the opportunity to create more employment.

At the same time, as our analysis suggests, there have also been some drawbacks – low year-on-year capacity addition, slower developments of decentralized renewable energy projects such as rooftop solar, and the need for more skill development activities. However, the government has reiterated its commitment to meet the 175 GW renewable energy target, with an increase in ambition to 275 GW in 2027.

Solar and Wind Jobs and Trainings in Perspective

5-fold increase in the workforce employed in the Indian renewable energy sector between FY14 and FY19.

Nearly 99,900 cumulative workforce employed in roof-top & utility-scale solar, & wind projects until FY19.

Over 58,000 workers trained by SCGJ between FY16 and FY19.

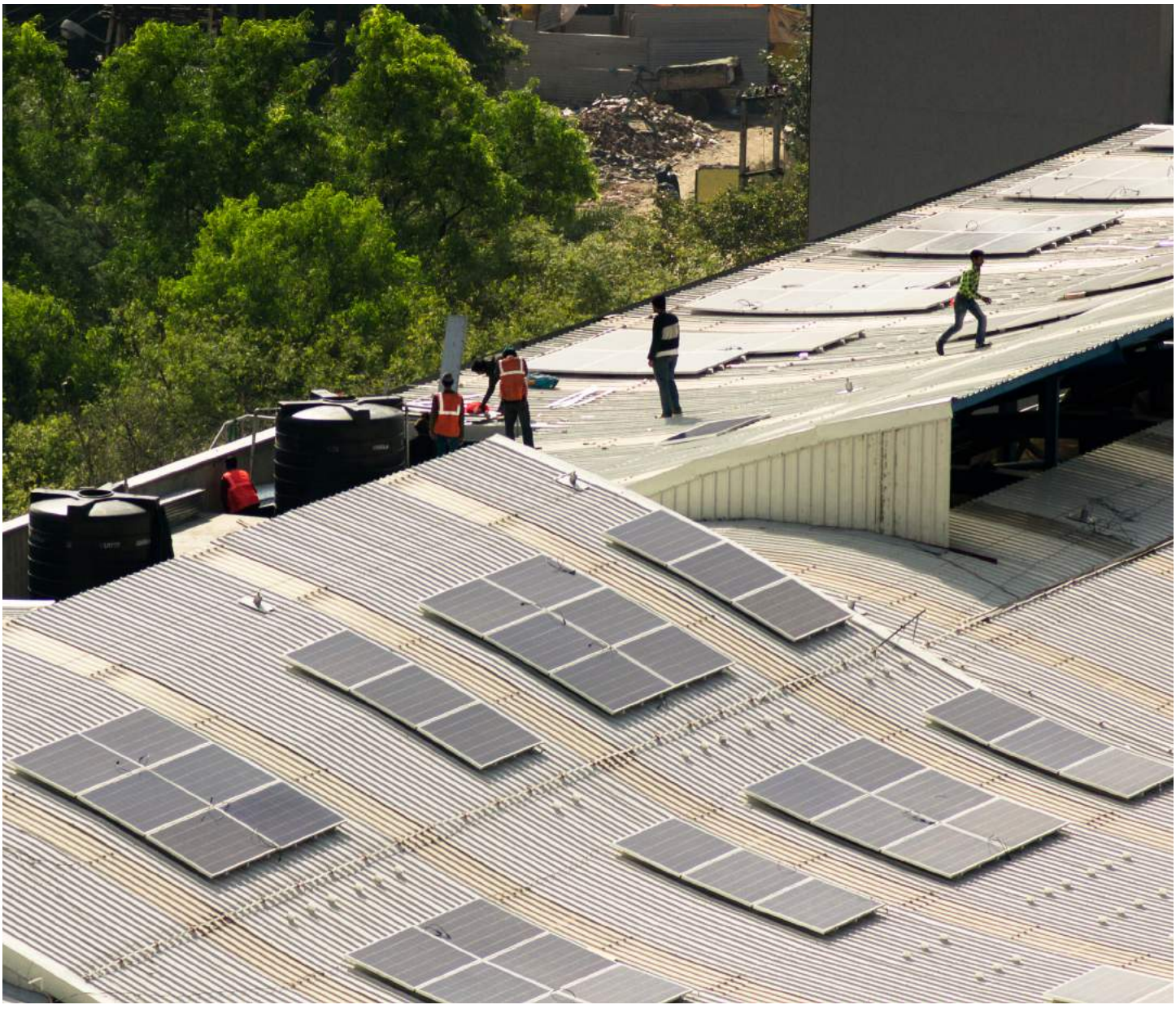
Over 30,000 additional workforce employed in FY18 in utility-scale solar, rooftop solar, and wind energy.

Nearly 12,400 additional workforce employed in FY19 in utility-scale solar, rooftop solar, and wind energy.

Over 330,000 cumulative employment potential in the solar & wind sectors alone if India meets its 175 GW renewable target.

As India works toward meeting these goals, maximizing job creation should be a key focus area for the government. The following recommendations can help:

1. **Strengthen support for decentralized renewable energy projects such as rooftop solar** since decentralized renewable energy (DRE) has the maximum job creating potential and the mix of utility-scale RE and DRE projects India choses will be pivotal in employment trends in this sector.
2. **Expand government programs and market investment to ensure steady renewable energy growth** to support clean energy job-creation to achieve India's clean energy potential of at least 330,000 workers and 1 million short-term and long-term job opportunities in the wind and solar sectors by 2022.
3. **Support local training centers with industry, particularly in the rural areas,** to provide a specialized workforce needed by developers, expand clean energy jobs across India, and spur local green entrepreneurs.
4. **Increase reporting of employment generation from renewable energy companies** by encouraging companies to report the number of jobs created and the kind of skills required to ensure market growth and political support over time.
5. **Promote domestic solar module manufacturing industry to boost employment** since meeting the demand for solar modules required for 100 GW of solar capacity domestically, can employ an additional 45,000 workers.



APPENDICES

APPENDIX 1: DIFFERENCE BETWEEN DIRECT JOBS, INDIRECT JOBS AND INDUCED JOBS

The analysis in this issue brief is limited to direct jobs created through installation and maintenance of the additional solar or wind capacity. This issue brief does not include indirect jobs for example, those in the manufacturing, financing, and distribution companies, or induced jobs, such a jobs created by earnings of workers employed in the renewable energy sector.

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.

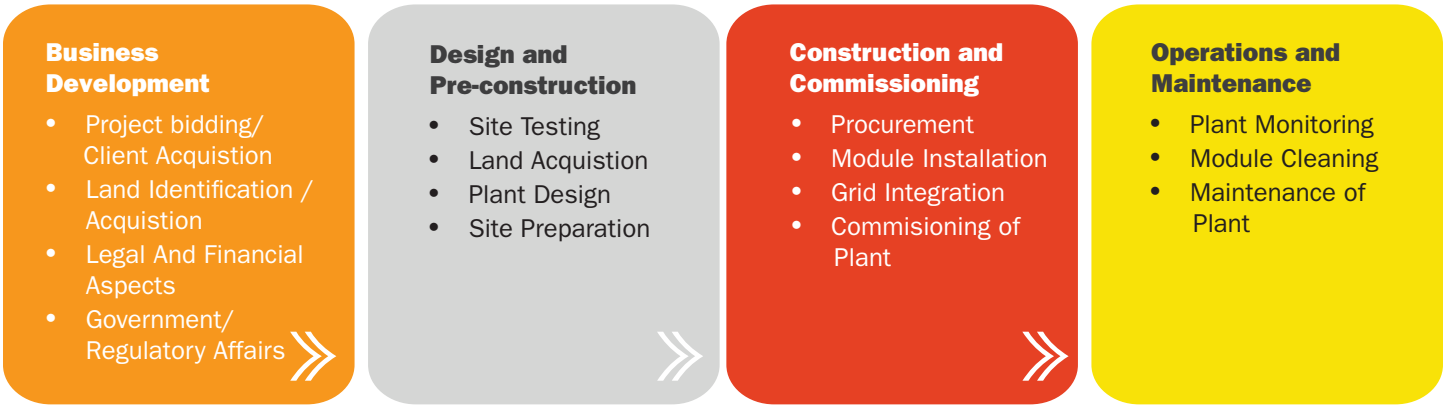
Indirect jobs are the jobs associated with the manufacturing of equipment and materials used for the facility, the supply chain that provides raw materials and services to these manufacturers, and the finance and banking sectors that provide services for the construction and operation of a facility.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

APPENDIX 2: PROJECT PHASES AND FTE COEFFICIENTS

Figure 8 Solar and Wind Deployment Phases

Source: CEEW-NRDC 2014, *Solar Power Jobs: Exploring the Employment Potential in India's Grid-Connected Solar Market.*[46]



An FTE coefficient is the 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. Table A1 shows the FTE coefficients for different phases of solar and wind energy projects.

The number of jobs created varies with the project phase and project type across wind and solar sectors. This difference arises due to the different types of business models for these two technologies. For example, for

Table 3 Coefficients for Different Phases of a Wind and Solar Project

Project Phase	FTE Coefficient		
	Wind	Utility-Scale Solar	Rooftop Solar
Business development	0.06	0.05	1.53
Design	0.1	0.2	8.85
Construction and commissioning	0.6	2.7	13.84
Operations and maintenance	0.5	0.5	0.5

Source: CEEW-NRDC-SCGJ, Greening India's Workforce, 2017

each MW of capacity added, wind energy creates uniform number of jobs in construction and pre-commissioning, operation and maintenance (O&M) stage of the plants. Most of the wind projects are of large capacity and owned by independent power producers (IPPs) which outsource the workforce for O&M.

The solar energy sector, on the other hand, creates far more employment opportunities in the construction and pre-commissioning stage than O&M. In rooftop solar, as the project scale is diverse, owners of the project often carry out the O&M themselves, eliminating the need to outsource these activities.

Rooftop solar projects are decentralized and more labor intensive, hence, create the maximum number of jobs across all segments, as indicated by a high FTE coefficient. These are followed by utility-scale solar and wind projects. Among the different segments, the construction and commissioning of a project creates the maximum number of jobs across all technologies. Further, irrespective of the technology, the least number of jobs are created in the business development phase.

APPENDIX 3: EMPLOYMENT ADDED IN DIFFERENT RE TECHNOLOGIES IN FY17, FY18, AND FY19

Table 4 Employment Added in Different RE Technologies in FY17, FY18, and FY19

Wind					
Installed Capacity Addition for Wind		**Capacity Addition Until FY16 (MW)**	**Annual Capacity (MW)**		
			FY17	**FY18**	**FY19**
		26,862	5,413	1,766	1,580
Change over previous year (MW)		-	1,990	-3,647	-186
Project Phase	**FTE Coefficient by Segment**	**Employment Added Until FY16**	**Annual Additional Employment**		
			FY17	**FY18**	**FY19**
Business development	0.06	311	119	0	0
Design	0.1	571	219	0	0
Construction and commissioning	0.6	3,113	1,194	0	0
Operations and maintenance	0.5	13,431	2,707	883	790
Total		**17,426**	**4,239**	**883**	**790**

Rooftop Solar					
Installed Capacity Addition for Rooftop Solar		**Capacity Addition Until FY16 (MW)**	**Annual Capacity (MW)**		
			FY17	**FY18**	**FY19**
		626	520	1,188	1,513
Change over previous year (MW)		-	183	668	325
Project Phase	**FTE Coefficient by Segment**	**Employment Added Until FY16**	**Annual Additional Employment**		
			FY17	**FY18**	**FY19**
Business development	1.53	520	280	1,022	497
Design	8.85	3,009	1,620	5,912	2,876
Construction and commissioning	13.84	4,706	2,533	9,245	4,498
Operations and maintenance	0.5	312	260	594	757
Total		**8,547**	**4,692**	**16,773**	**8,628**

Utility-Scale Solar					
Installed Capacity Addition for Utility-Scale Solar		**Capacity Addition Until FY16 (MW)**	**Annual Capacity (MW)**		
			FY17	**FY18**	**FY19**
		6,645	5,525	8,299	5,796
Change over previous year (MW)		-	2,522	2,774	-2,503
Project Phase	**FTE Coefficient by Segment**	**Employment Added Until FY16**	**Annual Additional Employment**		
			FY17	**FY18**	**FY19**
Business development	0.05	150	126	139	0
Design	0.2	601	504	555	0
Construction and commissioning	2.7	8,108	6,809	7,490	0
Operations and maintenance	0.5	3,398	2,825	4,244	2,964
Total		**12,257**	**10,265**	**12,427**	**2,964**

Source: CEEW-NRDC analysis, 2019

APPENDIX 4: QUALIFICATION PACKS/NATIONAL OCCUPATIONAL STANDARDS

Table 5 **Qualification Packs/National Occupational Standards**

No.	Qualification Pack Title	QP Code	NSQF level
1	**Solar PV Installer (Suryamitra)**	SGJ/Q0101	4
2	**Solar PV Installer – Electrical**	SGJ/Q0102	4
3	**Solar PV Installer – Civil**	SGJ/Q0103	4
4	**Rooftop Solar Photovoltaic Entrepreneur**	SGJ/Q0104	6
5	**Solar Proposal Evaluation Specialist**	SGJ/Q0105	7
6	**Rooftop Solar Grid Engineer**	SGJ/Q0106	5
7	**Solar PV Business Development Executive**	SGJ/Q0107	5
8	**Solar PV Site Surveyor**	SGJ/Q0108	6
9	**Solar PV Structural Design Engineer**	SGJ/Q0109	5
10	**Solar PV Designer**	SGJ/Q0110	7
11	**Solar PV Project Helper**	SGJ/Q0111	2
12	**Solar PV Engineer (Option: Water Pumping System)**	SGJ/Q0112	5
13	**Solar Site In-Charge**	SGJ/Q0113	6
14	**Solar PV Project Manager (E&C)**	SGJ/Q0114	7
15	**Solar PV Maintenance Technician - Electrical (Ground Mount)**	SGJ/Q0115	4
16	**Solar PV Maintenance Technician – Civil (Ground Mount)**	SGJ/Q0116	4
17	**Solar PV O&M Engineer**	SGJ/Q0117	5
18	**Solar Off Grid Entrepreneur**	SGJ/Q0118	5
19	**Solar Lighting Technician (Options: Home Lighting System / Street Lights)**	SGJ/Q0201	4
20	**Solar PV Manufacturing Technician**	SGJ/Q0119	4
21	**Solar Domestic Water Heater Technician**	SGJ/Q0601	4
22	**Solar Thermal Plant Installation & Maintenance Technician**	SGJ/Q0602	4

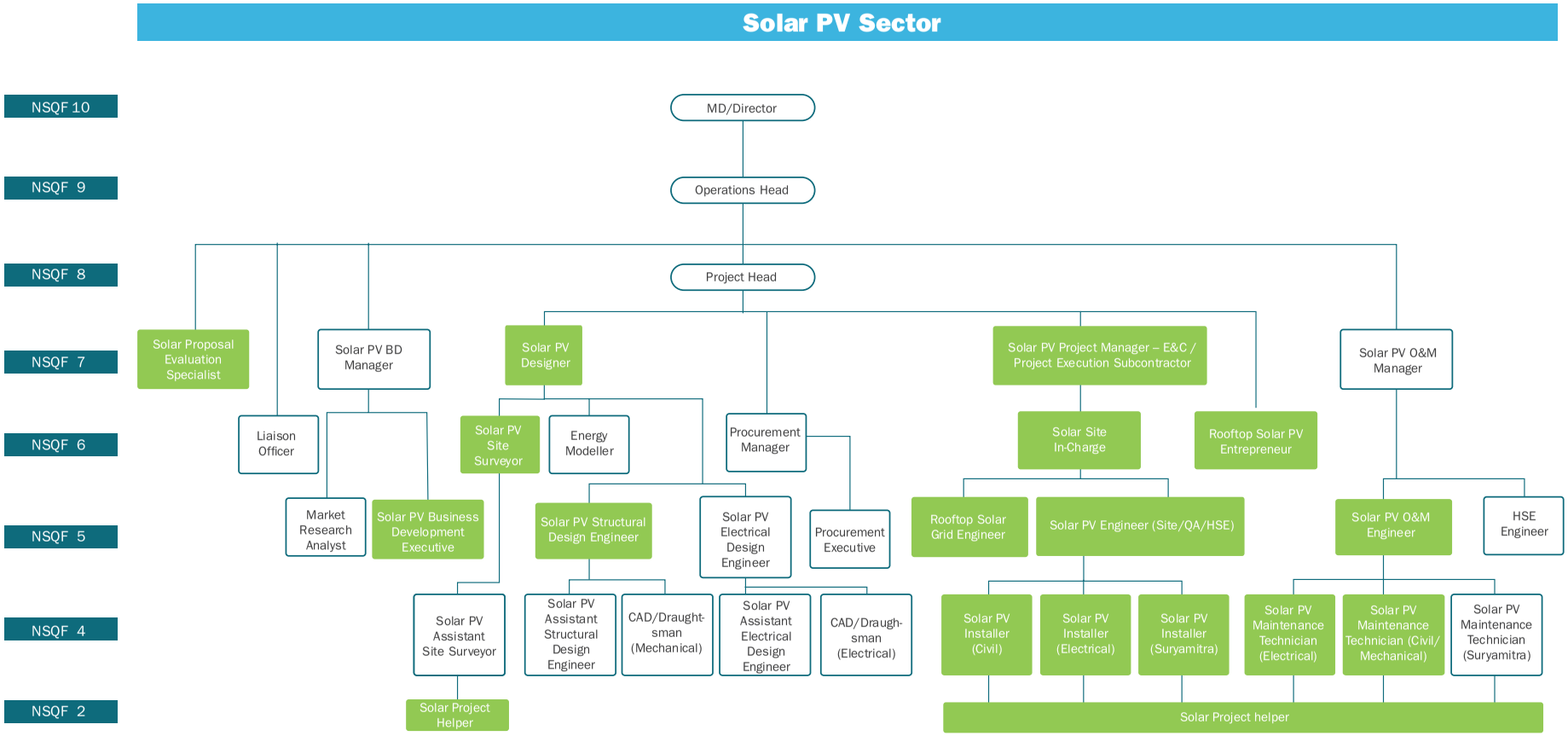
No.	Qualification Pack Title	QP Code	NSQF level
23	**Solar Thermal Engineer -Industrial Process Heat (Option: Consultant)**	SGJ/Q0603	5
24	**Improved Cookstove Installer**	SGJ/Q2101	4
25	**Portable Improved Cookstove Assembler**	SGJ/Q2102	3
26	**Portable Improved Cookstove Sales and Maintenance Executive**	SGJ/Q2104	4
27	**Portable Improved Cookstove Distributor**	SGJ/Q2105	6
28	**Assistant Planning Engineer – Wind Power Plant**	SGJ/Q1201	4
29	**Site Surveyor Wind Power Plant**	SGJ/Q1202	6
30	**Construction Technician (Civil) – Wind Power Plant**	SGJ/Q1402	4
31	**Construction Technician (Mechanical) – Wind Power Plant**	SGJ/Q1401	4
32	**Construction Technician (Electrical) – Wind Power Plant**	SGJ/Q1403	4
33	**CMS Engineer- Wind Power Plant**	SGJ/Q1501	4
34	**O&M Mechanical Technician – Wind Power Plant**	SGJ/Q1502	4
35	**O&M Electrical & Instrumentation Technician –Wind Power Plant**	SGJ/Q1503	4
36	**Animal Waste Manure Aggregator (Option: Biogas Plant Operator / Compost Plant Operator)**	SGJ/Q6302	4
37	**Agri-residue Aggregator**	SGJ/Q6201	4
38	**Biomass Depot Operator**	SGJ/Q6207	4
39	**Manager- Waste Management (Elective: Biomass Depot / Compost Yard / Dry Waste Center)**	SGJ/Q6501	6

Source: Modified table from Skill Council for Green Jobs, "Comprehensive List of Qualification Packs Developed by SCGJ," March 2018.[47]

**Only those qualifications packs relevant to solar, wind, and waste-to energy sector are included in the table above.*

APPENDIX 5: OCCUPATIONAL MAP AND CAREER PROGRESSION FOR EMPLOYMENT OPPORTUNITIES IN THE INDIAN SOLAR INDUSTRY

Figure 9 Occupational Map and Career Progression for Employment Opportunities in the Indian Solar Industry

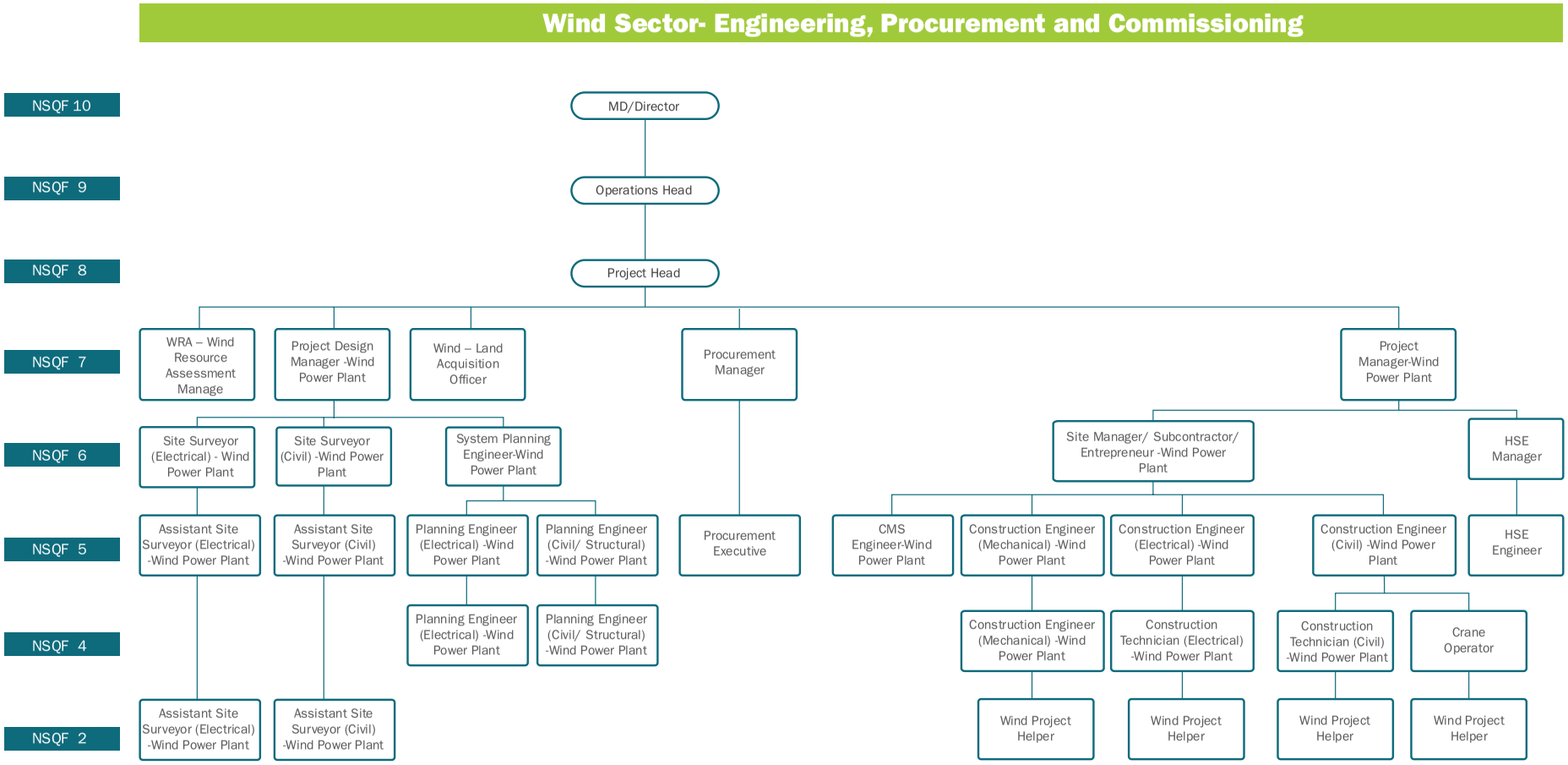


Source: 2019 update to the map developed in SCGJ, Skill Gap Report for Solar Wind and Small Hydro Sector, *2016.*[48]

** This map has been developed in consultation with experts and solar organizations across the country to help develop national occupational standards. The green boxes indicate that these jobs roles are included in the National Register, and that SCGJ has developed the corresponding qualification packs and course material for these roles.*

APPENDIX 6: OCCUPATIONAL MAPS AND CAREER PROGRESSION FOR EMPLOYMENT OPPORTUNITIES IN THE INDIAN WIND INDUSTRY

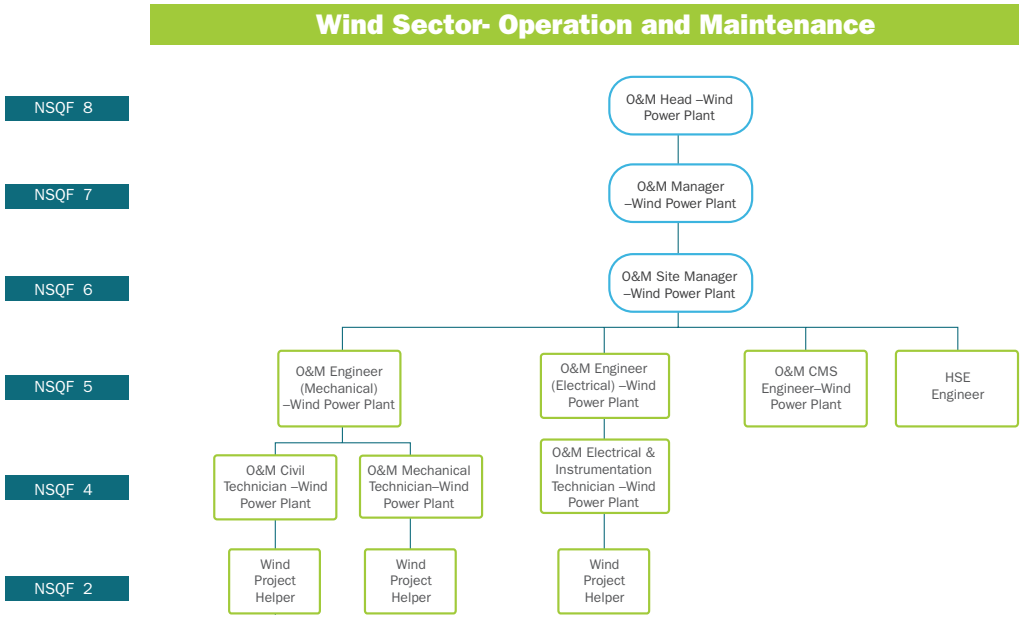
Figure 10 Occupational Maps and Career progression for Employment Opportunities in the Indian Wind Industry: Engineering, Procurement, and Commissioning



Source: SCGJ, Skill Gap Report for Solar Wind and Small Hydro Sector, *2016.*

** This map has been developed in consultation with experts and solar organizations across the country to help develop national occupation standards.*

Figure 11 Occupational Maps and Career progression for Employment Opportunities in the Indian Wind Industry: Operations and Maintenance



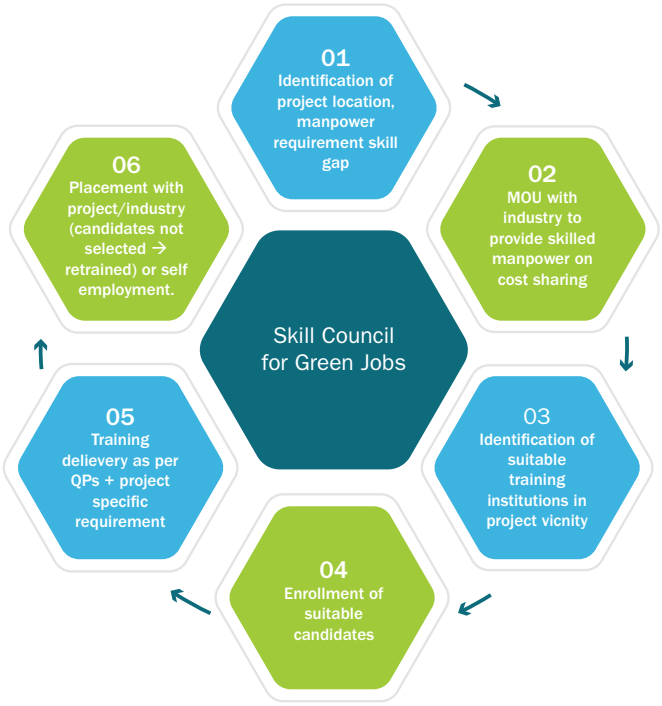
Source: SCGJ, Skill Gap Report for Solar Wind and Small Hydro Sector, 2016.

** This map has been developed in consultation with experts and solar organizations across the country to help develop national occupational standards.*

APPENDIX 7: SCGJ'S SKILL DEVELOPMENT STRATEGY

SCGJ's skill development strategy aims at working in close collaboration with the industry for skill development around solar parks, wind farms, and bio-energy projects.

Figure 12 Skill Development Strategy for Skill Council for Green Jobs



Source: Developed by SCGJ in 2017.

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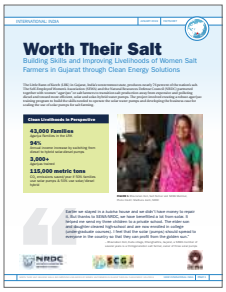
HIGHLIGHTED REPORTS



Worth Their Salt: Building Skills and Improving Livelihoods of Woman Salt Farmers in Gujarat through Clean Energy Solutions.

Greening India's Workforce: Gearing up for Expansion of Solar and Wind Power in India.

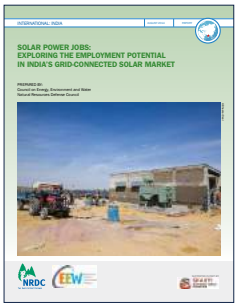
Filling the Skill Gap in India's Clean Energy Market: Solar Energy Focus.

Clean Energy Powers Local Job growth in India.

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

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

Creating Green Jobs: Employment Generation by GameSa-ReNew Power's 85 Megawatt Wind Project in Jath, Maharashtra.



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HIGHLIGHTED BLOGS

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