

REPORT

FEBRUARY 2023

# INDIA'S EXPANDING CLEAN ENERGY WORKFORCE

2022 UPDATE



## About this Report

This report is a part of series of issue briefs, reports, case studies, and fact sheets on clean energy in India. This employment discussion builds on earlier issue briefs on India's Expanding Clean Energy Workforce (2022), Powering Jobs Growth with Green Energy (2019), Greening India's Workforce (2017) and Clean Energy Powers Local Job Growth in India (2015).

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Skill Council for Green Jobs (SCGJ) was established in Oct 2015 under the aegis of Ministry of Skill Development and Entrepreneurship, Government of India to address skilled manpower requirement for the emerging climate resilient technologies and India's commitment to United Nations Framework Convention on Climate change (UNFCCC). Promoted by the Ministry of New and Renewable Energy and Confederation of Indian Industry, SCGJ was set up as a not-for-profit, autonomous, and industry-led organisation with a mandate to design and implement a wide range of capacity building and skilling interventions. SCGJ aims to identify the skilling needs of service users as well as manufacturers and service providers in clean energy sectors, and implement nation-wide, industry-led, collaborative skills development and entrepreneurial development initiatives to support India's potential for "green businesses". SCGJ is one of the first few Sector Skill Councils in the country to have been formally recognized as an "Awarding Body" by the National Council for Vocational Education and Training (NCVET), the regulator of skill ecosystem in the country. In line with the National Education Policy 2020 of India, SCGJ is now also working towards introducing vocational education in Green Business sectors in Schools and institutions of higher learning.

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## Editorial Team

CEEW Researchers and Authors: Akanksha Tyagi, Arvind Poswal  
Project Directors: Neeraj Kuldeep and Arunabha Ghosh

NRDC Researchers and Authors: Akanksha Golchha, Charu Lata  
Project Director: Sameer Kwatra and Dipa Singh Bagai

SCGJ Researcher and Author: Deepak Rai  
Project Director: Dr. Praveen Saxena

## Acknowledgement

The authors would like to thank Mr. Upendra Tripathy, Former Secretary, MNRE; Dr. Praveen Saxena, SCGJ; Ms. Charlotte Steiner, NRDC; Ms. Ritika Kapoor, NRDC; Mr. Neeraj Kuldeep, CEEW; Ms. Madhura Joshi, E3G; Mr. Saksham Nijhawan, Forum for the Future, and Ms. Vandita Sahay, World Resources Institute for their review comments. We sincerely value the contributions of the following NRDC staff: Kim Knowlton, Sameer Kwatra, Laurie Geller, and Susan Lee. The authors are grateful to the funders of our work for their generous support. We are grateful to colleagues at AES (India) Private Limited for their inputs in the case study on Battery Energy Storage Systems.

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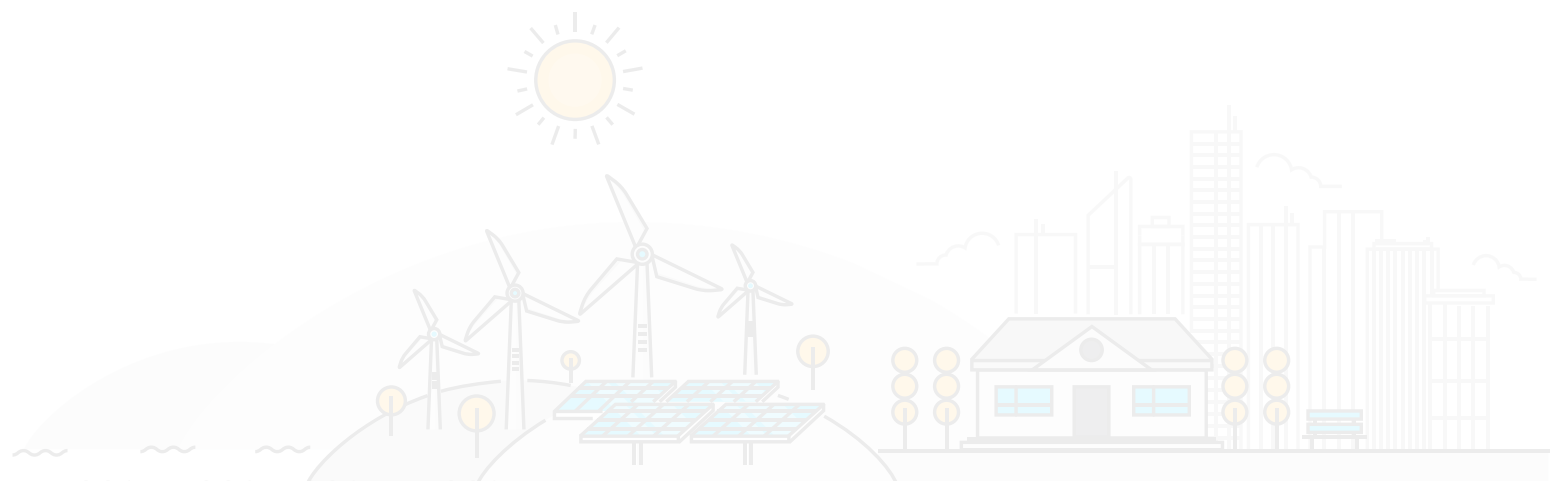


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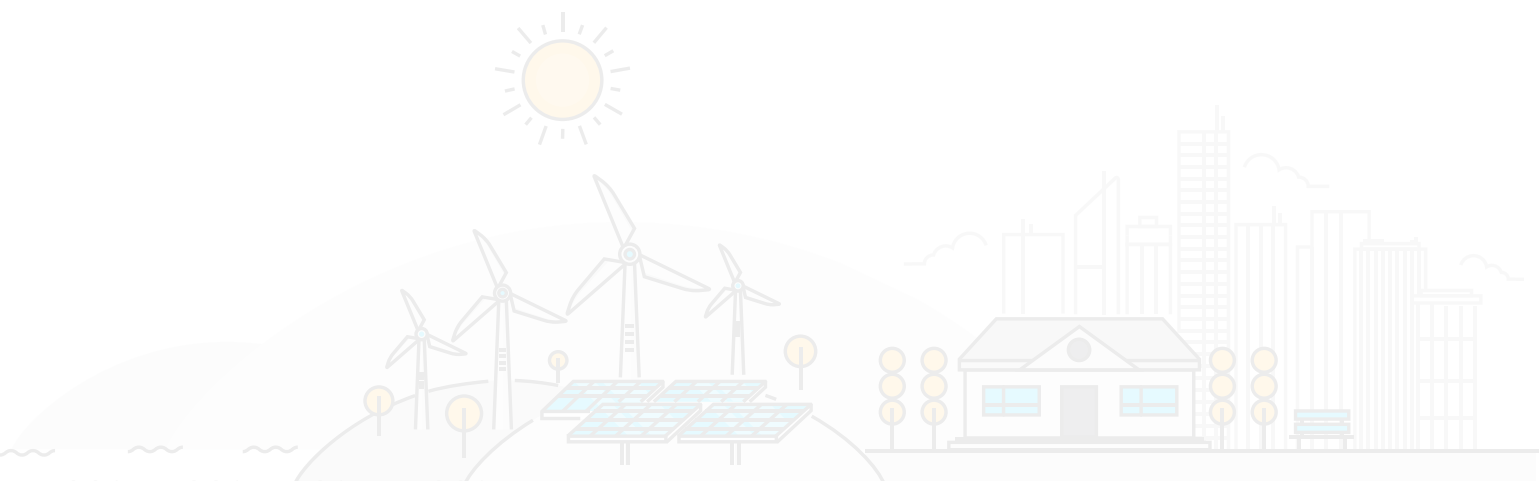
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## LIST OF ABBREVIATIONS

<b>BESS</b>	Battery Energy Storage Systems
<b>BoS</b>	Balance of System
<b>CEEW</b>	Council on Energy, Environment and Water
<b>EHS</b>	Environment and Health Safety
<b>EMC</b>	Electrical, Mechanical and Civil
<b>EoI</b>	Expression of Interest
<b>ESO</b>	Energy Storage Obligations
<b>ESS</b>	Energy Storage Systems
<b>FTE</b>	Full-time Equivalent
<b>FY</b>	Financial Year
<b>GW</b>	Giga Watt
<b>HVAC</b>	Heating, Ventilation, and Air Conditioning
<b>MSDE</b>	Ministry of Skills Development and Entrepreneurship
<b>MW</b>	Mega Watt
<b>NDC</b>	Nationally Determined Contributions
<b>NOS</b>	National Occupational Standards
<b>NRDC</b>	Natural Resources Defense Council
<b>NSQC</b>	National Skills Qualification Committee
<b>O&amp;M</b>	Operation and Maintenance
<b>PLI</b>	Production Linked Incentive
<b>PV</b>	Photovoltaic
<b>RE</b>	Renewable Energy
<b>RPO</b>	Renewable Purchase Obligations
<b>SCGJ</b>	Skill Council for Green Jobs
<b>SECI</b>	Solar Energy Corporation of India
<b>STEM</b>	Science, Technology, Engineering and Management
<b>TPDDL</b>	Tata Power Delhi Distribution Limited



# Executive Summary

India updated its Nationally Determined Contributions (NDCs) in 2022 to advance its 2070 decarbonization goals. Within the updated NDCs, meeting 50 percent of cumulative electric power installed capacity from non-fossil sources by 2030 is an important step towards renewable energy deployment and subsequent emissions reduction. The renewable energy sector has shown significant resilience after the COVID-19 pandemic and has reached a cumulative installed capacity of 120 GW at the end of year 2022. Since resumption of activities after the COVID-19 restrictions, there has been significant momentum in the growth and pace of renewable energy deployment, and the expansion of specialized skilling initiatives to support capacity addition with gainful employment. It is essential to estimate skill gaps resulting from the advent of new and emerging clean energy technologies being deployed. Skilling initiatives need to be aligned as per requisite demand in order to meet the 2030 progressive renewable energy capacity deployment goal.

This report provides an updated analysis on the number of direct jobs created from the solar and wind energy sectors in the financial year 2022 (FY22), building on earlier analyses by the Council on Energy, Environment and Water (CEEW), Natural Resources Defense Council (NRDC), and Skill Council for Green Jobs (SCGJ). It also introduces the employment and skilling insights of standalone battery energy storage system (BESS) deployment. Lastly, it provides information about updated trainings and skilling numbers from SCGJ across the renewable energy and green jobs' sectors.

## RECOMMENDATIONS

- **Mainstream industry relevant renewable energy courses at universities to develop highly skilled workforces:** Universities and premier institutes should include industry relevant courses at higher education levels and leverage industrial linkages to implement initiatives such as the National Credit Framework in order to mainstream skilling and vocational education. Along with other institutional measures, these programs can be jointly implemented with industry associations to foresee emerging skill requirements and create scalable training programs.
- **Expand existing institutional capacity at state levels for sector-centric skilling programs.** State skill development agencies should track demand for green jobs, bridge skill gaps and provide continuous reskilling opportunities to improve employability. They should also address regional skill requirements with stakeholders such as SCGJ and local industry to develop training and their related monitoring.
- **Create gender focused skilling courses to improve women participation in the clean energy workforce:** The entire skilling ecosystem should deploy gender-specific strategies for improving women representation in green jobs. Instruments such as women trainers, online trainings, career guidance can be helpful.
- **Support the existing workforce in conventional energy sectors in moving towards appropriate career trajectories with initiatives to upskill, reskill and possibly re-certify competence.** Promote inclusion of skilling programs with current schemes to ensure manufacturing, investments, and exports in value chains.

## KEY FINDINGS

- **In FY22, the solar and wind energy sectors added 52,700 new workers** in project development roles. This is eight times more than the additions in FY21.
- **99% of the new workforce (52,100 workers) were employed in the solar energy sector**, with the wind energy sector showing only very small growth (600 new workers).
- **India's solar and wind energy sectors employ 164,000 workers as of FY22**, showing a 47 percent increase from FY21. 84 percent of this workforce is in the solar energy sector.
- **100,000 people were trained by SCGJ in the renewable energy sector as of FY22, with 500,000 cumulative trainees across the green business domain.** The annual trainings have declined from 2019 due to the COVID-19 pandemic induced restrictions.
- **61 workers were required to deploy a 10 MW/10 MWh Battery Energy Storage System (BESS).** The majority of these were highly skilled workers with backgrounds in electrical, civil and mechanical engineering.
- The emergence of new sectors like solar module and battery cell manufacturing, hybrid configurations of projects, recycling requires **workers with advanced analytical and business skills** along with new **technical skills like solid state manufacturing, equipment engineering and robotics.**

# 164,000

Workers employed by wind and solar energy sectors as of FY22.

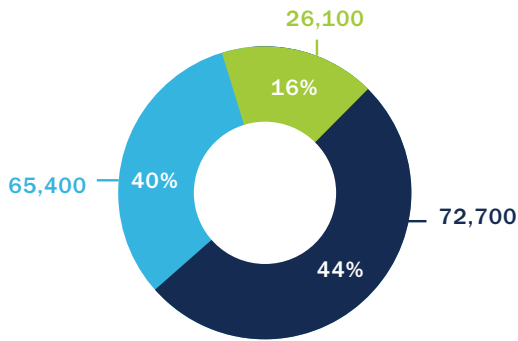


# Over 100,000

Workers trained by SCGJ as of FY22 of which more than 86,000 trainees have been certified under the Suryamitra training program

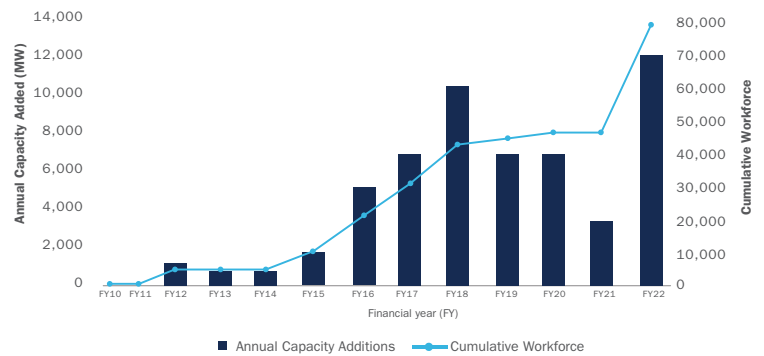


Cumulative Workforce Employed in Solar and Wind Energy Sectors as of FY22

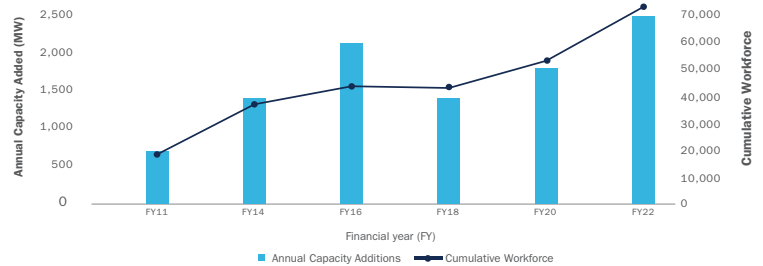


■ Utility-Scale Solar ■ Rooftop Solar ■ Wind

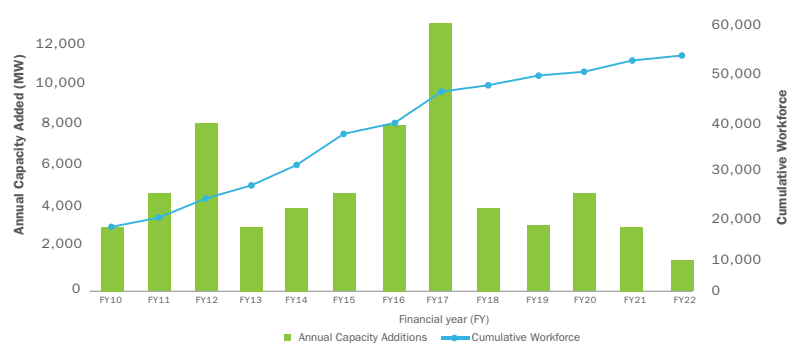
Cumulative Workforce Employed for 47 GW of Utility Scale Solar



Cumulative Workforce Employed for 8 GW of Rooftop Solar



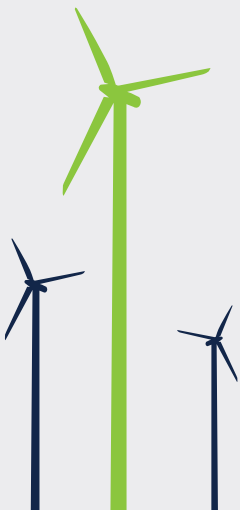
Cumulative Workforce Employed for 40 GW of Wind



# 52,700



additional people employed in solar and wind energy sectors in FY22 over FY21







# 1. Introduction

India's updated NDCs are a major step towards its climate goal of achieving net zero by 2070 as well as scaling India's renewable energy deployment and emissions reductions commitments by 2030.<sup>1</sup> India's climate agenda has transformed the country's energy mix with renewable energy sources constituting 29 percent of installed capacities: as of December 2022, renewable energy sources accounted for 120 GW (excluding large hydro).<sup>2</sup> The renewable energy sector in India has seen significant momentum as the country remains steadfast on deploying more clean energy technologies to meet its climate targets.

Achieving India's updated NDCs and net zero timeline is a vital step in its drive to meet its rising energy needs in a sustainable manner. India aims to meet 50 percent of its cumulative electric power installed capacity from non-fossil sources by 2030, most of which is expected to come from renewable energy sources.<sup>3</sup> Renewable energy remains central to India's growth and development trajectory, not only in terms of decarbonising the economy but also in terms of employment generation, as discussed in a report by CEEW, NRDC, and SCGJ.<sup>4</sup>

Since 2014, CEEW, NRDC, and SCGJ have actively tracked and published the job creation, workforce participation, and skilling requirements of India's solar and wind energy sectors. These reports have examined the impact of major developments such as policy announcements and market developments, as well as global disruptions such as the COVID-19 pandemic that affected job creation by altering the capacity deployment.

As per these estimates, by 2030 installation of new on-grid solar (238 GW) and wind (101 GW) capacities can potentially create about 3.4 million jobs (short and/or long term), considering that solar and wind plant construction activities require workforce for a specific duration instead of providing employment.<sup>5</sup> This can employ about one million people by 2030.<sup>6</sup>

## 1.1 OBJECTIVE

Building on the previous analysis, this report provides an updated analysis of direct jobs created from solar and wind sectors in FY22.<sup>7</sup> The report also provides employment insights and skill requirement for BESS to highlight the employment potential created by emerging technologies. It also qualitatively captures evolving skill requirements for solar project deployment roles and emerging trends for the solar photovoltaic (PV) module manufacturing industry. In addition, the report covers an analysis on training and capacity building initiatives undertaken by SCGJ, focusing on the renewable energy sector.

As the share of renewable energy technologies increases in India's energy mix, energy storages systems will be crucial to maintain the stability of the grid. Earlier in 2022, the Ministry of Power released guidelines for power procurement and utilisation of BESS.<sup>8</sup> Following this, Solar Energy Corporation of India (SECI) issued an expression of interest (EoI) for setting up 500 MW and 1,000 MWh standalone energy storage systems.<sup>9</sup> NTPC Renewables also invited global bids to set up a 250 MW and 500 MWh standalone ESS in Rajasthan.<sup>10</sup> Recently, the Ministry of Power issued energy storage obligations (ESOs) to increase the uptake of these technologies along with renewable purchase obligations (RPOs).<sup>11</sup> While RPOs mandate the obligated entities like power distribution companies to purchase or produce a minimum specified quantity of their total consumption from renewable energy sources, ESOs mandates them to store renewable energy as per the recommend trajectories. The target for 2030 is to purchase or produce ~43 percent renewable energy and store up to 4 percent of total consumption.

The proposed penalties under the Electricity (Amendment) Bill, 2022 on the obligated entities, in case they fail to meet the RPO targets would also ensure that India's power mix moves towards integrating more renewable energy, in line with India's 2030 climate commitments.<sup>12</sup> The growing interest in deployment of energy storage systems along with renewable energy necessitates a detailed understanding of the employment trends and skill requirements in this sector.

## 1.2 SCOPE AND METHODOLOGY

The jobs and workforce numbers are estimated for the four phases of solar and wind projects – business development, design, construction and commissioning, and operation and maintenance (O&M). The analysis here is restricted to workforce engaged in direct jobs created during these four project phases. Workforces in indirect and induced jobs created through manufacturing, financing or earnings of the engaged workforce, are not covered in the analysis.

All job numbers correspond to full-time equivalent employment and are estimated using the full-time equivalent (FTE) coefficients previously developed by CEEW-NRDC, as mentioned in Table 1.

**Table 1: Sector Specific FTE Coefficient**

Sr. No.	Sector	FTE Coefficient
1	Rooftop Solar	24.72
2	Utility-scale Solar	3.45
3	Wind	1.27

Source: CEEW-NRDC- SCGJ analysis, 2017<sup>13</sup>

The FTE or job-year is a ratio of the time spent by an employee on a particular activity/project each 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. These coefficients are derived from the primary surveys conducted in 2016-17 across the solar and wind energy companies that included developers, engineering construction and procurement contractors and solar PV module manufacturers.<sup>14</sup> The capacity data for the various sectors is taken from government reports.<sup>15</sup>

The qualitative inputs on the changing skill patterns in solar project development and PV module manufacturing were received via telephonic interviews. Overall, two manufacturers and three project developers shared inputs on these evolving skilling requirements.

## 2. New Workforce Additions in Solar and Wind Energy Sectors in FY22

India's solar and wind energy sectors continued its resilient growth following the height of the COVID-19 pandemic to add about 15 GW capacity in FY22, which is twice the capacity added in FY21 (6.5 GW).<sup>16</sup> Within these, about 92 percent (13.9 GW) of the capacity was added in solar

energy sector while wind sector did not grow much (1.1 GW added).<sup>17</sup> Within solar, utility-scale segment deployed more capacity (11.6 GW) than rooftop solar (2.3 GW).

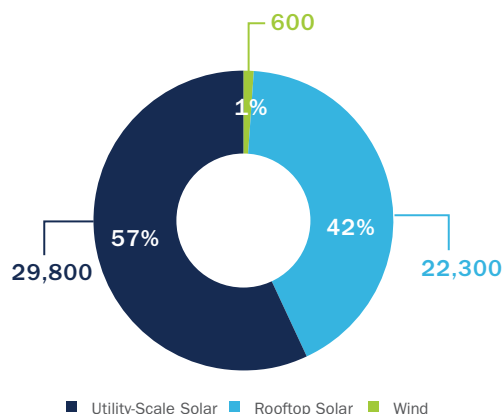
These capacity additions are less than the initial projections for India's goal of 500 GW of non-fossil fuel installed capacity by 2030, primarily on account of disruptions caused by COVID-19 pandemic.<sup>18</sup> In all the scenarios modelled in a previous CEEW-NRDC-SCGJ study published in January 2022, the annual capacity additions for solar and wind sector combined in FY22 were projected in the range of about 90 GW.<sup>19</sup> However, even though the actual deployments are short of these estimates, India's renewable energy deployment is expected to pick up pace in the coming years on account of policy and financial support provided by the Government of India across the renewable energy value chain.<sup>20</sup>

The following section gives details on the employment insights from the solar and wind energy sectors in FY22.

### 2.1 OVERALL ADDITIONS

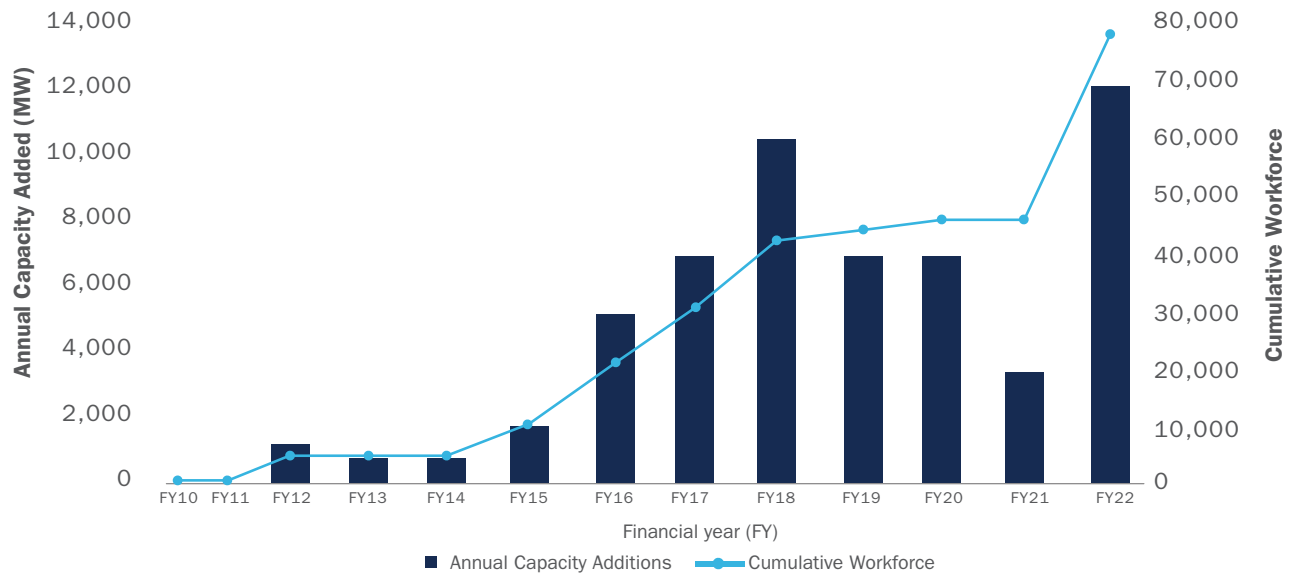
This immense scale of capacity deployment in the solar energy sector (13.9 GW) made it a bigger employer than the wind energy sector (1.1 GW) in FY22. 99 percent 52,100 of the new workforce added in FY22 were in the solar energy sector, while wind's share was a dismal one percent (Figure 1). The wind sector contributed to less than 600 jobs overall in FY22. Within solar, the utility-scale segment employed more workforce (57% of total workforce) than rooftop solar (42% of total workforce).

**Figure 1: 99% of the new clean energy workforce added in FY22 were in the solar energy sector**



Source: CEEW-NRDC Analysis, 2022

**Figure 2: New workforce additions in utility-scale solar segment in FY22 increased 16 fold over FY21**



Source: CEEW-NRDC Analysis, 2022

## 2.2 WORKFORCE TRENDS WITHIN SECTORS

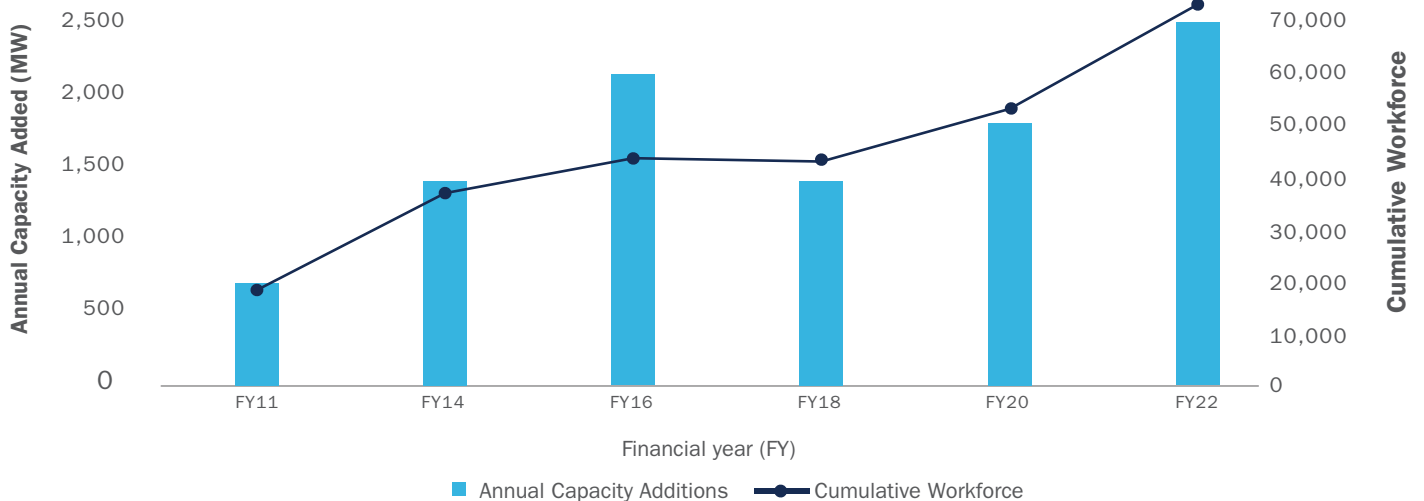
### Solar Energy Sector

**Utility-scale solar:** In the utility-scale solar segment, the annual capacity addition jumped to 11.6 GW in FY22, registering a strong year-on-year growth of 229 percent from the capacity added in FY21.<sup>21</sup> The deployment of this extensive capacity employed 29,788 new workers in FY22, a 16 fold increase from FY21 when 1,807 new workers were employed (Figure 2).<sup>22</sup> About 73 percent of this workforce was employed during the construction and commissioning phase, followed by operation and

maintenance (20 percent), design (6 percent) and business development (1 percent) (Table A2, Annexure 1).<sup>23</sup>

**Rooftop solar:** In FY22, 2.3 GW of capacity was added in the rooftop solar segment, up from 1.4 GW in FY21, which translates to a 61 percent year-on-year increase.<sup>24</sup> Deployment of this pent-up demand from the COVID-19 pandemic added 22,292 new workers, almost a 6 fold jump from FY21 (3,786 workers) (Figure 3).<sup>25</sup> Of this, 54 percent workforce was hired for the construction and commissioning phase, followed by design (35 percent), business development (6 percent), and operation and maintenance phase (5 percent) (Table A3, Annexure 1).<sup>26</sup>

**Figure 3: Workforce additions in rooftop solar in FY22 increased 6 fold over FY21**



Source: CEEW-NRDC Analysis, 2022

## Wind Energy Sector

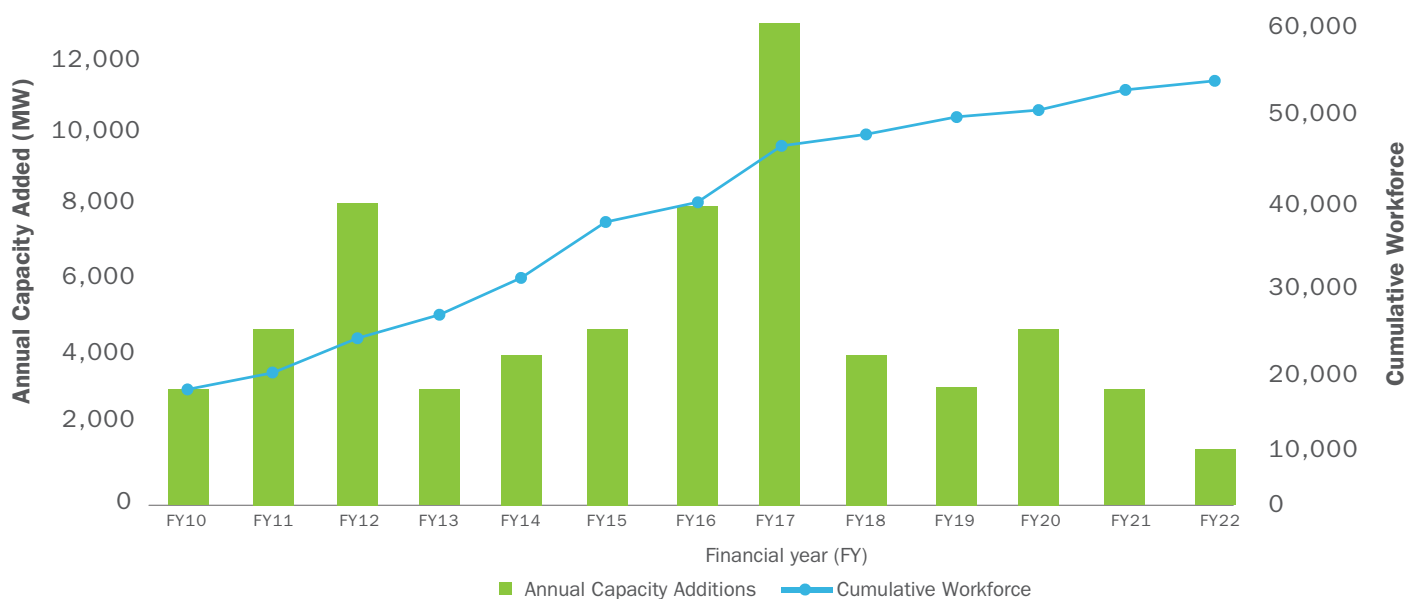
The annual capacity additions in the wind energy sector in FY22 amounted to 1.1 GW, a reduction of 28 percent from the capacity added in FY21 and 46 percent from the capacity added in FY20.<sup>27</sup> Deployment of 1.1 GW wind capacity employed 556 workers, a 28 percent decrease from FY21 (Figure 4).<sup>28</sup> This workforce was engaged in operation and maintenance activities with no new requirements arising for the other project deployment phases (Table A4, Annexure 1).<sup>29</sup> The declining capacity deployment trend in the wind energy sector over the past five years has stagnated the workforce additions to this sector and even led to job losses.

However, various reforms have been announced by the central government to support the domestic wind energy industry and are expected to revive the sector. For instance, the revamped auction process for wind projects now excludes the reverse bidding mechanism that was often used to discover the lowest tariffs but proved unsustainable for the project developers.<sup>30</sup> In addition, the government has also set a target to invite bids for 8 GW of wind energy projects each year till 2030.<sup>31</sup> These interventions are expected to restart capacity deployment and create new jobs in the sector.

## 3. Cumulative Workforce as of FY22 in Solar and Wind Energy Sectors

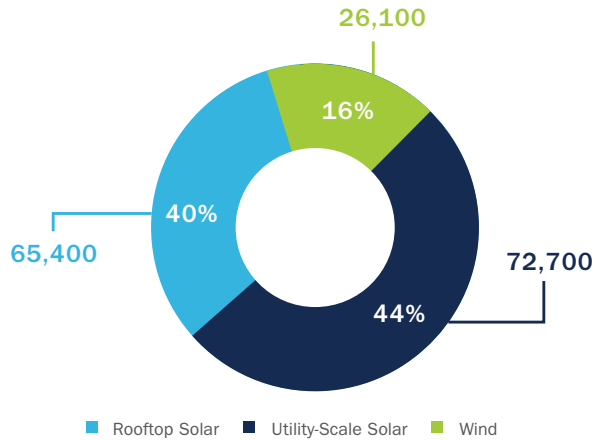
As of FY22, the solar and wind energy sectors employed 164,094 workers (Figure 5).<sup>32</sup> 84 percent (138,015 workers) of this workforce were employed in the solar energy sector while the remaining 16 percent (26,079 workers) were employed in the wind energy sector. Within solar, almost 53 percent (72,648 workers) of the workforce was employed in the utility-scale solar segment while the remaining (65,367 workers) was in the rooftop solar segment.<sup>33</sup> Despite a mere 16 percent (8.8 GW) share in the installed solar capacity, the rooftop solar segment shows comparable employment levels due to its distributed nature of deployment which requires more workers to install one MW than the utility-scale segment (Table 1).

**Figure 4: Workforce additions in the wind energy sector in FY22 reduced by 28% over FY21**



Source: CEEW-NRDC Analysis, 2022

**Figure 5: 164,000 cumulative workforce were employed in the solar and wind energy sectors as of FY22**



Source: CEEW-NRDC Analysis, 2022

## 4. Job Potential Estimates of New and Emerging Technologies

As new opportunities for job creation in the clean energy sector takes centre stage, it will be crucial to ensure that targeted upskilling/reskilling programs for the workforce are also implemented. For instance, as per the National Green Hydrogen Mission, approved by the Government

### OUTLOOK FOR FY23

India added about 10.9 GW of cumulative solar and wind capacity between April to December 2022.<sup>34</sup> There is an optimistic outlook for the remaining quarter of FY23 (January-March) as about 16 GW of cumulative renewable energy capacity is expected to be commissioned in this period.<sup>35</sup>

Within the solar energy sector, 7.9 GW of capacity was added between April to November 2022.<sup>36</sup> 85 percent (6.7 GW) of this capacity was added in the utility-scale segment and the remaining 15 percent (1.2 GW) in rooftop solar. These additions are greater than those observed in FY22, where 4 GW of cumulative solar capacity was added in the first three quarters. A similar trend is seen for the wind energy sector where 1.5 GW of capacity was installed in the first three quarters of FY23, compared to 0.836 GW in FY22.<sup>37</sup>

Extrapolating on earlier trends, the total new workforce additions in FY23 are expected to exceed FY22.

of India, over six lakh (0.6 million) clean jobs will be created by 2030.<sup>38</sup> Timely skilling interventions will be required to ensure that a skilled workforce is ready when the employment opportunities emerge. Figure 6 below provides an overview of skilling and job opportunities in the emerging technologies.

**Figure 6: New Skills and Jobs Opportunities in Emerging Technologies**



Source: SCGJ, 2022

Below is a case study providing an overview of jobs potential and skill sets across various functions for the deployment of a standalone grid-connected battery energy storage system.



## BATTERY ENERGY STORAGE SYSTEMS (BESS)

Batteries as storage technology find multiple applications in the electricity and mobility sectors. India is steadily increasing its focus on scaling battery energy storage systems in the electricity sector as discussed in previous sections. This section provides employment and skill trends from India's first standalone battery energy storage system, installed in 2019 in Rohini, Delhi, by Tata Power Delhi Distribution Limited (TPDDL).<sup>39</sup>

### Project details

The project is an equity venture of AES Corporation & Mitsubishi Corporation with TPDDL to demonstrate various use cases of batteries to the distribution companies. It was conceptualised in 2016.

<b>Capacity</b>	10 MW/ 10 MWh
<b>Location</b>	Tata Power-DDL Rohini Sector 24 sub-station, New Delhi
<b>Type</b>	Standalone grid-connected battery energy storage system
<b>Off-taker</b>	Tata Power-DDL
<b>Project Developer</b>	AES Corporation and Mitsubishi Corporation
<b>EPC</b>	Vasundhara Automation Engineers Private Limited
<b>Storage technology provider</b>	Fluence
<b>Construction duration</b>	11 months
<b>Commissioned date</b>	February 2019

The entire system is housed inside a building and consists of 'Fluence cubes'.<sup>40</sup> These modular cubes contain battery, inverter, controller and safety instruments like heating, ventilation, and air conditioning (HVAC), fire suppressors, cooling systems, etc. The cumulative capacity (10 MW/10 MWh) is achieved by scaling these cubes.

### Time and human resource requirement have been assessed across the following deployment phases –

- Business development - preparation of detailed project report, system specifications, logistics, viability assessment, legal and regulatory formalities, and general project management.
- Design and pre-construction - battery system sizing and configuration, balance of system (BoS) and HVAC system, bidding and finalisation of vendors and material procurement.
- Construction and commissioning - infrastructure construction, component installation and testing, checking the battery performance and auxiliary systems, completing grid connections to commission the system.
- Operation and maintenance (O&M) - battery operations and system observation, maintenance of battery and BoS, HVAC, fire-fighting system, electrical wiring, and grid elements.

Overall, these project deployment activities for the 10 MW/10 MWh standalone BESS at Tata Power-DDL's Rohini substation directly employed 61 workers (Table 2). Currently, the system is manually operated, but there is scope for automated operations in the future, which may downsize the workforce required.

When a BESS is planned in conjunction with renewable energy technology (solar or wind), the planning of the two components is done simultaneously. However, the design and construction and commissioning phases are separate for renewable energy and BESS. As a result, these phases require a dedicated workforce over and above what is required for commissioning the renewable energy components.

**Table 2: Employment generation across project deployment phases for 10 MW/10 MWh standalone BESS**

Phase	Approximate duration (months)	Workforce		Skill sets
		Permanent	Contractual	
Business development	4	10	4	Engineers (electrical, mechanical and civil) (EMC), project management and commercial, lawyers
Design and pre-construction	4	5	4	Design engineers (EMC)
Construction and commissioning	11	10	24	Civil and electrical engineers, safety and construction manager, electricians, riggers and fitters, commissioning engineer of the batteries, inverters and energy management system
Operation	Lifetime	4	0	Experience in grid system operations, project management
Maintenance	Lifetime	As required	As required	EMC diploma holders, OEM

Source: CEEW Analysis, 2022

## 5. Trainings and Capacity Building

India is one of the fastest growing economies in the world and with that comes the need to scale up employment opportunities.<sup>41</sup> The tremendous job creation potential of renewable energy sector can be leveraged through appropriate skilling interventions.



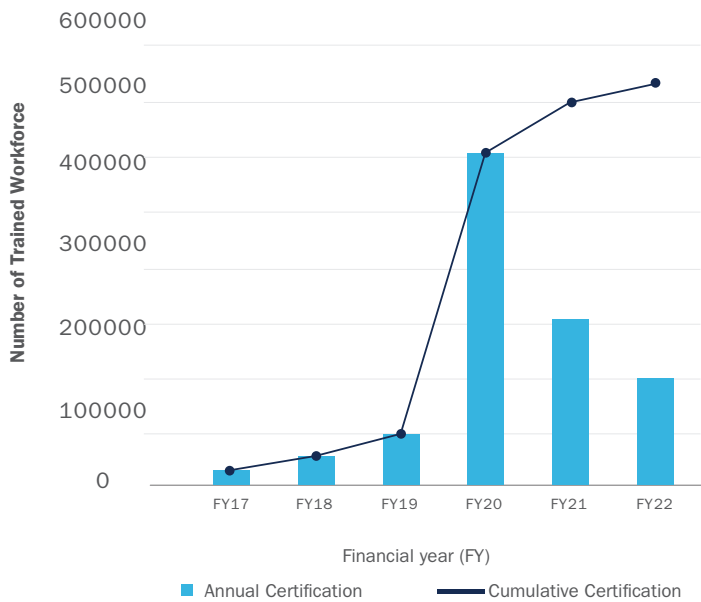
### TRAINING INITIATIVES BY SCGJ

With the target of bridging the gap between trainees (supply side) and employers (demand side) in the green sector, SCGJ develops strategies and plans skilling programs and interventions in alignment with evolving industry requirements. SCGJ provides trainings with a focus on installation and O&M job roles across both rooftop and ground mounted solar projects (Suryamitra Program), wind energy (Vayumitra Program), solar water pumping (Varunmitra Program) and the newly launched program on Small hydro power (Jal Urja Mitra). In addition, SCGJ is developing qualifications (Annexure 4) for futuristic and emerging areas critical to the energy transition including in e-mobility, green hydrogen, bio-fuels, energy storage, etc. These qualifications will ensure that skilled and certified candidates are readily available to meet the evolving need of the industry across the value chain. For instance, various skill interventions across the bioenergy sector are also being designed and implemented to meet the expected demand of over one million jobs mainly in biomass supply, installation, production, and O&M functions to support the National Bioenergy Programme.

SCGJ has also initiated the process to incorporate vocational education across green business sectors in schools, universities, and other institutions of higher learning in line with India's National Education Policy 2020. SCGJ has developed 50 National Skills Qualification Committee (NSQC) approved qualifications across various thematic areas along with their coursework and training content.<sup>42</sup>

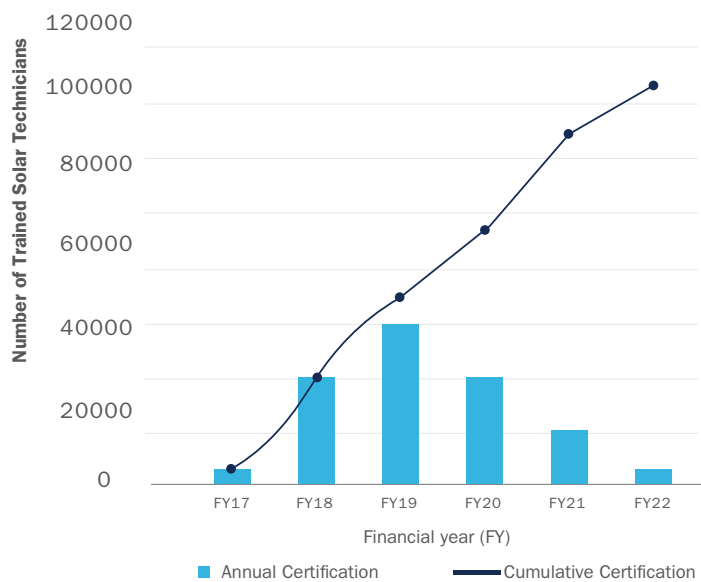
To date, SCGJ and its training partners have imparted physical training to over 509,000 trainees across green business domains (Annexure 2). This includes over 100,000 trainees in solar and other renewable energy domains (Figure 7). Of this, more than 86,000 trainees have been certified by the Government of India under the Suryamitra training program (Figure 8). In addition, SCGJ

**Figure 7: Cumulative workforce with training certifications from SCGJ as of FY22**



Source: SCGJ Analysis, 2022

**Figure 8: Cumulative workforce with solar training certifications from SCGJ as of FY22**



Source: SCGJ Analysis, 2022

has also developed an e-learning management system to enable remote learning and a job portal supporting the placements and employment of trained candidates across the country. Such innovations in training delivery mechanisms were developed to ensure that training and capacity building interventions could remain accessible to the potential workforce during the COVID-19 pandemic and beyond. Over 2,000 candidates have been virtually trained and certified through virtual instructor led trainings by December 2022.

As highlighted earlier, installed solar capacity has grown rapidly in India whereas the wind energy sector has stagnated. Concurrently, the demand for a trained workforce in the solar sector is also increasing. However, COVID-19 pandemic-induced restrictions have slowed the pace of training delivery across all thematic areas (Figure 8). As for the wind sector, the demand for additional skilled workforce has been limited, as discussed in Section 2. Consequently, the number of trainings provided under various programmes for the wind sector has not picked up pace. It is expected, however, that 5,000 candidates will be trained and certified across wind energy job roles through MNRE supported Vayumitra program by FY24.





## EMERGING SKILL REQUIREMENTS IN THE SOLAR INDUSTRY

### Solar project development

The current skilling initiatives have been successful in imparting the required skillset for project deployment activities like construction along with operation & maintenance (O&M). However, given the fast pace of capacity deployment, more skilled workforce is required to meet the demand. Some new requirements for the roles are listed below:<sup>43</sup>

- Business development and project design roles for hybrid configurations of the solar projects (with wind or energy storage hybrid)
- Recycling specialists for operation and maintenance
- Environment and health safety (EHS) specialists

### Solar manufacturing

CEEW-NRDC research found that there is a huge shortage of workers trained in upstream manufacturing segments (poly-silicon, ingots, wafers, and cells).<sup>44</sup> This segment is the focus of the recently launched INR 19,500 crore (USD 2.43 billion) tranche-II of production-linked incentive (PLI) scheme. This scheme targets 65 GW of domestic manufacturing capacity (29 GW fully integrated, 18 GW wafer to module integration and 18 GW cell to module integration).<sup>45</sup> These facilities will be different from existing solar cell and module facilities which are largely assembling units of MW scale. The key profiles in the new manufacturing lines can include manufacturing specialists, and facility (manufacturing building) specialists. Industrial production and engineering, robotics and automation, modelling, and data analytics are some key skills needed in this new sector. These highly specialised skills can be developed through courses like equipment engineering, solid-state device technology, and manufacturing processes. It is important to bridge the gap in academic knowledge and practical experience via internships.

## 6. Recommendations

As renewable energy deployment increases along with integration of emerging technologies, the number of potential jobs will also increase. Thus, developing streamlined initiatives to create a robust training and capacity building ecosystem will ensure that an industry ready workforce is available for the future jobs. The recommendations below primarily focuses on interventions required for skill development.

- Mainstream industry relevant renewable energy courses at universities for developing highly skilled workforce** – Several of the emerging sectors including energy storage, solar manufacturing, green hydrogen, etc. would need highly skilled workforce across the value chain. To meet the potential requirement, institutions for higher learning including leading universities and premier institutes should **introduce application oriented and industry relevant courses** in these areas, both for undergraduate programmes and for specialised post-graduate level degrees.

As the recently announced National Credits Framework by the Ministry of Skills Development

and Entrepreneurship (MSDE) allows integration of credits earned across the various education modes (school/higher/vocational/skills), the universities can also **embed multi skilling programs imparted at vocational institutions with existing undergraduate courses**. As a result, more candidates can now be onboarded under various technical and non-technical education pathways.

- Strengthen existing national skilling programmes and create training infrastructure at grassroots to create local skilled workers** – There is a need to **strengthen the existing skilling courses** to meet the evolving industry requirements and enhance the opportunities for the existing trained workforce. This includes upskilling modules for the trainees. The recently launched employability skills modules launched by MSDE are being integrated horizontally across all job roles is the right step in the direction.<sup>46</sup> These modules, aligned with the National Credits Framework requirement, provide a range of soft skills and other employability skills like communication, entrepreneurship, leadership, project management etc. to ensure the wholistic development of trainees at various levels across all sectors.

Simultaneously, skill development ecosystem with support from key stakeholders including leading industry and industry association should **upgrade the training infrastructure** by creating more training centres to implement various training programs in alignment with the requirements of the industry.

- c. Create gender focused skilling courses to improve women participation in the clean energy workforce** – More than 50 percent of the workers registered on the e-shram portal of the Ministry of Labour and Employment are women.<sup>47</sup> The skill ecosystem needs to deploy gender-specific strategies. Higher level policies and institutes should focus on improving existing skilling programmes to ensure women participation by providing online courses and career guidance to improve retention across sectors. This can play a critical role in creating employment and entrepreneurial opportunities for women, both in rural and urban areas.<sup>48</sup> In addition, a network of certified women trainers would encourage greater participation of women in training programmes.

Representation of women in the renewable sectors is low for several reasons: lack of access to opportunities, safety and security concerns, misperception of capabilities, and a mix of other societal and workplace challenges faced by women employees.<sup>49</sup> This also results from lower percentage of women enrolling in Science, Technology, Engineering and Management (STEM) courses thereby limiting the trainable talent pool.<sup>50</sup> Women are marginally well represented in the designing and pre-construction phases as compared to construction and operations phases. However, segments such as distributed renewable energy offer visible potential employment impact for women with prevailing higher skill and labour intensive activities.<sup>51</sup>

- d. Build comprehensive institutional capacity at the state level** – State skill development agencies should track demand of green jobs and identify skills gaps to abridge geography specific disparity. Further, these agencies should actively collaborate with industry and other stakeholders such as SCGJ to improve on delivering and monitoring new trainings. As such interventions require capital investments to become mainstream, finance mobilization through all sources including government funds allocated under specific policies and private capital, such as grants, corporate social responsibility funds, private investments will be important.

- e. Upskill and reskill existing workforce engaged in conventional sectors** – As India moves towards cleaner fuels for electricity generation and utilisation, skill transition will take a centre stage for the workforce impacted by systemic transitions across sectors such as power and mobility.<sup>52</sup> Dedicated resources are required to map existing skill sets and consequently upskill, reskill and in some case re-certify the existing workforce while facilitating appropriate career trajectories and enabling existing workforce to transition to higher roles.
- f. Create focused skilling centres for geographies with potential for higher just transition** – Given the technology and geographical constraints of renewable energy deployment, it may not always be possible for the states transitioning from fossil fuels to deploy renewable energy. Thus, mapping upcoming technologies in the state and related skill building interventions will play a critical role in addressing social and economic implications of this transition.

Dedicated skill interventions in the geographies with potential for high transition may be integrated with various centrally sponsored schemes like the PLI schemes announced in solar manufacturing and energy storage as well as the Green Hydrogen Mission. The strong skill development architecture could support just transition for the existing workforce while ensuring that appropriate capacities are built to support the growth of new and emerging sectors. This will ensure that domestic manufacturing, investments, and exports across the technology value chain are also supported with reliable supply of trained and certified candidates.

- g. Launch a renewable energy jobs dashboard** – As India recuperates from the COVID-19 pandemic and global supply chain crisis, estimates of jobs potential from renewable energy sector would be valuable for all key stakeholders in the energy ecosystem: policymakers, renewable energy industry, investors, and the research community. The continuous tracking and reporting of employment and skilling in renewable energy sector can support decision making and guide policy interventions, finance, and human capital development.

NRDC, CEEW, and SCGJ are developing a web portal to track the key metrics on employment in India's renewable energy sectors to provide this information to key stakeholders on a more recurring basis.

# Annexures

## Annexure 1

A full time equivalent (FTE) coefficient is the ratio of the time spent by an employee on a particular project/task each year to the standard total working hours in that particular year. In 2017, CEEW and NRDC calculated FTE per MW numbers separately for each phase of solar and wind project deployment (Table A1).<sup>53</sup> These FTE numbers are used as coefficients to estimate the total workforce expected to be employed in the solar and wind energy project deployment process based on excess capacity added every year (MW).

Table A1 shows the FTE coefficients for different segments of solar and wind energy projects.

**Table A 1: Solar and wind project deployment phases and the full time equivalent (FTE) coefficients**

Project segment	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 Analysis, 2017<sup>54</sup>

**Table A 2: Workforce additions in the utility-scale solar segment in FY22**

Cumulative capacity addition until FY22 (MW)	Annual capacity (MW)	Change over previous year (MW)
47,262	11,617	8,084
Project segment	FTE	Workforce additions
Business development	0.05	404
Design	0.2	1,617
Construction and commissioning	2.7	21,826
Operations and maintenance	0.51	5,940

Source: CEEW-NRDC Analysis, 2022

**Table A 3: Workforce additions in the rooftop solar segment in FY22**

Cumulative capacity addition until FY22 (MW)	Annual capacity (MW)	Change over previous year (MW)
8,859	2,295	873
Project segment	FTE	Workforce additions
Business development	1.53	1,336
Design	8.85	7,726
Construction and commissioning	13.84	12,082
Operations and maintenance	0.5	1,148

Source: CEEW-NRDC Analysis, 2022

**Table A 4 Workforce additions in the wind sector in FY22**

Cumulative capacity addition until FY22 (MW)	Annual capacity (MW)	Change over previous year (MW)
40,353	1,111	-442
Project segment	FTE	Workforce additions
Business development	0.06	0
Design	0.11	0
Construction and commissioning	0.6	0
Operations and maintenance	0.5	555

Source: CEEW-NRDC Analysis, 2022

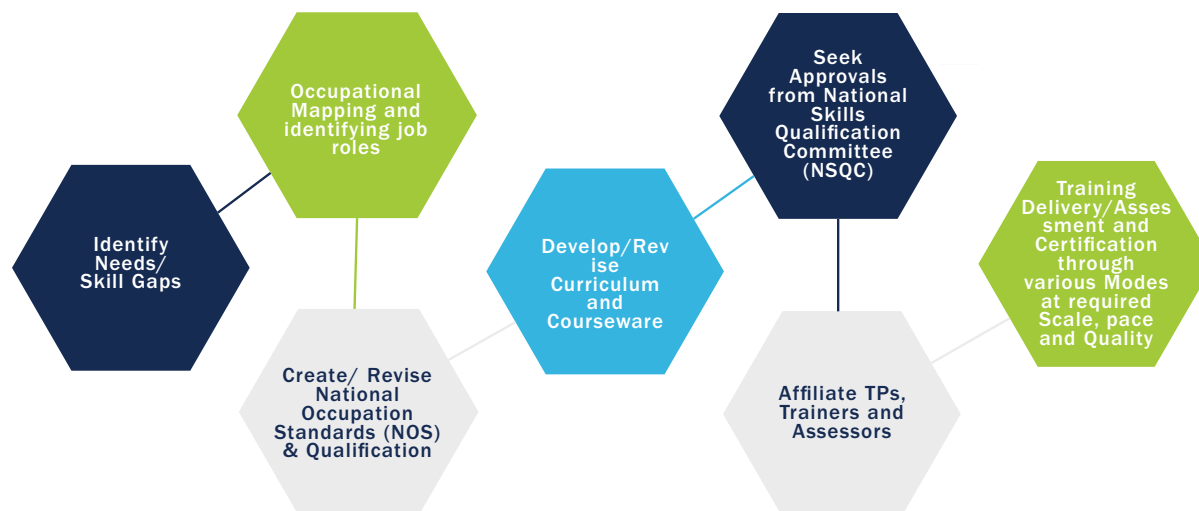
## Annexure 2

### Emerging green business sector areas with high job potential:

- Green Hydrogen
- Solar manufacturing
- EV Manufacturing, Operations and charging infrastructure
- Large Size Energy Storage
- Demand Side Management
- Floating Solar Power Plants
- E-waste Management
- Off Shore Wind Power Plants
- Wind-Solar Hybrid and other Renewable Energy Systems
- Biomass /Biofuels/ Bio CNG Production and Supply Chain
- De-Carbonisation of Energy Intensive Sectors
- Pollution Prevention and Control Network
- Green Buildings
- Green Financing

## Annexure 3

**Figure 9: Snapshot of training delivery cycle**











Source: SCGJ, 2022<sup>55</sup>

## Annexure 4

National Occupational Standards (NOSs) specify the standard of performance a job holder must achieve when performing a function in the workplace, together with the knowledge and understanding the job holder needs to meet a standard consistently. Each NOS defines one key function in a job role. A set of NOSs, aligned with the National Skills Qualification Framework for each industry sector is called a Qualification (also formerly known as Qualification Packs (QPs). Together, QP-NOS drive the creation of curriculum through which competency based trainings are delivered.

**Figure 10: Summary of SCGJ's Qualification**

 <b>Sector - Wise Job roles</b>	NSQF approved Job Level						<b>NSQC Approved Qualification</b>
	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	
 <b>Solar Photovoltaic</b>	1	2	8	6	1	2	<b>20</b>
 <b>Wind Energy</b>	0	1	3	2	0	0	<b>6</b>
 <b>Bio Energy</b>	0	1	3	1	1	1	<b>7</b>
 <b>Waste Management</b>	0	2	1	0	1	0	<b>4</b>
 <b>Waste Water Treatment</b>	0	1	3	0	0	0	<b>4</b>
 <b>Green Hydrogen</b>	0	0	1	1	0	0	<b>2</b>
 <b>Others</b>	0	3	6	1	0	0	<b>10</b>
<b>Total</b>	1	10	25	11	3	3	<b>53</b>

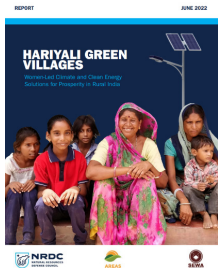
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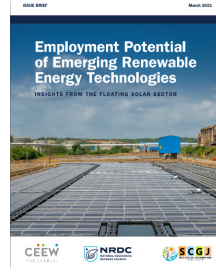
## Highlighted Reports



**Hariyali Green Villages: Women-Led Climate and Clean Energy Solutions for Prosperity in Rural India**



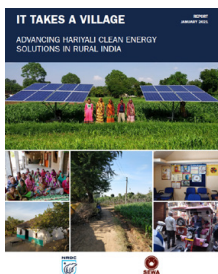
**India's Expanding Clean Energy Workforce: Opportunities in the Solar and Wind Energy Sectors**



**Employment Potential of Emerging Renewable Energy Technologies: Insights from the Floating Solar Sector**



**Creating Jobs and Income: How Solar Mini-Grids Are Making a Difference in Rural India**



**It Takes a Village Advancing Hariyali Clean Energy Solutions in Rural India**



**Worth Their Salt: Building Skills and Improving Livelihoods of Women Salt Farmers in Gujarat through Clean Energy Solutions India**



**Filling The Skill Gap in India's Clean Energy Market: Solar Energy Focus**



**Powering Jobs Growth with Green Energy**

## Highlighted Blogs

- **Catalyzing Clean Energy Solutions through Skilling, Sameer Kwatra and Akanksha Golchha, September 2022**  
<https://www.nrdc.org/experts/sameer-kwatra/catalyzing-clean-energy-solutions-through-skilling>
- **Jobs and Skilling: Training for the Clean Energy Transition, Amanda Maxwell and Upendra Tripathy, June 2022**  
<https://www.nrdc.org/experts/amanda-maxwell/jobs-and-skilling-training-clean-energy-transition>
- **Investing in People for Energy Access, Sameer Kwatra and Akanksha Golchha, May 2022**  
<https://www.nrdc.org/experts/sameer-kwatra/upskilling-and-reskilling-rural-households-energy-access>
- **Women in Action for Clean Technology Adoption, Sameer Kwatra and Akanksha Golchha, March 2022**  
<https://www.nrdc.org/experts/sameer-kwatra/women-action-clean-technology-adoption>
- **India Could Create Millions of Jobs Through Renewable Energy, Sameer Kwatra, Charlotte Steiner, Charu Lata and Akanksha Tyagi, January 2022**  
<https://www.nrdc.org/experts/sameer-kwatra/india-could-create-millions-jobs-through-renewable-energy>
- **Clean Energy Skills for Women Entrepreneurs in India, Sameer Kwatra, Charu Lata and Charlotte Steiner, July 2021**  
<https://www.nrdc.org/experts/sameer-kwatra/women-entrepreneurs-india-develop-clean-energy-skills>