PARTNERSHIP TO ADVANCE CLEAN ENERGY DEPLOYMENT (PACE-D)

Technical Assistance Program

Study Training Needs Assessment for Solar Energy – Executive Summary
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<tr>
<td>BOS</td>
<td>Balance of System</td>
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<tr>
<td>CII</td>
<td>Confederation of Indian Industry</td>
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<td>CIIE</td>
<td>Centre for Innovation, Incubation, and Entrepreneurship</td>
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<td>CNC</td>
<td>Computerized Numerical Control</td>
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<td>FI</td>
<td>Financial Institution</td>
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<td>GW</td>
<td>Gigawatt</td>
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<td>IIM</td>
<td>Indian Institute of Management</td>
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<td>Infuse</td>
<td>Indian Fund for Sustainable Energy</td>
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<td>IOM</td>
<td>Installation &amp; Operation Management</td>
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<td>ITI</td>
<td>Industrial Training Institute</td>
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<td>MNRE</td>
<td>Ministry of New and Renewable Energy</td>
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<td>MW</td>
<td>Megawatt</td>
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<td>MOP</td>
<td>Ministry of Power</td>
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<td>NISE</td>
<td>National Institute of Solar Energy</td>
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<td>NSDC</td>
<td>National Skill Development Corporation</td>
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<td>NGO</td>
<td>Non-Governmental Organization</td>
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<td>PACE-D</td>
<td>Partnership to Advance Clean Energy – Deployment</td>
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<td>PV</td>
<td>Photovoltaic</td>
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<td>RE</td>
<td>Renewable Energy</td>
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<td>SSC</td>
<td>Sector Skill Council</td>
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<td>SCGJ</td>
<td>Skill Council for Green Jobs</td>
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<td>SETNET</td>
<td>Solar Energy Training Network</td>
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<td>TA</td>
<td>Technical Assistance</td>
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<td>U.S.</td>
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<td>USAID</td>
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1 INTRODUCTION

The solar power sector in India is poised for a rapid growth in the next six years. The Government of India (GOI) has set an ambitious target of 100 Gigawatt (GW) of installed solar power capacity by 2022. Meeting this target is dependent on the availability of skilled human resources. This report presents an analysis of training needs from a survey of industry requirements and links it to specific programs and courses that will fulfill those needs.

1.1 BACKGROUND

Presently, strong initiatives are underway for the delivery of training in the solar sector in India. These initiatives are being driven by the Ministry of New and Renewable Energy (MNRE), which has been spearheading skill development and training in the renewable energy (RE) industry in India for the past two decades. In addition, MNRE has constituted the National Institute of Solar Energy (NISE) which implements human resource development goals of the solar sector.

Apart from MNRE and NISE, the National Skill Development Corporation (NSDC), under the Ministry of Skill Development and Entrepreneurship, partners with the Indian industry to promote skill development and achieve the goals of ‘Skill India’ (the national skill development mission). The Sector Skill Councils (SSCs) support the functioning of NSDC to develop the skills curriculum and training framework for each industrial sector based on the industry requirements. The Skill Council for Green Jobs (SCGJ) is the dedicated SSC for ‘green energy businesses’ across India.

The Partnership to Advance Clean Energy - Deployment (PACE-D) Technical Assistance (TA) Program (the Program) is a USD 20 million five-year bilateral program which is led by the United States Agency for International Development (USAID) and the U.S. Department of State and implemented in partnership with the Ministry of Power (MOP) and the MNRE. The Program has created a training network, namely the “Solar Energy Training Network (SETNET)”. The objective of SETNET is to build skills and capacities to ensure availability of qualified solar energy professionals to meet the national solar deployment targets. The aim is to provide a structured platform to NISE for solar-related technical and business training by building a strong network of qualified and trained professionals for the booming solar industry. SETNET was established under NISE to design four themed courses and select 35 accredited partners across India to impart training in the solar photovoltaic (PV) sector.

1.2 SCOPE OF THE STUDY

The Program commissioned a study on ‘Training Needs Assessment’ for the solar industry as one of the key operational strategies under its skill development objective. The study was designed to be carried out in two phases, i.e., Phase I and Phase II. The objective of Phase I - ‘Landscape Analysis’ was to attempt a comprehensive top-down mapping of value chains and segments within the solar sector, and derive skill requirements for human resources within each identifiable segment. Under Phase II - ‘Solution Design’, the skill requirements were aggregated to design specific interventions in the form of training.
courses. Phase II recommended specific enhancements or modifications to the existing training programs and courses including SETNET.

1.3 TASK FORCE

The Program engaged the Confederation of Indian Industry (CII) to carry out the training need assessment. In the inception stage, CII constituted a dedicated industry-led Task Force to guide, steer, and monitor project activities. The Task Force comprised of top officials from MNRE, SCGJ, NISE, and USAID, and key executives from few of the leading solar power companies of India. It was led by Mr. K. Krishan, Chairman, SCGJ and Dr. Praveen Saxena, Chief Executive Officer, SCGJ, and represented by leading solar companies including Chemtrols Solar, First Solar, Jakson Power, juwi India, Mahindra Susten, Swelect Energy Systems, and Vikram Solar (refer Annexure 1 for the Task Force structure).

Two Task Force meetings were held during the course of the study. The first meeting established a roadmap for the study and laid out the major tasks and milestones. The second meeting assessed and validated the key findings of skill requirements and outlined the tasks for upgrading the training curriculum.
Primary and secondary research methodologies were used in conducting this study, as shown in Figure 1. Primary research involved one-on-one interactions with solar industry experts and professionals to obtain inputs on the skill competencies and needs, training solutions and recommendations, and challenges faced in manpower sourcing and retaining. Secondary research was undertaken to survey the value chain and market segments of the solar PV industry and direct the efforts of primary research and analysis on specific areas.

The methodology and process used for primary research and analysis had distinct steps with specific questions being defined for each step at the outset. Dedicated questionnaires were framed for obtaining data in both Landscape Analysis and Solution Design Phases. The progression of analysis performed in the study is presented in Figure 1.
2.1 LANDSCAPE ANALYSIS PHASE

2.1.1 Data Collection

The nature of companies, employers, areas of operation, manpower, and skills are heavily influenced by the segment of the industry that is being studied. Therefore, the data collection process was first scoped with specific industry segments as shown in Figure 5. The required skills across key job roles were obtained through an extensive stakeholder survey with 340 organizations, involving one-on-one meetings with more than 50 organizations and around 120 experts in the solar industry. Multiple consultations were held with survey respondents and task force members on the study data. This iterative process ensured fine-tuning and accuracy of the results.
For the 50 organizations with which interactions were held, the first chart in Figure 3 shows the split among manufacturing and non-manufacturing sectors. The second chart shows the breakup into the various segments – PV module manufacturing (for the manufacturing sector) and utility-scale PV and rooftop PV (for the non-manufacturing sector). The third chart shows the specific split of companies within the non-manufacturing segment: utility-scale PV and rooftop PV.

2.1.2 Data Analysis

This step involved gleaning insights from the discussions and questionnaire responses to arrive at broad themes for action on skill development. The conclusions arrived at are based on the insights obtained that are highly qualitative in nature.

2.2 SOLUTION DESIGN PHASE

2.2.1 Training Recommendations

The inputs from the industry survey and skill requirement analysis were used to arrive at specific training themes and their components. Additionally, interactions were held with 10 training partners and institutes to validate the findings and provide recommendations for
upgrading the existing training curriculum (including SETNET). As seen in Figures 1 and 2, the study followed a logical structure – from the first step of identifying industry segments to the last step of designing training solutions – which is summarized in Figure 4. A detailed explanation of this logical flow is described in the subsequent chapter.

Figure 4: Logical Structure of the Study Analysis

The following two chapters present the findings and results of the study, for the Landscape Analysis and Solution Design Phases respectively.
3 PHASE I: LANDSCAPE ANALYSIS

The journey from manufacturing a solar cell to the generation and consumption of solar power requires value addition through a chain of specialized functions, giving rise to diversified skills and jobs. In Landscape Analysis, the study identified the level of knowledge and skills required for these jobs.

3.1 SEGMENTS AND VALUE CHAIN

As noted earlier, a ‘top-down methodology’ was followed in this study to assess the manpower skills and training requirements of the industry. The first step was to broadly categorize the solar industry into ‘manufacturing’ (solar PV modules) and ‘non-manufacturing’ (solar PV projects) sectors. A value chain was then charted to determine the processes and entities that operate in each segment. This primary level of classification, listing the segments and value chain of the solar industry, is depicted in Figure 5.

![Figure 5: Segments and Value Chain of Solar Industry](image)

From the value chain mentioned in Figure 5, one can deduce that the major business verticals that operate in the Indian solar industry can be classified as material supply (raw materials for manufacturing solar PV cells and associated components), solar PV module manufacturing (production and sale of solar PV modules), solar PV projects (project developers, financiers, installers, and operators) and consumers (utilities, decentralized retail and off-grid). Such a classification aids in identifying the core processes and functions in each business vertical.
3.2 KEY JOB ROLES

Each process/activity in the value chain can be visualized as functional fields that require qualified manpower for execution of the processes. For e.g., Figure 5 depicts that ‘manufacturing’ value chain consists of the functional processes of production of PV modules, followed by sales and marketing. Similarly, ‘solar PV projects’ value chain can be split into the functional processes of project development, project finance, project execution, and project operation and maintenance.

These functional fields are composed of job roles – depending on the work activities and manpower competencies – expertise, experience, and qualification. In the solar industry, certain job roles are considered more critical than others in terms of their direct bearing/impact on achieving the overall target of 100 GW by 2022. These job roles were identified as the ‘key job roles’ for the purposes of this study because:

- The competencies of these job roles have a huge impact on the plant durability, quality of installation, and overall project viability.
- The potential for employment creation of these job roles is significant.
- The industry strongly feels that availability of skilled manpower across these job roles would significantly enhance the competitive edge of the solar companies.

3.3 KEY SKILL NEEDS

The main responsibilities for the key job roles differ across technical, financial, and operational functions based on the job role. At present, employees across the key job roles possess skills to perform certain work functions as required; however, regarding certain job activities, ‘performance gaps’ were identified due to lack of requisite skills. These skill gaps are the barriers that should be overcome to ensure that employees across the key job roles execute their work activities efficiently. The industry has clearly enunciated the training requirements to overcome these barriers and meet the goal of improved quality and productivity.

Based on this ‘top-down’ methodology, the following section focusses on the progression from value chain to skill needs for the manufacturing (solar PV modules) and non-manufacturing (solar PV projects) sectors.

3.4 MANUFACTURING SECTOR: KEY FINDINGS

The manufacturing (solar PV modules) sector has been classified into Energy Generating System (crystalline PV cells and PV modules) and Balance of System (BOS). The study focuses on PV module manufacturing, as it is specific to the solar industry, with a substantial industrial presence (around 80 companies with varying manufacturing capacities), job-creation opportunities, and skill requirements. The BOS segment has not been considered for the purpose of this study since it is common to a range of industries/applications other than solar energy.

The key findings of the manufacturing (solar PV modules) sector include:
1. **Five key job roles** were identified for this sector – operator, supervisor, production manager, quality manager, and research and development (R&D) manager. These job roles have a direct impact on the scale-up of the segment and a significant potential for manpower addition.

2. The **key skill needs** were captured for each of these key job roles.

3. The installed manufacturing capacity is projected to be **15,000 Megawatt (MW) by 2022**. Around **6,000 jobs for skilled manpower** are expected to be created to achieve this target.

The value chain of PV module manufacturing segment is shown in Figure 6.

![Value Chain of Manufacturing (Solar PV Modules) Sector](image)

**Figure 6: Value Chain of Manufacturing (Solar PV Modules) Sector**
Key Job Roles, Competencies and Skill Needs

The job roles highlighted in orange in Figure 6 are identified as the “key job roles” of PV module manufacturing segment, based on the direct industry inputs, the potential for job creation, and the importance of skills to enable scale-up of the segment. These job roles cover the functional fields of assembly line production, quality, and R&D. The aggregated data from the industry interactions revealed the specific level of competencies for each job role, which should become the focus for a targeted skill development exercise.

Once the key job roles and competencies were determined, the skill needs were identified and mapped for these job roles. These skill needs should be the focus themes for developing a dedicated skill development curriculum.

Details on the entry-level criteria, key competency development themes and focus areas for skill development for these key job roles are captured in Figures 7 to 11.

Job Role 1 – Operator: Handling, Operating, and Assembly of PV Modules

Figure 7: Operator – Job Role Diagram
Job Role 2 – Supervisor: Supervising and Monitoring Assembly Line Operations and Achieving Productivity Targets

Training Needs for Supervisor in Solar PV Manufacturing
- Supervise and Monitor Assembly Line Operations
- Achieve Productivity Targets

Entry Criteria:
- Graduate / Diploma Engineers
- One to Four years experience in a module manufacturing / other manufacturing plant

Key Competency Development Themes:
- Managerial Competencies
- Supervisory Competencies
- Domain Specific Competencies

Focus Points for Skill Development:
- Assembly line - Machine operation and Understanding of the Process
- Focus on lamination process
- Workmanship skills related to soldering, tabbing and stringing

Figure 8: Supervisor – Job Role Diagram

Job Role 3 – Production Manager: Production Planning, Monitoring Productivity Targets, and Ensuring All Standard Compliances

Training Needs for Production Manager in Solar PV Manufacturing
- Supervise and Monitor Assembly Line Operations
- Achieve Productivity Targets

Entry Criteria:
- B.E. / B.Tech / Diploma
- 7 to 15 years experience in a module manufacturing / other manufacturing plant

Key Competency Development Themes:
- Managerial Competencies
- Supervisory Competencies
- Domain Specific Competencies

Focus Points for Skill Development:
- Knowledge on Product and Technology

Figure 9: Production Manager – Job Role Diagram
Job Role 4 – Quality Manager: Engineering Control of Plant, Ensuring Quality Plan Compliance, and Analyzing Customer Complaints

Training Needs for Quality Manager in Solar PV Manufacturing
- Ensuring quality plan compliance
- Analyzing and addressing customer complaints

Entry Criteria:
- B.E. / B.Tech / Diploma / Ph.D.
- 7 to 15 years experience in a module manufacturing / other manufacturing plant

Key Competency Development Themes

Managerial Competencies
- Reporting
- Communication with Managers (Design and Production)
- Customer Interaction

Supervisory Competencies
- Team Coordination
- Inspection and Testing

Domain Specific Competencies
- Electrical, Mechanical or Industrial Production Engineering
- Codes and Standards for Module Manufacturing

Focus Points for Skill Development
- Knowledge on Product and Technology
- Awareness of Environmental Management Systems (covering electronic waste management – hazards, disposal, etc.)

Figure 10: Quality Manager – Job Role Diagram

Job Role 5 – R&D Manager: New Product Development and Reliability Engineering

Training Needs for Quality Manager in Solar PV Manufacturing
- Ensuring quality plan compliance
- Analyzing and addressing customer complaints

Entry Criteria:
- B.E. / B.Tech / Diploma / Ph.D.
- 7 to 15 years experience in a module manufacturing / other manufacturing plant

Key Competency Development Themes

Managerial Competencies
- Reporting
- Communication with Managers (Design and Production)
- Customer Interaction

Supervisory Competencies
- Team Coordination
- Inspection and Testing

Domain Specific Competencies
- Electrical, Mechanical or Industrial Production Engineering
- Codes and Standards for Module Manufacturing

Focus Points for Skill Development
- Knowledge on Product and Technology
- Awareness of Environmental Management Systems (covering electronic waste management – hazards, disposal, etc.)

Figure 11: R&D Manager – Job Role Diagram
3.5 NON-MANUFACTURING SECTOR: KEY FINDINGS

The non-manufacturing (solar PV projects) sector is classified into segments based on the plant configuration – utility-scale PV, rooftop PV, and off-grid. Focus was laid on the utility-scale and rooftop segments alone, as skill needs of the off-grid segment has been covered by other recently published reports.

The key findings of non-manufacturing (solar PV projects) sector include:
1. **Six key job roles** were identified for this sector – project manager, project engineer, design engineer (electrical and mechanical), site engineer/site supervisor, site technician and operations and maintenance (O&M) engineer. These job roles have a pertinent impact on the plant installation, quality and durability, project viability, potential for job creation, and improving the competitiveness of companies.
2. For each of these key job roles, the **key skill needs** were captured.
3. For achieving the installed solar capacity target of **100 GW by 2022**, around **1,43,000 additional manpower** across the key job roles are expected to be created.

The value chain of utility-scale PV and rooftop PV segments is charted in Figure 12.
Figure 12: Value Chain of Non-Manufacturing (Solar PV Projects) Sector
Figure 12 shows that the principal functions and job roles lie within the EPC process (engineering, procurement, and construction), which is a vital link in the solar PV project implementation process.

Considering the solar stakeholders’ ecosystem, the job roles of entrepreneurs, bankers, and utilities have also been covered in this report.

‘Bankers’ and ‘utilities’ have an important stake in the project lifecycle, considering the project financing and power off-take roles of these entities respectively. The mapping of key challenges and institutional gaps which are impeding the accelerated scale up of solar PV rooftop in India focus on two broad themes - deployment and capacity building. After successful finalization and adoption of the policy, regulation and the interconnection guidelines/framework have been finalized; the onus of implementing these projects falls on three distinct stakeholders - the developer, the utility engineer and the banker. However, all these three stakeholders have had minimal support available when it comes to capacity building and training for scaling and rapid deployment of solar PV rooftop projects.

It is critical to build the capacity of bankers, entrepreneurs and utility professionals to realize India’s national target of 40 GW of solar PV rooftop. A specific training program for utility engineers on interconnecting solar PV rooftop installations is essential. This training program should provide an overview of the solar PV rooftop interconnection process and specific inputs on the key aspects for commissioning these installations.

There is a critical need for financing of solar PV rooftop projects to meet the national deployment targets. For enabling this, the banks and financial institutions (FIs) will need to develop an intrinsic understanding of the solar PV rooftop sector and related business models and technical architecture, commercial terms of engagement and the risks associated with these projects. The primary objective of the training program for bankers should be to develop comprehensive capacity amongst bankers and FIs to appraise and finance commercial and industrial solar PV rooftop projects.

Further, ‘entrepreneurs’ are included in the value chain, considering the various roles they could play across the business verticals of the solar industry (refer Figure 5). The training program for entrepreneurs should essentially train them to develop a comprehensive understanding of the solar PV rooftop sector amongst new stakeholders entering this sector, covering the aspects related to technical, policy and regulatory, business models, financing, contract structures and project management.

**Key Job Roles, Competencies, and Skill Needs**

The job roles highlighted in orange in Figure 12 are identified as the “key job roles” of the utility-scale PV and rooftop PV segments, based on the direct industry inputs and the potential for job creation.

The data aggregated from the industry interactions pointed to the specific level of competencies for each job role which should become the focus for a targeted skill development exercise.
Once the key job roles and competencies are determined, the skill needs should be identified and mapped for these job roles. These skill needs should be the focus themes for developing a dedicated skill development curriculum.

The top skill needs as per the survey responses for key job roles, covering the functional fields of project management, engineering design, site execution, and operations and maintenance, is shown in Figure 13.

The key observations from Figure 13 are:

- **Optimization (for design engineer)** is identified as the foremost skill need, with 59 percent of the respondents identifying it as a priority skill:
  - This implies that training programs for design engineers should necessarily have a separate course on optimization principles and techniques.
- 48 percent of responses show that knowledge regarding technical specifications, codes, and standards (for design engineer) are the second most important skills requirement:
  - This is directly linked to the quality aspect of the job role, and hence, this skill set is crucial as well.
- 48 percent of respondents identified the selection of inverters and batteries as a top skill need, (for electrical design engineer).
- Skill needs applicable to O&M engineer in data monitoring and control and preventive maintenance received 38 percent of responses.

Details on entry-level criteria, key competency development themes and focus areas for skill development for these key job roles are captured in Figures 15 to 20.
Job Role 1 – Project Manager: Deployment and Management of Resources for Timely Execution of Projects

Training Needs for Project Manager in Solar PV EPC
Management and deployment of resources in the timely execution of projects

<table>
<thead>
<tr>
<th>Entry Criteria</th>
<th>Key Competency Development Themes</th>
<th>Focus Points for Skill Development</th>
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<tr>
<td></td>
<td>Managerial Competencies</td>
<td>Project Management Techniques:</td>
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<td></td>
<td>Vendor Management</td>
<td>• Planning manpower and machinery</td>
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<td>Progress Reporting</td>
<td>• Implementing project management</td>
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<td></td>
<td>Customer Relationship</td>
<td>• planning techniques, mainly</td>
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<td>Technical Competencies</td>
<td>• critical path method (CPM) and</td>
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<td>Financial Management</td>
<td>• review of the same</td>
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<td>Project Planning, Scheduling and</td>
<td>• Interpreting requisite technical</td>
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<td>Tracking</td>
<td>• codes for obtaining regulatory</td>
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<td>Domain Specific Competencies</td>
<td>• approvals and permits</td>
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<td>Machinery and Material</td>
<td>• Adopting international best</td>
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<td></td>
<td>Procurement</td>
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<td>Standard Operating Procedures in</td>
<td>quality and speed of project</td>
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<td></td>
<td>Design and Site Execution</td>
<td>execution</td>
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Figure 14: Project Manager – Job Role Diagram

Job Role 2 – Project Engineer: Operate as a Link between the Project Manager and Project Implementation Teams
Training Needs Assessment for Solar PV EPC
Management and deployment of resources in the timely execution of projects

Figure 15: Project Engineer – Job Role Diagram

Job Role 3 – Design Engineer (Electrical and Mechanical): Create and Maintain the Engineering Design of the System
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United States Agency for International Development Contract AID-386-C-12-00001

Figure 16: Electrical Design Engineer – Job Role Diagram

- Bachelors or Masters in Engineering
- Two to Five Years Experience in electrical, mechanical or civil design

**Managerial Competencies**
- Communication with Site Engineer
- Assist the commercial team with tendering

**Technical Competencies**
- Use of Simulation Software
- Grid Integration
- Preparing Bill of Materials
- Energy Estimation

**Domain Specific Competencies**
- Analyze Project Requirements
- Create Design Basis Report
- Adapt Design to Site Conditions

**Optimization:**
- Implementing optimization techniques w.r.t:
  - Layout and design of plant systems & equipment
  - Cost-effective selection of equipment without sacrificing quality, durability, and performance
  - Incorporating latest trends and advancements in PV technologies & developments in module design and yields

**Technical specifications, codes and standards:**
- Preparing the design basis for respective engineering disciplines (electrical and mechanical)
- Preparing the bill of quantities
- Ability to apply relevant technical codes and standards in design

**Energy estimation and Simulation software:**
- Using simulation software and CAD tools, such as Energy Estimation and Shadow Analysis, for e.g.:
  - PVsyst, Shadow FX, BuildItSolar, etc.
  - Analyzing weather data from various meteorological databases, namely:
    - Meteornorm, NASA database, PVGIS 3 and 4, MREF, etc.
  - Calculating losses and preparing loss diagrams

**Testing and certification procedure for modules:**
- Analysing critical tests and testing procedures for module selection, namely:
  - PID free and PID resistant tests,
  - Electrical and mechanical tests, salt mist test, etc.
- Incorporating international codes and standards – IEC, ISO, etc. – covering certification methods for PV modules

**Selection of Inverters & Batteries:**
- Ability to select the required type of inverters
- Sizing and matching inverters to PV arrays
- Designing and sizing batteries, and their interconnection with PV arrays

**Electrical Earthing and Lightning Protection:**
- Ability to apply IEC codes for earthing and lightning design and maintenance, considering:
  - Separate earthing and lightning requirements for DC & AC fields in a solar plant
  - Measurement of earth resistance and maintenance of earth pits

**Grid Integration:**
- Interpreting Indian Electricity Grid Code and other state codes (for power evacuation)
- Understanding fault levels of the sub-station vs a vs the fault level of solar power plant
- Interpreting technical codes and standards for obtaining regulatory approvals and permits
- Selecting equipment with the right technical specifications (electrical switchgear and equipment for protection and measurement) as approved by Central and State statutory bodies

**Tracker systems:**
- Ability to select trackers (single axis and double axis) with respect to geographical locations (temperate and tropical zones) and irradiation profile (high or low altitudes)
- Conducting cost-benefit analysis – increase in energy yield of tracker-based plants with increase in capital expenditure of the plant
Training Needs Assessment for Solar Energy – Executive Summary: PACE-D Technical Assistance Program

United States Agency for International Development Contract AID-386-C-12-00001

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Figure 17: Mechanical Design Engineer – Job Role Diagram

Job Role 4 – Site Engineer/Site Supervisor: Plan, Execute, and Supervise Site Level Procedures for Installation and Commissioning

Figure 18: Site Engineer/Site Supervisor – Job Role Diagram
Job Role 5 – Site Technician: Implement Site Level Procedures for Electrical or Mechanical Work

Training Needs for Site Technician in Solar PV EPC

Implement site level procedures for civil, mechanical or electrical work

Entry Criteria
- Diploma or ITI
- One to Five Years of Site Level Experience in related trade

Key Competency Development Themes

Managerial Competencies
- Co-ordination with semi-skilled labor
- Supervision

Technical Competencies
- Implementing Best Practices for Plant Durability
- Implementation using DC Technology

Domain Specific Competencies
- Aligned to Electrician, Construction, Mechanic or Welder
- Proper Use of Tools
- Implementing Safety Precautions

Focus Points for Skill Development
- DC technology:
  - Ability to work with DC technology – high voltage DC and DC connections
  - Working with DC cables, considering durability, weather-proofing and related features
- Usage of Tools and Tackles:
  - Working with appropriate tools and tackles to enhance workmanship quality, durability and productivity

Figure 19: Site Technician – Job Role Diagram

Job Role 6 – O&M Engineer: Ensure Optimum System Performance and Customer Service

Training Needs for Operations and Maintenance Engineer

Ensure optimum system performance and customer service

Entry Criteria
- Bachelors or Masters in Electrical Engineering
- Two to Five Years Experience in operation and maintenance of large engineering systems

Key Competency Development Themes

Managerial Competencies
- Problem Resolution
- Customer Relationship
- Status Reporting

Technical Competencies
- Component Manuals and Service Guarantees
- PV Module Cleaning Procedures
- Monitoring and Performance Data

Domain Specific Competencies
- Monitoring and Control of Systems
- Preventive and Predictive Maintenance Procedures
- Plant Safety

Focus Points for Skill Development
- Data monitoring and control:
  - Monitoring strings to check and ensure optimal power generation
  - Ability to work on SCADA/PLC and control
  - Calculating Performance Ratio
  - Recording and analysing data of the plant weather station – usage of pyranometers, temperature indicators, anemometers, etc.
- Preventive maintenance:
  - Adopting best practices in Troubleshooting, Preventive and Predictive Maintenance
  - Ability to follow Standard Operating Procedures and manuals of plant processes and equipment

Figure 20: O&M Engineer – Job Role Diagram
Utility Engineers

The role of utilities in ensuring solar PV projects implementation is significant as utilities provide the infrastructure for power offtake. Thus, increasingly, policy makers are entrusting the responsibility of wide scaling solar PV programs, especially in the rooftop PV segment, to the distribution utilities with the view of enhanced energy security, energy access, and improved quality of electricity supply.

Utility engineers need to have an understanding of the technology, technical guidelines related to interconnection, standards, administrative procedures, and coordination required for enabling installation and operation of these projects. The utilities also need to ensure that there is a standardization process in the utility level approach, administrative procedures, systems, forms, and formats which allow indiscriminate access to the grid for all viable projects and systems. For this, the utilities require appropriately trained manpower, with an access to the good practices being followed to implement such programs and technical and procedural resources.
Bankers

The solar industry offers a platform for banks and FIs to expand their consumer base and diversify loan portfolios. The key challenges afflicting the deployment of financing for rooftop PV development include limited knowledge, awareness, and understanding of rooftop PV projects, especially amongst the bankers, FIs and lenders engineers, as well as, a paucity of trained and experienced lenders engineers.

The banks and FIs should develop an intrinsic understanding of the rooftop PV segment and related business models and technical architecture, commercial terms of engagement, and the risks associated with these projects. Also, a large team of trained manpower will be required at various levels of project planning, execution, and financing. Hence, there is a tremendous need for focused training in solar PV rooftop business.

<table>
<thead>
<tr>
<th>Key Competency Development Themes</th>
<th>Focus Points for Skill Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site feasibility evaluation of Solar PV power plant</td>
<td>Introduction to the Solar PV Rooftop Sector in India including the Policy and Regulatory Framework and Business Models</td>
</tr>
<tr>
<td>Financial viability &amp; due diligence of Solar PV power plant</td>
<td>Solar PV Rooftop Systems – Project Costing and Feasibility Analysis</td>
</tr>
<tr>
<td></td>
<td>Solar PV Rooftop Risk Assessment and Contracting Framework</td>
</tr>
<tr>
<td></td>
<td>Project Implementation, Evaluating a Techno-commercial, Reporting and Sanctioning of the Loan</td>
</tr>
<tr>
<td></td>
<td>Introduction to the Solar Rooftop Evaluation Tool</td>
</tr>
</tbody>
</table>

Figure 22: Banker– Job Role Diagram

Entrepreneurs

The solar industry is set to witness a boom in the involvement and growth of ‘entrepreneurs’. Hence, this study also focusses on ‘entrepreneurs’ as an independent entity in the solar industry. Entrepreneurs are being encouraged to be a part of the mainstream solar industry as owners, developers, installers, system integrators, equipment suppliers, service providers, and consultants.

Currently, the industry is witnessing an entry of early and medium-stage entrepreneurs who are interested in the process of launching a solar PV rooftop business and established entrepreneurs diversifying their business to the solar PV rooftop space. MNRE has opened the doors for entrepreneurs to be specifically involved in schemes related to grid-connected rooftop PV, and off-grid and decentralized systems, as well as, their empanelment as channel partners in such schemes. A target of 20 GW of solar capacity has been earmarked for entrepreneurs, to be implemented through these schemes.
Also, the Government has plans to turn 20,000 unemployed graduates into entrepreneurs, by working in tandem with the state government. The state government will choose these graduates, preferably engineers, who will then be trained by the central government for around three to six months.

From the above findings and analysis, it can be seen that:

- Five key job roles in the manufacturing (solar PV modules) sector and six key job roles in the non-manufacturing (solar PV projects) sector were identified.
- Competencies of these key job roles are specific only to the solar industry, considering the impact on plant quality and viability, and enhancing the competitive edge of the solar companies.
• Significant skill requirements exist for the key job roles identified in both manufacturing (solar PV modules) and non-manufacturing (solar PV projects) sectors.

It is imperative to bridge the skill needs by means of a dedicated training framework and address the skill requirements of the industry.
4 MANPOWER ESTIMATION

Apart from identifying the skill gaps to build a robust training framework, it is also important to have a sense of the size of training ecosystem required, for instance, training infrastructure, trainers, number of institutes to be established, and their regional presence. Such a training framework is directly dependent on the manpower which is required to meet the industry target of 100 GW of installed solar capacity by 2022.

In this section, the manpower estimation for both manufacturing and non-manufacturing sectors, covering the key job roles identified, has been presented.

4.1 MANUFACTURING SECTOR: MANPOWER ESTIMATION

The key findings of this section are:
1. By 2022, the installed manufacturing base of the country is projected to be 15,000 MW.
2. Around 6,000 additional manpower for skilled jobs is estimated to be created by 2022 to meet this target.

Methodology

The manufacturing sector of the solar industry is not as manpower-intensive as compared to the non-manufacturing sector. The PV module manufacturing plants are mainly classified into two types – automated and non-automated. Many higher capacity manufacturing plants are fully automated and employ people who are mostly conversant with various machine operations such as Computerized Numerical Control (CNC) operations, Robotics, Electroluminescence Testing, etc. Suitable candidates must have knowledge in fundamental physics and electronics. Graduates of recently initiated courses in Mechatronics (combination of Mechanical and Electronics engineering) are also very suitable for serving the solar PV manufacturing industry.

Interaction with 12 leading module manufacturing companies were held to estimate the manpower requirement as these companies have substantial installed manufacturing capacities and experience in India.

The steps involved and the assumptions considered are explained below:
- The projected manufacturing capacity to be installed in India by 2022 is **15,000 MW**.
- The rule of thumb for manpower estimation in the PV module manufacturing sector is that a workforce of 150 is employed in a 100 MW fully-automated manufacturing plant. This is the total manpower including unskilled manpower. Also, the increase in manpower on account of lack of automation can be assumed as 20 percent, which translates to 180 people employed in a 100 MW non-automated plant.
- The ratio of skilled to unskilled manpower in a fully automated plant (auto line) is 30 percent to 70 percent. The skilled manpower will be employed mainly for the job functions of stringing, tabbing, soldering, laminating, and lay-up. Workers involved in cleaning and packing jobs constitute of unskilled labor, whose educational qualification is HSC. This ratio is reversed in a non-automated plant (manual line) i.e., (70 percent skilled labor and 30 percent unskilled labor), as such a plant requires more skilled labor to handle the manual operations/facilities.
• Further, when the manpower requirement for 100 MW and 400 MW plant is compared, e.g., the skilled manpower requirement does not increase four times but only gets doubled. This is because the increase in manpower will be mainly for unskilled jobs such as cleaning and packing.

• As per the latest MNRE data, the installed manufacturing capacity in India is 5,620 MW. There are around 80 PV module manufacturing companies, with installed plant sizes ranging from 5-500 MW.

• Considering the above data, the following classification of manufacturing plants has been assumed, based on the level of automation:
  - Fully automated 50-500 MW
  - Non-automated 5 -50 MW

• With the above classification, the total capacities of automated and non-automated plants currently installed were determined as follows:
  - Fully automated 4,635 MW
  - Non-automated 985 MW

**Estimation for Additional Manpower Requirement in Manufacturing Sector**

Considering the above plant classification and installed capacities, it is assumed that the proportion of automated and non-automated plants will be the same as indicated above, to achieve the target of 15,000 MW by 2022.

Around 6,000 jobs for skilled manpower are expected to be created to achieve an installed manufacturing capacity of 15,000 MW by 2022.

**4.2 NON-MANUFACTURING: MANPOWER ESTIMATION**

The key findings are:

1. Around 143,000 additional manpower across the key job roles is estimated to be created by 2022 to meet the target of 100 GW of installed solar power capacity.
2. Around 70 percent of the manpower addition will be in project site-related job roles.
3. Further, to meet the above target, 12,000 jobs in additional direct job roles (covering the functions of sales, procurement, and product support) will be added.

**Methodology**

Close interactions were held with 10 leading solar companies to devise the methodology and estimate the total additional manpower required in the non-manufacturing sector, for achieving a target of 100 GW of installed solar capacity by 2022. As these organizations are involved in executing various sizes of rooftop and utility scale plants, they have a good implementation experience, and the ability to precisely estimate manpower and timeframe for installing different sizes of projects.

It was agreed by the industry that the number of implemented projects will not be constant throughout the period until 2022. Therefore, manpower/manpower addition required will also vary.

The steps involved and the assumptions considered are explained below:

- Typical plant sizes were considered for both rooftop and utility-scale PV projects. These sizes are reflective of the existing and future plant configurations which are expected to be installed as shown in Table 1.

**Table 1: Manpower Estimation of Non-Manufacturing Sector – Typical Project Sizes**

<table>
<thead>
<tr>
<th>Rooftop PV Capacity</th>
<th>Utility-Scale PV Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10 kilowatt (kW)</td>
<td>1-10 MW</td>
</tr>
<tr>
<td>10-100 kW</td>
<td>10-50 MW</td>
</tr>
<tr>
<td>100-1000 kW</td>
<td>50-100 MW</td>
</tr>
<tr>
<td></td>
<td>100-500 MW</td>
</tr>
</tbody>
</table>

- Manpower requirements for the above plant sizes were determined based on the inputs from the industry. The breakup is shown in Table 2.

**Table 2: Manpower Estimation of Non-Manufacturing Sector – Breakup as per Plant Sizes**

<table>
<thead>
<tr>
<th>Rooftop PV: 10-100 kW</th>
<th>Utility-Scale PV: 10-50 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>One project manager for five plants</td>
<td>One project manager for one plant</td>
</tr>
<tr>
<td>One project engineer for two plants</td>
<td>Three project engineers for one plant</td>
</tr>
<tr>
<td>Two electrical design engineers for five plants</td>
<td>One electrical design engineer for one plant</td>
</tr>
<tr>
<td>Two mechanical design engineers for five plants</td>
<td>One mechanical design engineer for one plant</td>
</tr>
<tr>
<td>One site engineer/supervisor for one plant</td>
<td>Five site engineers/supervisors for one plant</td>
</tr>
<tr>
<td>Two site technicians for one plant</td>
<td>25 site technicians for one plant</td>
</tr>
<tr>
<td>One O&amp;M engineer for five plants</td>
<td>Three O&amp;M engineers for one plant</td>
</tr>
</tbody>
</table>
Further, the overall number of plants to be installed in each size till 2022, and the yearly capacity addition (2017 to 2022), was assumed based on the targets set for rooftop and utility-scale solar plants.

The average time considered for executing projects of various sizes was based on the actual experience of the industry.

Based on this, the number of project teams required annually was determined.

The annual manpower required for each job role and plant size was then calculated.

Two scenarios were considered for estimating the additional manpower required as shown in Table 3.

### Table 3: Manpower Estimation of Non-Manufacturing Sector – Scenarios

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Higher Number of 100-1,000 kW Rooftop Plants and 100-500 MW Utility Scale Plants)</td>
<td>(Higher Number of 10-100 kW Rooftop Plants and 1-10 MW Utility Scale Plants)</td>
</tr>
<tr>
<td><strong>Rooftop PV</strong></td>
<td><strong>Rooftop PV</strong></td>
</tr>
<tr>
<td><strong>Plant Size</strong></td>
<td><strong>Plant Size</strong></td>
</tr>
<tr>
<td>10-100 kW</td>
<td>10-100 kW</td>
</tr>
<tr>
<td>100-1,000 kW</td>
<td>100-1,000 kW</td>
</tr>
<tr>
<td><strong>Utility-Scale PV</strong></td>
<td><strong>Utility-Scale PV</strong></td>
</tr>
<tr>
<td><strong>Plant Size</strong></td>
<td><strong>Plant Size</strong></td>
</tr>
<tr>
<td>1-10 MW</td>
<td>1-10 MW</td>
</tr>
<tr>
<td>100-500 MW</td>
<td>100-500 MW</td>
</tr>
</tbody>
</table>

**Estimation for Key Job Roles in Non-Manufacturing Sector**

Considering the scenarios indicated above, the projection for growth in job roles is illustrated in Figure 25.
An estimated **143,000 additional manpower for key job roles** will be required by 2022 to meet the target of 100 GW of installed solar power capacity. Figure 25 indicates that:

- Site technicians will account for 62,920 (44 percent) of the total manpower (143,000) expected to be added by 2022.
- Site engineers/supervisors will account for 32,890 (23 percent) of total manpower required by 2022.

The above numbers show that a substantial job creation potential exists for the key job roles identified. These results also reinforce the skill requirements for the project site-related job roles.
Estimation for Direct Support Job Roles in Non-Manufacturing Sector

Apart from the key job roles, manpower requirement was also estimated to support the job roles deemed necessary by the industry.

To support the key roles, other direct job roles include Sales Executive, Procurement/Commercial Engineer, and Product Support Technician. The same methodology and scenarios for the key job roles were considered to arrive at the manpower estimation. Around 12,000 additional manpower will be needed to support the job functions of sales, procurement, and product support.

The additional manpower required for these direct support job roles is shown in Table 4.

<table>
<thead>
<tr>
<th>Job Role</th>
<th>Additional Manpower Needed by 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Executive</td>
<td>9,000</td>
</tr>
<tr>
<td>Procurement/Commercial Engineer</td>
<td>1,000</td>
</tr>
<tr>
<td>Product Support Technician</td>
<td>2,000</td>
</tr>
<tr>
<td>Total Additional Manpower Required</td>
<td>12,000</td>
</tr>
</tbody>
</table>

Approximately, 155,000 additional manpower across the identified job roles is required to achieve a target of 100 GW of installed capacity by 2022.

Notes:

- The figures indicated in this chapter are an estimation of the manpower required for the identified job roles; it does not include manpower likely to be employed in other functions such as finance, human resources, etc., across the manufacturing and non-manufacturing sectors.
- Also, the figures do not include the indirect jobs likely to be created in these two sectors.

4.3 CHALLENGES IN MANPOWER SOURCING AND RETAINING

Presently, the solar industry is facing challenges in terms of recruiting and retaining manpower. Candidates with three to four years of experience and all-round skills in solar plant installation are scarce in the market. Large projects demanding more manpower are set up in remote locations where living conditions are tough, and this poses another hurdle for recruitment and retention since the requisite manpower is not always available at project sites. As the industry grows, it struggles to meet the high salary demands and remuneration expectations of employees. Numerous issues were highlighted by the industry. However, this project does not intend to provide solutions to these issues.

The survey responses regarding the challenges in manpower sourcing and retaining is shown in Figure 26.
Figure 26 shows a lack of adequate training/skills as a top challenge for manpower sourcing, i.e., 29 percent. Experience levels derive the second place, i.e., 24 percent. Further, the remoteness of work location is the biggest challenge for employee retention, i.e., 44 percent. However, the mismatch in work skills/experience derives a second place, i.e., 21 percent.
5  **PHASE II: SOLUTION DESIGN**

In Landscape Analysis, we charted the value chain of the solar industry, identified the key skill needs, and estimated the additional manpower required by 2022 for the key job roles.

In Solution Design, the study focusses on receiving recommendations from the industry and training institutes to improve the existing training framework of the solar industry.

The aim of Solution Design Phase was to design training solutions to upgrade and refine the existing training curriculum and structure (including SETNET), based on the manpower competency needs identified by the industry.

5.1  **CURRENT SCENARIO OF SOLAR TRAINING IN INDIA**

The global RE development trends in 2015 witnessed India being ranked among the top five nations in new investments, and among the top four regarding the creation of jobs in the green energy sector (IRENA report, June 2016). This encouraging development reiterates the growing penetration of RE in the mainstream energy sector, and the need to accelerate the scale-up of skill development programs.

5.1.1  **MNRE**

MNRE has been spearheading skill development and training in the RE industry in India for the past two decades. Apart from its in-house resources, the Ministry extensively interacts with industry experts, veterans, and professionals to identify the manpower competencies and skill gaps and chart the future course of skills for the industry. MNRE’s training programs cater to both the national and international audience.

The roots of a systematic approach to human resource development by MNRE can be traced back to FY 1999-2000, when the Ministry initiated training in the fields of project planning, system design, product development, O&M, and repair of deployed systems. A National Renewable Energy Fellowship Scheme was also instituted during FY 1999-2000. This scheme was revamped in FY 2007-08 to train professionals in the organizational framework of MNRE and state nodal agencies, as well as, collaboration with R&D institutes, non-governmental organization (NGOs), community-based organizations, and FIs for training manpower. Areas of training were also expanded to include social/economic trade, legal trade, Intellectual Property Rights (IPR), administration, and managerial and environmental aspects.

While such programs suffice for short-term training needs, MNRE has also developed an institutional framework in educational institutes to provide quality long-term training, through post-graduate, fellowship, doctorate, post-doctorate courses, and scholarship schemes. MNRE provides financial assistance to educational institutes to set up laboratories, libraries, and other training aids. In addition, the Ministry has incorporated subjects of solar lighting, solar thermal, and small hydro power in the regular syllabus of Industrial Training Institute (ITI) students of certain trades such as electrician, fitters, turners, welders, and plumbers.
MNRE is also active in the entrepreneurial and start-up ecosystem of the industry. To facilitate scalable new business models and start-ups in the sustainable energy, it has tied up with Indian Institute of Management (IIM) Ahmedabad’s Centre for Innovation, Incubation, and Entrepreneurship (CIIE) to set up the Indian Fund for Sustainable Energy (Infuse). The goal is to promote new and innovative business models (rather than creating new technologies), through mentoring, acceleration (capacity building of start-ups), and financial support (seed funding for pilot/demonstration projects, and financing their commercialisation).

In this context, MNRE released a report titled ‘Human Resource Development Strategies for Indian Renewable Energy Sector’ in 2010, in association with CII. This report analysed prevalent trends in the RE industry and outlined sector-wise strategies for human resource development and partnerships with industry and academia for skill development.

5.1.2 NISE

In line with the country’s ambitious plans for solar power, MNRE constituted NISE from its erstwhile Solar Energy Centre (SEC), as an autonomous institution in 2013. NISE is the apex R&D institution for solar energy in India; it assists MNRE in implementing the National Solar Mission (NSM) and also coordinates research, technological, and other related activities. It is an effective interface between the Government and institutions, industry and user organizations, for development, promotion and widespread utilization of solar energy in the country.

One of the major goals of NISE has been to institutionalize training specifically in the solar industry. To this effect, NISE has partnered with select training institutes to impart training in various locations across India. These institutes are accredited by NISE as the ‘affiliated’ training partners.

5.1.3 “Skill India”

“Skill India” is one of the most ambitious projects launched for creating job opportunities for the unemployed youth in the various services and manufacturing sectors throughout the country. It is a flagship program of the GOI, with a target to skill 40 crore of manpower by 2022. As RE is one of the targeted sectors, MNRE is involved in implementing various skill development programs throughout India.

5.1.4 SCGJ

SCGJ is the dedicated SSC for green energy businesses across India. It is promoted by MNRE and CII, with an inclusive representation of the Government, industry and industry associations across India, and financial support by NSDC.

SCGJ has the mandate to capture the skill requirements for both service users and manufacturers/service providers within the sector and implement a roadmap for nationwide and industry-led collaborative skill development initiative to fulfill India’s potential for green businesses.
The blueprint for skill needs is provided by the Qualification Packs (QP) and National Occupational Standards (NOS), which comprises of an exhaustive, qualitative description of skill sets, and responsibilities of all the job positions.

NOS defines the standard of performance that individuals must achieve when carrying out a function in the workplace, together with specifications of the knowledge and understanding to meet that standard consistently. It also describes what individuals need to do, know, and understand to carry out a particular job role or function. QP defines a set of NOS which are aligned to one job role.

Till date, SCGJ has successfully framed and released the following QPs, containing the respective NOS:

- Solar PV Installer (Civil)
- Solar PV Installer (Electrical)
- Solar PV Installer (Suryamitra)
- Solar Rooftop PV (Grid Engineer)
- Solar Rooftop PV (Proposal Evaluation Specialist)
- Solar Rooftop PV (Entrepreneur)

5.1.5 SETNET

SETNET was established by NISE, with the technical assistance from the USAID PACE-D TA Program, to provide structured training programs in the solar energy sector. NISE, under MNRE, is the body responsible for the implementation of SETNET. SETNET comprises 35 training partners empanelled by NISE across India. The objective of SETNET is “to build skills and capacities to ensure the availability of qualified solar energy professionals to meet the national solar deployment targets”.

SETNET has been designed to target employability/professional development-oriented training, with a standardized and diverse curriculum, and a pool of skilled and experienced trainers. SETNET seeks to implement market-based business models to address evolving needs, scale up training programs through institutional capacity, and leverage the benefits of experiential training.

SETNET course proposes four main themes as described in Figure 27.
Figure 27 reveals that SETNET themes closely match with the key job roles identified in the non-manufacturing sector of this study.

5.1.6 ‘Suryamitra’ Program

The “Suryamitra” program, launched by NISE in 2015, has a unique distinction of being the first institutionalized training program in the solar industry. This was necessitated by a sudden demand for an influx of trained workforce, following the ramp-up of the country’s solar power targets from 20 GW to 100 GW. At the outset, it was decided to equip 50,000 workers as ‘Suryamitras’, the ‘solar army’, to provide skilled technicians for installation, commissioning, and O&M of projects. The program is targeted at school matriculates and ITI/diploma holders.

5.1.7 Existing Solar Training Framework

Some of the leading organizations, apart from NISE, involved in solar training include The Energy and Resources Institute (TERI), Gujarat Energy Research & Management Institute (GERMI), National Power Training Institute (NPTI), National Centre for Photovoltaic Research and Education (NCPRE), Gujarat Institute of Solar Energy (GISE), Tamil Nadu Advance Training Institute (TATTI), Global Sustainable Energy Solutions (GSES), etc.

These institutes aim to formulate and execute the blueprint for human resource development for the solar industry in India. The majority of training is delivered by government institutes and private organizations. They impart training in various areas such as marketing, system design, project management, installation, operation and maintenance (IOM), and software and simulation tools. Few institutes are taking initiatives to train villagers and rural workforce to develop, operate and maintain decentralized solar power systems. Case studies are presented on solar cooking, rural household electrification, appropriate building technologies, rural health care, and micro-enterprises utilizing RE. Some institutes also explore different applications of RE technologies in developing countries, focusing on
effective technology transfer, infrastructure setup, economic viability, and financing of RE projects.

Several institutes are actively partnering each other and the local communities to impart training. These institutes also collaborate with each other in terms of resource sharing—trainers, classroom space, and other training infrastructure. The training courses are usually conducted in subsidy mode (subsidies provided by NISE/MNRE) or market mode (course fees paid by trainees).

Vocational training, an important aspect of skill development, is given due focus, in line with the vision of ‘Skill India’. Many universities (such as University of Lucknow) and ITIs have dedicated centers to impart vocational training.

5.1.8 Challenges in Existing Training Framework

Despite the widespread and vibrant training framework existing in the solar industry, training institutes still face a few challenges. The institutes feel that they need more freedom in modifying existing curriculum content and developing new content. Assessment mechanisms also pose a challenge. In some cases, there is a huge time gap between completion of training and the final assessment and certification. Further, sharing of trainers among institutes also suggests that there is a dearth in availability of qualified trainers across the country.

The institutes also desire a full-fledged involvement of the industry in training ecosystem, so that, the competency needs can be satisfactorily aligned with the industry requirements. Further, there has been limited success so far regarding paid training programs. Hardly any student/job professional has warmed up to this idea. Suitable solutions need to be devised to overcome this problem and appropriate training grants needs to be provided by MNRE and NSDC.

In this context, the recommendations of Solution Design Phase are aimed at augmenting the existing training framework of the solar industry.

5.2 OBJECTIVES OF SOLUTION DESIGN

The objectives of this phase include: evaluate the structure of incumbent training programs (including SETNET themes), define the learning objectives, map the target audience, and frame the assessment and certification mechanisms for the training programs.

The following components were considered for the data collection and analysis of Solution Design Phase:

- Validating industry findings of Landscape Analysis on job roles and skill competencies.
- Providing details on courses currently offered by the training partners.
- Suggesting recommendations on the existing training courses and SETNET themes.
- Estimating the growth in a training scenario in the next five years.
5.3 FINDINGS ON EXISTING TRAINING FRAMEWORK

The key findings on the existing training framework are:

1. The ‘Suryamitra’ course is being implemented successfully by various training institutes. Courses implemented in market mode have received mixed responses.
2. The course curriculum needs to be significantly enhanced, and periodic revisions are necessary for the course content, along with the involvement of the industry.
3. The quality of assessments, at the end of the courses, should be high. Further, assessments must be conducted immediately upon course completion.
4. Specific courses must be designed for entrepreneurs and rooftop PV technicians to meet the rapid skills demand required in the rooftop PV segment.

The above findings have been detailed in the following sections:

5.3.1 Courses Being Delivered

- **Suryamitra Course:** Presently, only ‘Suryamitra’ course is being delivered by various training institutes. The majority of participants are from rural areas, who meet the basic entry criteria. The course content and duration of Suryamitra are adequate and meet the skill needs of the target group. However, there were recommendations to have two sets/phases of the program – one phase of 600 hours duration, aimed at an absolute fresher who wants to enter the solar field, and another phase of 300 hours duration, aimed at those who have some work experience in the electrical/solar field. Intake for Suryamitra is on a first-come-first-served basis.

- **Courses for Graduate Engineers and Project Managers:** Courses for mid-level professionals have received a mixed response, especially those in market mode, i.e., where the course fee has to be paid by the participants. Some states such as Tamil Nadu have seen a strong response to courses of this kind; others such as Delhi have seen a mixed response, while states such as Telangana have seen a declining demand for such courses.

5.3.2 Course Structure and Curriculum

- Details about international standards as well as technology and quality benchmarks are currently not included in the curriculum. These would be essential to have skilled labor of world-class standards.
- It is essential that training curriculum be created and revised with the involvement of industry, in addition to academia and training institutions. This will ensure that courses are designed to meet the actual industry needs, thereby ensuring that the individuals who graduate from these training programs are more easily absorbed into the industry.
- A small portion of the course content (5-10 percent) must be allowed to be modified by the training partners at their discretion. This would enable them to cater to industry requirements as felt appropriate based on the hiring pattern at their centre, as also, include any new, important technological advancements instead of waiting for the content to be revised at fixed intervals.
• There is a need to implement more and better tools for training and engaging with the trainees. This is also important as each batch of trainees’ act as the “brand ambassador” for the course, responsible for spreading information about the course within their circles. Indeed, the better their experience with the course, the more they would recommend the course to others.

5.3.3 Assessment Methodology

• The quality of assessment should be extremely high, to ensure that graduating trainees meet the standards that industry requires.
• The current gap between course completion and assessment completion is not desired (for e.g., for Suryamitra courses, it is approximately three to four months); assessments should be necessarily completed immediately after completion of the course. Without this timeliness, trainees would not receive relevant certificates as proof of successful completion of the course.
• Since it is envisaged that a large number of jobs, particularly in the rooftop PV sector, will be created by entrepreneurs, it is essential that courses aimed at entrepreneurs and rooftop PV technicians be developed. Training partners should be given complete freedom to develop the content. The focus should be on current technologies, so that, entrepreneurs can be trained on making the best possible business decisions. Further, there need not be any educational qualification criteria for entrepreneurs (keeping in mind the fundamental spirit of entrepreneurship).
6 Recommendations to Improve Training Delivery Mechanism

Based on the findings of both Landscape Analysis and Solution Design Phases, key recommendations are proposed to upgrade the existing training structure for solar in India.

These recommendations cover the following aspects as summarized in Table 5.
- Broad set of learning objectives
- Target audience
- Mechanisms for certifying each of the four courses, which includes:
  - Entry criteria
  - Estimated hours of learning required
  - Assessment methods at the end of the course

Table 5: Recommendations on Training Themes and Structures

<table>
<thead>
<tr>
<th>Course Themes/Target Audience</th>
<th>Main Topics</th>
<th>Entry Criteria – Education</th>
<th>Entry Criteria – Experience (Years)</th>
<th>Course Duration (Hours)</th>
</tr>
</thead>
</table>
| Project Manager and Project Engineer          | • Scheduling and forecasting  
                                            | • Resource planning  
                                            | • Product costing and cost optimization  
                                            | • Critical path method                     | B.E. – Electrical  
                                            | • MBA                                    | One to two  
                                            |                                                  | (in solar sector)                          | Two to three                   |
| Design Engineer                               | • Plant design and equipment selection  
                                            | • Software and simulation tools  
                                            | • Direct Current (DC) technology  
                                            | • Grid integration  
                                            | • Testing and certification  
                                            | • Mounting structures for utility-scale PV and rooftop PV plants | B.E. – Electrical/  
                                            |                                                   |                                                    | Mechanical                    | Fresher                           | 30                      |
| Site Engineer/ Site Supervisor                | • Best practices in site installation  
                                            | • Earthing and lightning protection | B.E. – Electrical/ Mechanical           | Fresher                           | 90                      |
| Site Technician                               | • Earthing and lightning protection  
<pre><code>                                        | • Handling of tools and tackles     | ITI - Electrical, Fitter and any other equivalent qualification | Fresher                           | 90                      |
</code></pre>
<table>
<thead>
<tr>
<th>Course Themes/Target Audience</th>
<th>Main Topics</th>
<th>Entry Criteria – Education</th>
<th>Entry Criteria – Experience (Years)</th>
<th>Course Duration (Hours)</th>
</tr>
</thead>
</table>
| O&M Engineer                 | ● Data monitoring  
● Preventive maintenance | ● B.E. – Electrical/ Electronics  
● ITI - Electrical, Fitter and any other equivalent qualification | Fresher | 90 |
| Entrepreneur                 | ● Solar PV – Technical, financial and operational aspects  
● Market research and site feasibility  
● Cost estimation and project financing  
● Management of solar PV project lifecycle  
● Policy and regulatory framework and mechanisms | ● Any graduate  
● MBA | Not required | 40 |
| Banker                       | ● Introduction to solar PV, technology and design  
● Policy and regulatory framework and business models  
● Site and technology feasibility analysis  
● Project costing and financial viability  
● Risk assessment and contracting framework | ● Engineering, Business, Commerce graduates/ Probationary Officers/CA | 2 (in project finance) | 8 |
| Utility Engineer             | ● Basic topics of solar PV, technology and design  
● Policy and regulatory framework  
● Pre-commissioning inspection and metering service  
● Post-commissioning inspection and auditing of grid connectivity | ● Authorized persons to work on the grid as per The Indian Electricity Rules | > 5 (in grid connectivity) |
6.1 RECOMMENDATIONS BY INDUSTRY TO IMPROVE TRAINING FRAMEWORK

Based on the industry engagement, data analysis, and specific inputs, the following recommendations can be considered for training framework and curriculum of the solar industry:

- Training programs with **intensive focus and shorter duration**, covering three to five days, will be ideal. Further, training should be targeted at the lower management level employees – **engineers, supervisors, technicians**.
- **Soft skills** are vitally important and training in communication, man management, and behavioral skills should also be imparted.
- There should be **full-fledged, widespread, and large-scale involvement of the industry** in the development of training content and infrastructure.

Further, the industry feels that the following practicalities must also be given a due focus for training considerations:

- Multi-skilling needs for employees in key job roles should be addressed. For instance, in small-scale rooftop projects, site engineers must be competent in both electrical and structural execution.
- Project managers should be trained with the requisite capabilities and acumen to handle three to four project sites simultaneously.
- During site execution, certain work activities are considered basic or rudimentary, and complete importance is not accorded to these activities. However, the fundamental and elementary nature of such skills itself determines the overall outcome of project installation and has an impact on the plant lifetime. For e.g., providing separate earthing and lightning arrestors for DC and AC fields; using proper lugs, dyes, and crimping tools in cable termination; ensuring adequate anticorrosion coating for mounting structures, etc.
- To meet the target of 40 GW of rooftop PV, the industry will witness a boom in the coming two-three years. When this happens, there would be a tremendous need for dedicated ‘rooftop solar installers’ and this will become a new business model in itself. These installers should be ideally skilled in providing end-to-end solutions from concept to commissioning, right from energy estimation studies to project installation and operations. Manufacturers and contractors will only form the support structure to these solar installers.
- Mid-term experienced workforce from industries with technical overlap (energy, manufacturing, construction, etc.) will be recruited for project execution. This workforce must be swiftly trained and well acquainted with solar power technology, such that, there is no time lag in re-skilling and absorbing these workers.

6.2 RECOMMENDATIONS BY INSTITUTES TO IMPROVE TRAINING FRAMEWORK

Based on the interactions with the training institutes, the following recommendations can be drawn, covering the general aspects of the training framework:

1. **Course Content**
   - At least two key industry representatives from each segment of the solar industry should be involved in the preparation of course material. Further, the prepared course material
would be reviewed by additional three organizations (a mix of small, medium, and large) from each segment.

- Sections on international standards and benchmarks for technology, quality, and safety in all levels of course material should be included.

2. Course Structure (Intake, Duration, and Assessment)

- A basic entrance test must be conducted for all potential participants. Advertisements for the courses can indicate this entry requirement. The test itself will be aimed at checking some basic communication and language skills (local/regional/English, as appropriate), in addition to testing some basic technical skills for higher levels. The test may be administered individually, at the time of submission of documents for the course, or for all applicants in one sitting two weeks before the commencement of the course.

- For technicians, courses may be conducted in phases:
  - An initial phase of the course aimed at teaching the basics.
  - A more advanced level, catering to those who clear the first phase or have a minimum experience in the relevant areas.

- All assessment would necessarily have to be conducted within 10 days of the completion of any course. Additionally, course completion certificates should be provided within 15 days of completion of the assessment.

- This indicates a need to develop a suitable assessment methodology, as well as a network of assessors. It would be ideal to develop a set of assessors in each state, to ensure timely completion of the assessment process.

3. Sharing of Training Resources

- Currently, there exists a scenario of infrastructure sharing among training institutes. However, such a practice should become more widespread.

- To cater to the differing demand for different courses in different regions (which may be temporary), it would help to create a strong network among the existing trainers. This would facilitate trainers from one region traveling to another to meet the increased demand for some courses at any given time. This would also ensure that the pool of trainers is fully utilized.
7 Conclusion

The study on ‘Training Needs Assessment for Solar Energy’ captures a comprehensive picture on the value chain, skill needs, and training requirements desired by the solar industry. It establishes the context and lays the groundwork for upgrading an existing training framework and modifying the training curriculum.

In line with the recommendations by the industry and the training institutes, the following conclusions could be drawn from the study:

- The key job roles and training course themes identified in this study closely match the qualification packs and national occupation standards being developed by SCGJ.
- Under the key job roles, training needs should be imparted to an additional 143,000 professionals to meet the estimated manpower requirements for achieving a target of 100 GW of installed solar power capacity by 2022:
  - 14,000 project engineers
  - 5,000 project managers
  - 21,000 design engineers
  - 33,000 site engineers/supervisors
  - 63,000 site technicians
  - 7,000 O&M engineers
- A full-fledged new training theme can be developed to target the PV module manufacturing segment. Initially, the training topics could cater to the assembly unit functions of technicians, operators, supervisors, and production managers. Later, it can be expanded to cover R&D engineers, design engineers, and quality engineers. Training for this segment should also involve a substantial tie-up with module manufacturers as a major part of the training will be practical in nature targeting technicians, operators, and supervisors. Additional 6,000 skilled manpower will be trained to meet a target of 15,000 MW of manufacturing capacity by 2022.
- Training courses should be developed for sales executives, procurement/commercial engineers, and product support technicians. An estimated 12,000 professionals should be trained in these job roles.
- To train the whole manpower indicated above, an estimated 4,000 training programs need to be delivered over the next five years by the training institutes (considering an average batch size of 40 trainees).
- A series of short modules, spread over one to three days, can be conducted in the market mode to cater to the needs of an experienced industry personnel. Suggested courses include design modeling and simulation software, project management tools and techniques, quality and safety codes and practices, and communication skills.
- Presently, the Suryamitra course by NISE, utility engineers and entrepreneurship development courses delivered by USAID under the PACE-D TA Program are active.
  - In specific following training programs have already been developed to address the challenges of implementation of projects to meet the target of the
NSM. These training programs closely match the key job roles and training course themes identified in this study:

- For grid-connected rooftop solar PV sector, focused training for engineers working with the utilities is required. The USAID PACE D TA Program has developed a 1.5 day Utility Engineers Training Program, which has been validated by a few pilot programs across the country. The NOS and QPs have been notified by SCGJ. Around 400 training programs (considering a batch of 40 to 45) are required to be organized urgently to meet the solar rooftop target.

- In order to meet the NSM target, a large number of small and medium entrepreneurs are required to be trained. The USAID PACE D TA Program has developed an Entrepreneurship Development Program (EDP) of five-day duration. The NOS and QPs have also been notified by SCGJ.

- Financing of projects is a critical component for achieving the NSM targets especially when a large number of small decentralized power projects are envisaged. A short term course for officials of banks and FIs is therefore being developed by the USAID PACE D TA Program. The NOS and QP for the same has been notified by SCGJ.

- The Suryamitratra course developed by SCGJ addresses training of field technicians and small entrepreneurs who will be involved in installation, operation, maintenance and troubleshooting of solar installations of various sizes. These training programs are now being organized throughout the country to meet this particular segment of skilled manpower.

- Training courses for utility engineers, bankers, and entrepreneurs will be formalized soon by SCGJ.

Some of the other significant takeaways of the study are:

- Online modules should be developed for a wider reach to the target audience.
- Around 10 percent of the duration of each course should be devoted to soft skills training – communication, man management, and behavior.
- Around 20 percent of the duration of each course should be dedicated to quality, safety, and optimization principles.
- Multi-skilling of trainees should be a key objective of the training institutes.
- Training of trainers: For scaling the solar training programs, training courses and modules for developing appropriate trainers with adequate knowledge in the skill sector is critical. Development and delivery of the training modules require intervention of the experts in the field. The quality of the trainers needs to be assessed for large-scale quality training programs in the complete value chain. SCGJ has the mandate for training the trainers and accredit them. The list of qualified trainers for solar sector will be made available by SCGJ. This will benefit all the Indian training organizations to benefit from accessing the qualified trainers and engage them for delivering the solar training programs.
There should be a holistic partnership between the industry and institutes to deliver training. The industry should nominate top professionals as guest faculty in training institutes. Further, there should be collaboration for internship programs and certification courses between the industry and institutes, to impart new skills to graduating students and for upgrading the skills of professionals.

In this study, we have seen that currently, skill needs exist across the key job roles in manufacturing (solar PV modules) and non-manufacturing (solar PV projects) sectors. Significant manpower addition will take place in these job roles to achieve the country’s goal of 100 GW of installed solar capacity by 2022. Hence, it is imperative to bridge the manpower competency needs by means of dedicated training solutions.

The existing training framework of the solar industry has been broadly established in terms of the overall objectives, focus themes, areas for course design, and training infrastructure. However, there is a huge need to rapidly scale up this training framework to meet the targets set by GOI. MNRE is taking the lead in this front by expanding its training structure, incorporating more training programs, and exploring innovative methods to further institutionalize the training framework. In parallel, the industry can also broaden its training initiatives to accelerate the manpower skilling targets. The industry, MNRE, and training institutes should establish a long-lasting partnership to ensure effective training delivery. This would result in a vastly improved training framework, with a sustained focus on the industry’s skill needs being met by the training institutes.

Incorporating the recommendations of this study to upgrade the existing training framework and curriculum will further enable the Indian solar industry in implementing a high-quality skills program, which will serve as a benchmark to the nation in skill development.
### ANNEXURE 1: COMPOSITION OF THE TASK FORCE

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
<th>Organization</th>
<th>Official Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>K. Krishan</td>
<td>Chairman</td>
<td>CVC India Infrastructure Pvt. Ltd.</td>
<td>Chairman</td>
</tr>
<tr>
<td>Praveen Saxena</td>
<td>Co-Chairman</td>
<td>SCGJ</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>Nikhil P. G.</td>
<td>Member</td>
<td>NISE</td>
<td>Senior Scientist</td>
</tr>
<tr>
<td>N. Y. Dinesh Babu</td>
<td>Member</td>
<td>USAID PACE-D TA Program</td>
<td>Chief of Party</td>
</tr>
<tr>
<td>Bibek Bandyopadhyay</td>
<td>Member</td>
<td>USAID PACE-D TA Program</td>
<td>Senior Adviser</td>
</tr>
<tr>
<td>Sharad Saxena</td>
<td>Member</td>
<td>Chemtrols Solar</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>Sudershnan Gupta</td>
<td>Member</td>
<td>Jakson Power</td>
<td>Board Advisor</td>
</tr>
<tr>
<td>Amit Mittal</td>
<td>Member</td>
<td>First Solar Power India Pvt. Ltd.</td>
<td>Technical Director</td>
</tr>
<tr>
<td>Rajesh Bhat</td>
<td>Member</td>
<td>juwi India</td>
<td>Managing Director</td>
</tr>
</tbody>
</table>
ANNEXURE 2: LIST OF ACTIVE TRAINING PARTNERS UNDER SETNET

<table>
<thead>
<tr>
<th>NB Institute of Rural Technology</th>
<th>Everonn Skill Development Ltd.</th>
<th>GSES India</th>
<th>First Green Consulting Pvt. Ltd.</th>
<th>Bhilai Institute of Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADS Global Knowledge Academy</td>
<td>Surabhi Educational Society</td>
<td>IACHARYA Silicon Ltd.</td>
<td>OMS Power Training and Research Institute</td>
<td>Sri Eshwar College of Engineering</td>
</tr>
<tr>
<td>World Institute of Solar Energy</td>
<td>Mangla Smart Energy Solutions Private Ltd.</td>
<td>2E Knowledge Ventures Pvt. Ltd.</td>
<td>Sunshine Technologies</td>
<td>Amity University</td>
</tr>
<tr>
<td>University of Lucknow</td>
<td>TERI</td>
<td>Centre for Development of Imaging Technology</td>
<td>Gujarat Energy Research Management Institute</td>
<td>Thapar University</td>
</tr>
<tr>
<td>GSH India Private Limited</td>
<td>Institute for Energy Studies, Anna University</td>
<td>University of Agricultural Sciences</td>
<td>Indian School of Petroleum &amp; Energy</td>
<td>University Institute of Engineering &amp; Technology</td>
</tr>
<tr>
<td>Asia Institute of Power Management</td>
<td>AnthroPower</td>
<td>Tamil Nadu Advanced Technical Training Institute</td>
<td>TRA International</td>
<td>Cares Renewables Pvt. Ltd.</td>
</tr>
</tbody>
</table>