CREATING GREEN JOBS: EMPLOYMENT CREATED BY KIRAN ENERGY'S 20 MEGAWATT SOLAR PLANT IN RAJASTHAN, INDIA

India's rapid growth has resulted in energy demand that consistently outstrips supply. In 2010, as part of its plan to address the urgent and growing demand for energy by advancing clean energy solutions, the Government of India's Ministry of New and Renewable Energy (MNRE) launched the Jawaharlal Nehru National Solar Mission (NSM) to promote grid-connected and off-grid solar energy. The Mission's goal is to establish India as a global leader in solar energy through policies that lead to the deployment of 20 gigawatts (GW) of solar power by 2022, enough to meet the peak demand of Delhi—a city of 16 million people—3.5 times over.[1] Recognizing the vast potential for employment generation in the Indian renewable energy sector, the central government has also cited job creation as part of its rationale for the Solar Mission.

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As of the end of May 2014, more than 2.6 GW of grid-connected solar PV projects have been commissioned across India.[2] In addition to the NSM, twelve Indian states have adopted policies promoting solar energy, with Gujarat, Rajasthan, and Maharashtra having the highest capacity of commissioned projects.[3] To build on the momentum of the past few years of rapid solar deployment, MNRE and the Solar Energy Corporation of India (SECI) announced winning bids for another 750 megawatts (MW) of solar projects under NSM Phase 2, Batch 1 in February 2014.

Yet, despite the recent growth of India's solar energy market, the economic and employment opportunities and benefits generated by solar technologies and projects remain largely unknown, both to potential market investors and to the broader Indian public that stands to benefit from the growth of this industry. Renewable energy technologies are more labor-intensive than more mechanized fossil fuel technologies, as mature markets have demonstrated, and the growth of the India solar market offers a tremendous opportunity to create domestic jobs.[4]

To examine job creation in India's solar energy market, this profile evaluates the jobs created at the 20 MW grid-connected solar photovoltaic (PV) Solarfield Energy II project developed by Kiran Energy in Phalodi, Jodhpur district, Rajasthan, India. Across the 25-year project life, based on information from L&T Construction and Kiran Energy project teams, **the 20 MW solar PV project generated a total of 180.8 full time equivalent (FTE) jobs, primarily for highly skilled personnel and construction workers**. In the first year of operation, during the pre-commissioning phase, 17.5 FTE skilled jobs and 118.4 FTE construction jobs were created. Additionally, 8 FTE annual jobs for skilled electricians and engineers and nearly 37 FTE annual jobs for unskilled employment in operations and maintenance have been established post-commissioning for the 25-year operating life of the project.

Table 1: Project Details

Project Name	**Solarfield Energy Two Private Limited**
Developer	Kiran Energy Solar Power Private Limited
Engineering Procurement and Construction	Larsen and Toubro (L&T) Construction
Location	Phalodi, Jodhpur district, Rajasthan, India
Policy	National Solar Mission, Phase 1, Batch 2
Power Purchaser	NTPC Vidyut Vyapar Nigam (NVVN) Limited
Date of Commissioning	February 20, 2013
Solar PV System Information	
Size	20 MW
Solar Panel Supplier	First Solar
Inverter Supplier	SMA
Balance of System Suppliers	Pennar, MetalKraft, KEC, Schneider, Ames Impex Electricals, ABB
Financing	U.S. Export-Import Bank
Annual Generation	35,533,446 kilowatt-hours (kWh)
Employment Generation	
Highly Skilled/Senior Management	17.5 FTE pre-commissioning during first year of operation[5]
8 FTE post-commissioning for 25 year duration of plant operations	145.3 FTE during first year of operation
Unskilled Labor	118.4 FTE pre-commissioning during first year of operation
36.9 FTE post-commissioning for 25 year duration of plant operations	25 years
Total Employment Generation	180.8 FTE skilled and unskilled personnel during first year of operation
Project Operating Life	25 years

PROJECT-BASED EMPLOYMENT PROFILES

The employment opportunities created by India's growing solar energy market add to the already compelling reasons to implement robust clean energy policies at the national and state levels. The purpose of CEEW's and NRDC's project-based employment profiles is to demonstrate the range of activities and jobs created during the installation of a solar PV project, examining in detail the roles of two key players involved in this process: the project developer and the engineering, procurement, and construction (EPC) contractor.

This profile highlights the employment opportunities generated by project developer Kiran Energy's 20 MW grid-connected solar photovoltaic (PV) installation in Phalodi, Jodhpur district, Rajasthan. L&T Construction was the project's EPC contractor. The project was allocated to Kiran Energy as part of the NSM Phase 1, Batch 2 at a tariff of Rs. 9.34/kWh ($0.15/kWh).[6]

A dedicated project development team worked on this grid-connected solar PV installation over a period of 9 months, supported by the EPC team. Construction was spread over a period of 26 weeks, and the project was commissioned and connected to the grid on February 20, 2013.

About Kiran Energy and L&T Construction

Kiran Energy is a Mumbai-based project developer focusing on grid-connected solar energy. The company is building a portfolio of solar PV power plants in high-insolation zones across India. As of early 2014, Kiran Energy had a total capacity of 80 MW of installed solar PV projects in its portfolio, including India's single largest solar plant, a 60 MW facility in Rajasthan.[7] The company's commissioned PV projects also include a 20 MW project under NSM Phase 1, Batch 2 in Rajasthan.

L&T Construction is a part of Larsen & Toubro (L&T) Limited, a large technology, engineering, manufacturing, and construction organization with a track record of 70 years. L&T Construction is India's second-largest independent EPC company in the solar industry, with nearly a 13 percent market share among independent EPC companies as of August 2013.[8] The solar division of L&T Construction has installed more than 300 MW of solar PV and concentrated solar power (CSP) in India.[9]

STAGES OF THE KIRAN ENERGY SOLAR PV PROJECT INSTALLATION PROCESS

The solar installation process from bidding and procuring through constructing and commissioning the Phalodi project can be divided into the following four phases:

- Business Development
- Design and Pre-construction
- Construction
- Commissioning and Ongoing Maintenance

The following sections elaborate upon the timeline and key roles and activities involved in the completion of each stage of the solar project.

PHASE 1: BUSINESS DEVELOPMENT

A small project team conceptualized and bid for the Phalodi project. Key activities for this phase included the following:

- Technical, resource, and financial analysis of project viability
- Preliminary scoping of sites for project deployment
- Preliminary discussions with important players such as banks and the power distribution company
- Bidding for the project under Jawaharlal Nehru National Solar Mission
- Vendor management and coordination for key services and components, such as PV modules, inverters, EPC contractor selection

Stages of a PV Project Installation Process

BUSINESS DEVELOPMENT	DESIGN AND PRE-CONSTRUCTION	CONSTRUCTION	COMMISSIONING AND ONGOING MAINTENANCE
TIMELINE Nov '11 to May '12	May '12 to Nov '12	Nov '12 to Feb '13	Feb '13 onwards
KEY JOB ROLES • CEO or Business Head • Supplier Management • Scoping Land Availability • Financial Modeling • Government Liaison • Technical Design	• Project Manager • Civil Engineer • Electrical Engineer • Business Development • Procurement • Government Liaison • Finance	• Project Manager • Planning and Logistics • Civil Engineer • Electrical Engineers (AC and DC) • Stores, Quality, Safety and Accounts • Sub-contracted staff and labor	• Onsite monitoring • Maintenance staff • Security • Cleaning Staff

A team of five senior managers from Kiran Energy worked on business development activities for 10 weeks to prepare and bid for the 20 MW project under Phase 1, Batch 2 of the NSM. Winning bids were announced in December 2011. After holding discussions with potential service providers, Kiran Energy signed a contract for EPC services with L&T Construction in May 2012. L&T Construction's team, led by the head of solar business, dedicated approximately 6 weeks to pursuing a contract prior to signing with Kiran Energy. Table 2 summarizes the approximate time spent on key activities by both teams. At the end of the phase, the developer had a winning bid, a list of possible project sites, preliminary designs for project execution, and an EPC contract with L&T Construction. This initial pre-commissioning phase of the project created 0.7 FTE total employment opportunity for highly skilled employees during the first year, including business heads, project managers, engineers, and planners.

Table 2: Phase 1 Resource Requirements

Resource	Key Roles and Activities	Duration
Project Developer Team		
CEO/Head of Division	Project closure/bidding	2 weeks
CFO/Head of Finance	Financial feasibility analysis	2 weeks
Head of Operations	Preliminary site survey	1 week
Technical Head	Preliminary technical survey	1 week
Business Development Manager	Proposal writing, vendor coordination	4 weeks
EPC Team		
Head of Business	Project closure	1 week
Contracts Team	Technical bidding, commercial and legal	6 weeks
Technical Design	Technical inputs for bidding	0.5 week

PHASE 2: DESIGN AND PRE-CONSTRUCTION

Once the activities of Phase 1 were completed, the project moved into the design and pre-construction phase, which included the following key activities:

- Signing a power purchase agreement (PPA) for the sale of renewable energy
- Finalizing the project site
- Achieving financial closure for the project
- Civil and electrical design
- Order placement for PV system; planning for logistics and construction

During this phase, developer and EPC engineering teams worked together to design the project with inputs from the installation site, while the process of land acquisition was under way in parallel. The design team made key decisions on module specifications and component purchases with inputs from a centralized team of engineers at L&T Construction. Kiran Energy hired Tata Consulting Engineers, an independent team of technical consultants, for verification and development of project design. The project team chose to use modules by First Solar and inverters from SMA and purchased the balance of system components from a range of suppliers.

Table 3: Phase 2 Resource Requirements

Resource	Key Roles and Activities	Duration
Project Developer Team		
Project Director	Senior manager(s) responsible for team and planning oversight for EPC and project developer teams (33% time)	22 weeks
Head of Electrical	Electrical design for PV installation	22 weeks
Business Development / Procurement Manager	Vendor coordination and procurement of PV system components	8 weeks
Financial Consultant	Preparation and filing for international project loan	5 weeks
Government Liaison	Interface with local government and project site acquisition	6 weeks
EPC Team		
Head of Design	Overall drawing of system design for the PV installation, ensures compliance with customer specifications	3.5 weeks
Civil Design Team	Design of structures, foundations, and rest of plant (4 engineers)	3.5 weeks
Electrical Design Team	Solar field design (4 engineers)	3.5 weeks
Project Consultants (Tata Consulting Engineers)		
Electrical Engineering Consultant	Electrical design, on-site verification and coordination (2 engineers)	22 weeks
Civil Engineering Consultant	Civil design, on-site verification and coordination with design team	22 weeks

Kiran Energy also hired an external financial consultant to help with a loan application to the U.S. Export-Import Bank. The National Solar Mission mandates that project developers sign a power purchase agreement (PPA) with a power off-taker and achieve financial closure for the project within a stipulated period of time from announcement of bid results. Dedicated business development and government liaison teams worked on government permits and land acquisition.

Because of the complex and interconnected nature of activities to be executed during this phase, the project required a high level of coordination among the various teams involved. By the end of this phase, detailed plans for electrical and civil engineering of the PV system installation had been prepared. All activities under this phase were completed on time, except for a delay in the transfer of the title for land at the project site. Construction activity began eleven weeks later than planned, in November 2012. Key activities constituting this phase are summarized in Table 3. This second pre-commissioning phase of the project created 3.2 FTE total jobs for highly skilled workers.

Planning the Work Breakdown Structure and "Gangs"

The L&T planning team determines a "work breakdown structure" (WBS) for all activities constituting a solar project. The WBS divides a project into "packages"—solar field, infrastructural works, evacuation systems, etc. Each package is subdivided into a set of activities, and for each activity, a "gang"—a group of skilled, semi-skilled, and unskilled workers with a combination of tools and materials—is created. Each gang operates as a stand-alone entity that can begin and complete a given activity (structure erection, module mounting, etc.) independently.

Once the WBS of a project is defined, the company can plan and prepare for deployment of resources to complete all project activities as scheduled. L&T calculates resource requirements on the basis of known productivity norms of a gang and progress reports from various sites.

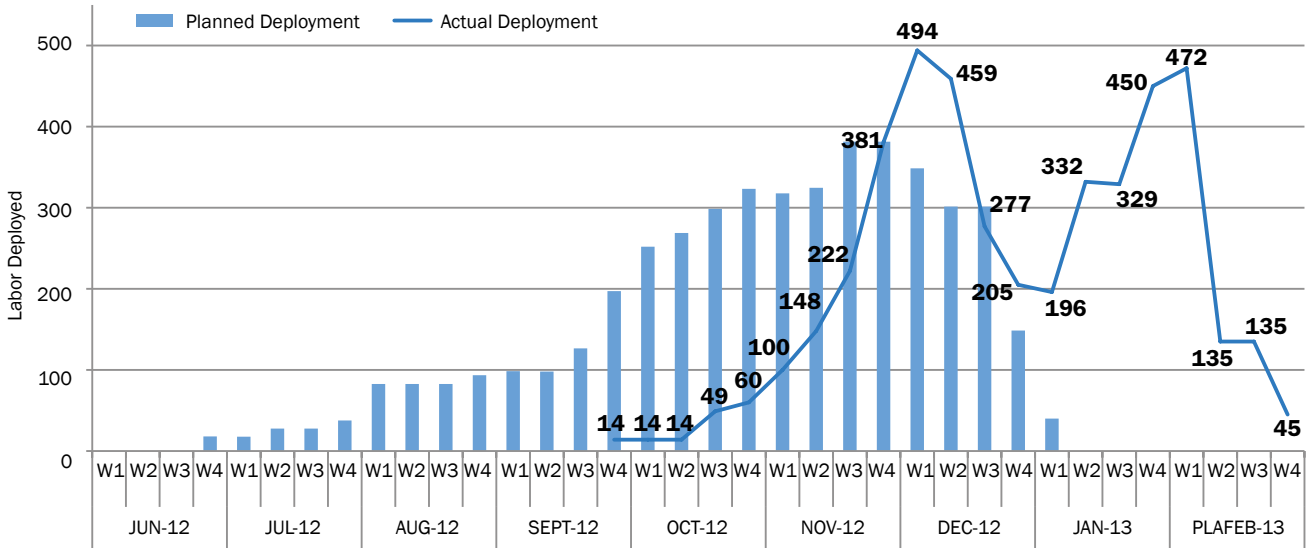
Table 4: Phase 3 Resource Requirements

Resources	Key Roles and Activities	Duration
Project Developer Team		
Project Manager	Project manager, assisted by 1 electrical engineer, responsible for construction activity oversight, quality assurance as per design, and timely completion of the project.	20 weeks
EPC Team		
Project Manager	Project manager, assisted by 1 deputy, responsible for team and construction activity oversight and timely completion of the project	31 weeks
Planning and Site Administration	8-person team made up of planning engineer, inventory manager, labor, safety, and quality personnel responsible for management of construction site, coordinating with client and design team	31 weeks
Civil Works	Team of 3 civil engineers working on implementation of civil works design for PV system installation	31 weeks
Electrical AC Works	Team of 4 electrical engineers working on implementation of electrical design of AC section of PV installation (inverter to substation), responsible for erection of transformers, inverters, HT cables, earthing (grounding of AC circuits), and transmission lines	12 weeks
Electrical DC Works	Team of 6 electrical engineers working on implementation of electrical design of DC section of the PV installation (modules to inverters), responsible for erection of PV structures, module mounting, cable termination, and solar field earthing	20 weeks
Project Consultants (Tata Consulting Engineers)		
Civil Engineering Consultant	Civil engineer responsible for quantity surveying, quality assurance as per design, and timely completion of the project	20 weeks
Electrical Engineering Consultant	Electrical engineer responsible for quantity surveying, quality assurance as per design, and timely completion of the project	20 weeks
Subcontractor Teams		
Site Engineer	Day-to-day management of skilled and unskilled labor, procurement of construction materials	21 weeks
Civil Works Labor	Up to 228 skilled and unskilled laborers to carry out a combination of civil works, such as structure erection, ramming, construction, and foundation works	14 weeks
DC Works Labor	Up to 171 skilled and unskilled laborers to carry out DC circuit activities, such as module mounting and cable laying	12 weeks
AC Works Labor	Up to 95 skilled and unskilled laborers to carry out AC circuit works, such as inverter erection, equipment installation, and cable laying	8 weeks

PHASE 3: CONSTRUCTION

Actual construction of the solar plant is the shortest phase of a PV system installation process. During construction, a combined team of civil and electrical engineers from L&T, Kiran Energy, and Tata Consulting Engineers continued to make tweaks to system designs prepared during the previous phase. A full-time site engineer oversaw all construction activity to ensure that it was per design. L&T Construction subcontracted civil and electrical construction work to local contractors familiar with the regional market and local conditions.

Figure 1: Solar PV Project Construction Activity, Planned Vs. Actual



Construction activity for the Phalodi project was spread over a period of 21 weeks (Figure 1), with labor deployment peaking at 494 persons during the first week of December 2012. The delay experienced in land acquisition at the end of Phase 2 resulted in a compressed time frame available for construction. As a result, in order to meet the commissioning deadline under NSM guidelines, L&T deployed a larger team than originally planned. Most activities defined as part of the project's work breakdown structure (WBS) took between 5 and 12 weeks to complete.

This final pre-commissioning phase of the project created 13.3 FTE total jobs for highly skilled employees—engineers, planners, project managers, etc. In addition, the construction phase of the project created one-time, construction-related employment of 118.4 FTE jobs. According to the information provided by L&T, approximately 40 percent of these jobs required a certain level of vocational skills, while the remainder were unskilled in nature.

PHASE 4: COMMISSIONING AND ONGOING MAINTENANCE

Once the system was tested for integrity, it was energized in coordination with technical support from the project's inverter suppliers. Kiran Energy's annual operations and maintenance (O&M) contract with L&T includes real-time remote monitoring of system performance and annual preventive maintenance carried out on-site by a trained technician. The project began supplying power to the grid in February 2013.

This post-commissioning phase of the project created 8 FTE annual jobs for highly skilled engineers and technicians for the operating life of the project. In addition, 36.9 FTE annual jobs for security guards and cleaners were established for the operating life of the project. With a 25-year expected operating life for the 20 MW solar plant, these roles should provide nearly 45 FTE of permanent employment for the next 25 years.

Table 5: Phase 4 Resource Requirements

Resource	Key Roles and Activities	Duration
On-site O&M and Monitoring Staff	8 employees (2 engineers and 4 technicians from the O&M contractor and 2 full-time engineers from Kiran Energy staff) are expected to work at the project site.	Operating life of the project
Unskilled Cleaners	9 cleaners are expected to clean the site on a monthly basis	200 days per year (260 days minus 60 days during rainy season) for operating life of the project
Security Staff	30 security guards patrol the site, working in two shifts with 14 guards during the day and 16 at night. This staff is expected to remain the same over time.	Operating life of the project

EMPLOYMENT GENERATION IN GRID-CONNECTED SOLAR PROJECTS

Table 6: First Year and Lifetime Employment Generation By Kiran Energy Project

Employment Generation	FTE
Total skilled employment in first year of construction	25.5
Total unskilled employment in first year of construction	145.3
Total skilled employment in project life	217.5
Total unskilled employment in project life	791.5

Based on information from L&T and Kiran Energy project teams, the 20 MW solar PV project at Phalodi generated a total of 25.5 FTE jobs for highly skilled personnel and 155.3 FTE unskilled roles during the first year of construction—180.8 FTE jobs total including both the pre-commissioning and post-commissioning phases. The breakdown of these roles across the project life cycle was as follows:

- The business development phase generated a total of 0.7 FTE activity.
- The project design and pre-construction phase created a total of 3.2 FTE activity.
- The construction phase created a total of 13.6 FTE jobs (time contribution multiplied by the number of people involved) for skilled employees. The construction process also created employment opportunities of 118.4 FTE for unskilled workers who may have some vocational skills.
- The O&M phase of the project establishes 36.9 FTE per year of unskilled employment and an additional 8 FTE per year of employment for engineers and skilled electricians for the duration of the assumed 25 year life of the project.

Training, Skills Enhancement and Efficiency in Project Development

L&T's Construction Skills Training Institute (CSTI) trains people for different trades (carpentry, civil and electrical works). L&T plans to start a solar training program in collaboration with MNRE and is currently preparing training materials. Candidates train for three to six months, after which they are retained on construction sites to work as skilled laborers. The program offers career growth potential for the workers if they stay with L&T.

For projects of 50 MW or larger, L&T typically establishes a small training facility on the project site, to ensure quality training for contract staff. Overall, more training and other human resource initiatives are needed to support India's solar energy market.

NOTES ON METHODOLOGY FOR CALCULATION OF EMPLOYMENT GENERATION

This case study was based on planning data, activity logs, and personal interviews with L&T Construction and Kiran Energy teams that worked on the project. Some of the estimates, particularly relating to time spent on business development, procurement, and vendor management activities, are rough approximations, as these teams work on several projects simultaneously and it is difficult to isolate time spent on a specific project.

For procurement- and engineering-related activities, project size is not very predictive of the amount of work days required. Typically, a dedicated team within the organization works on a number of projects simultaneously.

Because the job numbers for the construction and ongoing maintenance stages are project and site specific, the numbers for these stages are more reliable than those for the business development, design, and pre-construction phases of the project.

In addition to the specific jobs discussed in this profile, a number of additional jobs are created by solar PV grid-connected projects. These are mainly secondary and tertiary roles created in industries directly and indirectly related to solar PV, such as the manufacture and supply of inverters, cables, trackers, and other parts. These jobs are outside the scope of this analysis, and therefore not calculated.

CONCLUSION

When India's National Solar Mission was launched in January 2010, the Mission's objectives were to contribute to India's long-term energy security and its ecological security.[10] Three years into its launch, the Mission has also presented India's growing labor force with a range of new domestic jobs throughout the process of installing solar energy projects. As India moves toward its target of deploying 20 GW of solar power by 2022, the Indian government must not only have a thorough understanding of the employment opportunities created by the solar industry, but also factor in this job creation potential while designing and implementing clean energy policies at the state and national levels.

To truly realize the potential for employment opportunities that solar energy offers, Indian industry must strive to achieve greater transparency about the impact of solar projects on job creation. It also must collaborate on skills development in order to ensure that progress made toward energy and ecological security also helps India address its need to generate jobs for its rapidly growing workforce.

ENDNOTES

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