Detailed Project Report

Grid Connected Solar Rooftop Systems

At

M/s Cavendish Industries Ltd (a unit of JK Tyre), Haridwar

Submitted

to

State Bank of India

Project Company

Project Company	Total Capacity (MWp)	Project Cost (INR Crore)	Debt (INR Crore)	Equity (INR Crore)
TRUERE UP 2 PVT LTD	6.221	27.50	19.25	8.25

List of Sites and Corresponding Capacities

S.NO.	STATE	NAME & ADDRESS	kWp	TARIFF (RS./KWH)	PROJECT COST
1	HARIDWAR	CAVENDISH INDUSTRIS LTD	6221	4.79	27.50
			6221		27.50

*All amounts are in INR Crore.

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Abbreviations

AC	Alternating Current
APPC	Average Power Purchase Cost
CdTe	Cadmium Telluride
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CIGS	Cadmium Indium Gallium Selenide
Cr	Crore (10 Million)
DC	Direct Current
DISCOM	Distribution Company
DSCR	Debt Service Coverage Ratio
EPC	Engineering, Procurement and Construction
RPO	Renewable Purchase Obligation
GDP	Gross Domestic Product
GFDI	Ground Fault Detection Improvement
GW	Giga Watt
HV	High Voltage
IRR	Internal Rate of Return
IGBT	Insulated Gate Bipolar Transistor
IS	Indian Standard
JNNSM	Jawaharlal Nehru National Solar Mission
KM	Kilometre
kV	Kilo Volt
kW	Kilo Watt
kWh	Kilo Watt Hour
kWp	Kilo Watt Peak
LGBR	Load Generation Balance Report
MNRE	Ministry of New and Renewable Energy
MOSFET	Metal–oxide–semiconductor field-effect transistor

MPPT	Maximum Power Point Tracking
MU	Million Units
MV	Medium Voltage
MW	Mega Watt
MWp	Mega Watt Peak
NASA	National Aeronautics and Space Administration
O&M	Operation & Maintenance
ONAN	Oil Natural Air Natural
PCU	Power Conditioning Unit
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
REC	Renewable Energy Certificate
RES	Renewable Energy Sources
RPPO	Renewable Power Purchase Obligations
RPO	Renewable Purchase Obligation
RPS	Renewable Purchase Specification
SEB	State Electricity Board
Si	Silicon
SPV	Solar Photovoltaic
Wp	Watt Peak
FRP	Fiber Reinforced Plastic

1.0 Solar Resource Assessment

1.1 Solar Resource Assessment

1.1.1 Resource Assessment

The important meteorological parameters in the design of a solar PV power plant are:

1. Solar Radiation
2. Ambient Temperature
3. Wind Speed
4. Relative Humidity

These parameters can be obtained from number of sources. These resources are discussed in detail in next section.

1.1.2. Availability of Resource Data

In design of every solar power plant, solar radiation is the main input energy source for which quite a few data sets for meteorological analysis are available worldwide. These datasets provide information pertaining to Solar Irradiation, Wind and Temperature etc. These data sources are free as well as licensed and can be accessed by subscription. These datasets either make use of ground-based measurements at well controlled meteorological station source processed satellite imagery. A comparative analysis is shown in table below.

Table 1: Comparison of Meteonorm data sources

Database	Region	Values	Source	Period	Variables	Availability	PVsyst import
Meteonorm	Worldwide	Monthly	1700 Terr. Stations Interpolations	1960-1991 Averages 1995-2005 (V 6.0) Averages	Gh, Ta Wind Others	Software	Direct by file (300 stations in PVsyst DB)
Meteonorm	worldwide	Hourly	Synthetic generation	idem	Gh, Ta Wind Others	Software	Direct by file
Satellight	Europe	Hourly	Meteosat Any pixel of about 5x7 km2	1996-2000	Gh, Dh, Ta, WindVel	Software	Direct by file
US TMY2	USA	Hourly	NREL, 239 stations TMY	1960-1990 samples	Gh, Dh, Ta, WindVel	Web free	Included in database
IMD (Indian Metrological Department	India	Daily, Hourly, Monthl;y, Yearly	45 ground stations	From 1948-2008	GHI, DHI, DNI, Rh, Ta, Wind Vel	Paid access	Manual
ISM-EMPA	Switzerland	Hourly	22 stations DRY	1981-1990 samples	Gh, Dh, Ta, Wind Vel	Included in PVsyst	Includded in database
Helioclim (SoDa)	Europe Africa	Hourly	Meteosat	From 02/2004	Gh No Ta	Webrestricted 2005 free	Direct by copy/paste
NASA-SSE	Worldwide	Monthly	Satellites 1°x1° cells (111x111 km2)	1983-1993 averages	Gh, Ta	Web free	Direct
WRDC	Worldwide	Hourly Daily Monthly	1195 stations	1964-1993 each	Gh, No Ta	Web free	Direct by copy/paste
PVGIS-ESRA	Europe Africa	Monthly	Europe : 566 stations interp. 1x1 km2 Africa : Meteosat (Helioclim-1 database)	1981-1990 averages 1985-2004	Gh, Ta, Linke turbidity	Web free	Direct by copy/paste
Helioclim -1	Europe	Monthly	Meteosat	1985-2005	Gh	Web	Direct by copy/paste
(SoDa)	Africa		50x50 km2	each year	No Ta	Restricted 1985-89 free	
RETScreen	Worldwide	Monthly	Compil. 20 sources Incl. WRDC - NASA	1961-1990 averages	Gh, Ta, Windnvel	Software, free	Direct by copy/paste
SolarGIS	Europe Africa, Asia, Brazil, West Australia	Hourly	Meteosat Approx. 4x5 km2	From 1994 - 1999	Gh, Dh, Ta	Web, paid access	Direct

(Source: http://www.pvsyst.com/en/publications/meteo-data-sources)

1.1.3 Solar Resource Data Selection

For India data from NASA, Meteonorm, NREL, and IMD can be taken, but because of possible inaccuracy in NASA's data (as the grid area coverage is large 1°x1°, 111 km) and since IMD data is available only for few cities, data from Meteonorm is considered. For radiation parameters periods considered are from 1981 to 1990, 1986 to 2005 and 1991 to 2010. Data for any other site that is not directly available is to be obtained by interpolation (usually among the 3 nearest stations or a satellite-based data).

1.1.4 Solar Radiation

Solar PV systems for generation of electricity require sufficient solar radiation i.e. global horizontal irradiance. Generally, the setting up solar PV power plant for generating electricity is viable where the solar insolation exceeds about 1600 kWh/m^2/year. Higher the insolation higher is the energy production at output side (considering standard conditions).

In India, the range of solar insolation varies between 4.4-6.4 kWh/m^2/day, which lies under the acceptable value. The feasibility of the site is decided based on the solar radiation values obtained from the resources. Solar radiation data has been taken from Meteonorm as this is a dependable source. Refer Annexure-1 for details.

1.1.5 Temperature

PV modules have a temperature co-efficient that has a negative impact on voltage levels with rise in temperature; this means there will be a decrease in power output with a rise in temperature. The annual energy yield of a PV plant is heavily dependent on the actual solar resource of the site and ambient temperature. The increase in temperature has a major impact on the PV module by reducing its voltage, thereby lowering the output power. In addition, increases in temperature are found to be the cause for failure or degradation of PV modules.

Elevated temperatures increase stresses associated with thermal expansion and increase degradation rate by a factor of about two for each 10°C increase in temperature. The operating temperature of a module is determined by the equilibrium between the heat produced by the PV module, the heat lost to the environment and the ambient operating temperature. A PV module will be typically rated at 25 °C under 1 kW/m^2.

However, when operating in the field, they typically operate at higher temperatures, which are influenced by the site conditions. To determine the power output of the solar cell, it is important to determine the expected operating temperature of the PV module.

The temperature data has been taken from Meteonorm this is a dependable source.

1.1.6 Wind

The wind speed data in a solar power plant is an important aspect in design of its civil structures and analyzing solar PV panel performance. The bureau of Indian standards has published IS-875 which is an elaborate document covering the obtainable wind speeds in various parts of the country. A map has been appended to the IS which shows the wind speed in the form of zoning and the wind speed in any part of the country. In wind loading analysis, we have considered wind zone map which is extracted from IS-875 Part 3 1987 and is attached as Annexure-2.

2.0 Basis of Energy Generation Analysis

2.1 Annual Energy Yield Calculations

The annual energy yields from the proposed site have been calculated using the basic design and indicative layout as described in the previous sections. Arbutus has:

1. Sourced average monthly horizontal irradiation, wind speed and temperature data from the Meteonorm satellite image derived data. These data have been assessed and judiciously selected for use in the energy yield simulation software
2. Calculated the losses, using details of the inverter specifications, PV module specifications, PV module characteristics, on-site conditions and plot layout
3. Applied downtime losses, ohmic losses, module degradation and transformer losses to obtain energy yield that reflects a twenty-five-year plant life.

Steps 2 and 3 are facilitated using industry standard photovoltaic simulation software which simulates the energy yield using hourly time steps. The software takes as input detailed specifications of:

1. The solar PV modules
2. The inverter
3. Electrical configuration, including number of modules in series and parallel

2.1.1 Irradiation in the Plane of the Modules

The annual global irradiation incident on the collector plane has been maximised by using fixed tilt and flush mounting system for the 4.348 MWp solar rooftop system at the proposed location.

2.1.2 Corrections and Losses

Data obtained for irradiation on collector plane, PV module and inverter specifications and plant configuration are input into the PV modelling software to calculate DC energy generated from the modules in hourly time steps throughout the year. This direct current is converted to AC by the inverter.

Table 2: Description of Energy Yield Losses

Loss	Description
Incident angle	The incidence angle loss accounts for losses in radiation penetrating the front glass of the PV modules due to the angles of incidence other than perpendicular.
Low irradiance	The conversion efficiency of a PV module reduces at low light intensities.
Module temperature	The characteristics of a PV module are determined at standard temperature conditions of 25°C. For every °C temperature rise above this, module efficiency reduces according to their temperature coefficient.
Soiling	In general, these losses are associated dust, dirt or pollution, which accumulates on the surface of modules
Module quality	Most PV modules do not match exactly the manufacturer’s nominal specifications. Modules are sold with a nominal peak power and a given tolerance within which the actual power is guaranteed to lie.
Module mismatch	Losses due to "mismatch" are related to the fact that the real modules in an array do not all rigorously present the same current/voltage profiles: there is a statistical variation between them.
DC wiring resistance	The electrical resistance in wires between the power available at the modules and at the terminals of the array gives rise to ohmic losses (I^2R).
Inverter performance	The inverter losses include efficiency, and other losses due both to the power and voltage threshold and to operation above nominal power and voltage Inverters convert from DC into AC with a certain specified maximum efficiency. Depending on the inverter load, they will not always operate at maximum efficiency.
AC losses	This includes transformer performance (MV/HV) and ohmic losses in the cable leading to the plant switchyard.
Degradation	The performance of a PV module decreases with time.

3.0 INTRODUCTION

Oriana Power Private Limited forms SPV named TRUERE UP 2 PVT LTD which is planning to set up 1.250MW_p grid-connected solar photovoltaic power plants in the state of Rajasthan under REIL tender.

This report provides the techno-commercial details of the project and covers:

- Objectives of the project
- Location and site details
- Tentative plant layout
- Provisional system design and system description, including selection of module supplier from Goldi/Reputed Imported Solar ("Top Tier Global Module Manufacturers")
- Requirement of utilities
- Relevant standards
- Description of power evacuation system and interfacing with the grid
- O&M requirements along with organizational arrangements
- Project implementation schedule
- Equipment list with brief technical specification
- Detailed financial analysis and cash flow (including P50, P90 analysis)

Summary of the proposed plants is given in the table below:

Location	6.221 MWp in Lakshar
No. of Location	1
Mounting Type	Fixed Tilt
PV Module type	Mono-Crystalline
PV Module Make	Goldi/Reputed Imported/Equivalent
PV Module Rating	540/570 Wp
Total no. of Modules*	11520/10914 No's
Inverter type	String Inverter
Inverter Make	Sungrow/Growatt

Inverter power	4400 kW
Total no. of Inverters*	1 No's

Table 3: Summary of PV Power Plant

Table 4: Summary of PV Power Plant (SPV Level)

Location	6.221 MW
Mounting Type	Fixed Tilt
PV Module type	Mono-Crystalline
PV Module Make	Goldi/Reputed Imported/equivalent
PV Module Rating (Wp)	540/570 Wp
Total number of Modules*	11520/10914 No's
Inverter type	String Inverter
Inverter Make (proposed)	Sungrow/Growatt
First year P50 Energy Yield (MWh/Annum)	9200 MWh/year
First year P90 Energy Yield (MWh/Annum)	8280 MWh/year
Total Project cost (INR Crore)	27.50
Debt: Equity	70:30
Equity (INR Crore)	8.25
Average DSCR at P90	1.3

4.0 SOLAR POLICIES

4.1 Open Access Solar Policy Uttrakhand

Uttarakhand is a relatively young state, having been formed in the year 2000. it is located in the Northern part of the country and is most famous for its temples and pilgrimage centres. The capital city of Uttarakhand is Dehradun, a famous hill station. Uttarakhand has a connected solar power of about 45.10MW and has seen 3.95MW get commissioned in the Financial Year 2016/17. Until 2016, the state had about 23 solar power plants, but since then Uttarakhand Renewable Energy Department Agency or UREDA has mandated to setup another 2000 solar plants that would produce as much as 44MW of electricity, in chasing the run from the centre that a least 8% of the power utilised in the state must come from solar. In November of last year, 200 farmers were empowered to install solar power generation plants in their fields to push the adoption of solar. A fixed price of Rs 4.35 per unit was set, at which the farmers would sell the power back to the state government. These farmers have since been named 'Solar Farmers'. Another private player, Rays Power Infra is working on a 100MW project in the state in Roorkee district. By the end of the Financial Year 2019, an additional 196.0MW has been targeted by the state government. Beyond Solar PV, solar lead solutions such the *installation of solar water heating systems* have proved to be quite popular in the state.

Key point of solar policies as follows:

Capacity Size: Up to sanctioned load

Voltage Levels:

HT/EHT Level: >100kWp.

5.0 SITE ASSESSMENT

5.1 Location

5.1.1 Cavendish Industries Ltd

JK Tyre has also enhanced its global reach by taking over Tornel, a renowned Mexican company, which has 3 plants in Mexico. All of these plants are equipped with the world's most advanced manufacturing and testing machines.

JK Tyre started manufacturing tyres in 1977 with a capacity of 0.5 million tyres per annum. It has grown multi-fold over the years, and currently has a capacity of more than 16.6 million tyres per annum from its 12 plants in India and Mexico. With the commissioning of the Greenfield Project in Chennai, the capacity across 12 plants has crossed the milestone of 20 million tyres per annum.

JK Tyre ,in April 2016, acquired Cavendish Industries Limited in Haridwar, UKD. While the acquisition added three modern plants to its portfolio taking the total count to 12, it helped the tyre major foray into the two/three wheeler segment as well.

The 6 MWp plant is proposed to be developed at Cavendish Industries Ltd (a JK Tyre unit), Haridwar. The coordinates of the site are given below:

Latitude: 29.734203° N
Longitude: 78.016639° E

Figure 1: Location of project site- Cavendish Industries Ltd (a Unit of JK Tyre)

6.0 SYSTEM DESIGN

6.1 DESIGN BASIS

6.1.1 Meteorological Database

Solargis time series provide a long-term record of solar and meteorological data. Although the Solargis data is of high-quality, for large-scale and utility-scale projects it needs to be supported by regional validation and site-specific uncertainty estimates.

A regional evaluation of the model uncertainty is particularly important in territories, where solar power development is only starting. For this purpose, we provide a detailed solar resource validation and assessment study as an add-on consultancy service to the standard data delivery.

Validation information related to solar and meteorological data from nearby sites is included to support bankability of the assessment. On-site measurements, when available, can be integrated into the analysis to reduce uncertainty and give higher confidence to project stakeholders.

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6.1.2 System Design Software

PVSYST V7.3.40 has been used for carrying out the system design and computing the annual energy yield.

1. PVSYST is a PC software package for the study, sizing and data analysis of complete PV systems.
2. It deals with grid-connected, stand-alone, pumping and DC-grid (public transport) PV systems, and includes extensive meteorological and PV system components databases, as well as general solar energy tools.
3. PVSYST predicts the energy generations for a year of the required location with the help of Meteonorm file of the same location.

6.1.3 Drafting Software

AUTOCAD is used as the drafting software for creation of 2D drawings that will be used as reference and for construction. AutoCAD software is used in a range of industries, employed by architects, project managers and engineers, amongst other professions.

6.1.4 Module Selection

It was explained earlier that mono-crystalline silicon technology was preferred for the project due to the following reasons

1. Good commercial efficiencies
2. Lower cost due to fall in silicon prices
3. Lesser area requirement for installation
4. Higher bankability

The preferred module has been shortlisted based on quality of raw materials, manufacturing equipment, quality-controlled process and R&D laboratories. The company will choose a module supplier from Top Tier Global Module Manufacturers. Technical specifications of Tria/Equivalent modules are attached as Annexure-3.

The number of modules to be supplied shall be worked out as per the energy generation analysis, the DC plate rating and the AC capacity. Module frames shall be made of corrosion resistant material, which shall be electrically compatible with the structural material used for mounting the modules. The module shall be provided with a junction box with provision of external screw terminal connection and with arrangement for provision of by-pass diode. The box should have hinged, weatherproof lid with captive screws and cable gland entry points. The solar PV modules must be tested and certified by an independent international testing laboratory. The modules shall meet standards applicable, as per IEC 61215 and IEC 61730.

6.1.5 Mounting Selection

The type of mounting structure has been selected based on the energy generation analysis. The objective of the project is to set up power plants with maximum energy generation.

Considering all the parameters for solar rooftop system it is considered fixed and Flush mounted system for installation. For flat RCC roof fixed tilt system will be used and for tilted tin sheet roof flush mounting system will be considered.

6.1.6 Inverter selection

As there are several roofs for solar PV installation use of central inverter call for installation will increase laying of cable from different roofs to central inverter which lead to increase dc losses and that will directly impact on energy generation.

On the other hand, String inverters have efficiencies in the range of 98.8%, require less cable length and voltage is stepped up to intermediate voltage directly. Also, installation of string inverter is quick and required less space as compare with central inverter. Hence for this project we have used String Inverters.

Governing Standards: Inverter should conform to IEC 61683 and UL standards for safety.

Post techno-commercial evaluation of major inverter suppliers, the developer after negotiation with Sungrow and Growatt.

Sungrow is a global leading inverter solution supplier for renewables with over 49GW installed worldwide as of June 2017. Founded in 1997, Sungrow has established 16 subsidiaries worldwide located throughout the Americas, APAC, the Middle East, Europe and Africa, maintaining a market share of around 25% in Germany and over 15% in the world. Sungrow possesses a dynamic R&D team which accounts for over 35% of the company's total workforce. The company has also invested its own in-house testing center approved by UL, CSA, TÜV Rheinland, and TÜV SÜD. In 2016, Sungrow launched a new storage inverter factory, setting its combined annual manufacturing capacity at 18 GW for PV inverters and 3 GW for storage inverters.

Growatt is a new energy enterprise dedicated to the R&D and manufacturing of PV inverters including on-grid, off-grid and storage inverters, and user side smart energy management solutions as well. The power capacity of Growatt on-grid inverters ranges from 750W to 250 kW, meanwhile its off-grid and storage inverters cover a power range from 1 kW to 630 kW. Growatt inverters are extensively used worldwide for applications in residential, commercial, PV poverty alleviation, utility-scale scenarios as well as other storage power station projects.

Since its foundation in 2010, Growatt has established branch offices one after another in Germany, US, UK, Australia, Brazil, Thailand, India, Netherlands, etc in order to better serve the customers across the globe. Growatt always sticks to the R&D investment and technology innovation, and provides customers with premium products and services through its core inverter technology, rigorous quality control and continuous improvement of customer service. By the end of 2019, Growatt has shipped over 1.7 million inverters to over 100 countries and regions across the globe. Growatt has been recognized as the No.1 Chinese Residential PV Inverter Brand, three years in a row according to PVBL. By 2018 Growatt has become the TOP 3 single-phase inverter brand according to the IHS Markit's world inverter shipment ranking.

Flexibility of installation: The forced air-cooling system, designed for a simple and fast maintenance allows for the maximum flexibility of installation.

The illustrative image of the Inverter is given below:

Figure 20: Illustrative image of the Central Inverter

For design and calculation purposes, a 4400 kW Sungrow central inverter has been selected. This gives an insight into energy generation possibilities and consequent revenue generation.

These are three phase inverters with compact enclosures and protection level suitable for indoor use. Technical specifications of the selected inverter are attached as Annexure-4.

6.1.7 Proposed Design of 6.221 MWp Solar Power Plant

The layout of the PV power plant is prepared after shadow analysis of respective building roofs. Proposed system is combination of fixed tilt system due to availability of RCC, refer Annexure-5 for tentative plant layout. Refinements required in plant layout shall be assessed during the detailed design and engineering phase.

The energy yield is computed with 540/570 Wp module of Goldi/Reputed Imported/Tier-1 and 5 MVA Sungrow central inverters. The energy generation details are given in Annexure-6.

As multi MPPT string inverter used respective string will directly connected to Inverter. String level monitoring is also possible through these inverters. Fuse, DC disconnector along with SPD is inbuilt in inverter so there is no requirement of DCDB. But considering different roofs and single inverter for these roofs, consultant recommends providing at least DC disconnector on each roof. Refinements required in DC design shall be assessed during the detailed design and engineering phase.

The tentative DC side single line diagram (SLD) is attached as Annexure-7.

The cables used in the solar PV plant have to be robust and resist high mechanical load and tension along with the UV rays of the sun. High temperature resistance and weather proofing characteristics provide long life.

Modules are equipped with attached junction boxes with 4mm^2 cable, MC4 connectors. Modules will be interconnected with these cables in series to form a string of 20 modules by MC4 connectors. 4 mm^2/ 6 mm^2 single core cables shall be used to connect strings to String Inverter. These cables will be cross-linked polyolefin insulated, with ultraviolet (UV) and temperature resistant properties.

Technical specification of DC cables is shown in the table below.

Table 3: Brief technical specifications of DC Cables

Item	Specifications
Cables from String to SCB/Inverter	1.8 kV, Single Core, XLPO insulated, PVC sheathed, unarmoured cable, confirming to IEC 60228 standard annealed tinned coated copper conductor size 4 sq.mm, RED
	1.8 kV, Single Core, XLPO insulated, PVC sheathed, unarmoured cable, confirming to IEC 60228 standard annealed tinned coated copper conductor size 6 sq.mm, BLACK

Output of String Inverter will be combined with circuit interconnect at each site separately.

6.1.8 Lightning & Over Voltage Protection

Lightning protection shall be provided in accordance with IS 2309. Detailed risk analysis shall be made to consider the requirement vis-a-vis obtaining insurance cover. The cost for providing full lightning protection should be compared with possible shadow losses that might accrue due to the lightning arrestor mounting and fitment.

Necessary concrete/structural foundation for holding the lightning conductor in position will be made after giving due consideration to the maximum wind speed and maintenance requirement at site in future. Each lightning conductor shall be fitted with individual separate earth pit as per required Standards including accessories, and provided with masonry enclosure with cast iron cover plate having a locking arrangement, watering pipe using charcoal or coke and salt as per required provisions of IS.

As distance between roofs are more and to maintain earthing resistance less than 1-ohm consultants recommends that separate DC earthing to be provided for each roof.

The illustrative image of lightning arrestor is given below:

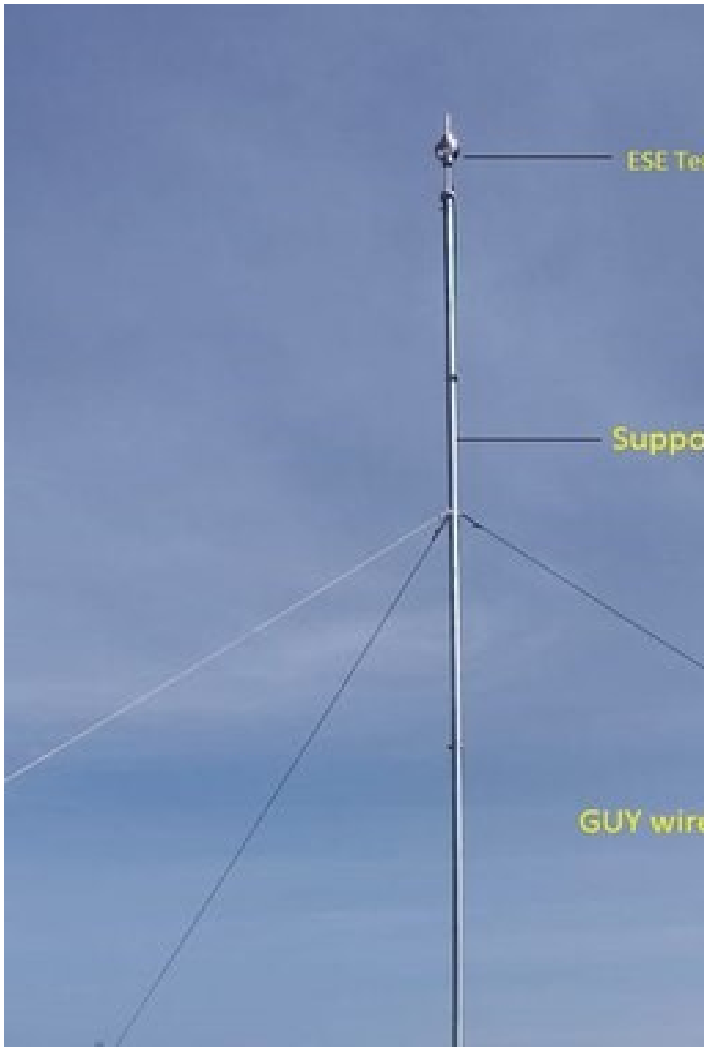

Figure 21: Illustrative image of lightning arrester

6.1.9 Safety Regulations

Statutory regulations on safety measures shall be strictly followed. Safety appliances, viz. fire extinguishers, sand buckets, earth rods, gloves, rubber mats, danger sign boards, safety regulation charts, etc. shall be procured and installed as per safety norms.

6.1.10 SCADA

The entire solar PV power plant shall be integrated with Supervisory Control and Data Acquisition (SCADA) system which should communicate with all the inverters for displaying parameters mentioned below. The integrated SCADA shall have the feature to be used either locally via a local computer or also remotely via the Web using either a standard modem or a GSM / WIFI modem and broadband. SCADA shall have provision of tracking the status of breakers and relays. SCADA shall be confirming to IEC 60870.

Following parameters shall be shown in the SCADA system:

1. Data from Weather station
2. PV module back surface temp
3. Line and phase currents
4. Cumulative energy exported
5. AC and DC side Power of each inverter
6. Current and voltage of each sub-array/string.
7. Inverter data

The major SCADA features incorporated into the control system are listed below.

1. Operator interface of latest technology: Instantaneous grid, array, inverter, AC, and metering of all parameters.
2. Integrated AC, DC data points logging: Instantaneous logging of all parameters. Including AC parameters, the generator run hours and energy details.
3. Fault and system diagnostics with time stamped event logging. Selectable event logging resolution for enhanced diagnostics.

The typical schematic of SCADA system is given in the figure below:

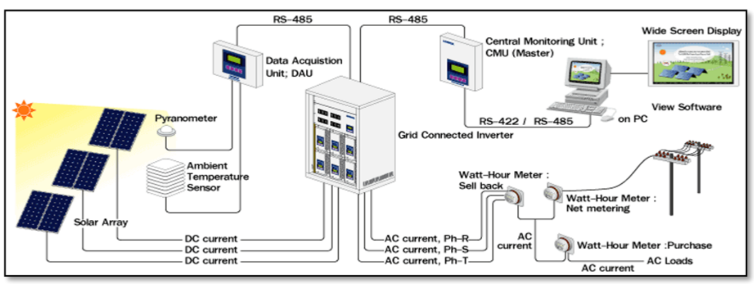

Figure 22: Typical schematic of SCADA system

7.0 ENERGY GENERATION ANALYSIS

The simulation of energy generation is one of the most important tasks because the results lead to understanding the viability of the project by through working out possible revenues. The results are brought out in Annexure-6.

7.1 Yield Prediction

Table below gives, at a glance, the energy yield from the solar PV plant during the first year. However, there is bound to be a certain amount of degradation of modules each year. As per data available, the degradation of Mono/Poly-crystalline modules is not more than 0.7 %

annually. Keeping this figure as the datum for calculations the anticipated energy yield for every year is shown in the below table:

Table 4: Energy Yield Prediction for 6.221 MWp Solar PV Power Plants

Parameter	6 MWp
PV module	Goldi/Reputed Imported/Equivalent
Module peak power (Wp)	540/570 Wp
Number of Modules	11520/10914
Peak power of plant (MWp)	6.221 MWp
Solar Radiation (m2/day)	4.75 m2/day
Losses	
IAM factor on global	1.34%
Module degradation	0.5%
PV loss due to irradiance level	0.59%
Array Soiling loss	2.0%
Module quality loss	-0.4%
LID loss	2.0%
Module array mismatch loss	2.0%
Ohmic wiring loss	0.97%
Inverter Loss during operation (efficiency)	1.26%
Auxiliary loss	1.11%
Transformer Losses	1.08%
AC Ohmic Loss	0.13%
First Year Energy Yield P50 (MWh/annum)	9200 MWh/annum
First Year Energy Yield P90 (MWh/annum)	8280 MWh/annum
First Year Specific Yield (kWh/kWp/year) at P90	1331 kWh/kWp/year
Performance Ratio (PR) (%)	84.68%

7.2 P50, P90 Annual Energy Yield Prediction

Table below summarize the predicted P50, P90 yields for Solar PV power plant for Mono crystalline technology.

Table 5: P50, P90 Annual Energy Yield Prediction –SPV Plant for 6 MWp

Sl. No	Site Details	Capacity (KW)	GHI (kWh/M2)	Generation P50 (MWh/year)	Generation P90 (MWh/year)
1	Cavendish Industries Ltd	6221	1566	8322	7490

The Power Purchase agreement is for 25 years, so the P50, P90 annual energy yield for 25 years is shown in Table below.

Table 6: P50 Annual Energy Yield over 25 years for 6.221 MWp Project after AC losses and degradation from second year onwards

Year	Each Year's individual P50 (1.5% in 1st yr and 0.75% annual degradation) (MWh/annum)	Each Year's individual P90 (1.5% in 1st yr and 0.75% annual degradation) (MWh/annum)
1	1,479.00	1,331.00
2	1,471.61	1,321.02
3	1,464.25	1,311.11
4	1,456.93	1,301.28
5	1,449.64	1,291.52
6	1,442.39	1,281.83
7	1,435.18	1,272.22
8	1,428.01	1,262.68
9	1,420.87	1,253.21
10	1,413.76	1,243.81
11	1,406.69	1,234.48
12	1,399.66	1,225.22
13	1,392.66	1,216.03
14	1,385.70	1,206.91
15	1,378.77	1,197.86

7.3 Capacity Utilization Factor

The Capacity Utilization Factor (CUF) is the ratio of the actual output over the period of a year and its output if it had operated at nominal power the entire year, as described in the formula below.

$$AC\ CUF = \frac{Energy\ generated\ per\ annum}{8760(hours/\ annum)\ x\ Installed\ Capacity\ (kWac)}$$

$$DC\ CUF = \frac{Energy\ generated\ per\ annum}{8760(hours/\ annum)\ x\ Installed\ Capacity\ (kWdc)}$$

* DC The CUF of the 6.221 MW PV plant under TRUERE UP 2 PVT LTD - is computed to be 16.9% at P50 level and is 16.5 % at P90..

AC The CUF of the 6 MW PV plant under TRUERE UP 2 PVT LTD - is computed to be 20.3% at P50 level and is 19.8 % at P90.

7.4 Performance Ratio

Performance ratio of the SPV Plant shows quality of components and installation. The PR, usually expressed as a percentage, can be used to compare PV systems independent of size and solar resource. The PR may be expressed as:

$$PR = \frac{Anual\ AC\ Yield}{(Area\ of\ modules)x(Anual\ Insolation)x(Module\ efficiency)} \times 100\%$$

By normalizing with respect to irradiation, the PR quantifies the overall effect of losses on the rated output and allows a comparison between PV plants. First year PR for the 6.221 MW PV plant TRUERE UP 2 PVT LTD - is computed to be 82.45%.

8.0 FINANCIAL ANALYSIS

8.1 Project Costing

For 6.221 MW solar PV Project, the weighted average capital cost is estimated to be INR 4.00 Cr/MWp. The breakup of the total project cost is given in below table.

Table 7: Project Cost

Sr. No	Particulars	Total Cost (In Crores)
1	EPC Cost + GST	24.88
2	Pre-Operational Expenses	0.12
3	IDC	2.49
	Total Project Cost	27.50
	Per MWp Project Cost	4.42
	DSRA	1.09

8.3 Financials Analysis Assumptions

The proposed Solar PV Power Project is of 6.221 MW capacity. The life of the project is considered as 25 years. Here, technology considered for energy generation is –

The following table shows the financial assumptions:

Table 8: Financial Assumption

1.250 MW Solar Project – Mono/Poly-Crystalline		
Parameters Value Units	Parameters Value	Parameters Units
Project Details		
Life of Project Considered	*15*	years
Project capacity (AC)	5.00	MW
Project capacity (DC)	6.00	MWp
Generation Details		
CUF (P90)	12.8	*%*
Annual Generation (P90)	7490	MWh/Year
Degradation in energy generation for First year	1.5%	per annum
Degradation in energy generation from Second year	0.5%	per annum
Capital Expenditure and Structure		
Price/MWp	4.42	Rs. in Crores
Total Project Cost	27.50	Rs. in Crores
Financed by --		
Equity Capital (30% of Project Cost)	8.25	Rs. in Crores
Total Debt (70% of Project Cost)	19.25	Rs. in Crores
Govt Incentives	NA	Rs. in Crores
Interest Cost	*9.00*	%
Project IRR	9.5%	%
Operating Expenses		
Operation &Maintenance (O&M) Expenses	3 lakhs	Per MWp
Annual escalation in O&M Expenses	4%	per annum

Depreciation (SLM) and Tax Rates		
Depreciation Rate (For P& L)	6.67%	
Depreciation Rate for IT(SLM)	40%	
Depreciation value (% of Project cost)	100%	
Income tax Rate	15.00%	
Education Cess on Income tax and Surcharge	10.00%	
Minimum Alternate Tax	N.A.	

8.4 Project Financials

The detailed financial include following parameters,

1. Projected income statement
2. Projected balance sheet statement
3. Projected cash flow statement
4. Projected DSCR
5. Calculation of IRR

For detailed, financial kindly refer Annexure [9]

9.0 APPROVALS AND PERMITS

9.1 List of Approvals Required for the Project

A solar power plant is primarily non-polluting and hence is not covered under the list of installations requiring pollution clearance. However, other appropriate mandatory clearances may have to be fulfilled. The various clearances that may be required for the Solar PV power project are listed in the table below

Table 9: List of approvals

Sr. No.	Type of Clearance/ Approval	Authority	Remarks
1	Approval for Power Evacuation (Net-Metering)	DISCOM	The Company shall obtain grid connectivity approval from DISCOM for the project under Net metering mechanism. Please note that Maximum allowable capacity under net metering mechanism is 1MW. If plant capacity is more than 1MW and fill fulling other norms in solar policy special application should be filled in concern with respective DISCOM.
2	CEIG Approval	CEIG	CEIG approval required for commissioning plant more than 100 kW.

After signing the PPAs, the off-taker has to submit a consumer application form for net metering to the concerned DISCOM. The DISCOM issues an acknowledgement of the consumer application form. Net Metering installation is not necessary for commissioning of plant and can be done even after commissioning of the Solar PV Plant. The steps for net metering approval are as follows:

1. Consumer application along with payment
2. Feasibility Inspection by DISCOM officials
3. Consumers shall Enter into Net Metering Agreement with DISCOM
4. Request for inspection by DISCOM official of the installed solar plant
5. Inspection, Calibration of Meters & Synchronization of installed SPV system by DISCOM
6. In the next billing cycle, net billing system would start

After installation of the plant but before commissioning, CEIG approval is needed to be obtained. The application to CEIG for its approval can be submitted either before installation or post commencement of installation work. The following documents are required to be furnished at the time of application:

1. Requisition letter of the owner/tenant of the installation.
2. Computer print/ Blue print of electrical drawings showing: Single line diagram of the installation, indicating rating, size and details of protection, details of loading, etc.
3. Site plan locating the proposed roof top solar equipment's.
4. Plan and elevation of the solar unit, inverter unit and control panel showing all round clearances etc.
5. Details of earthing provided for the proposed installation.
6. Requisite fees paid receipt/challan for drawing approval
7. Copy of Licensed Electrical Contractor and Supervisor permit duly endorsed in favour of LEC.
8. Structural stability certificate obtained from the certified structural engineer for the roof where proposed solar PV modules are to be erected.
9. Proof of ownership of property where installation is done

After completion of solar roof top installation work, the following documents shall be submitted by the consumer for pre-commissioning inspection:

1. Requisition letter of the owner/tenant of the installation of plant
2. Work completion report
3. Requisite inspection fees paid receipt /challan as per fees notification
4. Manufacturers test report of the solar roof top installation & Calibration report of Energy meter and connected current transformers and protective relays if any
5. List of authorized persons who will operate at the said installation
6. At the time of inspection, a responsible representative of the Consumer / Electrical supervisor shall be present along with testing instruments
7. The defects pointed out during the inspection should be rectified in order to bring the installation in general conformity with the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2010 and a rectification report signed by the consumer, and contractor should be sent to the jurisdictional officer of the Electrical Inspectorate

After verification of the compliance report by the inspecting officer safety approval would be granted under Regulation 32 of CEA (Measures Relating to Safety and Electric Supply) Regulations, 2010

10.0 PROJECT MANAGEMENT

10.1 Project Planning

Project management plays a vital role for projects starting from conceptualization to final project completion. Project design, tendering, bidding, contract finalization, material procurement, implementation and final commissioning are all key components of any solar PV power project which involves intensive planning and monitoring for a successful project execution.

Project management software like Microsoft Projects and Primavera can be used to plan, track and monitor solar PV projects efficiently. Project management software also provides a common platform of communication between different stakeholders involved in the project.

The first step is to develop a work breakdown structure for the project which organizes and defines the scope of the project in a structured format. The next step is to bring all stake holders together to discuss and list all project work packages and associated activities under each major category.

All individual tasks required in the project are listed as project activities and each activity is defined a duration and associated cost. Once all activities are listed, they are linked together to form a network diagram. The network diagram provides linkages between different project activities and defines predecessor activities, float available for each activity and showcases inter-dependencies between each task. The network diagram further helps to identify the critical path of the project. The critical path includes activities which if delayed will eventually delay the project completion.

Detailed work breakdown structure and planning of activities ahead of time gives an added advantage to the project team to closely monitor the project timeline. The software can also be used to allocate resources like man power, equipment etc. along with costs for each activity. The schedule will help to assign manpower, track actual progress from planned and raises alarms in case of project delays.

The overall project activities for the SPV power plant divided into sub packages as given below. The split of supplies is as follows:

1. Construction of walkway to roof, safety training for all site employees.
2. Supply, erection, installation of SPV modules on structures. Supply, erection, installation and testing of PCUs. Interconnection of equipment's and commissioning of the power plant. Completion of earthing system before commissioning. Supply, installation and commissioning of data monitoring system.

3. Actualize grid feed-in by synchronizing SPV power supply with conventional grid supply.
4. Acceptance test of metering system and energy sale.

10.2 Project Organization

10.2.1 Project Management Organization

As the Developer, TRUERE UP 2 PVT LTD Solar is engaged across the full technology, project, and transaction life cycle. Work undertaken by TRUERE UP 2 PVT LTD Solar as part of its role as Developer of the projects includes, among others:

1. Site Assessment and Design
    1. Conducting multiple visits to various sites in the allocated states to assess the feasibility and size of solar rooftop plant that can be installed at various sites
    2. Undertaking irradiation analysis using multiple software Metenorm, SolarGIS, NASA etc. and estimation of generation using PVsyst
    3. Preparation of preliminary design of the plant, including system sizing, plant layout, interconnection/backup design, broad component selection, etc.
2. Meeting Regulatory Requirements
    1. Ensuring requisite approvals from regulatory authorities are obtained including signing of PPA, securing project sanction documents, liaising with NVVN and SECI, etc.
3. Engineering Procurement Construction & Equipment Management
    1. TRUERE UP 2 PVT LTD Solar is actively engaged in developing a strategy for EPC and O&M and negotiating with and selecting an EPC contractor for the cost-effective development of the projects
4. Equipment Management and Vendor Coordination
    1. Oriana Power shall be responsible for sourcing complete material to be used in the project and has been negotiating with Top Tier Global Module Manufacturers and inverter manufacturers for sourcing the same
5. Project Management and Supervision
    1. Overall management of project during actual construction phase and supervision of activities of the EPC and vendors
6. Operations & Maintenance
    1. Post commissioning, the plants will be monitored locally by TRUERE UP 2 PVT LTD team daily

7. Monitoring plant uptime, performance, irradiation and shutdowns, origination and monitoring of payments and financial accounts are some of the activities to be undertaken by TRUERE UP 2 PVT LTD as part of its strategy for operations and maintenance of the plant

After the completion of the project planning, the operational project team will take over. The project team will work to ensure that the project is completed on time as per the agreed specifications.

The overall execution strategy involves Oriana Power team overseeing the work of the in-house client management, technical and project management teams. Further, the strategy envisages a central EPC contractor which will be overseeing the work all other subcontractors.

A dedicated in-house Project Manager will be responsible, along with the EPC Contractor, the implementation and management of the project. Each project manager will be responsible for overseeing execution of the projects in specified states.

The developer has engaged Oriana Power Pvt Ltd as the EPC Contractor for commissioning of Rooftop/Ground Solar Power Projects with total capacity of 6 MWp.

Oriana Power has registered office in Delhi. The company is promoted by EPC division of Oriana group of company. The company has executed Rooftop and Ground mounted solar power projects with aggregate capacity of 100 MW+.

10.2.2 The Project Management Function and Execution

The Project Manager supported by his team is responsible for undertaking all activities to ensure the effective and efficient execution of the project. The Project Manager is the formal point of contact for the developer and contractor on all matters relating to the project. Specifically, the following key functions are undertaken:

1. Overall project management and coordination between EPC and Client
2. Management of client interfaces
3. Planning and time scheduling of all activities based on an integrated master programme; management of resource levels as required
4. Management of EPC's subcontractors, sub-vendors, and equipment expediting
5. Quality assurance and control
6. Monitoring and reporting
7. Spares, maintenance and service management
8. Site management

9. Training and manpower development including client operator and maintenance training during the commissioning of the plant at site
10. Project cost control

10.2.3 Progress Reporting

The team shall document all steps in the project implementation process through weekly reports and the creation of a poster which shall display relevant information.

Weekly Status Reports

The team shall maintain contact with advisors and the course coordinator and advise them on the current project status. The team shall document project work each week, and report weekly via email on the current status and plans for the upcoming week. Major setbacks, meeting agendas, attendance, and accomplishments from the previous week shall all be reported, as shall individual accomplishments by group members. The time spent by each member shall be recorded and a semester tally shall be kept of all hours spent on the project by the team members.

10.3 Project Implementation

Tentative solar photovoltaic rooftop plant project schedule as per following image.

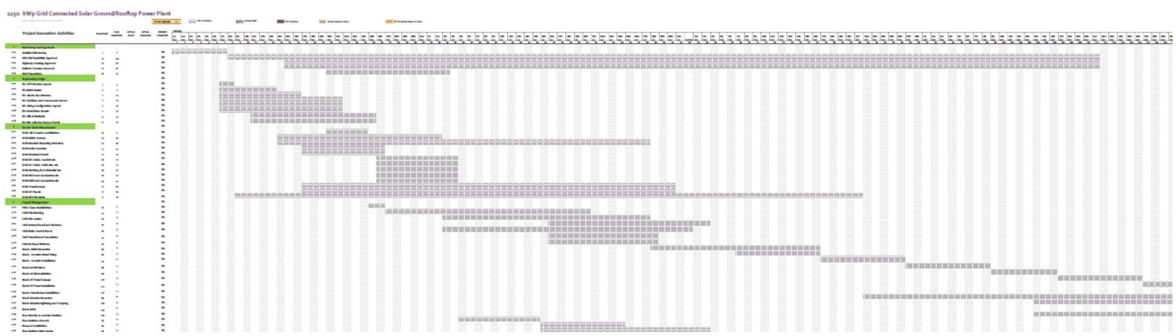

Figure 23: Project Management Schedule

11.0 OPERATION AND MAINTENANCE REQUIREMENT

This section of the report outlines the operation and maintenance philosophy that will be adopted for the proposed solar PV rooftop power plants. The broad outlines given here will be useful guidelines for the basic and detailed engineering of the plant, so that most of the requirements of the operation and maintenance of the plant are met and provided for in the engineering stage itself.

11.1 System Design Suited for O&M

The main objective of operation and maintenance is the high availability and reliability of the plant. In order to achieve the main objective, the following principles would be adopted.

1. Building up adequate capacity to ensure generation of power as per design estimates. This is done by applying liberal de-rating factors for the array and recognizing the efficiency parameters of PCUs, etc.
2. Providing redundancy to ensure at least 50% availability in case of major breakdowns.
3. Use of equipment and systems with proven design and performance that have a high availability track record under similar service conditions.
4. Selection of the equipment and adoption of a plant layout to ensure ease of maintenance
5. Strict compliance with the approved and proven quality assurance norms and procedures during the different phases of the project.

The basic and detailed engineering of the plant will aim at achieving high standards of operational performance especially with respect to the following key parameters:

1. Optimum availability of modules during the day time
2. Ensuring module layout to prevent shading
3. High DC system voltage and low current handling requirements
4. Selection of PCUs with high track record

The plant instrumentation and control system should be designed to ensure high availability and reliability of the plant to assist the operators in the safe and efficient operation of the plant. It should also provide for the analysis of the historical data and help in the plant maintenance people to take up the plant and equipment on preventive maintenance.

11.2 Operation Requirements

The operation of the plant starts with the commissioning. In broad terms, commissioning can be defined as setting up of the plant to work safely and reliably. It is necessary to ensure that all equipment is completely erected before operations begin. Although this may be considered difficult, the other extreme of operating a plant with insufficient instrumentation, controls, and alarms is very dangerous. Although some compromise could be made with regard to plant completion, the commissioning procedures should never compromise personnel and system safety.

A proper checklist procedure should be drawn up which would include all the sections of the plant and shall take into account the contractual responsibilities, the technological relationship between the various sections, pre-commissioning, cleaning requirements etc. The checklists procedure helps in the following:

1. To ensure that the necessary checks are carried out on each item of the plant before it is put into commercial service
2. To ensure that energy is supplied to equipment or a plant when it is safe to do so
3. To facilitate the recording of the progress on the various commissioning activities
4. To provide a basis for the plant history

The operation of the power plant unit interconnected to the grid is an activity that must be properly coordinated, within the plant as well as within the designated sub-station to which the plant feeds power.

An important feature of the modern power generating plant is the automatic safety lock-out devices. While sufficient thought goes into it at the design stage, it remains the responsibility of the operating staff to ensure that the safety devices are set correctly and kept in operation.

While safety of the plant and personnel is the foremost importance in the operation, the efficient operation of the plant cannot be ignored. While operating, it is important to check the essential parameters of the plant and equipment to ensure that the plant performance is at the optimum level. Any variations in the operating parameters or any deviations from normal performance of the equipment or plant will have to be analysed immediately to diagnose the problem and to take remedial measures to bring back the plant and equipment to its original parameters.

The plant operator should follow the guidelines given below:

1. Frequent checking and calibration of instruments;
2. Cross checking instrument indications with each other to determine whether the instrument is faulty or there is an abnormal operating condition;
3. Analysing indicated data to determine accurately what could be wrong.

11.3 Maintenance Requirements

The main objectives of the plant maintenance are to keep the plant running reliably and efficiently as long as possible. Reliability is impaired when a plant undergoes forced and unforeseen outages. This aspect assumes greater significance for a solar PV power plant exporting power to the State Electricity grid under contractual commitments. It is imperative that any planned maintenance is undertaken with closer coordination with State Electricity board substation.

Efficient operation implies close control not only over the cost of production but also over the cost of maintenance. There are two components in maintenance cost: one is the direct cost of maintenance, (i.e. the material and labour), and the other is the cost of production loss.

The following steps will help in reducing the breakdown maintenance and also in planning for preventive maintenance:

1. Careful logging of operation data/historical information from the Data Monitoring Systems, and periodically processing it to determine abnormal or slowly deteriorating conditions.
2. Walk down checks of the plant.
3. Careful control and supervision of operating conditions.
4. Regulate routine maintenance work such as keeping equipment clean, cleaning SPV modules.
5. It is extremely important that proper records are maintained not merely for the maintenance work done but also of the material used and actual man hours spent, etc. Data logger shall

keep records that are most useful in future planning of outages and providing for effective control.

6. Another important requirement of a good maintenance program is to ensure that spares are ordered in time and good stocks of the frequently required spares are maintained.

Depending on the O&M requirements the firm will make necessary arrangements for proper implementation of O&M. This will be through direct presence of the firm's staff or through their local technology partners. Typically, the power plant will be under the charge of an engineer supported by adequate staff for security and O&M.

11.4 O&M Schedule

O&M can be divided into three parts - Preventive Maintenance, Breakdown Maintenance, and Predictive Maintenance. Breakdown maintenance as the name suggests will be carried out as and when breakdown occurs. Preventive maintenance would be undertaken as per a present frequency. Normally Preventive Maintenance is undertaken during no or less energy generation period for example within period 6 AM to 8 AM and 5 PM to 6.30 PM.

11.4.1 Preventive Maintenance

The developer will provide a comprehensive O&M programme for the Project. The O&M team will operate the solar facility in accordance with an Operations and Maintenance Agreement (the "O&M Agreement") which shall provide for, at a minimum, the following services:

1. Performing routine and non-routine maintenance on the solar facility during and after the EPC warranty period;
2. Cleaning of Solar Modules;
3. Operating the solar facility:
4. Providing all materials and services necessary for solar facility maintenance;
5. Monitoring the operations of the Project via the computer monitoring system;
6. Performing all duties to the standard mandated by the PPA;
7. Complying with all regulatory obligations;
8. Developing operating and safety plans;

Solar photovoltaic systems are highly reliable and require minimal maintenance. Several maintenance activities need to be completed at regular intervals during the lifetime of the system. In order to maintain a solar PV plant there are a number of requirements which are discussed below. The energy yield of the plant will be monitored using the remote data acquisition system connected to each inverter. Significant reduction in energy yield will trigger specific maintenance requirements, such as inverter servicing or module replacement. In addition to this, on-going maintenance of the plant may be required. Typical activities are as described below.

MODULES: Visual inspection and replacement of damaged modules will be required. Cleaning of the module glass surface during long dry periods may be considered.

The water requirement for cleaning of modules is an important aspect to be kept in view. Assuming a minimum of three litters of water per module, the water requirement for cleaning of the whole plant (11116 modules) is approximately 10000 litters, depending on the option chosen. Module cleaning needs to be carried out periodically (Per module 2 times in one month) to remove dust, bird droppings etc. on the module and enhance the energy generation. Along with the module cleaning, for the construction of various structures (like IR, MCR Rooms, Pile Foundation etc.) in the plant, water is required.

MODULE SUPPORT STRUCTURE: Frequent visual inspection for general integrity of the structure, corrosion, damage and fatigue. All frame connections should be checked for deflections or tears at the module and cross beams to assess the need for replacement.

WIRING AND JUNCTION BOXES: Visual inspection for corrosion, damage such as chafing, and damage by rodents and birds, and for overheating of cables and connections. This requires the skills of an electrical technician.

INVERTERS: Inverter maintenance requires the skills of an electrical technician. It involves: visual inspection of the fans, tightening leads and cleaning using a vacuum cleaner or brush.

11.4.2 Breakdown Maintenance

Breakdowns can occur due to lack of routine or preventive maintenance, bad climatic conditions, disturbance in utility grid etc. As breakdowns affect energy generation and hence revenue generation, these kinds of faults need to be immediately corrected. Breakdowns can occur at any part of the system between solar PV modules to substation end. Staff should take care of routine or preventive maintenance at those parts of the system where chances of occurrence of breakdown are more.

11.4.3 Predictive Maintenance

This is undertaken with the help of FLIR camera, which identifies hot spots in solar modules and other electrical appliances. The pictures from the FLIR camera indicate components and fitments which are hotter than the surrounding fitments, clearly implying that the 'hotter' component is under electrical stress. A quick analysis of the feeding and off taking sub systems would help in preventing a breakdown in the coming future.

12.0 SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT

12.1 Social Impact

Solar energy requires only a one-time production of equipment; it rates far lower in environmental damage than other energy production types. Solar energy has no by-products, no substantial raw material consumption aside from initial construction of panels and less waste material. In fact, even after 25 or 50 years, when the solar panels fail, they can still be recycled to another form.

The followings are the social impact due to solar photovoltaic power plant:

1. Employment

   Most solar plants are installed in rural areas where land is cheap, industrial development is little and unemployment is high. When companies decide to build and operate solar energy facilities, the projects often help to create numerous jobs for the locals. For instance, workers are needed to plan the project, develop and implement the project, build the solar energy plant, manage the equipment and operate the facility. Thus, many new jobs can be fulfilled by workers because of a city or state using solar energy facilities to generate electricity for the area, and this would in turn help decrease the unemployment rate of the given area.

   Also due to rooftop solar PV plants which will be installation on all type of roofs and in rural as well as in city area provides employment.

2. Improved electricity availability

   The key development objectives of the power sector are supply of electricity to all areas including rural areas. Solar energy can also be used to meet our electricity requirements. Through solar photovoltaic (SPV) cells, solar radiation gets converted into DC electricity directly. This electricity can either be used as it is or can be stored in the battery. This stored electrical energy then can be used at night.

   If the means to make efficient use of solar energy could be found, it would reduce our dependence on non-renewable sources of energy and make our environment cleaner.

3. Industrial development.

   It has been often found that jobs tend to get created for workers and entrepreneurs wherever solar plants come up, thus strengthening the economy and the local youth.

4. Reduction of the national dependency on fuel imports

India is dependent on import of crude oil and fossil fuels fin which precious foreign exchange is eroded. Solar energy which is abundant in India if tapped can lead to savings in foreign exchange, protection of environment etc.

12.2 Environmental Impact

Followings are the environmental impact due to solar photovoltaic power plant:

1. Health

   Generating energy from solar panels emits very little pollution into the air, and thus solar energy is a much cleaner source of energy than the burning of fossil fuels. Cities or areas that decide to use solar energy to power the buildings would thus enjoy a cleaner quality of air in the region, which in turn can make the citizens and workers in the area healthier. Furthermore, studies indicate that burning fossil fuels helps facilitate global warming. However, because solar panels emit very low amount of hazardous pollution into the air, solar energy does not damage the atmosphere or cause global warming. Thus, if areas decide to use solar energy to generate electricity, the shift will help diminish the effects of global warming, such as the sea levels rising and storms intensifying.
2. Using solar power helps reduce our energy reliance on fossil fuels. The electricity generated by solar power system is clean, renewable and reliable. It will help reduce the amount of greenhouse gases – a major contributor to global climate change.

13.0 CONCLUSION

The 6 MW solar photovoltaic plants under TRUERE UP 2 PVT LTD have been found to be technically and commercially viable. The site conditions are suitable for setting up the PV power plants. The estimated energy generation of the plant for 6 MW is expected to be 8507 MWh/year (P50) and 8669 MWh/year (P90). The total project cost works out to be Rs. 31.15 Cr for 6 MW solar project and the Project IRR is 10.15%.

End of Report