200 MW SOLAR POWER PROJECT IN ODISHA

PILOT PROPOSAL

HRDS INDIA

CONTENTS

1.PREAMBLE

Demand for Electric power in the state of Odisha is increasing every year due to the rapid industrialization of the state, rise in living standards of the society, government-initiated electrification programmes etc.

Reference, report on resource adequacy plan for the State of Odisha, published by the Central Electricity Authority, Government of India, published in July,2024, the electricity demand for the state is increasing with a compound annual growth rate (CAGR) of 3.92%as forecasted by the 20thElectric Power Survey (EPS).

The state produces almost 24% of India's coal annually. However,the state has to import renewable energy to meet the stipulated renewable purchase obligation (RPO) mandates.

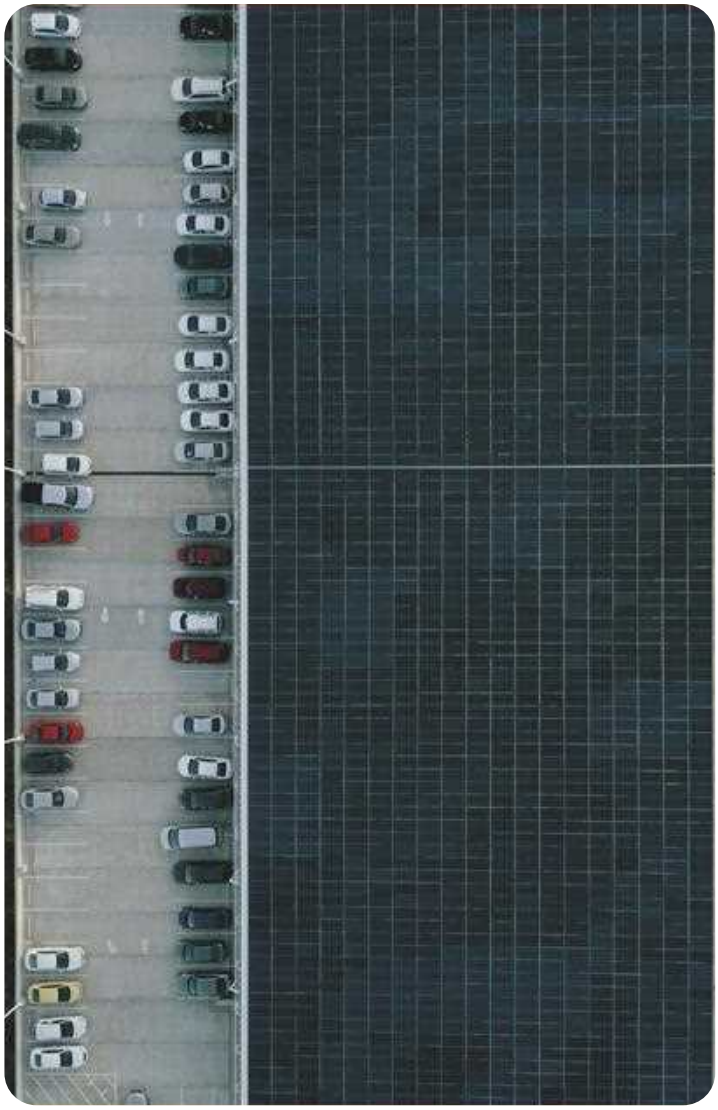
Government of India, the ministry of power has set new RPO targets of 43.3% by the end of 2029-30 from the existing 22.41%in 2022-23.

This necessitates the State of Odisha to go for an additional installation of 4,167 MW of Solar Power Resources apart from the already planned capacity of 2,271 MW for the period of 2024/25 to 2033/34.

The state is having considerable areas with low ecological significance such as rocky/stony barren lands, mining/industrial wastelands, open and dense scrubs etc in its various geographical locations. Apart from such lands, it is reported that around 125 out of the total 204 numbers of reservoirs in the state are fit for setting up floating solar projects.

The increasing requirement by the state to import renewable electricity to meet the RPO stipulations, reception of high level of solar irradiation in the country, availability of largeland and shallow waterareas of low ecological significance etc. are some of the major reasons to go for largescale solar power production in the state.

In view of the above, HRDS a leading NGO, withastrongand proventrack record of undertaking nation buildingprojects, is presentingthispilotproposalforsetting up and operating a 200MW solar PV plant project on Build Own Operate and Transfer mode,andisdescribedherewith.



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2.HRDS INDIA-INTRODUCTION

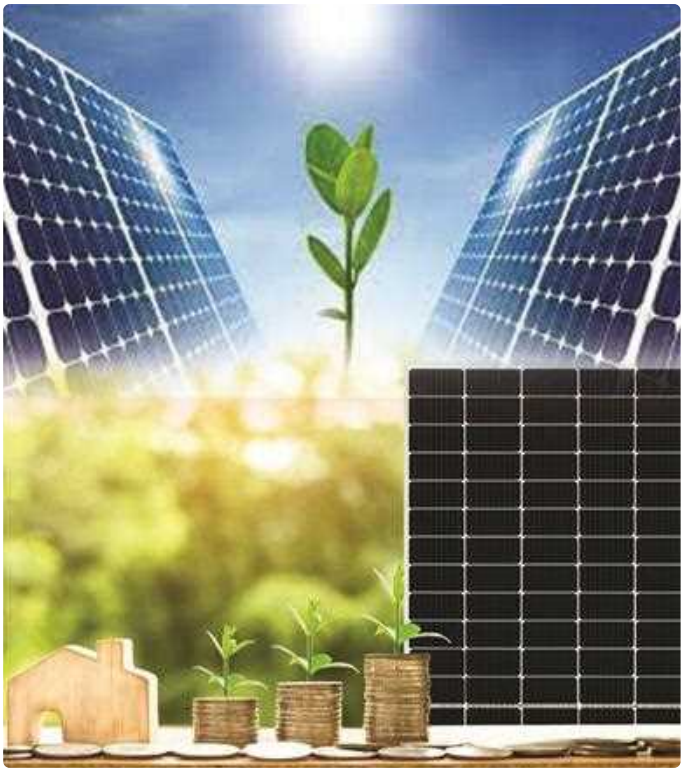
HRDS INDIA, High Range Development Society India is a Non-Governmental Organisation dedicated to the upliftment of the society through successfully undertaking projects in

Rural housing,
Health and sanitation
Environmental protection,
Women empowerment and
Bringing latest and sustainable technologies to the country

A group of socially committed energy professionals, actively rendering engineering and project management services to the energy industry for decades is organised under HRDS as Energy, Environment & Sustainability Team, EEST a division of HRDS

HRDS-EEST is committed to the development and implementation of renewable energy systems as well as protection of the environment. We are targeted in developing, installing and operating solar and other renewable energy-based power generation plants.

3. ADVANTAGES
OF SOLAR POWER PLANTS



Harnessing solar energy for production of electricity is becoming a very active component of global energy production arena.

Major benefits of solar power plants are briefed below.

1. Renewable Energy Resource

Solar energy is inexhaustible unlike fossil fuels. It is continuously replenished by the sun and hence a major sustainable and reliable renewable energy resource.

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2. Environment Friendly

It one of the very unique advantages of solar energy that it is having most minimum environmental impact on resourcing and harnessing the solar power.

3. Low Operation & Maintenance (O&M) costs.

Normally solar PV plants have no moving/mechanical parts and hence minimum wear tear. It needs regular cleaning of the panels especially in dusty environments.

4. Long life span of the plant

The vital component of the production process is solar panels and the panels now available in the market is having a guaranteed production life span of 25-30 years. Hence without major retrofits, the panels are reliably producing power for 25-30 years without major additional costs.

5. Development of reliable of energy portfolio for the state/country.

Comparatively at very lower cost energy is resourced through solar pv projects, which enhances energy security of the state/country. It relieves from the burden of energy imports or use fossil fuels.

6. Minimise the dependence of Fossil fuels

The more the state utilizes the solar power, need for depending fossil fuels for power generation becomes decreased or even nullified in due course.

7. Development the region and property value.

Usually most of the solar power plants are set up in areas where the land is not having no other major uses, non-agricultural land or shallow watery areas. But once the solar plant is set up and road, electricity, water, communication etc. utilities are established there, automatically the price of property in that region shall get very high appreciation.

8. Reduction in Carbon emissions & Green-house gases

Considering the features viz. reduction in use of fossil fuels, use of renewable energy, reduced air pollutants, minimal use of water for plant operations etc. and as a typical solar panel saves over 900 kilograms of carbon dioxide per year so that it pays back the carbon emission for its manufacture within 1.6 years, it can be very well stated that Solar power plant is one of best energy producer with minimum Carbon emission & minimum Green House gases.

It may be highlighted that Solar power plants do not produce any air pollution nor any greenhouse gases when they are installed and in operation.

9. Tax incentives

Grants, tax incentives and rebate programs are being given to support installation of more and more Solar PV projects.

10. Employment Generation

Installation and operation of Solar power plant necessitates a healthy mix of highly skilled, semi-skilled and unskilled manpower for various activities and hence a sustainable source for employment for local personnel also.

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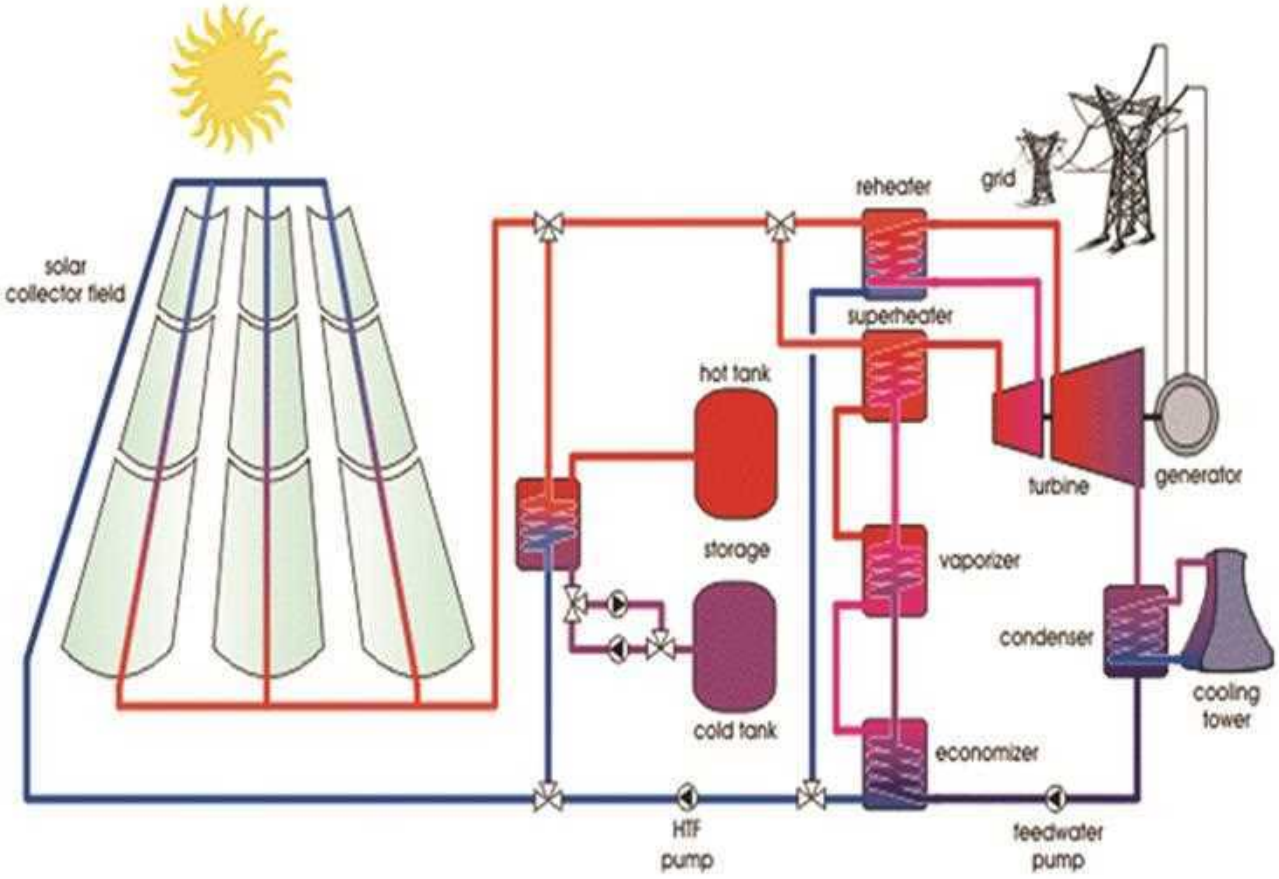
4. SOLAR ELECTRIC POWER PRODUCTION - BASICS

Solar photo-voltaic plants and their production is well accepted globally, and hence standardization is also well in progress.

Solar Power plants generally harness the heat in the solar radiation or the photo-electric energy.

Concentrated Solar Power (CSP) plants :

The plants harnessing heat energy from the electro magnetic radiation in sunlight do concentrate the heat radiations (Concentrated Solar Power -CSP) through convex lenses or converge through mirrors with concave/cylindrical profiles



(SCHEMATIC OF CSP SOLAR POWER PLANT: PIC. COURTESY: RESEARCH GATE)

The heated liquid medium (normally molten rock/salt) shall be send to heat exchangers to feed steam turbines coupled with gensets to produce electric power.
The excess molten rock with high temperature in the day-time is stored in insulated tanks in underground, which will be pumped to heat-exchangers and turbines in night time to produce electric power in the night is a unique advantage of using CSP systems.
Cost of setting up the concentration reflector systems, storage systems and heat to electric conversion systems accrue to a very much higher price per MW for the CSP systems compared to the cost per MW for the Solar PV plants.

Solar Photo-Voltaic (PV) plants

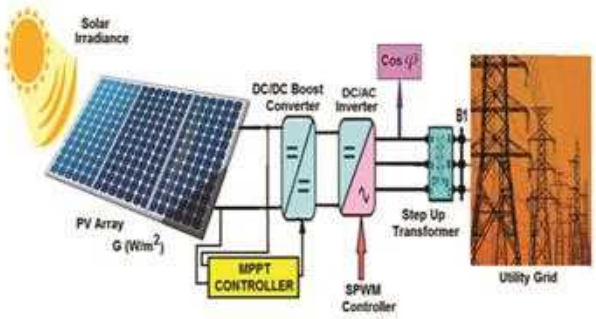
A. When sunlight is fallen on solar PV panels made up of specific photo-electric materials, they capture sunlight. Once the sunlight falls on the solar cells contained in the panel, the photons (particles of light) transfer their energy to the electrons in the solar cells.

B. This energy acquired by the electrons or the electrons become energized, generate a flow of electrons which becomes formation of direct current (DC) electricity flow. The cells are inbuilt in the panels as arrays and the panels are typically arranged in large arrays to generate substantial D.C electric power output..

C. Inverter conversion. The DC electricity generated by the solar panels is converted into alternating current (AC)

electricity using inverters. AC electricity of requisite frequency is the standard form of electricity consumed by the industrial/domestic/public utility customers.

D. Transmission and distribution. The AC electric output from the inverter is then sent to a transformer, where it is stepped up to the required higher voltage for efficient transmission through power transmission lines to the destinations. At destinations the higher transmission voltage shall be stepped down to suitable distribution voltage/service voltage for supplying the customers through distribution network.



SCHEMATIC OF GRID CONNECTED PV SOLAR POWER PLANT , PICTURE COURTESY : @mdpi.com)

Solar Photo-Voltaic (PV) Power

Solar Photo Voltaic power production is world's least costly option in producing utility scale power production currently followed in many countries. Photo Voltaic (PV) panel is the technical word for which is commonly called as solar panels.

Solar Photo-Voltaic system is quite modular and hence such modular production industry can produce for small roof top mounted solar panels to panels for any large size of plants. Also it is possible to set up huge plants by progressively commissioning multiple phases on costs pro-rata, which is not possible in other types of utility-scale bulk power production systems.

Every nation is striving to increase their renewable power capacity to reach the Net-Zero emission status. Hence scaling up the solar PV production is the best cost effective way to achieve this target.

In India the share of solar power production against the total installed power capacity is increasing every year. Now in 2024, Solar leads among the renewable energy sector by producing 34% of renewable energy produced as well as accounts for 13.22% of India's total power capacity.

In 2021 the new solar power capacity added was 10GW, compared to 3.2 GW in 2020. The growth in solar power installations added up is increasing year by year in India.
Following table depicts the annual progress in the growth of solar installations in India since 2014.

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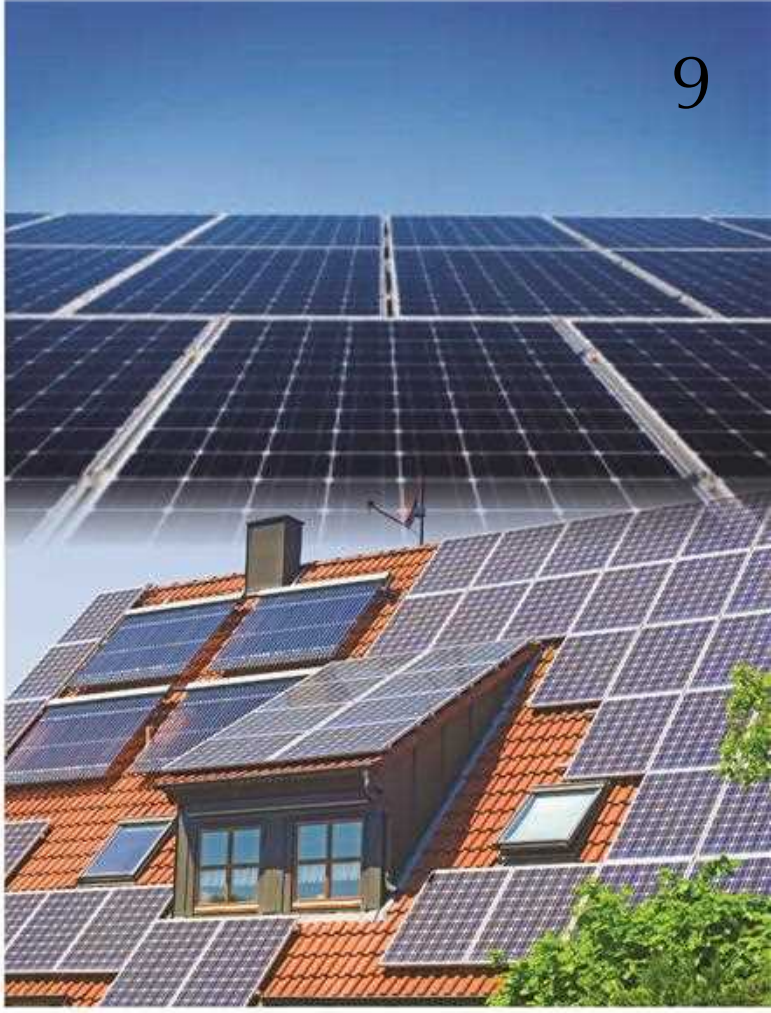
Solar Power -Installed capacity in India

Cumulative until 31-03-2014- 2,822MW	
Year	Added Installed capacity in MW per year
2014-15	1,172
2015-16	3,130
2016-17	5,659
2017-18	9,564
2018-19	6,751
2019-20	6,510
2020-21	5,629
2021-22	12,761
2022-23	12,784
2023-24	15,033
2024 (April 1 -October 31)	10,306



5. PROJECT PROPOSAL

We, HRDS INDIA proposes to set up a solar power plant with a capacity for producing 200MW electric power (in two phases of 100MW each). The proposed solar power plant shall be grid connected, enabling provision of the produced power to the state electricity authority/GRIDCO. The project shall be facilitating the power supply at a competitively low price, meeting the RPO mandates by minimizing the import of renewable electricity by the state, without harming the environment, and for a guaranteed period of production for 25-30 years

We are highly resourceful in terms of technical competence for the design, procurement, installation, integration, commissioning, start-up, operation and maintenance of the entire plant and allied systems viz. panel arrays, invertors and conditioning systems, control systems, swich gear & controls, electrical substation and transmission systems.

Apart from the project management team, competent finance and operations management professionals are teamed to achieve high level of efficiency in all aspects of the projct, plant installation, production operations and plant maintenance.

We are committed to the sustainable development, resourcing and utilization of renewable energy and assistance to the state through

providing good quality electric power at comparatively lower cost to the state.

We look forward to prepare a detailed project report and presentation on setting up the proposed solar power plant in any of the above mentioned ecologically low-profile geographic locations with availability of sufficient solar irradiation and with proximity to GRIDCO network connectivity etc., based on the feedback from your esteemed office. We intend to undertake this project through build, own, operate and transfer BOOT mode, with the Energy department / the State government.

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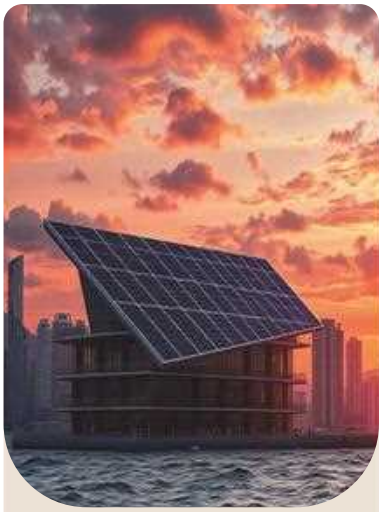
6. LOCATION OF SOLAR POWER PLANT - FEATURES

• Identification of sufficient land at suitable location is one of most important resource to be organized.

• Land in a comparatively levelled terrain and of approximately 400-450, hectares of land area, in any of the ecologically low- profile areas, and with good solar irradiance and with proximity to the High tension transmission net work of GRIDCO, shall be made available for the construction of the project.

• The plant would be setup using Tier-1 modules. This is based on a proven technology.

• Once the location of the solar power plant is decided, requirement of solar panels, distribution of panel arrays, intermediate junction, inverter stations, substation, metering and power evacuation program etc. shall be evaluated and finalised.



• Apart from the proximity to the transmission lines, access to state highways, rail, ait and sea ports etc. of the proposed sites are considered and given due weightages and evaluated to finalize the location.

• As most of the areas in the state is receiving solar irradiance of about 5.5 – 6.0 kWh/m²/day, and suitable for Solar PV Power Plant Installation. Below picture shows the distribution of solar irradiance on different places in Odisha with annual total solar irradiance data.

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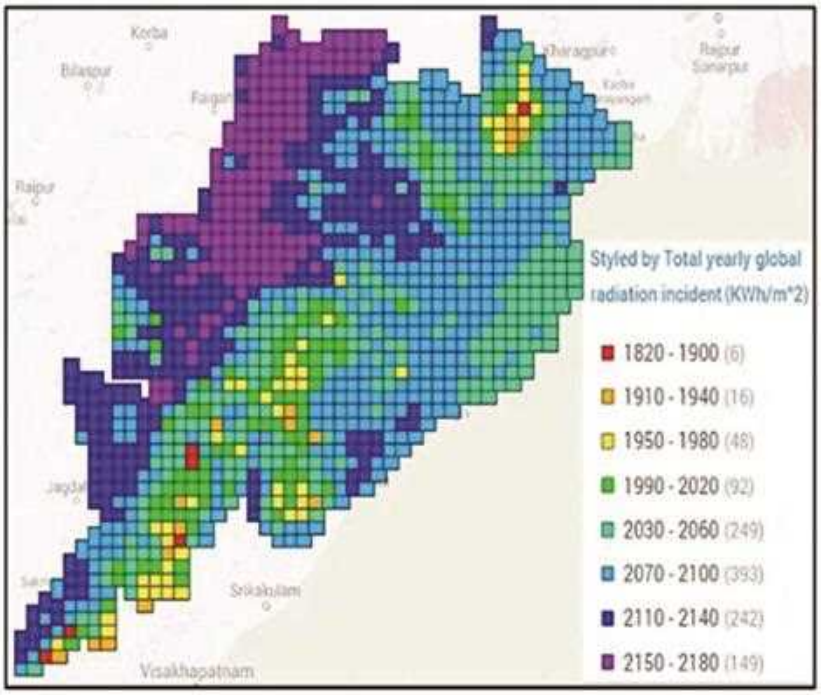


YEARLY GROSS SOLAR RADIATION MAP – STATE OF ODISHA, REF. RESEARCHGATE

- The power plant shall be built using Tier 1 modules of the state of the art tech nology developed for commercial installations.

- The total cost of installing power plant shall be estimated and along with other indirect expenses, depreciations, pay back of loans and interests etc. and oper ational costs, risks

and contingencies shall be evaluated and arrive a competent sale price for the electricity produced as well as in terms with the stipulations of SECI/GRIDCO/State Energy department, a mutually acceptable Power Purchase Agreement (PPA) for a period of 30+ years shall be signed.

- The state government shall arrange to provide us suitable land area for the project.

- The state government/GRIDCO/SECI shall arrange to r evacuate electric power from the power plant through their transmission network.

7. SOLAR POWER PLANT - TECHNICAL COMPONENTS

7.1 SOLAR PHOTO-VOLTAIC (PV) PANELS.

Solar PV panels of half cut monocrystalline type shall be used to set up the solar power plant.

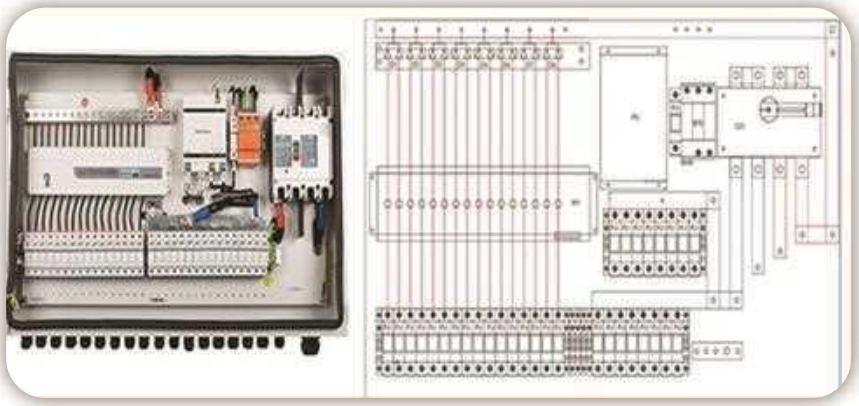
570-650 Wp capacity panels are proposed and procured from Tier-1 suppliers in India.

MONO PERC HALF -CUT SOLAR PANELS

Solar panels shall be tested and certified by a competent testing lab of repute and accredited with ISO/UL as per relevant IEC standards.

7.2 PV COMBINER BOX

PV combiner box, is a safe electrical enclosure, that combines the D.C outputs of multiple solar panels into a single line for connection with inverters or other similar junction boxes.



PV DC COMBINER BOX SOLAR ARRAY WITH 16 CHANNELS.
Pic courtesy @ solarsunever.com

Advanced PV combiner boxes also facilitate to integrate short-circuit and overvoltage protection, as well string monitoring solutions (I,V, T and SPD and switch isolator status), for PV systems using central inverters with PV panels.

The PV combiner boxes normally manufactured to meet IP-65 protection rating, usually made up of metal or poly carbonate for long life and durability, easy installation, efficient and safe connectivity of strings etc.

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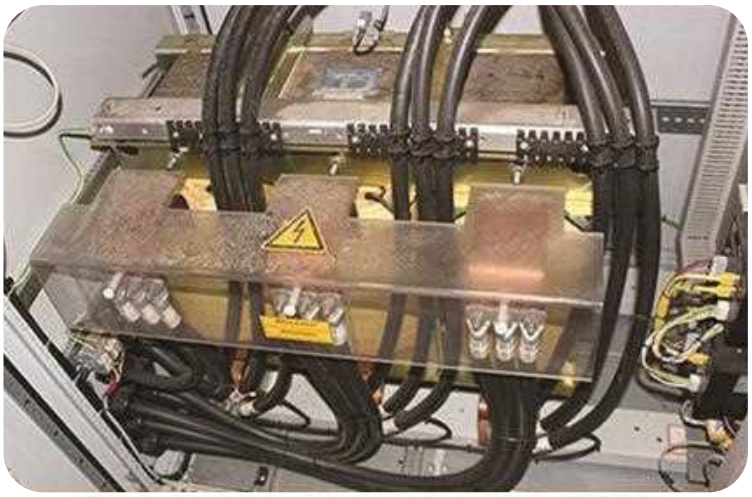
7.3 Cables & Connectors

Solar cables and connectors facilitate the weatherproof interconnection of solar modules, panels, inverters and other components. They streamline installations, lowering the expense and time of maintenance. Safety is ensured by adequately engineered solar cable connectors, which reduce the possibility of electric shocks and fires. They are essential for guaranteeing smooth energy transfer between these components in Solar PV systems. Reliable cables and connectors reduce power losses, improving system effectiveness are to be used for connecting power cables.



SOLAR POWER PANEL CABLES & CONNECTORS
pic courtesy @ icotek.com

7.4 Module Mounting Structure

SOLAR MODULE SUPPORT STRUCTURES DESIGNED AND ENGINEERED SPECIFIC TO SITE CONDITIONS – PICTURE COURTESY@ SALSARENGINEERING

• Photovoltaic arrays are mounted on a stable, durable structure that can support the array and withstand wind, rain, hail and other adverse conditions. Sometimes, this mounting structure is designed to track the sun. However, stationary structures are usually used with flat plate systems. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly.

• These structures tilt the PV array at a seasonal optimum tilt angle determined by the latitude of the site, the requirements of the load and the availability of sunlight. Among the choices for stationary mounting structures, rack mounting may be the most versatile.

Generally the solar module mounting structure shall be

1. Able to assemble easily and quickly.

2. With good strength, durability and safety.

3. Designed for optimum performance and comparatively lower cost.

4. Having a maintenance free life of 25+ years.

5. The structure shall be well protected (Hot dip galvanized/ coated/cathodic protected etc.) against corrosion and other adverse climatic conditions.

7.5. Inverters

• Inverters used in solar power plants converts DC Power generated by the Photovoltaic (Solar) array to AC Power that is fed to the Utility Power Grid System, generally through substations.

ABB, PVS-175 SOLAR INVERTER - 1500V DC INVERTER

- Basically, an inverter accomplishes the DC-to-AC conversion by switching the direction of a DC input back and forth very rapidly. As a result, a DC input becomes an AC output. In addition, filters and other electronics can be used to produce a voltage that varies as a clean, repeating sine wave that can be injected into the power grid. The sine wave is a shape or pattern the voltage makes over time, and it's the pattern of power that the grid can use without damaging electrical equipment, which is built to operate at certain frequencies and voltages.

- To convert DC solar power to AC and for linkage with the grid, special grid interactive inverters will have to be installed along with interfacing, protection and control mechanisms to operate in parallel with the grid. These will be housed in an indoor arrangement as they are IP54 rated inverters.

- Three-phase inverters like ABB make PVS-175-TL delivers up to 185 kVA at 800 Vac and ultra-high-power density with advanced digital capabilities

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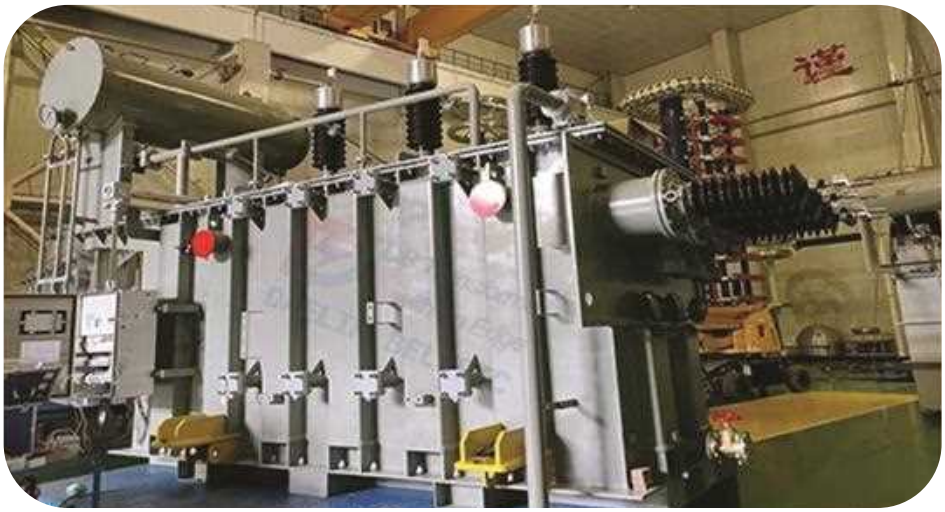
7.6. Solar Power Transformer:

• The grid-connected voltage is the voltage level at which electricity is delivered to the parallel network of the public grid. It is divided into high voltage (66kV and above), medium voltage (3 to 35kV) and low voltage (380/220 to 690V) levels.



TRANSFORMER - The voltage of this oil-immersed transformer can reach 345kV, and the maximum capacity can reach 500MVA. Courte-

- Low-loss power solar transformer has the advantages of low loss, light quality, high efficiency and impact resistance, etc.
- Generally following Standards/Codes shall be followed in the engineering of transformers

1. GB 6451 Specification and technical requirements for oil- immersed power transformers
2. IEC 60076 Power Transformers
3. AS NZS 60076 Power Transformers
4. CSAC88-16 Power Transformers
5. ANSI/IEEE C57.12.00 IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

7.7. Lightning & Over Voltage Protection

Lightnings are extremely powerful and can spread across the whole solar farm in a fraction of a second, damaging the equipment irreversibly. This can happen not only through power supply cables, but also through serial communication buses, such as RS485 or RS232 copper wires. Serial communication is almost always needed in a photovoltaic system to remotely monitor health status and efficiency parameters of panels and solar trackers, using PPCs (Power Plant Controllers). That's why also communication networks in solar power plants need lightning protection.

7.7 Lightning Protection for Array Yard

• The SPV power plant shall be provided with Lightning and over voltage protection. The main aim of over voltage protection is to reduce the over voltage to a tolerable level before it reaches the PV or other sub-system components.

• The source of over voltage can be lightning or other atmospheric disturbance. The lightning conductors shall be made as per applicable Indian Standards in order to protect the entire array yard from lightning stroke.

• Necessary concrete foundation for holding the lightning conductor in position will be made after giving due consideration to maximum wind speed and maintenance requirement at site in future.

• Each lightning conductor shall be fitted with individual earth pit as per required standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as per required provisions of IS. Shall ensure adequate lightning protection to provide an acceptable degree of protection as per IS for the array yard. If necessary, more numbers of lightning conductors may be provided.

Lightning Protection for Compact Solar Substation

• The compact solar sub-station is to be protected from lightning strikes with lightning conductor as per requirements of IS Standards

7.8 LT Power Interfacing Panel

- The panel shall have adequate inputs to take in from individual PCUs and adequate out puts to individual transformers.
- The panel shall be floor mounted type. All the measuring instruments such as voltmeter, ammeter, frequency meter, electronic energy meter (for measuring the deliverable units for sale), selector switches and mimic front panel will be present.

7.8 Earthing System

The standard earthing system of a solar farm is as follows: The DC and AC sides of the system are galvanically (functionally) isolated. The DC side of the PV system may be either grounded or ungrounded. When it is grounded it is done at the ground fault protection device of the inverters.

EARTHING & GROUNDING FOR PV PLANT . PIC Courtesy @ PRASUN BARUA

LT Side

- The earthing for array and LT power system shall be as required as per provisions of IS.

Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance. Each array structure of the SPV yard shall be grounded properly.

- The array structures are to be connected to earth pits as per IS standards. The earthing for the power plant equipment shall be made as per provisions of IS. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

- The complete earthing system shall be mechanically and electrically connected to provide independent return to earth. All three phase equipment shall have two distinct earth connections. An earth-bus shall be provided inside the control room. For each earth pit, necessary Test Point shall have to be provided.

- In compliance to Rule 33 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.

HT Side

- All HT side equipment's and parts shall be earthed as required as per provisions of IS.

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7.9 Protective Relays

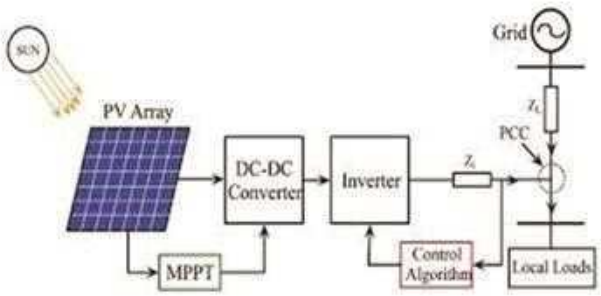
• The SPV system and the associated power evacuation system shall be protected as per

Indian Standards. Over Current Relays, Reverse Power Relays and Earth Fault Relays are the minimum requirements.

PROTECTIVE RELAYS PIC COURTESY @CLEANTEC CONTROLS1

7.10 Grid Interface

• The Inverter output voltages a needs to be stepped up to grid voltage (66kV /132kV etc.) in order to evacuate the power at grid operating voltage. This stepping-up of voltage is done in two steps with two different transformers.



- It is important that the SPV power plant is designed to operate satisfactorily in parallel with the grid under extremely high voltage and frequency fluctuation conditions, so as to export the maximum possible units to the grid.
- It is also extremely important to safeguard the system during major disturbances like tripping/ pulling-out of big generating stations and sudden overloading during falling of portion of the grid loads on the power plant unit in island mode, under fault/ feeder tripping conditions.
- Typically, there are few conditions that must be met before synchronization of two AC sources of supply can take place these are:

- Must have equal line voltage (within a prescribed window which is mostly ± 10%)
- Equal frequency levels (± 1.5 cycles)
- Same phase sequence and phase angles
- Similar waveforms
- The power generated has to be stepped up to required voltage level as per nearest substation and fed to nearest grid substation.

8. POWER EVACUATION SYSTEM & GRID INTERACTION

- The generated power will be evacuated to at the Grid Voltage of GRIDCO Substation. Location of the substation shall be located suitably.
- Substation shall have sufficient space for bay extension and interconnection. Intercon nection approval has been received.

8.1 Suitability of Power Plant Unit to Operate in Parallel with Grid

- It is important that the SPV power plant is designed to operate satisfactorily in parallel with the grid under extremely high voltage and frequency fluctuation conditions, so as to export the maximum possible units to the grid.
- It is also extremely important to safeguard the system during major disturbances, like tripping/pulling-out of big generating stations and sudden overloading during falling of portion of the grid loads on the power plant unit in island mode, under fault/feeder tripping conditions.

• Typically, there are few conditions that must be met before synchronization of two AC sources of supply can take place these are:

- Must have equal line voltage (within a prescribed window of ± 10%)
- Frequency limit Max: 50.2 Hz, Min: 49.5 Hz.
- Same phase sequence and phase angles
- Similar waveforms

8.2 System

• The solar PV power generated will be converted to 405 V AC using PCU, and then it will be stepped up to 33kV level & then 220kV
• Protection, metering & control panels for the switchyard and grid feeder will be accommodated in the plant's switchyard.

8.3 Transformer

• The quantity and capacity of 0.405/33Kv, 33/220 kV stepped up MVA transformers will depend upon the electrical system specification and the total no. of solar compact substations

• The transformer conforming to applicable standards will be complete with the fitting and accessories like conservator, MOG, breather, Buchholz relay with contacts for alarm and trip, pressure relief devices, thermometer pockets, OTI & WTI, valves, earthing terminals cooling accessories, bi- directional flanged rollers with locking and bolting device for mounting on rails, air release devices, inspection cover, off load tap changer (OLTC), marshalling box, etc.

8.4 Circuit Breakers

• Circuit breakers of suitable type shall be provided in SPV plant switchyard/ solar station as well as in grid sub-station for the plant feeder. The circuit breaker and accessories will be in general conforming to IEC standards.

• The circuit breaker will be totally re-strike-free under all duty conditions and will be capable of breaking magnetizing current of transformer and capacitive current of unloaded overhead lines without causing over voltages of abnormal magnitudes.

• The circuit breakers will be suitable for use in the
switchgear under the operating conditions.

• Closing coil will be suitable for operation at all values of voltages between 85% and 110% of the rated voltage. Shunt trip will operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

8.5 Lightning Arrestors

• Lightning arrestors of adequate capacity will be provided for transformer/ switchyard equipment protection and on terminating ends of the transmission lines.

• The lightning arrestor will be heavy duty station class type,
discharge class III, conforming to IEC specification.

• Arrestors will be complete with Insulating base, self- contained discharge counters and suitable milli-ammeters.

8.6 Isolators and Insulators

• Isolators complete with earth switch (wherever necessary), galvanized steel base provided with holes, solid core type post insulators with adequate creep age distance, blades made up of non-rusting material, operating mechanism (gang operated, manual/motor charging mechanism).

• They will be of centre-post rotating horizontal double break type and consist of 3 poles.

• Solid core type post insulators of adequate creepage distances (suitable for very high pollution category) will be provided for insulation and support in switchyard at plant DISCOM substation side

8.7 Instrument Transformers

• The instrument transformers and accessories will conform
to applicable standards.

• Instrument transformers will be mounted on suitable kV class, sealed porcelain bushings suitable for outdoor service and upright mounting on steel structures. Instrument transformers will be hermetically sealed units with in-built provision to dissipate any excessive pressure build up.

• Current transformers will be of ring type with suitable construction at the bottom for bringing out secondary terminals.

8.8 Safety Earthing System

• A safety earthing system consisting of a buried GI flat conductor earthing grid will be provided for the switchyard. The earthing system will be formed to limit the grid resistance to below 1 ohm. In the switchyard area, the touch potential and step potential will be limited to the safe values.

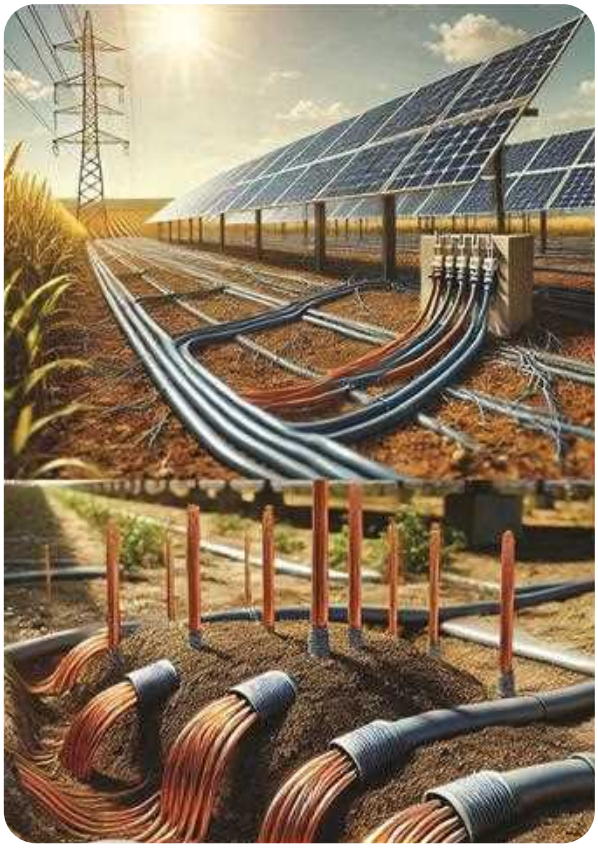
• The buried earthing grid will be connected to earthing
electrodes buried underground.

Neutral point of transformer, non-current carrying parts of equipment, lightning arrestors, fence, etc., will be earthed rigidly.

• The following factors will be considered for earthing system design:

• Magnitude of fault current

• Duration of fault



8.9 Lightning Protection System

• Switchyard equipment will be shielded against direct lightning strikes by providing spikes/ shield wires.

• The spikes/ wires shall be formed to shield all substation equipment with an angle of shield of 30 Deg / 45 Deg.

8.10 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.

Oil collection pits and soak pits for the transformers shall also be constructed. All cables in switchyard shall be neatly laid/ dressed and shall be barricaded inside trenches along the length with fire proof bricks

9. ESTIMATION OF POWER GENERATION

Modules are normally warranted for 90% for first 10 years and 80% up to 25 years.
Average degradation is 0.8% per year. With experience of crystalline modules, probability calculation done considering yearly degradation of 0.7%

Probability of exceedance is considered from the point of bankability.

These parameters have been currently arrived based on the experience and standard thumb rule and this consideration is based on a normal distribution of the expected yields. However during design & engineering phase detailed analysis along with manufacturer's data sheets shall be done.

The estimated specific generation of solar power from the Project Phase I will be 830 kWh/kWp/year and another 830 kWh/kWp/year for the Phase II also.

Hence the total solar power from the 200MW project will be 1860 kWh/kWp/year.

10. ENVIRONMENTAL AND SOCIAL RISK ANALYSI

Prior to detailed project feasibility studies and analysis, it requires evaluating the environmental and social risks associated with the proposed project and to implement mitigation measures to avoid adverse impacts during the project lifecycle. Project need to comply with guidelines stipulated by relevant national and international bodies, local laws and regulations relating to the environment, social issues and occupational health and safety matters. Such study shall be conducted by an organization of proven trac expertise, recognitions and good repute in the field.

The study shall be planned only after the location for the project is suggested and primarily approved.