# SARVESH ENGINEERING

PRESENTATION ON THE PROPOSED PROJECT - SOLAR PANEL MANUFACTURING.

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## INTRODUCTION TO SOLAR ENERGY.

Why solar energy is one of the key solutions to world energy demand -

The sun is the most plentiful energy source for the earth. All wind, fossil fuel, hydro and biomass energy have their origin in sunlight. Solar energy falls on the surface of earth at a rate of 120 petawatts (1 petawatt = $10^{15}$ watt). This means that all the solar energy received from the sun in one day can satisfy the whole world's demand for more than 20 years.

Environmental aspects –

Solar energy is clean and renewable. It doesn't emit carbon dioxide during operation. The major material of photovoltaic panel which is the most commonly used today is silicon. Silicon is abundant and environmentally safe materials.

SOLAR TECHNOLOGIES –

There are several kinds of solar techniques that are currently available. However, each of them is based on quite different concept and science and each has its unique advantages.

Generally speaking, non-concentrated photovoltaic solar panel (PV) and concentrated solar panel (CSP) are the two matured technologies. They have been commercialized and expected to experience rapid growth in future.

Solar thermoelectricity systems (STA), dye sensitized solar cell (DSPV) and concentrated photovoltaic system technology are the new and upcoming fields.

Although the solar energy is a small fraction of current energy mix for the whole world, it is expected to have rapid and constantly growth in the future and will eventually become the largest share of energy in the global energy mix.

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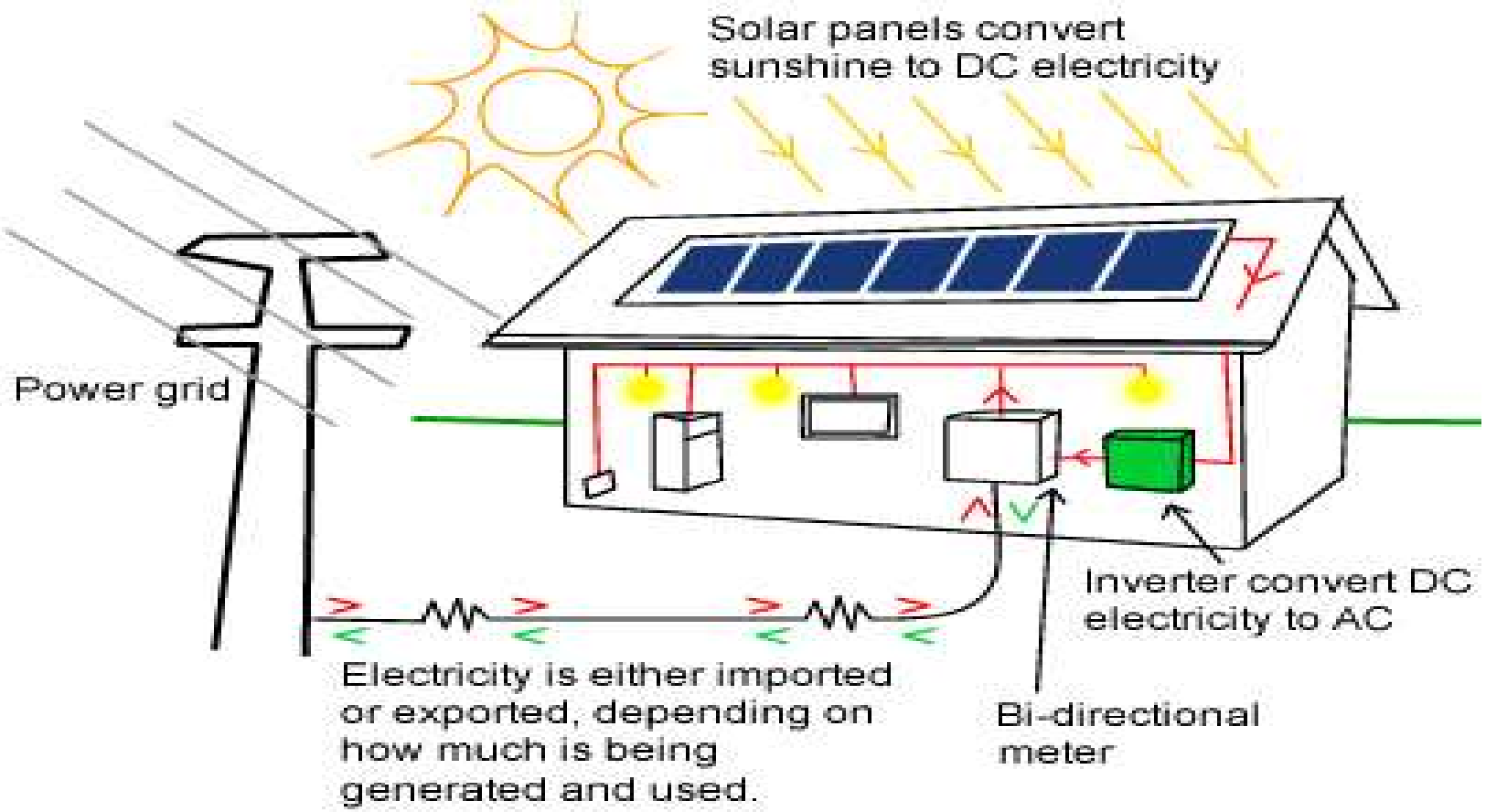

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## INDIAN SCENARIO

India has vast untapped resources of renewable energy.

INDIAN government has ambitious long term plan to attain it's Solar power generation capacity of 20,000 MW by the year 2020, which would be increased to 100,000 Mw by the year 2030, and further 200,000 MW by 2050. The plan aims at bringing down the solar power generation cost between $0.0846 and 0.1058 per KWH by 2017-2020 in order to make solar power competitive with power generated from fossil fuels.

In order to achieve the proposed targets, government is likely to make an investment of approximately $ 18 to 22 billion over a period of 30 years.

The capacity of 20,000 MW include 12,000 MW of power connected to national grid, 3,000 MW of power from 1 million captive and grid connected rooftop PV installations with an average individual capacity of 3 KW each, 3,000 MW of rural installation, and 2,000 MW of distributed solar PV applications such as telecom towers.

The country has total 17 PV cell manufacturers with installed capacity of 2953 MW and 1448 MW operational capacity.

For module manufacturing country has 8113 MW of installed capacity and 5286 MW of operational capacity. There are total 104 module manufacturers, top 20 companies have 70% of the operational capacity. Emmvee photovoltaics, Vikram solar and Waree energies, each have 500 MW of installed capacity and all their installed capacity is operational.

From barely 20 MW in 2011, India's installed solar capacity has increased to 8.062 GW as on 31.07.2016.

The awareness for solar energy among people has made it a strong contender for cheaper and eco-friendly resource of power**.** Various indigenous and foreign solar power brands forayed into the Indian market via the franchise route for aggressive pan-India expansion to gain quicker and higher returns.

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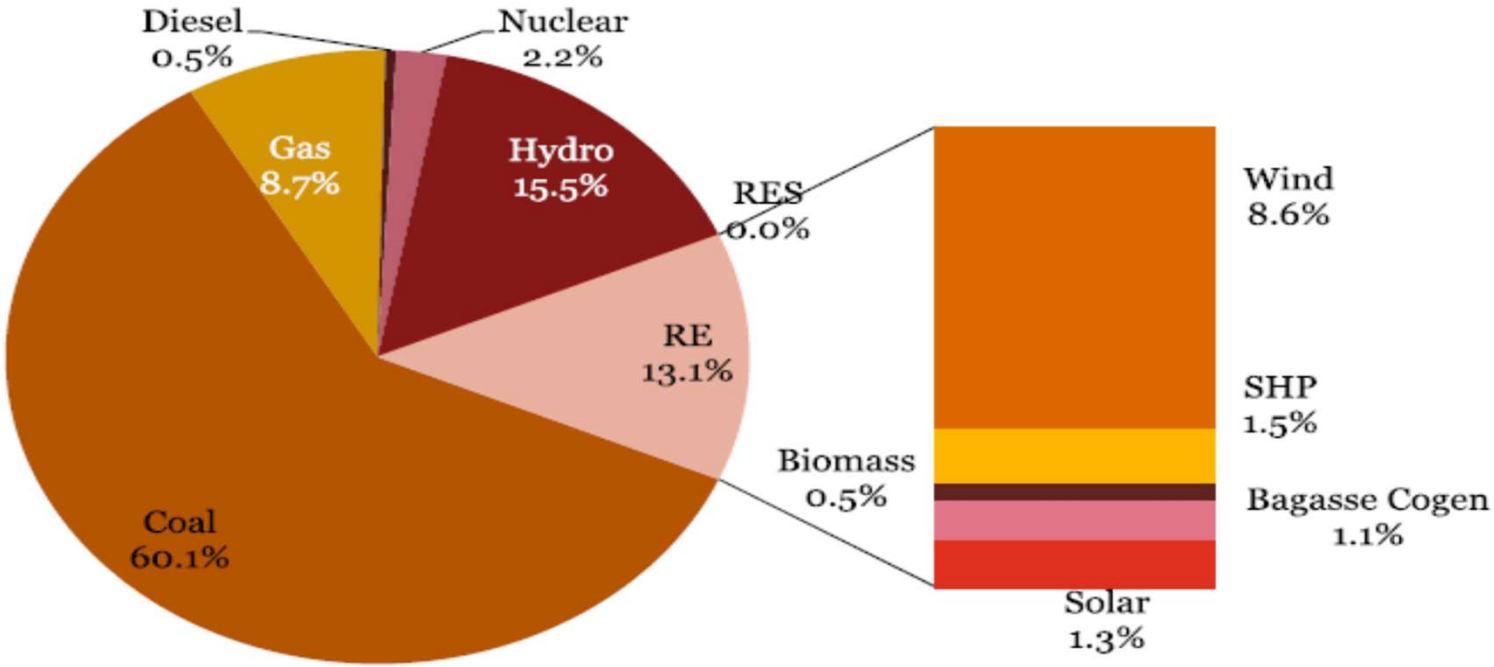
# *Present Power Scenario of India*

Total installed capacity of **263.66 GW** and RE capacity of **34.35 GW** (**13%** of Installed capacity and approximately **7%** of electricity produced) *(as on March 2015)*



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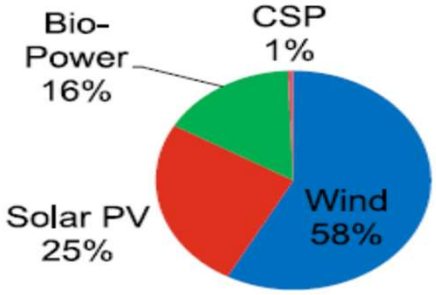
## *Renewable Energy: Globally and India's position*

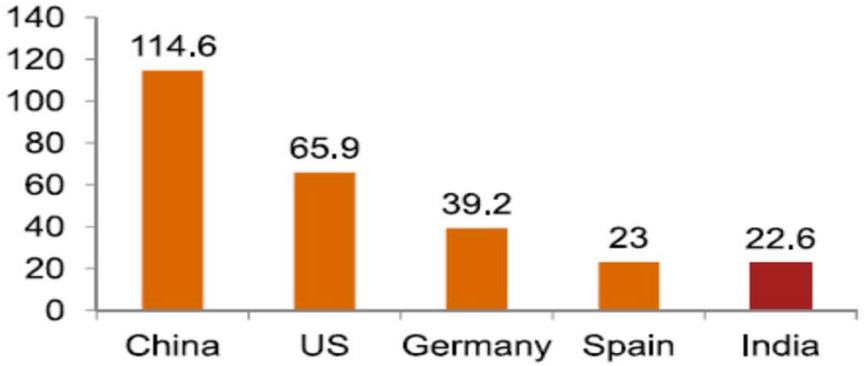
### Global Installed RE Capacity



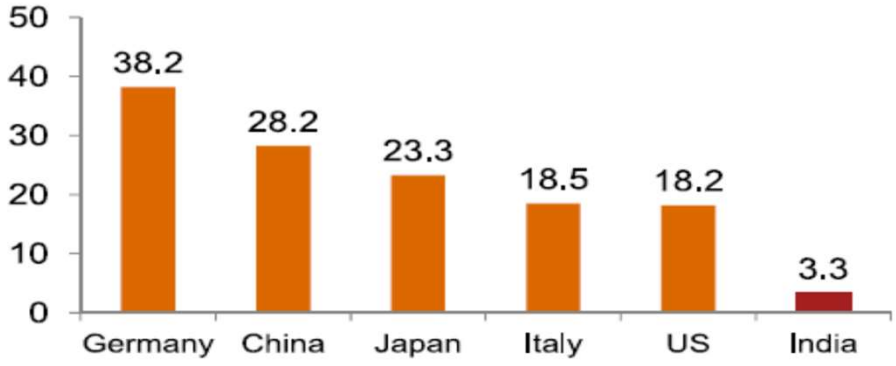

- Global RE installed capacity of 673 GW*
- Global Wind: 370 GW* and India **5th** with 22.6 GW
- Global Solar: 177 GW** and India **11th** with 3.3 GW

**As on Dec 2014: Global Wind Energy Council*
***As on Jan 2014, IEA PVPS)*

### Country wise Wind (GW)




### Country wise Solar (GW)



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## New Vision:

| | Current Situation | NAPCC | Scale up targets |
|---|---|---|---|
| Capacity | Installed capacity stands at **34.5 GW** | RE installed capacity of **142.3GW** by 2020 | **175 GW** by 2022<br>• Solar 100 GW<br>• Wind 60 GW |
| RPO | ~ 7% power from RE with each state having specific RPOs | **15%** RE power by 2020 | RPO of **10.5%** required for 100 GW solar by 2022 |

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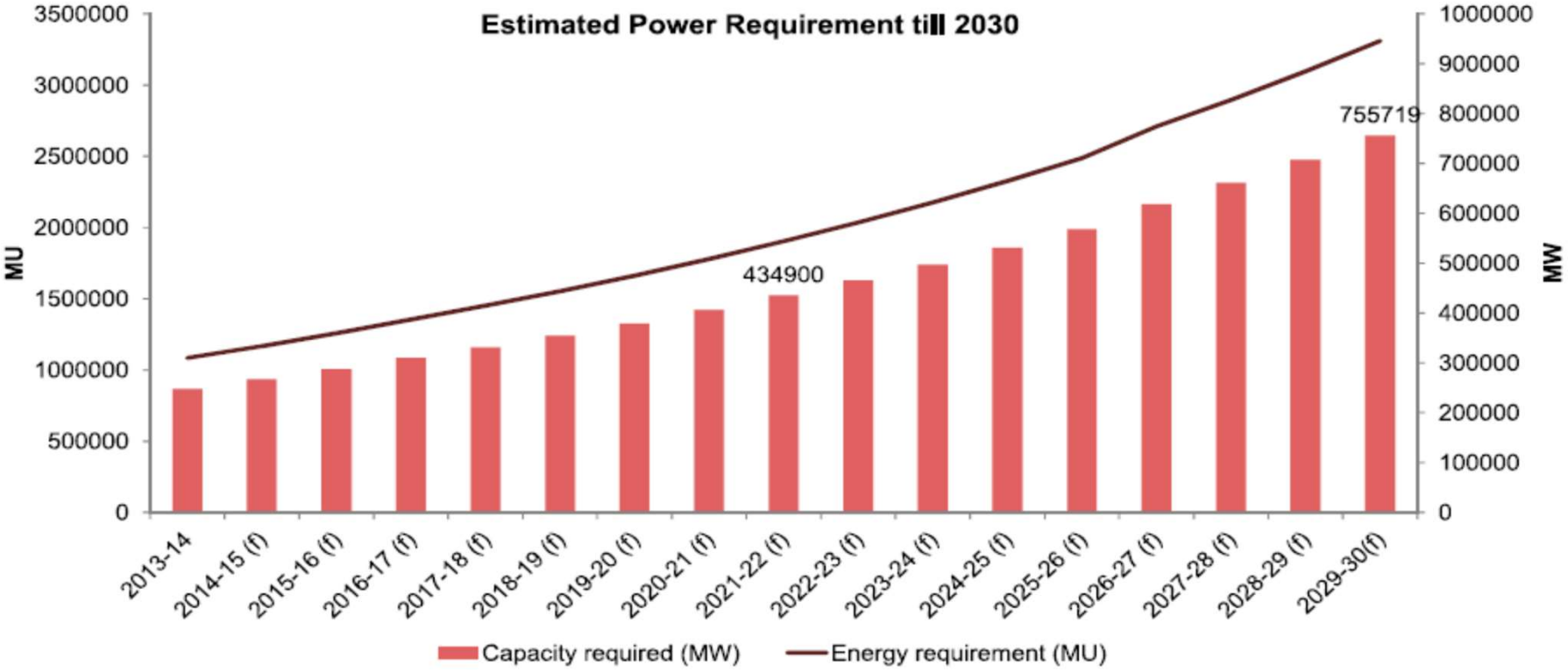
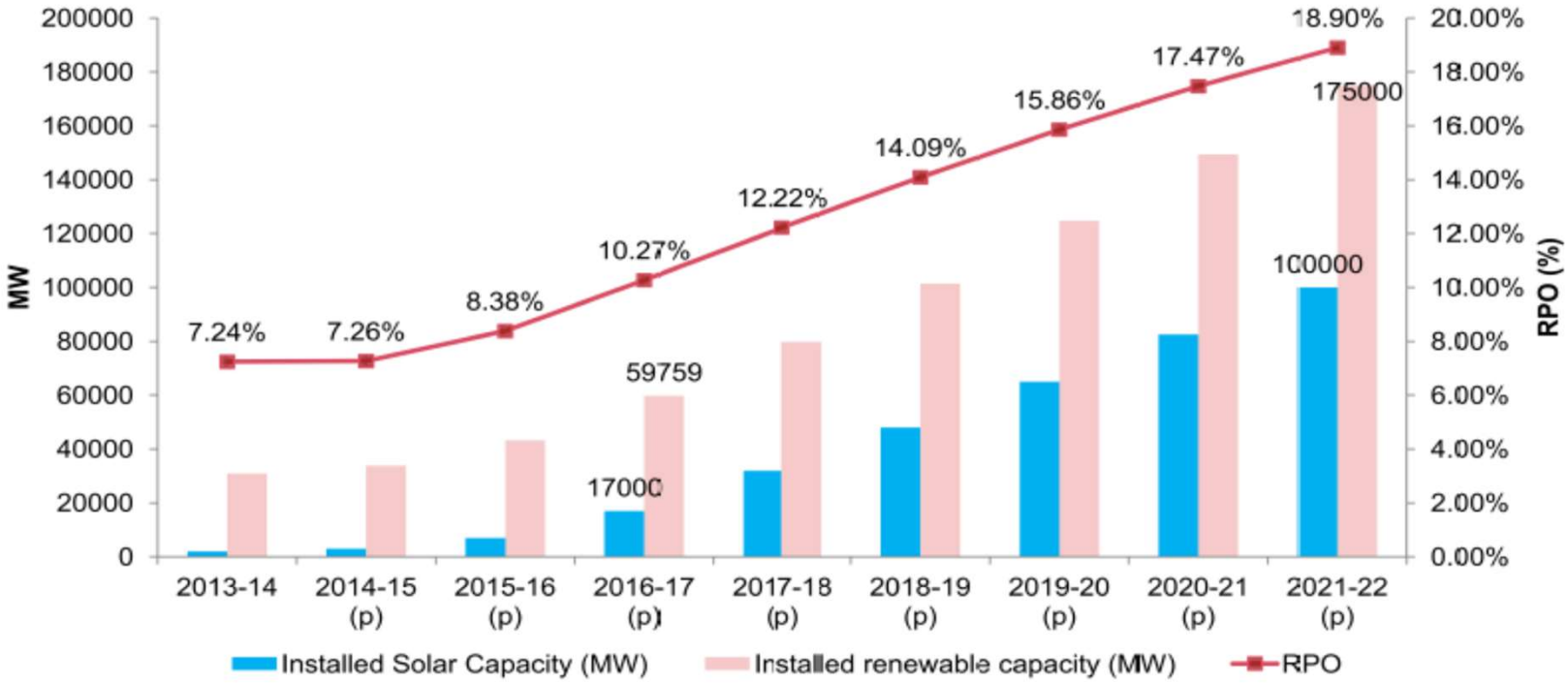
## *Projected power requirement*

Energy requirement is expected to increase by 200% from FY 15 to FY 30



# *Share of RE in future energy mix*

175 GW RE will contribute to **18.9%** of the entire power consumption in India in 2022



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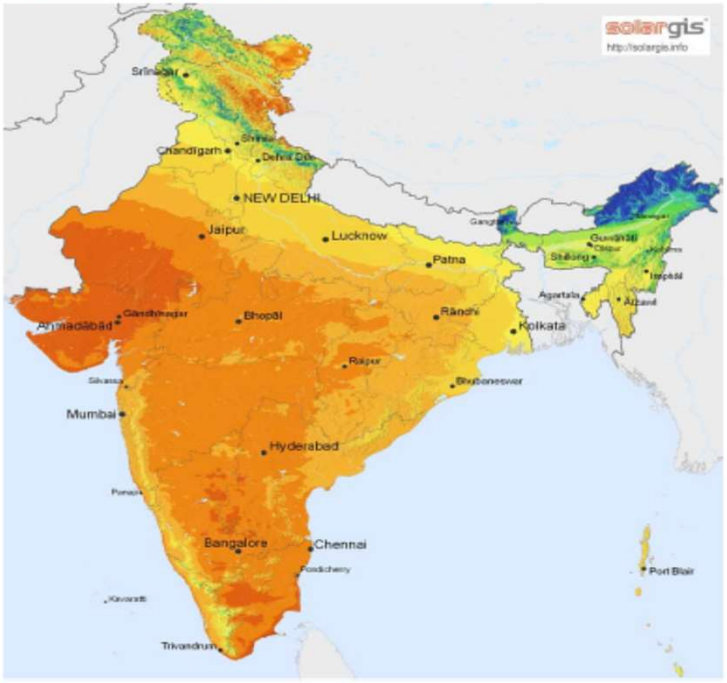
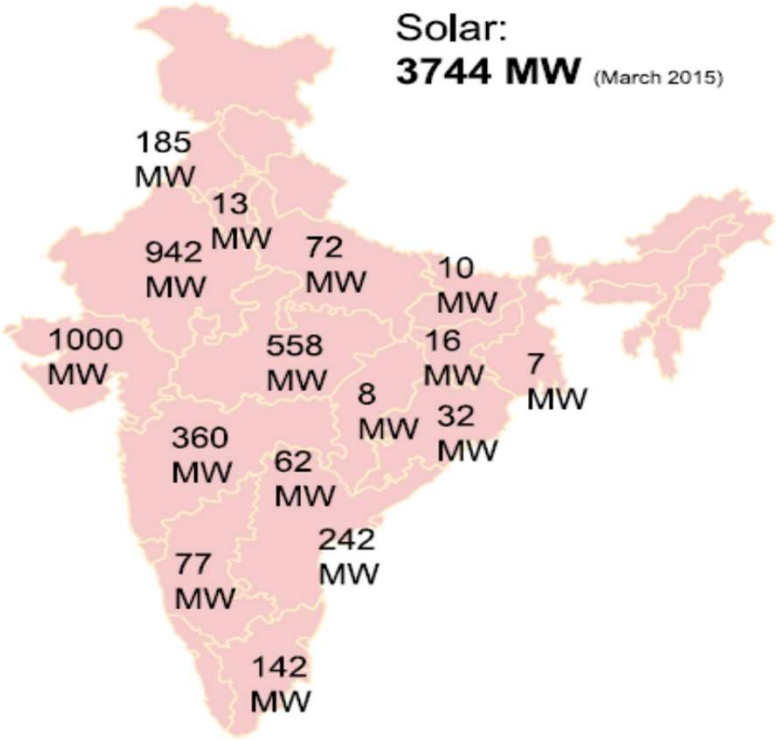
## *Solar Energy across states*

**Solar Resource**




Average annual sum (2005-2010)

< 1250 1400 1550 1700 1850 2000 2150 > kWh/m²




- Current Installed capacity of **3744 MW**
- Solar potential stands at **748 GW**

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## Solar Scale-up Plans- 100 GW Vision

**Category 1. Rooftop Projects**

**40,000 MW**

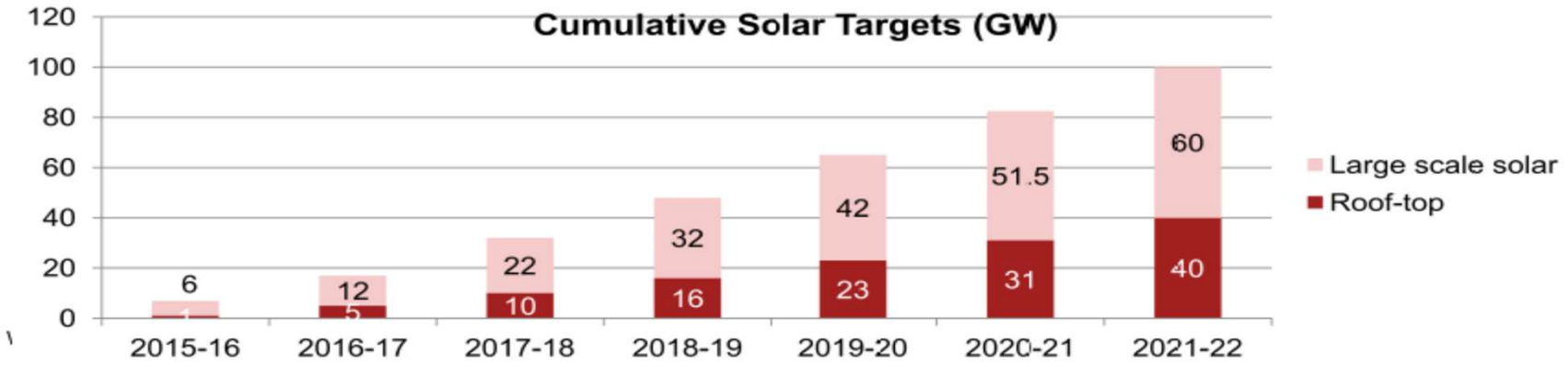
**Category 2. Large scale Projects**

**Inside Solar park**

**20,000 MW**

**Outside Solar Park**

**40,000 MW**



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## *40 GW through grid connected rooftop*

| | |
|---|---|
| Status | 358 MW Projects sanctioned and 41 MW installed<br>[Potential for 124 GW exists] |
| Target | **40,000** MW by 2022 of which **10 GW** during 2015-16 to 2017-18. |
| Current support | Financial assistance of 15% of the benchmark [Reduced from 30% earlier] |

**Updates:**

- 14 States have rooftop provisions in their Solar Policy and 20 States/UTs have notified regulations
- Rooftop included under IPDS and guidelines issued
- Guidelines issued to include rooftop under housing loan and **9 banks** have issued instructions
- Central Electricity Authority (CEA) has notified technical standards for connectivity and metering

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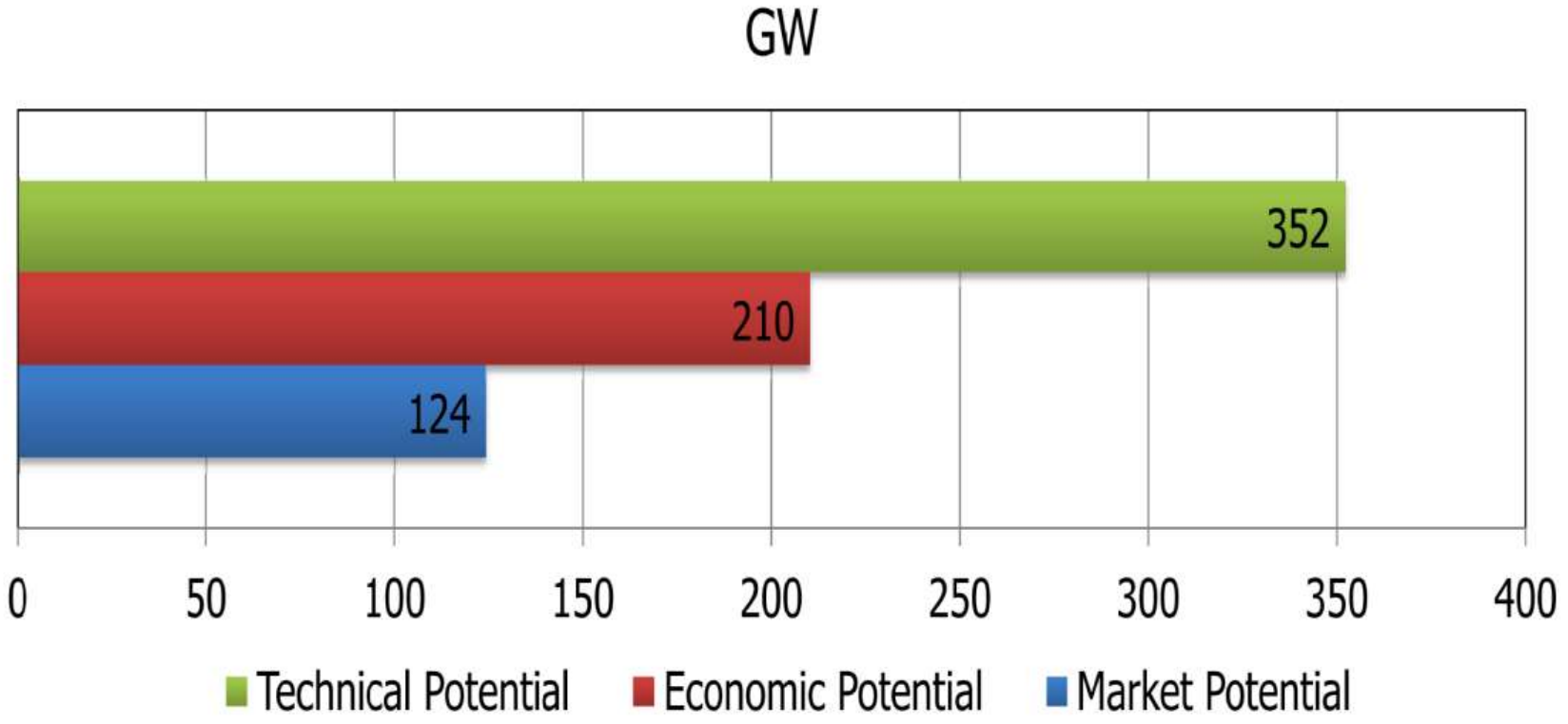
## INDIAN MARKET POTENTIAL FOR SOLAR POWER GENERATION.



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## *Reliance 100 MW Solar CLFR Plant in Rajasthan*

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***Punjab Engineering College, Sector – 1, Chandigarh***

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## SOLAR ENERGY END USAGE.

Solar energy is used for various different applications as listed here below -

- Generate electricity using photovoltaic solar cells.
- Generate electricity using concentrated solar power.
- Generate electricity by heating trapped air which rotates turbines in a Solar updraft tower.
- Generate hydrogen using photo-electrochemical cells.
- Heat and cool air through use of solar chimneys.
- Heat buildings directly, through passive solar building design.
- Heat foodstuffs, through solar ovens.
- Heat water or air for domestic hot water and space heating needs using solar-thermal panels.
- Solar air conditioning. Etc.

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## TYPES OF SOLAR POWER PLANTS.

There are two main ways to use solar energy to generate electricity –

1) Photovoltaic type – Photovoltaic type (PV) system converts sunlight directly into electricity.

The electricity goes into an inverter and into the power lines to home. The sun illuminates the solar cells in the PV array, which converts light energy in to electricity

Modes of generation –

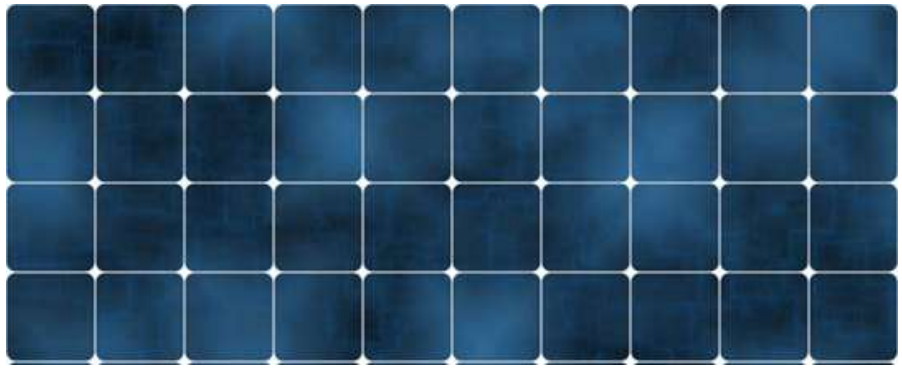
- Conventional silicon based technology,

Monocrystalline technology – Mono crystalline cells are made from thin slice or wafer cut from a single large crystal of silicon. The cells are then doped and the fine current collecting wires printed on or in the surface of the cell. Generally monocrystalline cells have the high efficiency, but it attracts higher price also.

This type of cell takes more energy to make than any other and so

Has a greater energy payback period, though this is usually still

Within five years.



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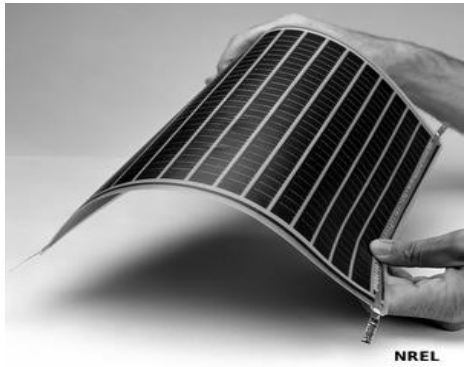
Polycrystalline cells are made from thin wafers of silicon cut From a large cast billet. The billet is not a large single crystal but many crystals clumped together.

Polycrystalline cells are usually slightly less efficient than monocrystalline cells. But because they are square, can be fitted in to a rectangular frame of a solar panel with high space efficiency. Polycrystalline panels are slightly larger than monocrystalline panel of same rating. Polycrystalline cells also have a current collection grid printed on them.

Amorphous/thin film panels involve deposition of very thin film of silicon or other materials directly onto a substrate such as glass, Plastics or stainless steel.




This technique produces a cell with lower efficiency than the cut wafer Varieties, but has the advantage of eliminating the need for intercell Connections. Unisolar makes triple junction, nine layer thin film amorphous panels with a much higher efficiency than the older types. The layer of silicon are deposited directly on to a stainless steel substrate and are then coated in a flexible plastic protective layer.

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## SAVINGS IN EMISSION BY SOLAR ENERGY.

For every kWh of electricity generated by solar energy, the following emissions are avoided since that kWh need not be generated from a fossil fuel power plant. In one year, the approximate avoided emissions in lbs/year are:

| SOLAR POWERPLANT SIZE | CO2 | NOx | SOx | PARTICULATES |
|---|---|---|---|---|
| 1 kW | 2,508 | 6.3 | 5.2 | 0.36 |
| 10 kW | 25,800 | 63 | 52 | 3.6 |
| 100 kW | 258,000 | 1 630 | 520 | 36 |
| 1 MW | 2,580,000 | 6300 | 5200 | 360 |

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## ADVANTAGES OF SOLAR ROOF TOP SYSTEM.

- Savings in transmission and distribution losses.
- Low gestation period.
- No requirement of additional land.
- Improvement of tail-end grid voltage and reduction in system congestion with higher self-consumption of solar electricity.
- Local employment generation.
- Reduced power bill by supplying surplus electricity to local electricity supplier.
- Battery elimination makes easy installation and reduced cost maintenance.

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## PHOTOVOLTAIC SOLAR PANEL (PV)

Photovoltaic (PV) technology is a clean energy, carbon-free alternative gaining tremendous momentum especially in today's energy market. Fossil fuels have negative impacts on our environment and the costs continue to rise. In this decade new technologies and increasing manufacturing scale have reduced the cost and increased the efficiency of PV technology.

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing photovoltaic material. Materials presently used for photovoltaics includes monocrystalline silicon, Polycrystalline silicon, cadmium telluride, and copper indium gallium selenide/sulphide. Photovoltaic solar panel is the most commonly used solar technology to generate electrical energy.

There are three major types of PV panels –

Crystalline silicon – The majority of PV modules (85 to 90% of global annual market) are based on wafer-based crystalline silicon. Crystalline silicon is sub divided in to mono crystalline and poly crystalline. Multi crystalline silicon modules have a more disordered atomic structure, leading to lower efficiencies. But they are less expensive and more resistant to degradation due to irradiation. Crystalline silicon PV modules are expected to remain dominant PV technology until at least 2020, with a forecast market share of about 50% by the time.

Thin Film – Thin films are made by depositing extremely thin layers of photosensitive materials in the micron range on a low cost backing, such as glass, stainless steel or Plastic.

The main advantages of thin films are relatively low consumption of raw materials, high automation, and production efficiency, easy of building integration, improved appearance, good performance at high ambient temperature, and reduced sensitivity to overheating. The major disadvantage is lower efficiency and limited experience with life time performances. For power generation thin film technology requires more land than crystalline silicon technologies.

Thin film technologies are growing rapidly and expected to increase their market share significantly by 2020.

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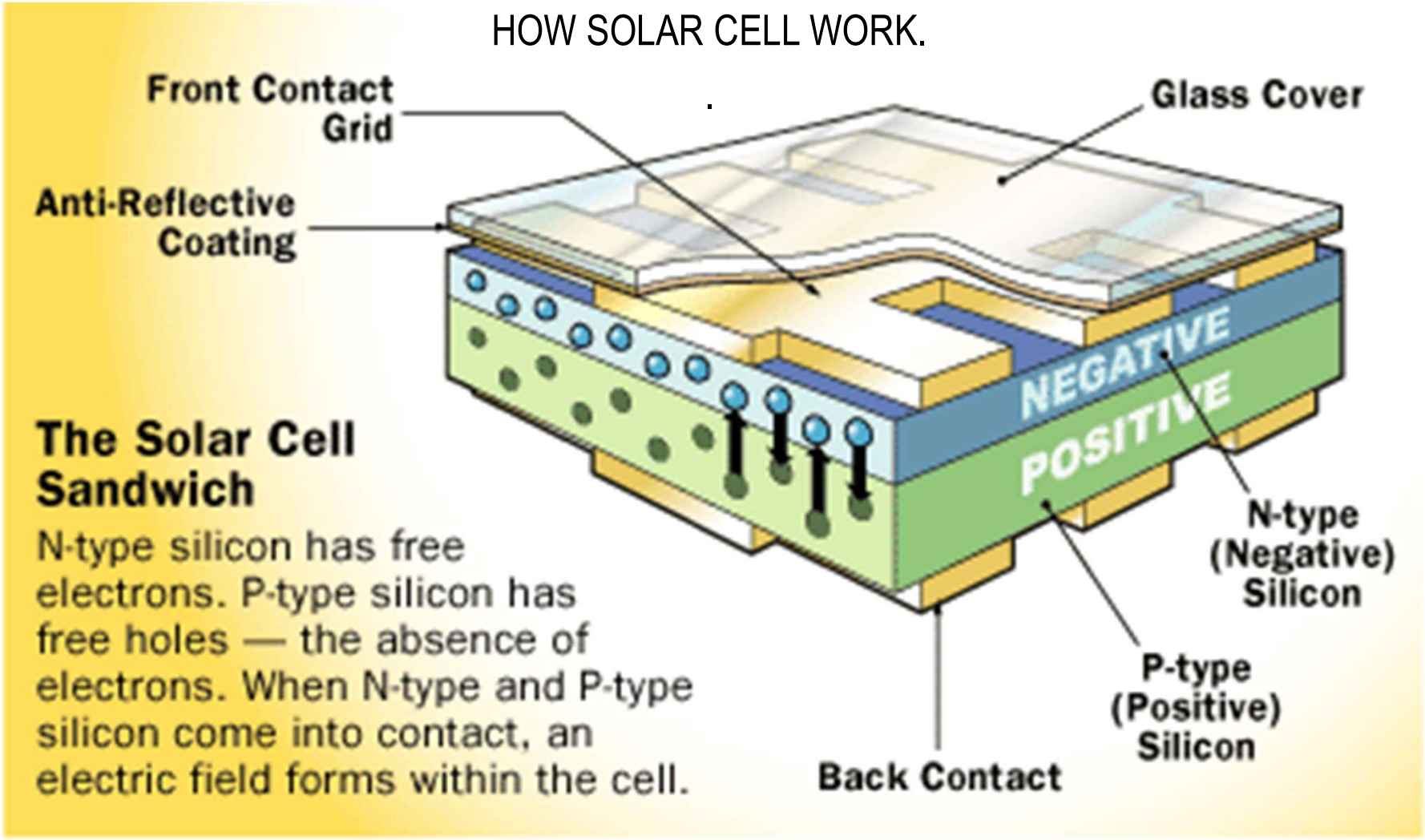
HOW SOLAR CELL WORK.



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## PANEL RATINGS.

There are a number of different ratings on solar panel, as listed here below –

- Rated (peak) power – maximum sustained power output of the panel, assuming a level of insolation (strength of light falling panel) of one KW per square meter. In general the solar panel's rating is the rated peak power.
- Nominal Voltage (Vn) – The system voltage that the panel is designed to be used in. Some panels are rated at 6 V, 12 V and 24 V, but they will produce voltage more than the rating, where as the grid-interactive system have nominal output of 48 v or even high.
- Voltage at peak power (Vp) – This is the voltage measured across the panel when the panel is producing peak power.
- Current at maximum power (Im) – The maximum current available from panel at peak power.
- Open circuit voltage (Voc) – The maximum voltage available from the panel with no load attached. This is usually around 21 volts for a 36 cells 12 volt unit.
- Short circuit current (Isc) – The current obtained when the output of the panel is short circuited with an isolation level of 1000 watts per square meter at a panel temperature of 25 degree C.
- Temperature at rated power – This is the temperature that the solar panel manufacturer rates their panel at. Most of the panels are rated to put out their maximum power at 25 degree C.
- Current-Voltage curves (IV) – These are the graphs of out put voltage versus current for different level of insolation and temperature. They can tell a lot about panel's ability to cope with temperature increases, as well as performance on overcast says.

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## PNEL PERFORMANCE

Heating & shading --.

These are the two factors that can greatly affect solar panel performance. In general, solar panel performance decreases as the temperature increases, and a panel rated at 25 degree C will not perform as well when operating at a higher temperature .

Shading affects different panels in different ways. The reduction in performance of the crystalline panel types, even when a single cell from panel is shaded, is quite considerable.

Amorphous panels often perform somewhat better, especially panels which have bypass diodes built in to each cells.

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## SOLAR CELL/MODULE MANUFACTURING CAPACITY.

As per the National Solar Mission targets, indigenous manufacturing capacity to the tune of 4-5 GW is to be achieved by the year 2020 in India. As per the information available with MNRE till date, the installed capacity of Solar cells and Modules in the country is 1468 MW & 5648 MW respectively.

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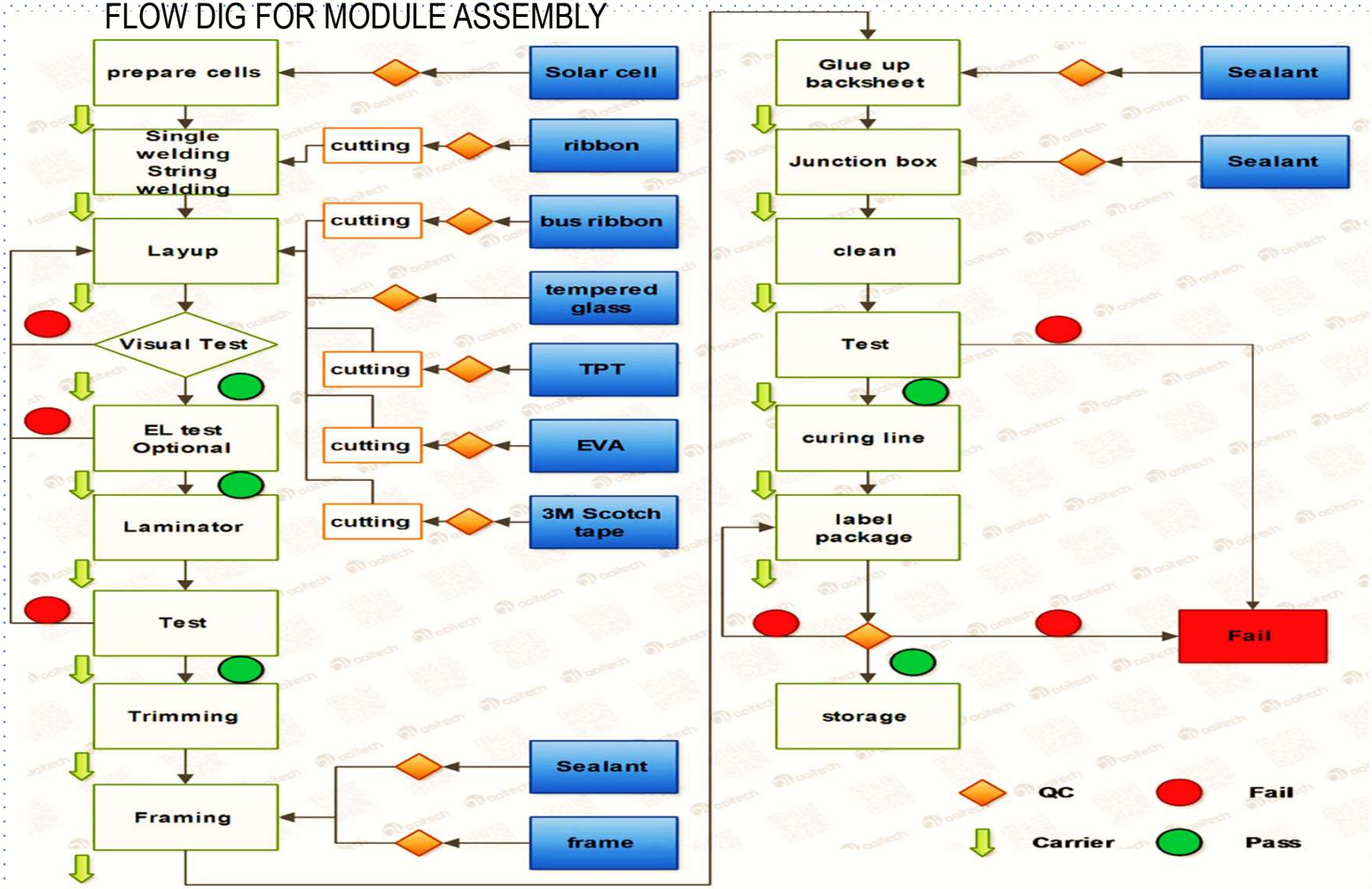
## FLOW DIG FOR MODULE ASSEMBLY



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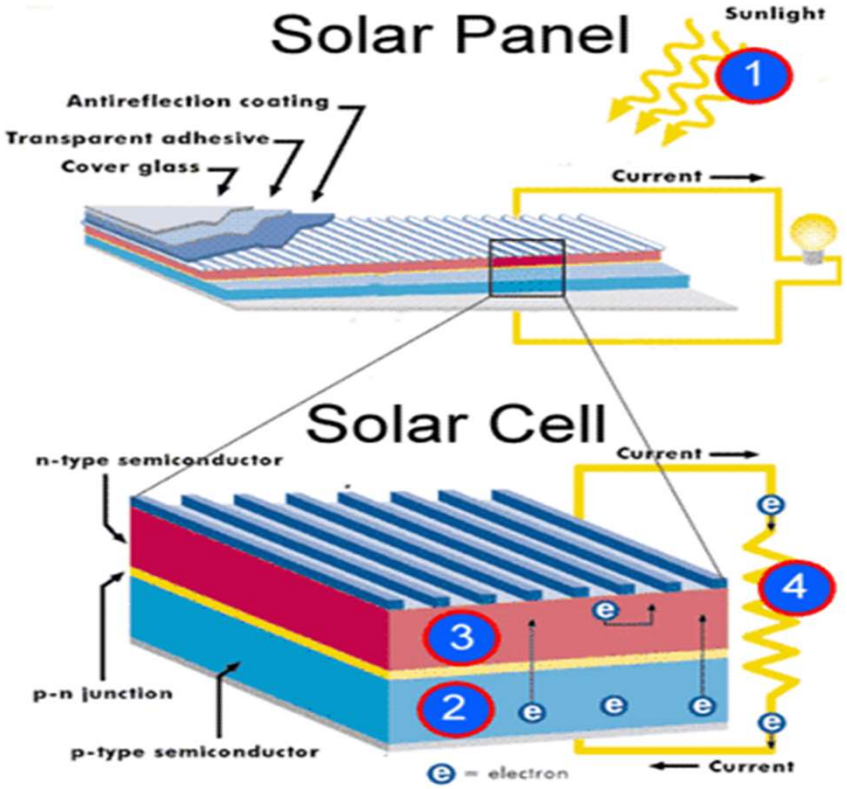
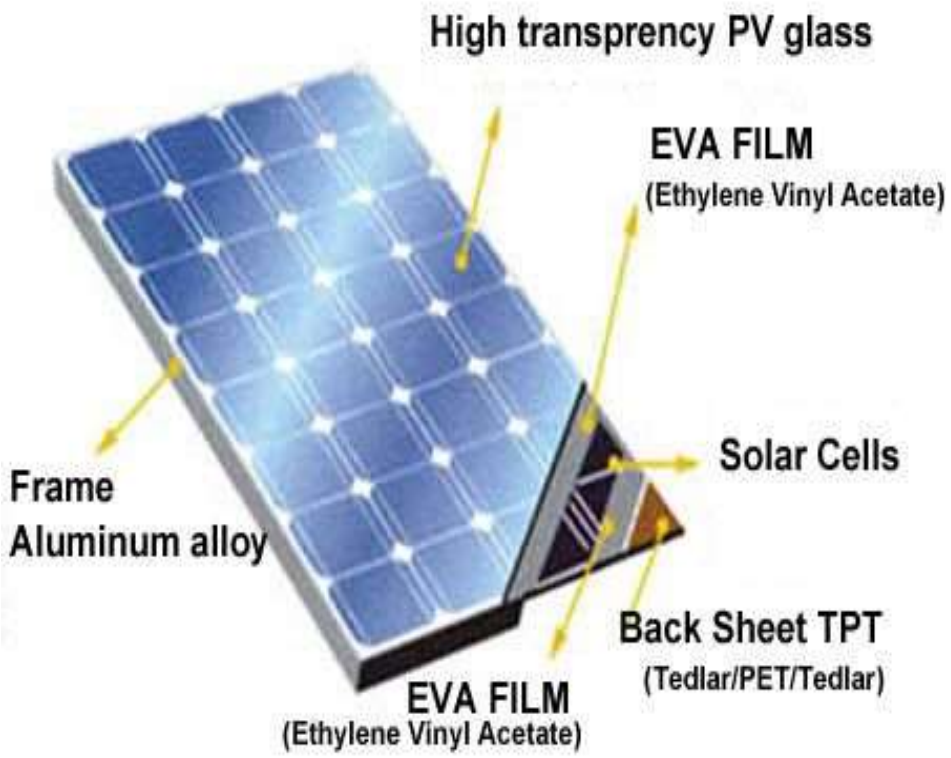
## SOLAR CELL AND MODULE CONSTRUCTION.



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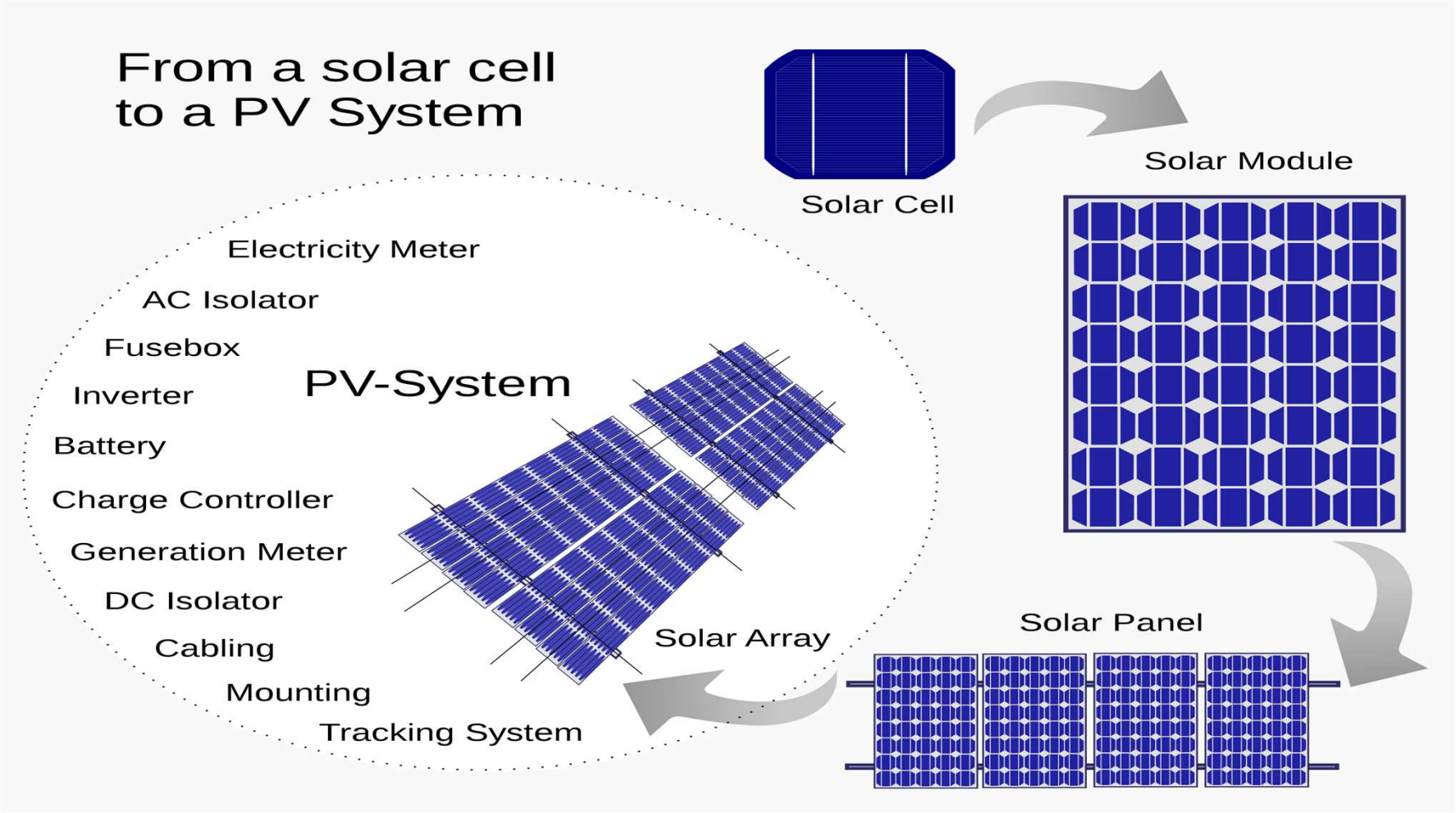

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## SOLAR MODULE MAKING.

Solar power generation equipment consist of –

Cell tester,

Automated Stringer,

Electroluminescence tester,

Fully automated laminator,

Trimming station,

Frame maker,

Silicon dispensing machine,

Sun simulator,

Ribbon cutting machine,

Eva back sheet cutter,

Fiber laser scriber

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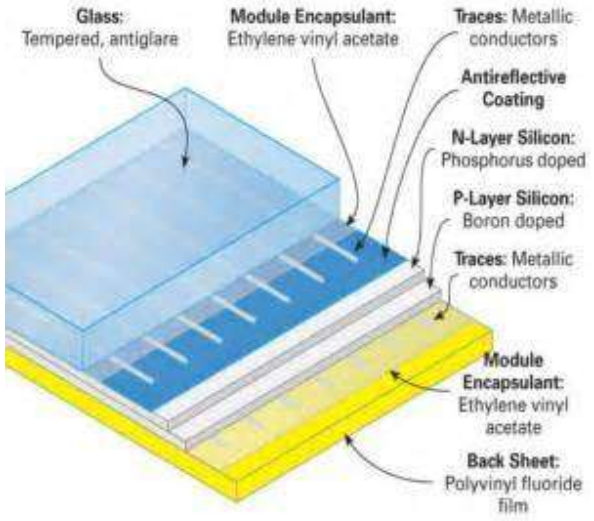
## SOLAR MODULE COSTCOMPONENTS

Solar Module is an assembly of different components and as such the cost of each component and labour for assembly need to be considered.

Solar module is made of enlisted components –

- Aluminium frame
- Thoughted glass
- Non reflective layer
- Electrical connection
- N type silicon wafer
- P type silicon wafer
- Electrical connection
- Backing layer (EVA)
- Junction box
- Labour for assembly



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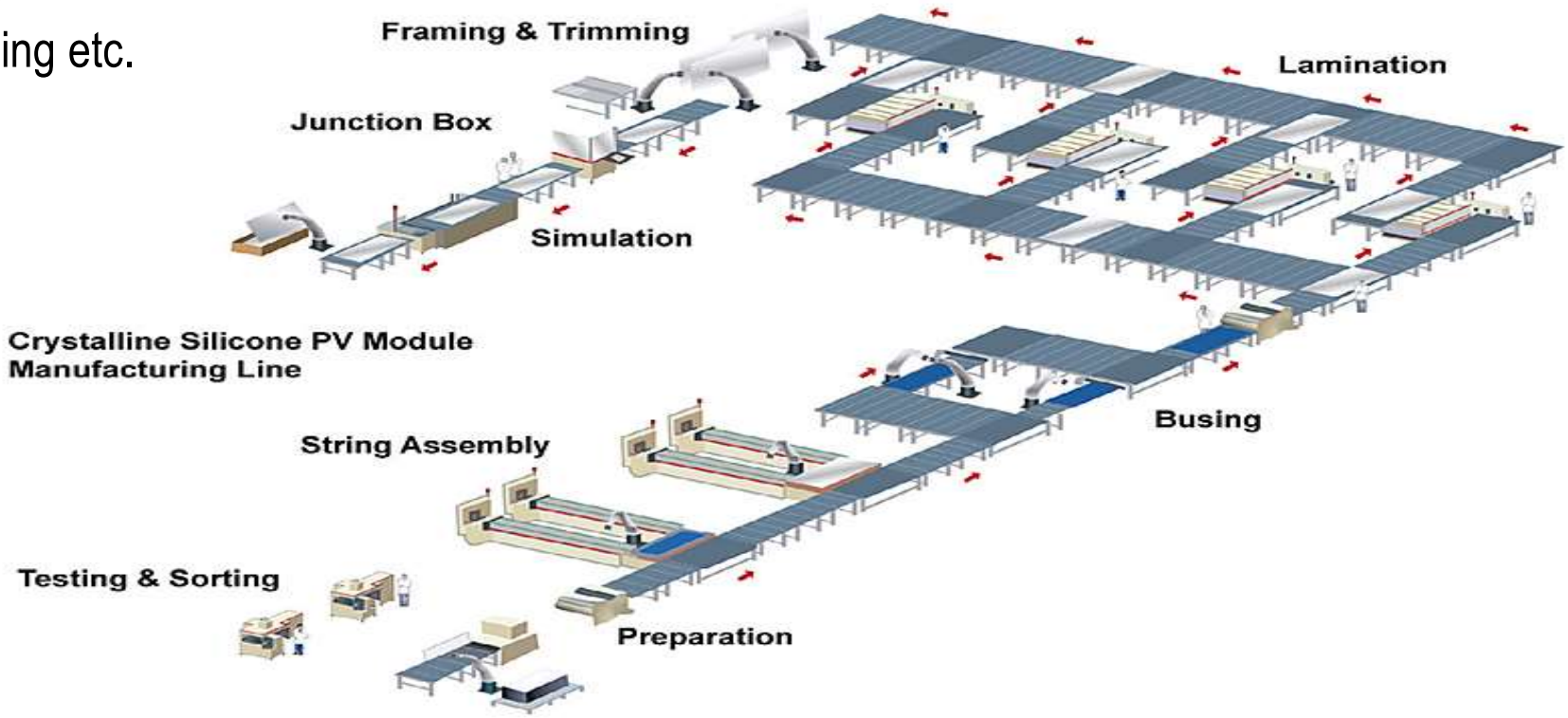
SOLAR MODULE MAKING EQUIPMENT CONSIST OF –

Wafer soldering, Glass cleaning, Laser cutting, Laminator, Sun simulator, Framing, Aluminium cutting,

Punching etc.



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## WHY SHOULD ONE INVEST IN THIS SECTOR

India has the fifth largest power generation portfolio world wide with a power generation capacity of 304 plus GW

Economic growth, Increasing prosperity, a growing rate of urbanisation and rising per capita energy consumption has led to increase demand for energy in country.

India has huge renewable energy resource availability and potential.

The target of national Solar Mission has been scaled up to 100 GW from 20 GW of grid connected solar power by 2022, which creates a positive environment among the investors keen to tap into India's renewable energy potential.

Government of India has a target of adding 175 GW of renewable power in the country by 2022, which will offer massive investment opportunities across the value chain.

Since government has very ambitious plans on Solar installations, and the policies are formed to support the business in long run, this sector will have a very high growth in next 10 year.

The solar business is booming up, and shall continue an attractive business definitely for next 2-3 decades.

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## IS IT BENEFITIAL TO START PV MODULE BUSINESS IN INDIA?

Global PV module production capacity is around 47.5GW and it is expected to grow to 135GW by 2020.
Greentech Media expects production overcapacity to fall to just 26% in 2017. Hence pressure from PV modules prices may come down by 2017.
So setting up a PV module manufacturing in India is definitely advantageous.. There are few more benefits to produce in India-

- As per announcements, 32% all new capacities addition is coming up in India, thanks to Mr. Narendra Modi's energy and prominence.
- India provides 10 year tax concession window and accelerated depreciation benefit, which is one of best incentives in the world.
- Since demand is becoming truly global now rather than just US, China, Japan and Germany, Indian manufacturers can look at Africa as additional market for PV modules.
- India has compulsory domestic PV module manufacturing in National Solar Mission that could generate a demand of 3-4GW a year.

The government of Maharashtra has made it compulsory for all new commercial and major residential buildings to have roof top solar installation, where all the security lighting and common lighting should use solar power. This has opened up a very big market in Maharashtra for solar modules.
Apart from the new buildings, existing buildings, government offices, educational institutes etc are also opting for solar power, mainly due to the awareness created.
These existing establishment also have a great potential requirement of solar installations.
Starting a solar module business in India is definitely a beneficial and attractive business for next decade. Specially considereing the ambitious plans set by government, it's policies to support and the global pressure on more and more usage on renewable energy usage has created a huge opportunity for this business.

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## WHY SHOULD ONE START MANUFACTURING SOLAR MODULES.

India is having very high Solar intensity and availability solar sun shine is almost for 300 days a year.

Indian society is a matured citizen society, open for adopting new technological challenges, aware of pollution, need of green technology, and promoting green technology where ever possible. The state government is promoting Solar energy power generation.

Since there are many new solar projects going on in the country, there is a great potential of domestic consumption of solar modules locally.

The solar modules can be easily exported, to developed and under developed countries. The local labour cost is cheaper compared to European market, which makes assembly of solar modules in India cost effective. Also the majority of materials used for solar modules are exported to European countries from India, so the costing of these components will be lower, which again makes the solar module cost attractive. With this cost advantage the solar modules made in India, can be exported to Europe, America and other developed countries as well.

India is having very good relations with Africa, Middle east and other countries, a lot of goods and services are exported to these markets. Solar modules and complete turn key project for solar power generation can be exported to these countries form India.

Considering the expected growth in the market in next decade, and the ambitious targets set by government, India is perfect location for manufacturing solar modules.

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## CONCLUSION

Since there is energy shortage in the country, and Solar energy is the renewable energy, do produce any harmful gases, do not require any fuel to burn, solar energy is the best option to use for coping up with the higher demand of energy.

Government in India has ambitious plans to produce solar energy in near future. Government is also supporting and promoting the solar energy power generation by various ways.

Solar power generation and there by solar module manufacturing is very attractive and profitable business for the near future.

The payback period of the project is less than 18 months, the project is commercially viable.

Considering all the points discussed here above the project is financially, and technically viable.

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## OUR PROFILE

MR. Nandkishor Sarolkar is a Mechanical engineer, backed up with post graduation in Management (Production and Marketing management, two principle subjects), having wide experience of about 42 years in industry of repute (20 years over seas experience).

Mr. Sarolkar is well aware of Mechanical, Hydraulic, Pneumatic and electrical systems. Having hands on experience in power generation and power distribution (LT side).

Mr. Sarolkar is nominated member of Kenya Bureau of standards.

Last designation as a CEO/Managing director of “Bericap” India Pvt. Ltd., MNC with head quarters at Germany, having 21 manufacturing plants world wide, with in house tool development and R & D centres. “Bericap” is well known name in plastics caps and closures. “Bericap” is preferred supplier of major brand owners.

Mr. Sarolkar is owner of eight no of design registration (IP) in India.

Mr. Sarolkar has successfully made strategic alliance for Pune based company with renowned and reputed European Solar module maker, for manufacturing solar modules in Pune.

Mr. Sarolkar is well acquainted with the technology and having very good relations with the European equipment manufacturer.

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## CONTACT DETAILS.

PL. Feel free to contact us, should you require additional information on the subject.

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