CHAPTER – II

OVERVIEW OF ENERGY SECTOR IN INDIA
CHAPTER - 2
2. OVERVIEW OF ENERGY SECTOR IN INDIA
ENERGY/ POWER

2.1 Introduction to Energy

Energy is the capacity of the body to do work. It counts the total capacity that the body can do. Energy is the prime and most important and universal measure of all kinds work by human being and nature. All that materializes the world is the appearance of movement of power /energy in one of its forms.

2.2 Various Types and States of Energy

There are two types of energy sources shown as below Conventional and Non-Conventional Sources.

**Energy Source**

1) Primary Conventional Energy Source
   a) Coal
   b) Oil
   c) Gas
   d) Nuclear Energy
   e) Hydroelectricity

2) Secondary Non-Conventional Energy Source
   a) Water (Tide)
   b) Geothermal
   c) Solar
   d) Wind
   e) Bio

**States of Energy:**
1. Electrical Energy
2. Mechanical energy (kinetic and potential)
3. Thermal (or) Heat energy
4. Chemical energy
5. Electromagnetic energy
6. Gravitational energy
7. Nuclear energy

S.I unit - Joule or KJ or Watt.h.
2.3 Conventional (Primary) Energy Sources

“Conventional energy is the conventional fossil fuels such as coal, oil and gas, which are likely to reduce with time. The use of fossil fuels and nuclear energy replaced totally the non-conventional methods because of inherent advantages of transportation and certainty of availability; however these have polluted the atmosphere to a great extent. In fact, it is feared that nuclear energy may prove to be quite hazardous in case it is not properly controlled. India is blessed with an abundance of sunlight, water and biomass. Enthusiastic efforts during the past two decades are now bearing fruit as people in all walks of life are more aware of the benefits of Non-Conventional energy source, especially decentralized energy where required in villages and in urban or semi-urban centers. India has the world’s largest programme for Non-Conventional source of energy.” (Kedar, 2015)

Examples: Coal, Oil, Gas, Nuclear Energy, Hydroelectricity.

2.4 Non-Conventional (Secondary) Energy Sources

“Non-Conventional source of energy is energy sources obtained from sources that are fundamentally infinite. Examples of Non-Conventional include wind energy, solar energy, geothermal energy, water/ tidal energy and Biomass energy. Previously these were Conventional energy source before James Watt invented the steam engine in the eighteenth century. In fact, the New World was explored by man using wind-powered ships only. The non-conventional sources are available free of cost, are pollution-free and inexhaustible. Man has used these sources for many centuries in propelling ships, driving windmills for grinding corn and pumping water, etc. Because of the poor technologies then existing, the cost of harnessing energy from these sources was quite high. Also because of uncertainty of period of availability and the difficulty of transporting this form of energy, to the place of its use are some of the factors which came in the way of its adoption or development.

Non-Conventional source of energy is energy sources obtained from sources that are essentially infinite. Examples of Non-Conventional include wind power, solar power, geothermal energy, tidal power and hydroelectric power. Previously these were Conventional energy source before James Watt invented the steam engine in the eighteenth century. In fact,
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2.5 Solar Energy

2.5.1 Introduction

“Energy from the sun is called solar energy. The Sun’s energy comes from nuclear fusion reaction that takes place deep in the sun. Hydrogen nucleus fuse into helium nucleus. The energy from these reactions flow out from the sun and escape into space. Solar energy is sometimes called radiant energy. These are different kinds of radiant energy emitted by sun. The most important are light infrared rays. Ultra violet rays, and X- Rays. The sun is a large sphere of very hot gases. Its diameter is 1.39x106KM. While that of the earth is 1.27x104 KM. The mean distance between the two is 1.5x108KM. The beam radiation received from the sun on the earth is reflected in to space, another 15% is absorbed by the earth atmosphere and the rest is absorbed by the earth’s surface. This absorbed radiation consists of light and infrared radiation without which the earth would be barren. All life on the earth depends on solar energy. Green plants make food by means of photosynthesis. Light is essential from in this process to take place. This light usually comes from sun. Animal get their food from

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plants or by eating other animals that feed on plants. Plants and animals also need some heat to stay alive. Thus plants are stores houses of solar energy. The solar energy that falls on India in one minute is enough to supply the energy needs of our country for one day. Man has made very little use of this enormous amount of solar energy that reaches the earth.

### 2.5.2 Solar Energy applications

1. Heating and cooling of residential building.
2. Solar water heating.
4. Salt production by evaporation of seawater.
5. Solar cookers.
7. Solar Refrigeration.
8. Solar electric power generation.
9. Solar photo voltaic cells, which can be used for electricity.
10. Solar furnaces.

### 2.5.3 Solar Collectors

“A solar collector is a device for collecting solar radiation and transfer the energy to fluid passing in contact with it. Utilization of solar energy requires solar collectors. These are generally of two types.

a. Non-­concentrating (or) flat plate solar collector.
b. Concentrating (focusing) type solar collector.

The solar energy collector, with its associated absorber, is the essential component of any system for the conversion of solar radiation into more usable form (e.g. heat or electricity). In the non-concentrating type, the collector area is the same as the absorber area. On the other hand, in concentrating collectors, the area intercepting the solar radiation is greater. By means of concentrating collectors, much higher temperatures can be obtained than with the non-concentrating type. Concentrating collectors may be used to generate medium pressure steam. They use many different arrangements of mirrors and lenses to concentrate the sun’s rays on
the boiler. This type shows better efficiency than the flat plate type. For best efficiency, collectors should be mounted to face the sun as it moves through the sky".5

2.5.4 Solar Cooker
“In our country energy consumed for cooking shares a major portion of the total energy consumed in a year. In villages 95% of the consumption goes only to cooking. Verity of fuel like coal, kerosene, cooking gas, firewood, dung cakes and agricultural waste are used the energy crisis is affecting everyone. It is affecting the fuel bills for those who use it for heating the houses and cooking their food. The poor of the developing countries who have been using dry wood, picked up from the fields and forests as domestic fuel, have been affected in their own way, due to scarcity of domestic fuel in the rural areas. At present, fire wood and cow dung too precious to allow to be used for burning and cooking. It is very useful to improve the fertility of the soil, it should be used in proper way. The supply of wood is also fast depleting because of the indiscriminate felling of trees in the rural areas and the denudation of forests. There is a rapid deterioration in the supply of these fossil fuels like coal, kerosene or cooking gas. The solution for the above problem is the harnessing of solar energy for cooking purpose. The most important is that the solar cooker is a great fuel saver. The department of new conventional energy source has calculated that a family using a solar cooker 275 days a year would save 800kgs of fire wood or 65 liters of kerosene. Similarly an industrial Canteen or a Hostel mess using the larger community solar cooker which can cook for 20 to 25 people could save 400kgs of fire wood or 335 liters of kerosene per year.

2.5.5 Water heater
It is a device to heat water using solar energy. Solar water heaters are one of the best options to be adapted in the developing country. Solar water heating systems are commercially produced in the country. Most of the systems available in India are designed to give water temperature from 60 to 90oC. These are suitable for pre heating feed water to boiler and processing industries and hot water application in Hotels, Bakeries, and Industries etc. The term solar water heater includes conventional flat plate collector with either thermo siphon or forced circulation flow system. A solar water heater normally consists of the following components:
(a) A flat plate collector to absorb solar radiation and convert it into thermal energy.

5 NON-CONVENTIONAL ENERGY SOURCES, For the Course of Rural Engineering Technician State Institute of Vocational Education Directorate of Intermediate Education Govt. of Andhra Pradesh, Hyderabad. 2005
(b) Storage tank to hold water for use and cold water feeding the flat plate collector.

(c) Connecting pipes inlet and outlet, for feeding cold water from the storage tank and taking hot water to the storage tank or point of use.

It is of a simple, small capacity, natural circulation system suitable for domestic purpose. The two main components of the storage tank, the tank being located above the level of the collector. As water in the collector is heated by solar energy, it flows automatically to the top of the water tank and its place is taken by colder water from top of the tank. Whenever this is done, cold water automatically enters at the bottom. An auxiliary heating system is provided for use on cloudy or rainy days.

Typically, such systems have capacities ranging from 100 to 200 liters and adequately supply the needs of a family of four or five persons. The temperature of the hot water delivered ranges from 50 to 70oC. Solar water heating is a good example to illustrate one of the assets of the direct use of solar. This is the possibility of matching the temperature achieved in the heating device with the temperature required for end use. As a result of this matching, the thermodynamic efficiency based on considerations of availability of energy can be shown to be higher in the case of solar water heating system than a water heating system using natural gas or electricity. Solar water heaters of the natural circulation type were used fairly widely from the beginning of the twentieth century till about 1940 until cheap oil and natural gas became available. Now they are being installed again. They are in widespread use in countries like Israel, Australia and Japan.

2.5.6 Solar Pumping

Solar pumping consists in utilizing the power generated by solar energy for water pumping useful for irrigation. Solar energy offers several features that make its utilization for irrigation pumping quite attractive, first, the greatest need for pumping occurs during the summer months when solar radiation is greatest second, pumping can be intermittent to an extent, during periods of low solar radiation when pumping decreases, evaporation losses from crops are also low. Finally relatively inexpensive pumped storage can be provided in the forms of bonds. A number of recently constructed solar irrigation pump installations are now operational. The major obstacle to increase use of solar irrigation system at this time is their relatively high capital cost. If the costs of solar pumps can be substantially reduced and assuming that conventional fuel costs continue to rise, solar; irrigation could become economical, and increased use of such system might be anticipated in future.

The basic system consists of the following components:
a. The solar collector.
b. The heat transport system.
c. Boiler or Heat exchanges.
d. Heat engine.
e. Condenser.
f. Pump

The solar pump is not much different from a solar heat engine working in a low temperature cycle. The sources of heat is the solar collector, and sink is the water to be pumped.

The primary components of the system are an array of flat-plate collectors and a Rankine engine with an organic fluid as the working substance. During operation a heat transfer fluid (Pressurized water) flows through the collector arrays. Depending upon the collector configuration, solar flux and the operating conditions of the engine, the fluid will be heated in the collector to a higher temperature, the solar energy which is thus converted to the thermal energy. The fluid (water) flows into a heat exchanger (boiler), due to temperature gradient, and comes back to the collector. This water yields its heat to an intermediate fluid in the boiler. This fluid evaporates and expands in the engine before reaching the condenser, where is condenses at low pressure. The condenser is called by the water to be pumped. The fluid is then reinjected in the boiler to close the cycle. The expansion engine or ranking engine is coupled to the pump and it could of course be coupled to an electric generation”.

2.6 Solar Photo Voltaic

“The direct conversion of solar energy in to electrical energy by means of the photo voltaic effect, that is the conversion of light (or other electromagnetic radiation) in to electricity. The photo voltaic effect is defined as the generation of the electromotive force as a result of the absorption of ionizing radiation energy conversion devices which are used to convert sun light to electricity by the use of the photo voltaic effects are called solar cells. A single converter cell is called a solar cell or more generally, a photo voltaic cell, and combination of such cells, designed to increase the electric power output is called a solar module or solar array. Photo voltaic cells are made of semi-conductors that generate electricity when they absorb light. As photons are received, free electrical changes are generated that can be collected on contacts applied to the surface of the semi-conductors. Because solar cells are

6 NON-CONVENTIONAL ENERGY SOURCES, For the Course of Rural Engineering Technician State Institute of Vocational Education Directorate of Intermediate Education Govt. of Andhra Pradesh, Hyderabad. 2005
not heat engines, and therefore do not need to operate at high temperatures, they are adopted to the weak energy flux of solar radiation, operating at room temperature. These devices have theoretical efficiencies of the order of 25 percent. Actual operating efficiencies are less than this value, and decrease fairly rapidly with increasing temperature. The best known applications of photo voltaic cells for electrical power generation have been in spacecraft, for which the Silicon cell is the most highly developed type. The Silicon cell consists of a single crystal of silicon into which a doping material is diffused from a semi-conductor. Since the early day of solar cell development, many improvements have been manufactured with areas 2x2Cm, efficiencies approaching 10 percent, and operating at 280C. The efficiency is the power developed per unit area of array divided by the solar energy flux in the free space (1.353 KW/m2). For terrestrial applications, silicon solar cells have shown operating efficiencies of about 12 to 15 percent. Though Silicon is one of the earth’s most abundant materials, it is expensive to extract (from sand, where it occurs mostly in the from SiO2) and refine to the purity required for solar cells. The greater barrier to solar cell application lies in the costs of the cells themselves. Reducing the cost of Silicon Cells is difficult because of the cost of making single crystal. One very promising method is being developed to produce continuous thin ribbons of single-crystal Silicon to reduce fabrication costs. Cells made from the ribbon have so far shown efficiencies of around 8 percent. Several other kinds of photo cells are in the laboratory stage of development. Cadmium Sulfide cells are other possibilities. So far, efficiencies have been in the range of 3 to 8 percent and these cells have been less durable than Silicon cells owing to degradation with exposure to Oxygen, water vapor and sunlight, especially at elevated temperatures. The active part of the Cadmium Sulfide cds cell is a thin polycrystalline layer of cds, about 10μm. Thick on which a layer of Cu2S compound perhaps 0.1μm thick is grown. These cells can be made by deposition on long sheets of substrates, a process that might be adaptable to expensive mass production. Photo voltaic cells could be applicable to either small or large power plants, since they function well on a small scale, and may be adaptable to local energy generation on building roof tops. The cost of the energy storage and power conditioning equipment might, however, make generation in large stations the most economical method; solar cells have also been used to operate irrigation pumps, navigational signals high way emergency call system, railroad crossing warnings, automatic meteorological stations, etc.; in location where access to utility power lines is difficult”.

https://en.in.wikepedia.org/wiki/solar_power_in_india#cite_note_mnreJan 142-2
2.6.1 Applications of Solar Photo-Voltaic System in Rural Areas

“A variety of PV system configurations have been developed and deployed for rural applications such as drinking water supply, street lighting irrigation water pumping and for operation of electronic equipment’s. Government of India is sponsoring, a program for Popularizing solar lighting, solar water pumping etc.; by providing capital subsidies and concessional interest on borrowed capital.

Solar lighting

Electricity for lighting during night is one of the most convenient and preferred form of energy. However in our Country out of 6 Lacks villages, 1 lakh villages are still to be electrified. Even in electrified villages, only a quarter of house-holds have proper connection. Owing to power shortage in many stages, electricity supply situation in villages is precarious and mostly it is not available even in electrified villages for lighting when it is most needed. The bulk of rural house-holds in India, normally use kerosene lanterns lanterns for meeting their lighting requirements. It is estimated that around 100 million kerosene lanterns are used in India. These lanterns provided insufficient and poor quality of light.

For village lighting, three major system Configuration are available;

a. Domestic lighting system or solar lantern.
b. Pole mounted standalone street lighting system.
c. Non-grid interactive centralized lighting system.

a. Solar lantern

Solar photo-voltaic powered lights called lanterns are considered to be alternative solution to village lighting needs. A typical solar lantern consists of small photovoltaic module, alighting device, a high frequency investor, battery charge controller and appropriate housing. During day time, module is placed under the sun and is connected to lantern through cable for charging a typical lantern uses a 10 watt lamp. The expected life of the lamp is 3 to 5 years. Storage battery is one crucial component in lantern; Recombinant maintenance free absorbed electrolyte batteries are being used. The battery has a life of 3 to 5 years. Sealed nickel Cadmium battery is a good option considering their deep discharge characteristics. It is important to have reliable electronics to operate the lamp and provide suitable protection. A
2.7 Energy Scenario in India

“Energy is Capacity of body to do work. There two forms of Energy as follows:-

Non-Conventional source of energy is energy sources obtained from sources that are essentially infinite. Examples of Non-Conventional include wind power, solar power, geothermal energy, tidal power and hydroelectric power. Previously these were Conventional energy source before James Watt invented the steam engine in the eighteenth century. In fact, the New World was explored by man using wind-powered ships only. The non- conventional sources are available free of cost, are pollution-free and inexhaustible. Man has used these sources for many centuries in propelling ships, driving windmills for grinding corn and pumping water, etc. Because of the poor technologies then existing, the cost of harnessing energy from these sources was quite high. Also because of uncertainty of period of availability and the difficulty of transporting this form of energy, to the place of its use are some of the factors which came in the way of its adoption or development. Conventional energy is the conventional fossil fuels such as coal, oil and gas, which are likely to reduce with time. The use of fossil fuels and nuclear energy replaced totally the non-conventional methods because of inherent advantages of transportation and certainty of availability; however these have polluted the atmosphere to a great extent. In fact, it is feared that nuclear energy may prove to be quite hazardous in case it is not properly controlled. India is blessed with an abundance of sunlight, water and biomass. Enthusiastic efforts during the past two decades are now bearing fruit as people in all walks of life are more aware of the benefits of Non-Conventional energy source, especially decentralized energy where required in villages and in urban or semi-urban centers. India has the world’s largest programme for Non-Conventional source of energy”.

2.8 Supply Options for Conventional Energy

“Strategies to meet India’s energy requirement are constrained by country’s energy resources and import possibilities. Unfortunately, India is not well endowed with natural energy resources. Reserves of coal oil, gas and Uranium are meager though India has large reserves

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8 https://en.in.wikepedia.org/wiki/solar_power_in_india#cite_note_mnreJan 142-2
of thorium. While coal is abundant, it is regionally concentrated and is of low calorie and high ash content, though it has the advantage of low sulphur content. The extractable reserves, based on current extraction technology, remain limited. Hydro potential is significant, but small compared to India’s needs and its contribution in terms of energy is likely to remain small. Further, the need to mitigate environmental and social impacts of storage schemes often delays hydro development thereby causing huge cost overruns”.10

2.9 Non-Conventional Energy in India
India has been making continuous progress in conventional as well as Non-Conventional power generation. The trajectory of growth of installed capacity since 2002 (start of the 10th five year Plan), 2007 (start of 11th Plan), and as of 30 November 2010, providing energy access and energy security for the poor would, therefore, continue to be a major issue and problem. Solutions to this simply have to be found but which no longer appear possible from conventional sources. It is clear that India’s need for secure, affordable, and environmentally sustainable energy has become one of the principal economic and development challenges for the country. It is also clear that while energy conservation and energy efficiency have an important role to play in the national energy strategy, Non-Conventional energy will become a key part of the solutions and is likely to play an increasingly important role for augmentation of grid power, providing energy access, reducing consumption of fossil fuels and helping India pursue its low carbon developmental pathway.

Status of Non-Conventional Energy Source
“During the last many years the share of Non-Conventional energy has steadily increased due to the initiative taken by Government of India. It is estimated that total share of Non-Conventional energy will be 15.9% by 2022. In the larger perspective of grid power an innovative scheme is being tried in India called as tail-end grid. So far the emphasis has been on large plants whether they are wind, solar, hydro or biomass. Locations for wind and hydro are fixed. However, for biomass the difficulties of ensuring collection and transportation of fuel are leading towards smaller plants. For solar PV, a total of 100 MW capacity is being set up with smaller plants of 100 KW to 2 MW, which are connected to grid through 11 kV feeders. It is expected that small plants would reduce the transmission losses by 5-7% with

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respect to large capacity plants of 50 - 100 MW size and improve both voltage and frequency at the tail end. The same approach is being planned for biomass based power plants of up to 2 MW capacity as the logistics of fuel management would become much more manageable and more environmentally friendly. It is envisaged that hundreds of such plants will be built in the next few years thus improving the transmission infrastructure.

2.9.1 Biomass Power and Bagasse Cogeneration Program

This program aims at the utilization of biomass, such as agro-waste in the form of straws, stalks, stems and fibers; agro-industrial processing residues such as shells, husks, deoiled cakes, wood from dedicated energy plantations and bagasse from sugar mills, for power generation using combustion technology. The current potential for power generation from surplus agro and agro-industrial residues is estimated at 17000 MW. With efficient power cogeneration plants in new sugar mills and modernization of existing ones, the potential of surplus power generation through bagasse cogeneration in sugar mills is estimated at 5000 MW. Thus the total estimated biomass power potential is about 22,000 MW.

2.9.2 Wind Power

The wind power program is the fastest growing Non-Conventional energy program in India and is almost entirely coming through private sector investments. India has a potential of around 48,500 MW. With a capacity addition of 12,800 MW, it contributes to around 75% of the grid-connected Non-Conventional energy power installed capacity. The major wind power capacity is in the states of Tamil Nadu, Gujarat, Maharashtra, Karnataka and Rajasthan. Wind electric generators of unit sizes between 225 kW and 2.10 MW have been deployed across the country. Wind Electric Generators of unit capacity up to 2.10 MW are being manufactured India. An ambitious target of 9,000 MW was set for 11th Plan, of which 5,715 MW had already been achieved by September, 2010. This has been possible because of the multidimensional approach of central and state governments. The main driving force for development of wind sector has been the provision of accelerated depreciation of 80%, an incentive also available to many other sectors. This provision has enabled large profit making companies, small investors and captive users to participate in the sector. However, independent power producers (IPPs) and foreign direct investment (FDI) were not able to benefit from the accelerated depreciation provision. The effort is to do 2000 MW or more annually.
2.9.3 Small Hydro Power

The estimated potential for power generation in India from small hydro plants is about 15,000 MW from 5718 identified sites. So far over 760 small hydropower projects aggregating to 2,803 MW have been set up in various parts of the country and 285 projects of about 940 MW are in various stages of implementation. At present, a capacity addition of about 300 MW per year is being achieved, of which about 70% is coming through the private sector. Attention is being focused on States with the maximum hydro potential and improving environment policies to attract private sector investments.

2.9.4 Employment Opportunities

Non-Conventional energy has vast potential in terms of creating new job opportunities in India where there is high rate of unemployment and disguised employment. The report estimates that implementation of the National Action Plan on Climate Change could create an Additional 10.5 million direct green jobs”.

2.10 Introduction to Energy Scenario and Current Status in India and worldwide

“In latest years ease of use of power in India has both increased and improved but demand has constantly outstripped supply and substantial energy and peak shortages prevailed in 2009-10. There are also various estimates of 25000 to 35000 MW of power being produced by diesel generation to meet the deficits. Electricity shortage is not the only problem. Its spread is an equally serious issue. In the past, the selection of an energy resource for electricity generation was dominated by finding the least expensive power generating plant. Although such an approach is essential, there is growing concern about other aspects of power generation such as social, environmental and technological benefits and consequences of the energy. It can be observed that coal has the maximum global warming potential followed by Natural Gas and others. Further, it needs to be reemphasized that for India, like most developing countries, the cost of producing electricity is of paramount concern while planning for the type of plant to be installed and commissioned and more so with abundant supply of coal. However, in the long run if we take the effect of the pollutants on human health and environment and cost as well as efforts needed to improve or alter the path of degradation, the initial higher cost of using Non-Conventional resources for producing energy may not be too big. A high degree of caution is also needed as emerging economies like India

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may not at present have financial resources to leapfrog directly to cleaner mechanisms of energy. Since global warming is an international phenomenon and it has no boundaries there is an urgent need for the transfer of technology and development of appropriate financial instruments from developed the world to nations who are still trying to find their rightful places. No argument is needed to understand that the world is today facing the problem of global warming due to rapid industrialization and urbanization followed by the western world. In terms of per capita equity India is 145th in the world with a release of 1.25 t CO2 per annum.

2.11 Solar power

“Among the various Non-Conventional energy resources, India possesses a very large solar energy potential; most parts of the country are blessed with good amounts of sunshine. There are about 300 clear sunny days in a year in most parts of country. The average solar radiation incident over India varies from 4 kWh/day - 7 kWh/day. The solar radiation received over the Indian land area is estimated to be about 5,000 trillion kWh/year. In June, 2008, a National Action Plan on Climate Change was announced, which included eight major national missions with the one on solar energy being the centre piece. This mission envisages a major step up in the utilization of solar energy for power generation and other purposes.

Employment Opportunities

As stated in a report by The Climate group and HSBC, Non-Conventional energy has vast potential in terms of creating new job opportunities in India where there is high rate of unemployment and disguised employment. The report estimates that implementation of the National Action Plan on Climate Change could create an Additional 10.5 million direct green jobs and India’s share of US $ 2.2 trillion can be US $ 135 billion. Further, global expansion of wind power could create 288,500 Indian jobs if Indian firms were able to penetrate 10% of the global market”.

2.12 List of the Solar Equipment’s/ Products:

1) Solar Hand Held Lantern/Emergency Light
2) Solar Portable Battery Charger
3) Solar Universal Battery Charger

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4) Solar Home/Indoor Lighting Systems
5) Solar Power Plants, Standby Power Supply
6) Solar Glow Sign Boards
7) Solar LED Lights
8) Solar Street Lighting Systems
9) Solar Garden Lights
10) Solar Water Pumps

**Solar PV Security Systems**

1) Solar Hand Held Search/Dragon Light
2) Solar Hand Held Rechargeable Torch
3) Solar Stand Alone Security/Street Light
4) Solar Hand Held Metal Detector (With rechargeable Ni-Cd Cell)
5) Solar Door Frame Metal Detector (With Battery back-up)
6) Solar Under Vehicle Mirror Trolley
7) Solar Guard Watch Monitor
8) Solar IR Sensor
9) Solar Beam Detector
10) Solar Traffic Control Systems

**Solar Thermal Systems**

1) Solar Water Heating System
2) Solar Stills (For Distilled Water)
3) Solar Food Warmer, Cookers & Steam Cooking Systems
4) Solar Cabinet Driers
5) Solar Timber Seasoning Kiln
6) Solar Space Heating Systems
7) Solar Swimming Pool

**Solar Wind Electric Generator**

1) Solar Wind Turbines
2) Solar PV Wind Hybrid Systems
Solar Products Spares and Accessories

1) SPV Modules / Panels  
2) Solar CFL / LED Luminaires  
3) Solar Flat Plate Collectors  
4) Solar Charge Controllers  
5) Solar UPS / Inverters  
6) Solar Power Control Units  
7) Solar Batteries  
8) SPV Modules Mounting Structure  
9) Solar Street Light Poles, Battery Boxes,  
10) Installation Material, Tanks, Vessels and Heat Exchangers. Etc...

2.13 List of Solar Photovoltaic Manufacturing Companies:

Indian Solar panel manufacturers. Crystalline Solar Panel manufacturers whose headquarters is in India. There are two types of Solar Manufacturers in India first is Mono-crystalline second is Polycrystalline power technology with different power ranges and production with the different capacity in Megawatt. Photovoltaic companies include PV capital equipment producers, cell manufacturers, panel manufacturers, silicon manufacturers and installers. List as follows;

1. TATA Power Solar Systems Pvt. Ltd.  
2. Swelect Energy Systems Ltd.  
3. Emnvee Group  
5. Moser Bear Solar Division  
6. Waaree Energies Ltd.  
7. Websol Energy System Ltd.  
9. Indosolar Ltd.  
10. HHV Solar Technologies Pvt . Ltd.  
12. CEL  
13. Euro Multi-vision
14. Indosolar  
15. Jupitor Solar  
16. KL Solar Technology  
17. Maharshi Solar  
18. UPV Solar  
19. Websol Solar  
20. Reylon Solar Pvt Ltd

2.14 Top 10 PV Countries

<table>
<thead>
<tr>
<th>Total capacity</th>
<th>Added capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Germany 38,200</td>
<td>1. China 10,560</td>
</tr>
<tr>
<td>2. China 28,199</td>
<td>2. Japan 9,700</td>
</tr>
<tr>
<td>3. Japan 23,300</td>
<td>3. United States 6,201</td>
</tr>
<tr>
<td>4. Italy 18,460</td>
<td>4. UK 2,273</td>
</tr>
<tr>
<td>5. United States 18,280</td>
<td>5. Germany 1,900</td>
</tr>
<tr>
<td>6. France 5,660</td>
<td>6. France 927</td>
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<td>7. Spain 5,358</td>
<td>7. Australia 910</td>
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<tr>
<td>8. UK 5,104</td>
<td>8. South Korea 909</td>
</tr>
<tr>
<td>10. Belgium 3,074</td>
<td>10. India 616</td>
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2.15 Rural electrification

“Developing countries where many villages are often more than five kilometers away from grid power are increasingly using photovoltaics. In remote locations in India a rural lighting program has been providing solar powered LED lighting to replace kerosene lamps. The solar powered lamps were sold at about the cost of a few months' supply of kerosene. Cuba is working to provide solar power for areas that are off grid. More complex applications of off-
grid solar energy use include 3D printers. RepRap 3D printers have been solar powered with photovoltaic technology, which enables distributed manufacturing for sustainable development. These are areas where the social costs and benefits offer an excellent case for going solar, though the lack of profitability has relegated such endeavors to humanitarian efforts. However, in 1995 solar rural electrification projects had been found to be difficult to sustain due to unfavorable economics, lack of technical support, and a legacy of ulterior motives of north-to-south technology transfer.

**Energy Conservation:**

Energy conservation has emerged as a major policy objective, and the Energy Conservation Act 2001, was passed by the Indian Parliament in September 2001, 35.5% of the population still live without access to electricity. This Act requires large energy consumers to adhere to energy consumption norms; new buildings to follow the Energy Conservation Building Code; and appliances to meet energy performance standards and to display energy consumption labels. The Act also created the Bureau of Energy Efficiency to implement the provisions of the Act. In the year 2015, Prime Minister Mr. Modi launched a scheme called Prakash Path urging people to use LED lamps in place of other lamps to drastically cut down lighting power requirement. Energy efficient fans at subsidized price are offered to the electricity consumers by the electricity distribution companies (DisComs) to decrease peak electricity load”.

2.16 **Non-Conventional Energy in India:**

“Non-Conventional Energy in India comes under the purview of the Ministry of New and Non-Conventional Energy. India was the first country in the world to set up a ministry of non-conventional energy resources, in early 1980s. India’s cumulative grid interactive or grid tied Non-Conventional Energy capacity (excluding large hydro) has reached about 42.85 GW, surpassing the installed capacity of its Hydro-electric power in India for the first time in Indian history. 63% of the Non-Conventional power comes from wind, while solar contributed nearly 16%.

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Non-Conventional Energy Sources:

### Table and Graph 2.16.1 Non-Conventional Energy by Installed Capacity

<table>
<thead>
<tr>
<th>Source</th>
<th>Total Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Power</td>
<td>26,866.66</td>
</tr>
<tr>
<td>Solar Power</td>
<td>6,762.85</td>
</tr>
<tr>
<td>Biomass Power (Biomass &amp; Gasification and Bagasse Cogeneration)</td>
<td>4,831.33</td>
</tr>
<tr>
<td>Small Hydro Power</td>
<td>4,273.47</td>
</tr>
<tr>
<td>Waste-to-Power</td>
<td>115.08</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42,849.38</strong></td>
</tr>
</tbody>
</table>

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### Solar Power:

India is densely populated and has high solar insolation, an ideal combination for using solar power in India. Much of the country does not have an electrical grid, so one of the first applications of solar power has been for water pumping, to begin replacing India's four to five million diesel powered water pumps, each consuming about 3.5 kilowatts, and off-grid lighting. Some large projects have been proposed, and a 35,000 km² area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 gigawatts.

The Indian Solar Loan Programme, supported by the United Nations Environment Programme has won the prestigious Energy Globe World award for Sustainability for helping
to establish a consumer financing program for solar home power systems. Over the span of three years more than 16,000 solar home systems have been financed through 2,000 bank branches, particularly in rural areas of South India where the electricity grid does not yet extend.

Launched in 2003, the Indian Solar Loan Programme was a four-year partnership between UNEP, the UNEP Risoe Centre, and two of India's largest banks, the Canara Bank and Syndicate Bank.

Announced in November 2009, the Government of India proposed to launch its Jawaharlal Nehru National Solar Mission under the National Action Plan on Climate Change with plans to generate 1,000 MW of power by 2013 and up to 20,000 MW grid-based solar power, 2,000 MW of off-grid solar power and cover 20 million square metres with collectors by the end of the final phase of the mission in 2020. The Mission aims to achieve grid parity (electricity delivered at the same cost and quality as that delivered on the grid) by 2020. Achieving this target would establish India as a global leader in solar power generation.

Indian Electrical and Electronics Manufacturers Association (IEEMA) Plays a major role in Non-Conventional Energy”\(^{14}\).

2.16.2 Installed capacity for different source of Power 2016 GW.

<table>
<thead>
<tr>
<th>Source: Ministry of Coal, NHPC, Central Electricity Authority (CEA), Corporate Catalyst India, TechSci Research Notes: MW - Megawatt, GW - Gigawatt * - Data is for April-October 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capacity for different sources of power -2016 (^*) (GW)</td>
</tr>
<tr>
<td>Thermal</td>
</tr>
<tr>
<td>Hydro</td>
</tr>
<tr>
<td>Renewables</td>
</tr>
<tr>
<td>Nuclear</td>
</tr>
</tbody>
</table>

2.17 The Government of India launches an ambitious rooftops solar subsidy schemes:

India’s Cabinet Committee on Economic Affairs (CCEA) sanctioned INR 50 billion (USD 750 million) funding for 30% subsidy on the total capital for solar rooftop installations. The subsidy will be restricted for the government, residential, institutional and residential segments only and the government expects this subsidy to support total rooftop capacity of 4,200 MW until this budget is exhausted.

The fund unavailability issues with previous subsidy schemes are likely to get resolved;

Significant changes to allocation process mean that the funds will be better directed to needier customers and potential for abuse will be much lesser than before; and

We expect significant growth in the rooftop market particularly in the government and institutional segments but the entire rooftop market will benefit from growth through overall industry learning and skills enhancement.

Based on past experience in India with rooftop capital subsidy, the two key issues here are: i) how will the new subsidy scheme work; and ii) and will the subsidy be effective in kick starting the growth in rooftop solar in India?

An approval by CCEA is a strong assurance of availability of funds. However, we will need to see an appropriate increase in the budget for Ministry of New and Non-Conventional Energy (MNRE) for FY 2016-17 (to be presented in March 2016). Earlier experience in this relation is mixed as in March 2015, when INR 6 billion was sanctioned for a similar subsidy scheme, funding availability proved to be a problem. The difference this time is that the government is targeting a huge jump in rooftop solar capacity addition from 200 MW in FY 2015-16 to 4,800 MW in FY 2016-17. And there is a palpably stronger commitment from the government to support the sector.

Moreover, the capital subsidy is being allocated to specific parts of the economy where funding availability is a big impediment to growth of rooftop solar. Subsidy is not being made available for commercial and industrial customers because these consumers pay higher tariff and can also avail the accelerated depreciation benefit.
The biggest change in the subsidy scheme is that funds will no longer be disbursed through MNRE ‘channel partners’. There will now be three key modes of subsidy disbursement – Solar Energy Corporation of India (SECI), schemes run by state governments and subsidy disbursements through financial institutions. SECI is already believed to be in the process of allocating subsidy for 750 MW of rooftop capacity to systems aggregators and EPC contractors. The states are also likely to follow a similar aggregated capacity allocation route. Another important mode for subsidy disbursement is going to be through financial institutions. MNRE is likely to provide an in-principle approval to the State Bank of India to disburse subsidies. These disbursements will be clubbed with the rooftop solar loan schemes of the bank.

As the new scheme is not applicable on the industrial and commercial segments, these segments are expected to continue to grow at a decent pace. We expect a significant growth in the government and institutional segments as soon as the subsidy disbursement mechanisms get going. In its first leg, SECI may lead the charge on this. This growth is expected to start playing out over the next 6-12 months. As the subsidy disbursement mechanisms for the residential market would primarily be taken up by states and financial institutions, it may take up to a year for the mechanisms to become operational.

Overall, there are many improvements to the subsidy allocation process and together with the bigger allocation of funds, this is a very positive development for the sector. BRIDGE TO INDIA believes that this subsidy scheme will result in substantial growth of the rooftop sector in the temporary. In the longest time, this market needs a very strong concerted effort from the government on policy and regulatory front to achieve its growth potential in a sustainable manner.

2.18 MNRE / NABARD Schemes for Solar Home Lighting:

MNRE (GOI) has signed an MOU with NABARD to promote Solar Home Lighting Systems to rural areas. This program is to be implemented under the Jawaharlal Nehru National Solar Mission. JNNSM aims to achieve 20000 mw of solar power production by the year 2022.
### 2.18 Subsidy and Loan Details

<table>
<thead>
<tr>
<th>S#</th>
<th>Model</th>
<th>Solar Module</th>
<th>Battery</th>
<th>Inverter</th>
<th>Load</th>
<th>Backup</th>
<th>System Cost (MRP) (Rs.)</th>
<th>Subsidy (Rs.)</th>
<th>Bank Loan (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TL 200</td>
<td>100 x 2 Nos.</td>
<td>12 V/75 Ah X 2 Nos.</td>
<td>24V/800VA</td>
<td>3 CFL Lights, 2 Fans &amp; 1 TV</td>
<td>3 to 4 hours</td>
<td>45000/-</td>
<td>20000/-</td>
<td>25000/-</td>
</tr>
<tr>
<td>2</td>
<td>TL 250</td>
<td>250 Wp</td>
<td>12 V/100 Ah X 2 Nos.</td>
<td>24V/800VA</td>
<td>4 CFL Lights, 3 Fans &amp; 1 TV</td>
<td>3 to 4 hours</td>
<td>56700/-</td>
<td>25000/-</td>
<td>31700/-</td>
</tr>
<tr>
<td>3</td>
<td>TL 300</td>
<td>150 x 2 Nos.</td>
<td>12 V/120 Ah X 2 Nos.</td>
<td>24V/1000VA</td>
<td>5 CFL Lights, 3 Fans &amp; 1 TV</td>
<td>3 to 4 hours</td>
<td>65000/-</td>
<td>30000/-</td>
<td>35000/-</td>
</tr>
</tbody>
</table>

**Table 2.18 Subsidy and Loan Details**

**Please note:** - Specifications and scheme subject to up-dation and change from time to time.

**TERMS & CONDITIONS:-**

1. Customer has to submit the sanction letters received from the Bank through dealer in your local area.
2. Installation, commissioning and fault repair and maintenance for 5 years is the scope of Dealer.
3. Price Quoted excludes transportation charges.
4. Equipment / material will be dispatched upon receiving the sanction letter from the Bank.