SOLAR ENERGY- A RENEWABLE SOURCE OF ENERGY

INTRODUCTION

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy.

Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions.

Only a very small fraction of the total radiation produced reaches the Earth. The radiation that does reach the Earth is the indirect source of nearly every type of energy used today. The exceptions are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was dependent upon the sun.

Due to the nature of solar energy, two components are required to have a functional solar collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloud cover, for example, the amount of energy produced energy generator. These two components are a collector and a storage unit. The collector simply by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container.

Window of Opportunity: Solar Energy Industry in India

Solar energy is one of the purest and clean forms of energy we receive on earth, without any environmental degradation. Thanks to the never-ending solar radiations we receive, it is responsible for all the life processes taking place on earth. If we tap into this energy systematically, this can be the largest source of energy, and even a tenth of energy from solar rays on earth can solve the entire energy crisis

In India, however, the potential of energy from solar rays is about 750GW. If this energy is utilized, we won't need any other source of energy in our country. There are many ways converting solar energy to electricity, but most widely used ones are by using photo-voltaic cells (also called solar cells) and concentrated solar power, where solar rays are focused and the concentrated power generates heat to run the solar plant.

Solar energy has gained a lot of significance in recent decade, due to shortage of non-renewable sources of energy. As on 30 June 2015, the installed grid connected solar power capacity is 4,060.65 MW, and India expects to install an additional 10,000 MW by 2017 and a total of 100,000 MW by 2022.

India being the first country in the world to setup the ministry of non-conventional energy resources, Gujarat has been a leader in solar power generation and contributes 2/3rd of the 900 MW of photovoltaic in the country

There have been a few initiatives from the government, such as the Indian Solar Loan Programme, which has focused on financing solar home power systems, to increase the use of solar energy for domestic use. It may also include lighting, irrigation or water heaters. Notably, Bangalore city has the largest deployment of solar water heaters in India.

Solar industry has Investment 2015 also highlights a record $119 billion in new investment. Gujarat and Rajasthan alone account to more than 88% of total solar energy produced in India.

As an entrepreneur, the potential for innovation is endless in this sector, as the whole world is moving in a direction to minimize the use of renewable energy and opting for solar devices. Right from automobiles to domestic appliances and handheld devices, solar is going to dominate the market in our near future. Moreover, as the efficiency of solar cells is less than 10%, there is huge scope for innovators to develop energy efficient solar devices and make it cost-effective to address the demands of the large population in our country.

Advantages of Solar Energy

1. You Can Make Money

One of the best advantages of solar energy, and the one that is primarily responsible for the rapid growth of solar installations in Europe over the past several years is that you can make money from the sun.

As a result of feed In Tariff policies in place in much of Europe, you can build sell the electricity, and that income can last for 20 years or more.

For each dollar you can reduce your electrical bill, your house can increase in value by up to $20.

Even if you don't build the solar yourself – in some markets solar companies might be willing to lease your roof or land to install their solar installation. In some cases a joint venture arrangement is also a possibility.

2. You Can Save Money

If you use the electricity yourself, instead of buying it from the grid, you can save money, which is just as good as making money. This advantage alone is propelling the rapid adoption of solar energy in the USA and many other markets around the world.

3. Solar Energy Is Abundant

The sun will be around a lot longer than oil, coal or gas will be.

Some of the materials used to make solar cells to convert the solar energy into electricity, such as the more exotic composite materials may run out over time, but the basic elements used to make solar cells (e.g., silicon and aluminum) are all abundant and recyclable.

4. As Long As there is Light – It Works

The amount of sunshine can vary depending on where you are or what the weather is like, but as long as there is light (even a small amount) PV cells can still produce electricity.

5. Sunshine Is Free

Solar energy is free. Sure, there is an initial capital cost to install a system that will convert the electromagnetic energy and photons sent out by the sun into electricity, but once you have made the investment and the sun keeps shining you will be producing electricity. No one will be sending you a bill for sunshine.

6. Environmentally Friendly

Solar energy powers the environment and life on the planet so there's no energy source more earth-friendly. Compared to the burning of fossil fuels, which release greenhouse gases, carcinogens and carbon dioxide, solar cells do not release anything harmful into the air as they convert the sun's energy into electricity. If you want clean air – one of the important advantages of solar energy is that it will help get us there.

7. Solar Energy Is Cost Effective

While a solar photovoltaic panel is still relatively expensive, it will pay for itself over time from the sale of electricity or from saving you money by reducing the amount of electricity you'll have to buy. The time it takes you to recover your net investment (investment less incentives) is known as the payback period. Generally, the payback period for solar installations is getting shorter and shorter.

Note: Solar hot water panels have been greatly improved in recent years and, with lower cost, payback times for domestic systems can not be as short as five years.

In some geographical areas producing electricity from the sun already costs less per kilowatt hour of electricity produced than producing it from fossil fuels.

As coal, gas, oil and nuclear energy fuel prices continue to raise solar energy will become even more cost effective. There is a start up cost, but then it starts paying for itself. Once you break even, everything after that is profit. Compare this to paying a monthly bill and getting no return on investment.

8. Solar Energy Is Clean

Solar energy is a clean alternative to fossil fuels and nuclear power. It’s silent. Solar power can be captured anywhere without creating noise pollution that might otherwise up set neighbors and wildlife. Thus, no danger of damaging our already damaged environment further and you can be part of the Green initiative, lower your carbon footprint, and save our planet from harmful greenhouse gases.

9. Greatly Reduced Contribution to Global Warming

One of the greatest advantages of solar energy, of course, is that there is no carbon dioxide, methane or other emissions that warm the atmosphere. However, manufacturing, transporting and installation of solar panels are necessarily accompanied by some of those emissions.

Solar Energy Potential in Industries

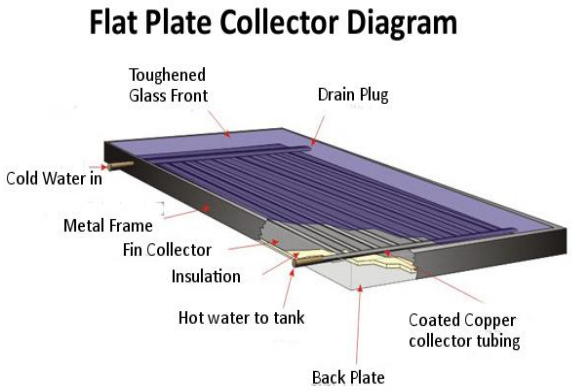
There is a vast potential for use of solar energy devices / systems in industries for process heat and other thermal applications.

Presently energy for these applications is being met mainly through fuel oil which is not only import dependent but also creating huge GHG emissions in atmosphere resulting threat to our planet.

India is consuming over 100 million tons of oil every year for various uses. Out of this, almost 40% is being consumed in the industrial sector alone. Further, 40-50% of this consumption is in thermal form alone with temperature range below 250 c which comes to around 15 million tons of fuel oil per annum. The applications include mercerizing, drying and finishing in textile industry, cooking, drying and canning in food industry, craft pulping, bleaching and drying in pulp and paper industry, drying and cleaning in leather industry and various such applications in many more industries. The working fluid required for these applications is pressurized hot water, steam or hot air in temperature range of 60-250 C.

There are number of solar energy technologies which can be used for such applications and reduce consumption of fuel oil mainly during day time. The technologies include solar water heating systems, steam generating systems and air heating systems based on flat plate or evacuated tube collectors and automatically tracked solar concentrating collectors.

Solar water heating is well established technology and is in promotion worldwide. It can be used in industries for boiler feed applications in raising water temperature from 25 to 80 C and thereby saving substantial amount of fuel oil being used in boilers. 10,000 liters per day capacity system may cost between Rs. 15-18 Lacs and can save around 14,000 liters of fuel oil per year for a period of about 20 years, the life of the system.



Solar heating system based on flat plate collectors have been found to be useful in food processing industries for drying of various food products.

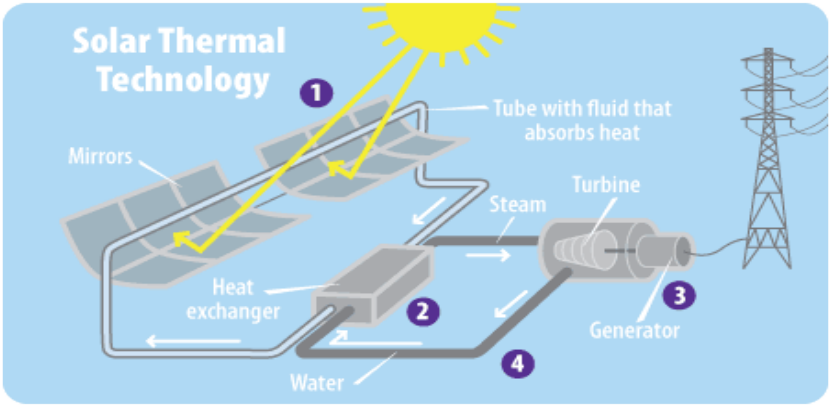
These industries generally require hot air at low temperature as process heat for drying of products such as tea leaves / coffee beans, and also for processing of fruits, spices, cereals, mushroom, vegetables, fish, seafood etc

Steam generating system:- Two types of solar steam generating systems; one based on fixed receiver E-W automatically tracked concentrating technology (Scheffler) and the other on fully tracked receiver on dish technology

1. Fixed receiver E-W tracked technology- A solar steam generating system based on this technology comprises elliptically shaped parabolic solar concentrators (each of 16 sq. m. size in general) arranged in pairs of sleeping and standing dishes in parallel modules, aligned in a perfect east – west direction. Receivers (heat exchangers painted black) are placed in the focus of each pair of dishes. Above the receiver is a header pipe half-filled with water. Cold water enters the receiver through the inner pipe coming from header. Solar rays falling onto the dishes are reflected and concentrated onto the receivers. Due to the high temperatures achieved, the water within the receiver is converted into steam. The steam generated in the system is stored in the upper half (empty portion) of the header pipe and if the steam is not drawn, the pressure of steam keeps on increasing.

The steam is then drawn / sent to the kitchen for cooking food or to other units for variety of applications including laundry, process heat, sterilization, air conditioning etc. Each set of dishes of the system is connected with a metal wire rope which is further connected to a winch having DC motor fixed with a timer mechanism. This mechanism keeps on moving the dishes in the direction of the sun. This type of tracking system is called central tracking. To ensure that steam is available even when sun is not there (at night and on cloudy days in monsoon) the Solar Steam generating system is connected with a Fuel fired boiler which acts as a back-up system.

A solar steam system comprising of 96 sq.m of dish area of this technology (6 dishes each of 16 sq. m) may generate around 150 to 200 kg of steam in a day depending on location and various other features can save around 4,500 liters of diesel in a year.



2. Fully automatically tracked large dish technology-

It is a Fresnel paraboloid reflecting concentrator (named Arun 160) mounted on a flat dish with downward facing cavity receiver at its focus designed to absorb the concentrated solar energy and to transfer it for useful application. The concentrator tracks the sun on two axes, continuously facing it to capture maximum amount of solar radiation over a day. The dish concentrator along with the receiver is mounted on a specially designed tower.

The system is equipped with a heat retrieval mechanism (which may consist of piping and fittings, insulation, fluid circulating pump, etc.), and system controls related to tracking, thermal system and security/ emergency measures. The configuration of an industrial process heat solar system depends on the respective application. Broadly, it may consist of one (or more)

number of solar dish, specially designed heat exchangers for transferring solar heat to the existing thermal system in the user industry, fluid pre-treatment equipment and storage vessel (if required), apart from piping/ fittings, fluid circulating pump(s), insulation, control valves etc. on application side for delivery of heat as per the requirements.

A unit of ARUN-160 dish concentrator having 160 square meter of aperture area was developed and installed at Mahanand Dairy at Latur in Maharashtra for pasteurization of about 20,000 to 25,000 liters of milk under MNRE sponsored R&D and has been working satisfactorily since 2006. The dishes are now being installed at various places for different applications under a field evaluation demonstration project of MNRE.

Each dish of this technology having a weight of around 20 tones could generate around 600 to 700 of steam in a day depending on the solar insolation and steam pressure. More dishes could be installed for meeting the required steam in an establishment at desired temperature and pressure but the initial investment will be too high.

Hot air is also required in industries such as leather, textiles, chemicals, rubber, paper, pharmaceuticals etc. Solar Energy use for Drying:

It is estimated that over 800 million kg, of tea leaves are being produced and dried in Southern states, Himachal Pradesh, West Bengal, Assam and North East States. Another 250 million kg of coffee beans are also being produced and dried in Southern states, Himachal Pradesh, West Bengal, Assam and North East States. Another 250 million kg of coffee beans are also being produced and dried every year. Millions of tons of food and industrial products are also being dried annually in various industries in the country. The systems installed in industries for drying of various products have been saving a significant amount of fossil fuel, apart from improving the quality of end product and reducing GHG emissions. A typical system of 100 sq. m. of flat plate collector area may cost around Rs. 5-6 Lacs which could save up to 6000 liters of conventional fuel for a period of over 15-20 years. Over 60 such systems of different capacities comprising of 12,000 sq. m of collector area are functioning in the country.

Solar Air Heating/Drying System (At Tea Industry, Coonoor, TN)

Solar collectors
(Outside view)

Tea drying
(Inside view)

Solar Fish Drying at Fishermen's Association, Vishakhapatnam

Solar collectors installed at roof (Outside view)

Fish drying (Inside View)

100 kW Solar Cooling Plant with PTCs & Triple Effect VAM

We choose solar energy because…..

- Solar energy is a clean and renewable energy source.
- Once a solar panel is installed, solar energy can be produced free of charge.
- Solar energy will last forever whereas it is estimated that the world's oil reserves will last for 30 to 40 years.
- Solar energy causes no pollution.
- Solar cells make absolutely no noise at all. On the other hand, the giant machines utilized for pumping oil are extremely noisy and therefore very impractical.
- Very little maintenance is needed to keep solar cells running. There are no moving parts in a solar cell which makes it impossible to really damage them.
- In the long term, there can be a high return on investment due to the amount of free energy a solar panel can produce, it is estimated that the average household will see 50% of their energy coming in from solar panels.

References:

- http://www.ccs.neu.edu/home/feneric/solar.html
- http://yourstory.com/2013/10/window-of-opportunity-solar-energy-industry-in-india/
- http://www.solar-facts-and-advice.com/advantages-of-solar-energy.html
- http://mnre.gov.in/file-manager/UserFiles/solar_energy_potential_in_industries.pdf
- http://www.processindustryforum.com/hottopics/advantages-and-disadvantages-of-solar-energy
- http://mnre.gov.in/file-manager/UserFiles/Brief_Solar_Steam_generating_Systems.pdf