Sustainability Outlook

October, 2012

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OFF-GRID SOLAR THERMAL TECHNOLOGIES: SOLVING INDIA'S ENERGY CRISIS

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The Earth receives more than enough energy from the sun in an hour to supply the world's energy requirements for the whole year. Unfortunately we harness only a tiny portion of the available solar energy and the world still primarily relies on power plants that burn fossil fuels. Thus, we don't have an energy problem, we have a conversion problem. If we are able to harvest sunlight in efficient and effective ways, then we can prevent the global energy crisis.

Industrial process heat (IPH) applications below 250°C contribute to about 15 to 20% of India's total oil consumption (almost 80%-90% of which is imported). Cooling or air conditioning is another energy-intensive process amongst the various energy-consuming applications.

According to a study by McKinsey, the power deficit in India could be as high as 25% by 2017. Almost 70% of our country's population depends on biomass for its energy needs, consisting of more than 32% of the total primary energy use in the country. Due to the scarcity of fossil fuels, their rising costs, the related pollution problems and the ever increasing power shortage, there is a dire need to make use of renewable sources of energy to meet these demands of IPH and energy for comfort cooling.

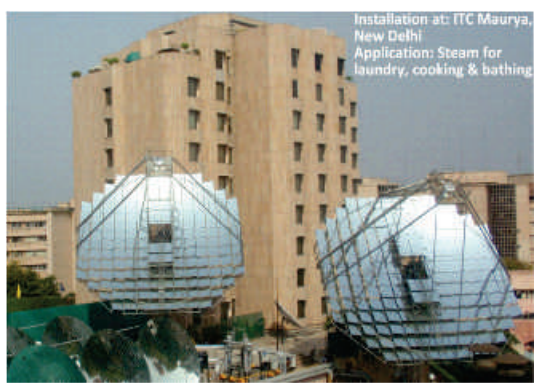
About 5 to 7 kWh/sq.m. of global solar radiation (on non-tracking horizontal surface) is available in India for about 300-330 days a year. Also, many cooling loads have a high coincidence with the availability of solar irradiation. The use of an appropriate solar technology for cooling and IPH applications can have a positive impact on the Indian energy and environmental scenario.

Solar thermal system applications

Even though several applications are possible by harnessing solar energy, utilizing it to generate steam and hot water is the most economically viable. Not only does it offer a potential solution to the oil security threat confronting India, but also a remedy to the environmental damage caused by conventional fuels.

Industrial sectors such as food processing industries (dairy industry, sea food processing industry, and sugar industry), textile processing industry, pharmaceutical industry, pulp & paper industry, chemical industry, auto component industry etc. have large requirement of thermal energy in their manufacturing plants which can be fully or partly met by harnessing solar energy.

Hotels & hospitals are one of the major sectors consuming large amounts of energy. A part of this energy goes into providing hot water for bathing and washing, steam for cooking and laundry. Use of appropriate solar thermal technologies can effectively and economically replace the use of conventional fuels by boilers.



"We don't have an energy problem, we have a conversion problem"

Comfort cooling applications

Another interesting application is the use of solar energy for cooling purposes. Solar-assisted cooling systems utilize the thermal energy of solar radiations captured through solar concentrators to power thermally driven cooling machines. As many cooling loads, such as air conditioning, have a high coincidence with the availability of solar irradiation, the combination of solar thermal and cooling has a high potential to replace conventional cooling machines based on electricity.

Cooling & air conditioning is one of the most energy-intensive processes amongst the various energy-consuming applications. Some estimates suggest that HVAC (Heating, Ventilation, and Air Conditioning) networks account for over 30% of a building energy usage. Thus, any technology that can help to save energy in the cooling and air-conditioning applications can help reduce India's power shortage burden to a great extent.

Applications in mass cooking

Many religious places and schools/colleges across the country provide meals to devotees and students respectively on a daily basis. Many industries, too, run canteens or messes that provide meals to their employees. Many of them have mass cooking facilities which utilize high cost fuels like LPG. Solar energy can be used to substitute the use of these fuels.

Desalination Application

Water demand for food, industry and people is on the rise. The world's water consumption rate is doubling every 20 years, outpacing by two times the rate of population growth. It is projected that by the year 2025 water demand will exceed supply by 56%, due to persistent regional droughts, shifting of the population to urban coastal cities, and water needed for industrial growth. The supply of fresh water is on the decrease. There will increasingly be a dependence to treat sea water to generate the requisite level of water for our daily use.

Desalination is the process that removes some amount of salt and other minerals form saline sea water, providing reliable fresh water. Solar thermal heat can be harnessed for this too. The heat is required to produce steam, which is further used for multi-effect distillation, a desalination process. Using the ARUN® solar thermal technology, it is estimated that for 169 sq. m. of collector area, 2500 liters of desalinated water can be produced using multi-effect evaporator.

Cold Storage

In India, due to improper post-harvest management and lack of access to electricity in rural areas, cold storage is falling short of requirement. Every year, millions of tons of fresh produce gets spoiled even before it reaches the consumers.

Cold Storage implies storing of agricultural produce like vegetables and fruits at low temperature ranging from 0 °C to 10 °C. According to an estimate by TERI, cold storages in India consume 30,000 MW of the installed power capacity. Considering that much of the cold storage needs to be in the rural areas where power shortages are high, off-grid solar thermal driven refrigeration system seems to be a good solution. Since solar driven system cannot extend beyond sunny hours, suitable hybridization of the system needs to be explored. Biomass fired gasifier is one alternative that can be researched to integrate with solar driven refrigeration to provide back-up heat and much needed power, since biomass is locally available in rural areas.

Solar Water Heating

Solar water heating is a technically proven successful application for use of thermal energy. However, the market for the solar water heater is not yet fully developed. Solar water heaters are available in two different technologies known as Flat Plate Collector technology (FPC) and Evacuated Tube Collector technology (ETC). Both FPC and ETC products are commercialized and economically viable in India with payback of investment in less than 3 to 4 years.

Hot water at 60°C of 100-300 liters capacity is suited for residential application. Larger systems can be used in restaurants, canteens, guest houses, hotels, hospitals etc. A 100 liters capacity per day of solar water heating system can replace an electric geyser for residential use and saves 1500 units of electricity annually, which also amounts to 1.5 tonnes of CO_2 per year. Currently, total solar water heating system installed in India is around 4 million square meters and per MNRE estimates is expected to grow to around 20 million square meters in 2020.

In India, concentrating solar devices producing higher temperatures (80°C to 250°C) have been deployed successfully at several places. In the concentrating collector type, majority of the solar thermal installations on ground have been of the parabolic dish collector. For various reasons, parabolic troughs have not been successfully deployed in industrial process heating requirement in India.

In the parabolic dish collector type, two prevalent technologies are ARUN® and Scheffler. Scheffler dishes have been historically installed for cooking applications at religious places, whereas ARUN dish was developed with a focus on industrial process heat & cooling applications.

Economic Viability

Since the power source (the sun) is free and solar systems require very little maintenance, the majority of the lifetime cost is made up of the cost of the components and their installation. The basic parameters that should be considered while evaluating the investment in any solar energy system are as follows:

- Cost of the Solar Energy System
- Subsidies
- Financing options
- Value of Energy generated
- Non-finance factors that influence the economics

Other than the standard internal rate of return (IRR), net present value (NPV) and the payback period calculations that are most widely used in evaluating investment opportunities, some sector specific economic indicators that must be considered are as below:

- Cost per kcal of energy delivered over the lifetime.
- Energy per unit area occupied.

At installations where a solar thermal system substitutes petroleum-based fuels such as furnace oil, HSD, LPG, PNG, etc, the payback periods are less than 3-4 years, while the life of these systems is greater than 20-25 years, making the economics very compelling.

Impact

The use of an appropriate solar technology for several industrial applications can have a positive impact on the Indian energy and environmental scenario. In urban areas the off-grid solar energy is mainly being used for solar water heating in residential areas. On the other hand, there is a significant impact potential in rural areas emanating from the use of off-grid solar energy in cooking and cold storage purposes.

India is the place where large advances in solar technologies for satisfying the thermal energy needs of industries are taking place. The technology has moved beyond the 'pilot installations' phase and its performance has now been technically and commercially proven on ground. The future for off-grid solar thermal power in India seems bright with the government promoting & creating awareness about the use of solar energy in India, thereby providing financial assistance in the form of subsidiaries and soft loans.

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