

A review on Solar Thermal Energy

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Abstract—The solar thermal structure yields thermal power from the heat of the sun. The vital working principle is the thermal collectors must reach a temperature higher than the object to be warmed for the system to operate with a positive energy gain. There are many types of solar energy; probably the most general is the photovoltaic energy which is based on electrical energy production by photovoltaic panels. But there are other ways to obtain electrical energy from sunlight with perhaps better results. Solar thermal power involves none of the polluting emissions or environmental safety concerns associated with conventional generation technologies. There is no pollution in the form of exhaust fumes or noise during operation. Solar-thermal power stations have several advantages over solar-photovoltaic projects. They are typically built on a much larger scale, and historically their costs have been much lower. Compared with other renewable sources of energy, they are probably best able to match a utility's electrical load, says Nathaniel Bullard of New Energy Finance, a research firm. There are many other uses for solar thermal technology. These include refrigeration, air conditioning, solar stills and desalination of salt water and more. More information on these technologies is available in the relevant texts given in the reference section at the end of this fact sheet.

Key words: Solar, Thermal, Energy, Power, Biomass

I. INTRODUCTION

The solar energy use is not something new, it has been used several centuries ago for different functions, but it was replaced for crude oil in the industrial revolution.

Currently, due to high costs of crude oil and its grate environmental impact, it has decided to return to the use of solar energy. If crude oil had not replaced the solar energy, surely that currently, we would have more technology in renewable energy.

There are many types of solar energy; probably the most popular is the photovoltaic energy which is based on electrical energy production by photovoltaic panels. But there are other ways to obtain electrical energy from sunlight with probably better results.

In solar thermal power plants the incoming radiation is tracked by large mirror fields which concentrate the energy towards absorbers. They, in turn, receive the concentrated radiation and transfer it thermally to the working medium. The heated fluid operates as in conventional power stations directly (if steam or air is used as medium) or indirectly through a heat exchanging steam generator on the turbine unit which then drives the generator.

Solar thermal power is a relatively new technology which has already shown enormous promise. With few environmental impacts and a massive resource, it offers opportunities to the sunniest countries of the world comparable to the breakthrough offshore wind farms are

currently offering European nations with the windiest shorelines.

The solar thermal system produces thermal power from the heat of the sun. The key operating principle is the thermal collectors must reach a temperature higher than the object to be warmed for the system to operate with a positive energy gain. Therefore the colder the object to be warmed, the less solar energy required to produce an energy gain. Once the collectors are hot enough, a pump is turned on to circulate water through the collectors and transfer their heat to one of two heat exchangers located in the house.

II. ENVIRONMENTAL IMPACT

Solar thermal power plants produce electricity in much the same way as conventional power stations. The difference is that they obtain their energy input by concentrating solar radiation and converting it to high temperature steam or gas to drive a turbine or engine. Four main elements are required: a concentrator, a receiver, some form of heat transport media or storage, and power conversion. Many different types of systems are possible, including combinations with other renewable and non-renewable technologies.

Competition with the economics of solar thermal power plants comes mainly from conventional grid-connected fossil fuel-fired power plants, particularly the modern natural gas-fired combined cycle plants in mid-load or base-load operation mode. In small-scale off-grid generation systems, such as islands or developing countries, the competition comes from gas oil or heavy fuel oil-powered diesel engine generators.

III. OPPORTUNITIES FOR SOLAR THERMAL POWER GENERATION IN INDIA

Solar thermal power generation can play a significant important role in meeting the demand supply gap for electricity.

- Rural electrification using solar dish collector technology
- Typically these dishes care of 10 to 25 kW capacity each and use striling engine for power. These can be developed for village level distributed generation by hybridizing them with biomass gasifier for hot air generation.
- Integration of solar thermal power plants with existing industries such as paper, dairy or sugar industry, which has cogeneration units. Many industries have steam turbine sets for cogeneration. These can be coupled with solar thermal power plants. Typically these units are of 5 to 250 MW capacities and can be coupled with solar thermal power plants. This approach will reduce the capital investment on steam turbines and associated power-house infrastructure thus reducing the cost of generation of solar electricity

- Integration of solar thermal power generation unit with existing coal thermal power plants. The study shows that savings of up to 24% is possible during periods of high insolation for feed water heating to 241 C.

IV. ADVANTAGE OF SOLAR THERMAL POWER

Solar-thermal power stations have several advantages over solar-photovoltaic projects. They are typically built on a much larger scale, and historically their costs have been much lower. Compared with other renewable sources of energy, they are probably best able to match a utility's electrical load, says Nathaniel Bullard of New Energy Finance, a research firm. They work best when it is hottest and demand is greatest. And the heat they generate can be stored, so the output of a solar-thermal plant does not fluctuate as wildly as that of a photovoltaic system. Moreover, since they use a turbine to generate electricity from heat, most solar-thermal plants can be easily and inexpensively supplemented with natural-gas boilers, enabling them to perform as reliably as a fossil-fuel power plant.

Solar systems have a number of positive attributes that are likely to promote greater use.

- They provide no exhaust gases (there may be some related emissions from pumping energy if required)
- Good quality collectors will have a life of 20 to 30 years
- Long term independence from fuel price inflation
- Total cost analysis predominantly based on known initial capital cost
- Low maintenance
- Potential for government subsidies
- Certainty of fuel supply
- They can enhance the environmental credibility of building

V. CHALLENGES

The most obvious is competition with abundant and inexpensive coal. Until more nations begin taxing carbon emissions, especially the United States and China, the cost of coal-fired plants will remain economical. Every ten days another coal power plant is built in the People's Republic.

A. Land Requirements

Another challenge for solar thermal is the amount of space required for efficient production of energy. Not only space, but space that gets a consistent amount of direct sunlight. Solar thermal power plants typically require 1/4 to 1 square mile or more of land. One silver lining of global climate change and human impact on the land is that more and more farmland is becoming unsuitable for agricultural production. This land, presumably originally chosen for its sun exposure, begs to be used for solar thermal energy production. Utilization of desertification can prove to be a boon for solar thermal real estate procurement and growth.

B. Biomass Heating

Biomass heating is an alternative and renewable source of home heating that is growing in popularity. This is largely due to its affordability over more traditional fuel types and the fact that Maine has significant, locally produced wood fuel resources.

C. Biomass Briquetting

It is the process of converting low bulk density biomass into high density and energy concentrated fuel briquettes. Biomass Briquetting plants are of various sizes which convert biomass into solid fuels. Briquettes are ready substitute of Coal/wood in industrial boiler and brick kiln for thermal application. Biomass briquettes are Non-conventional Source of energy, Renewable in nature, Eco friendly, nonpolluting and economical. Process of converting biomass to solid fuel is also non-polluting. Briquettes produced from briquetting of biomass are fairly good substitute for coal, lignite, firewood and offer numerous advantages:

- Briquettes are cheaper than coal.
- Oil, coal or lignite, once used, cannot be replaced.
- High sulfur content of oil and coal, when burnt, pollutes the environment. There is no sulfur in Briquettes.
- Biomass briquettes have a higher practical thermal value and much lower ash content (2-10% as compared to 20-40% in coal).
- There is no fly ash when burning briquettes.
- Briquettes have consistent quality, have high burning efficiency, and are ideally sized for complete combustion.
- Combustion is more uniform compared to coal and boiler response to changes in steam requirements is faster due to higher quantity of volatile matter in briquettes.
- Solar PV systems have been come out as a very useful energy source for the last three decades. Some of the main applications are:
 - Space Power System
 - Low power Military applications at remote locations
 - Standalone Residential and Industrial applications
 - Home appliances
 - Mobile power systems
 - Home appliances (Low power electronic applications)

Briquettes are usually produced near the consumption centers and supplies do not depend on erratic transport from long distances.

VI. OTHER USES OF SOLAR THERMAL

There are many other uses for solar thermal technology. These include refrigeration, air conditioning, solar stills and desalination of salt water and more. More information on these technologies is available in the relevant texts given in the reference section at the end of this fact sheet.

Solar thermal power stations

There are two basic types of solar thermal power station. The first is the 'Power Tower' design which uses thousands of sun-tracking reflectors or heliostats to direct and concentrate solar radiation onto a boiler located atop a tower. The temperature in the boiler rises to 500 - 700EC and the steam raised can be used to drive a turbine, which in turn drives an electricity producing turbine.

The second type is the distributed collector system. This system uses a series of specially designed 'Trough' collectors which have an absorber tube running along their length. Large arrays of these collectors are coupled to provide high temperature water for driving a steam turbine.

Such power stations can produce many megawatts (MW) of electricity, but are confined to areas where there is ample solar insolation. Solar thermal power plants with a generating capacity of 80 MW are functioning in the USA.

A. Facts about solar thermal energy

- Australia has the highest average solar radiation of any continent. This means we have the potential to lead the world in solar energy production. Go Australia!
- Another form of solar thermal energy is known as 'passive thermal energy'. You don't need any fancy equipment to harness passive thermal energy. It simply involves using the heat from the sun to do things such as dry our clothes or warm us up in cold weather.
- There are only a small number of solar thermal power stations currently operating in Australia. The largest is the Liddell Power Station in New South Wales.
- Solar power is a zero-emission electricity source and one megawatt hour (MWh) of solar-derived electricity prevents about one tone of carbon dioxide (CO₂) from being released into the atmosphere.

VII. CONCLUSION

Energy is one of the most important requirements for this world to function properly. Its availability and regular supply are of paramount interest. As we are all aware, energy and fuel prices are rising day by day and the negative effects of global warming are more and more visible. Solar thermal power stations are among the most cost-effective renewable power technologies; they promise to become competitive with fossil-fuel plants within the next decade. Solar power is a zero-emission electricity source and one megawatt hour of solar-derived electricity prevents about one tone of carbon dioxide (CO₂) from being released into the atmosphere. Biomass heating is an alternative and renewable source of home heating that is growing in popularity. This is largely due to its affordability over more traditional fuel types and the fact that Maine has significant, locally produced wood fuel resources.

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