Anindya Lahiri
Consultant
A.T.E. Enterprises Private Limited,
Pune

After a university degree in chemical engineering, Mr Anindya Lahiri has about 40 years of wide-ranging experience in energy and environment fields, including renewables. During his career, he has demonstrated expertise in sales, marketing, strategic business planning, starting up new businesses, profit centre management, establishing dealer networks, business development, product development, precision manufacturing, business acquisition, key account management, and organization building. He retired as President and Head of Operations at HMX Business Unit of A.T.E. Enterprises Private Limited on 30 June 2021. Post his retirement he has started working as a consultant with the A.T.E. Group for developing the solar thermal business in the domestic market and the IoT business in the international markets.

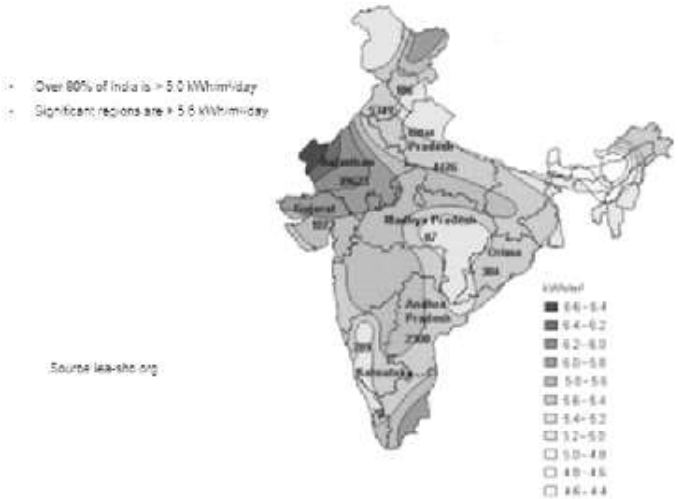
Save With Heat From the Sun

Introduction

The world is facing grave challenges posed by carbon emissions leading to climate change. All stakeholders are pulling together with long-term plans to switch over to renewable energy from carbon intensive fossil fuels. Sooner this is achieved, the better it is for the world and humanity.

India has set an ambitious target to be 'net zero' by 2070. The government has actions planned immediately and is committed to reduce carbon emission by one billion tonnes by 2030 and to reduce emission intensity of nation's economy by 45% by the end of the decade. India further plans to expand its installed capacity of renewable energy to 500 GW by 2030. As of 31 December 2021, the total installed capacity for renewable energy in India is 151.4 GW with solar power contributing to 49.34 GW (Source: www.investindia.gov.in/sector/renewable-energy).

India's potential for harnessing solar power is immense given the medium to high radiation in many parts of the country. The solar map of our country given below gives an idea of our advantageous position in terms of availability of solar radiation.



It is clear from the above map that solar potential is excellent to very good in the states of Rajasthan, Gujarat, Tamil Nadu, Ladakh, and good in several other states apart from a few coastal areas and areas which are affected by rain during most times in the year.

Solar Energy – Alternative Technologies

The two solar energy technologies are:

- Solar Photovoltaic – this technology directly converts sunlight into electricity using panels made of semiconductor cells
- Solar Thermal – this technology captures the sun's heat. The heat generated from solar thermal can be used for power generation and for low and medium temperature process heating.

According to Bloomberg NF report, industrial process heat accounts for 29% of the world's total energy demand, and out of this 31% is the share of low temperature heating up to 150 °C. In India, the share of the requirement is 7% of the global demand for process heating.

In this article, we will be discussing decarbonising the industrial process heat demand through solar thermal technology deployment.

Solar Technology Comparison – Photovoltaic v/s Thermal

The table below makes a technology comparison between Solar Photovoltaic (PV) and Solar Thermal. Under Solar Thermal I have considered in depth two products, i.e. Compound Parabolic Concentrator (CPC) and Parabolic Dish (PD).

Different Solar Thermal Products

Let us now have a close look at the different products that come under this technology, their technical parameters, output, and applications.

(CPC - Compound Parabolic Concentrator, ETC - Evacuated Tube Collector, FPC - Flat Plate Collector, PTC - Parabolic Trough Collector, PD - Parabolic Dish)

As, it can be seen from the above diagram, thermal technology comes in two types: non-imaging and imaging. Non-imaging refers to products which are non-tracking. CPC, ETC, and FPC are the products that come under non-imaging type. Imaging refers to products which track the path of the sun and it includes products such as PTC, Scheffler, and PD.

Product Overview

Now, let us look at the brief overview of these products including their output and applications:

Parameters	Solar PV	Solar Thermal (CPC & PD)
Output produced	High grade electricity	Low grade heat energy
EM spectrum utilized	Visible	Infrared
Efficiency	14 to 18%	60 to 65%
Energy output, kWh/m^2 per day (At 5 kWh/m^2 per day)	0.7 to 0.9 kWh	3 to 3.25 kWh
Area required for 1 kW	8 to 10 m^2	2.5 to 3 m^2
Performance in India	System power output decreases with rise in ambient temperature	System output improves as ambient temperature rises
Subsidy	Not available	May be available

i. Flat Plate Collectors (FPC)

- Non tracking technology
- Concentration ratio is 1
- Natural circulation
- Goes up to maximum 50°C with its efficiency range
- Provides hot water that is mainly used for bathing

ii. Evacuated Tube Collector (ETC)

- Non-tracking technology
- Concentration ratio is 1
- Natural circulation
- Goes up to 60°C with its highest design efficiency range
- Provides hot water that is used for bathing and for other medium temperature applications

iii. Compound Parabolic Concentrator (CPC)

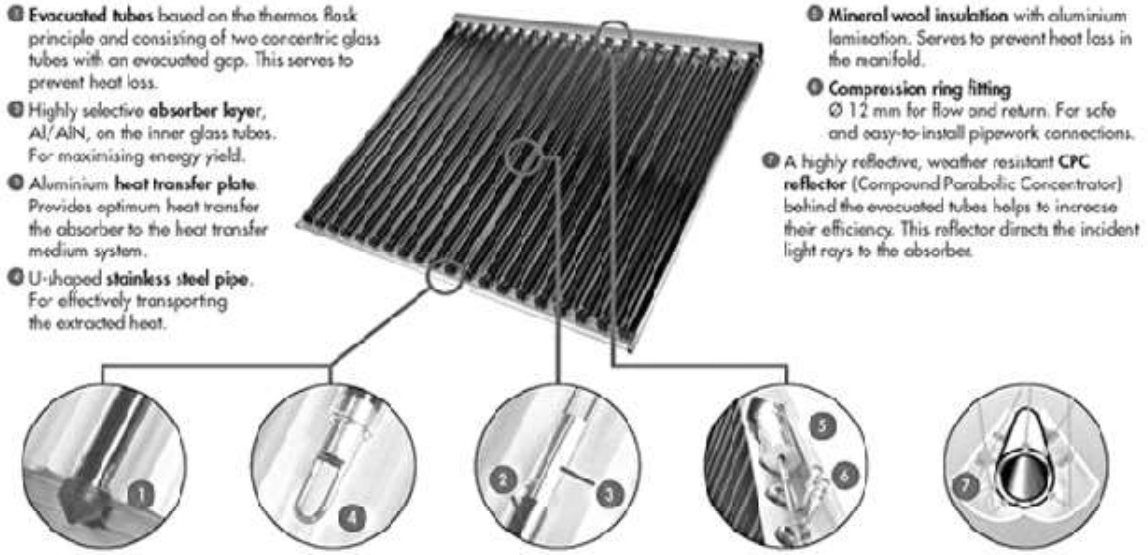
- Non-tracking technology
- Concentration ratio is 2 to 5
- Forced circulation
- Goes up to 95°C with its efficiency range
- Provides hot water suitable for process heating

Part description of Compound Parabolic Concentrator (Source: linuo-ritter-international.com)

The reflector below the vacuum tubes carrying hot water does not allow the radiation to escape and it gets reflected to the surface of the tubes. This increases the efficiency of the CPC and can be used for higher temperature up to 90°C in a non-pressurised system.

iv. Parabolic Trough Collector

- Single axis solar concentrator
- Concentration ratio is 15 to 45



- Forced circulation
- Provides steam with a temperature of up to 120°C with its efficiency range
- Mainly used for process heating applications

v. Scheffler Dish (SD)

- Single axis solar concentrator
- Concentration ratio is 10 to 15
- Forced circulation
- Temp at receiver is 750°C to 800°C
- Steam pressure goes up to 2.5 bar
- Mainly used for steam generation

vi. Parabolic Dish (PD)

- Double axis solar concentrator
- Concentration ratio is 100 to 350
- Forced circulation
- Temp at receiver is 900°C to 1000°C
- Steam pressure goes up to 4 bar
- Mainly used for steam generation

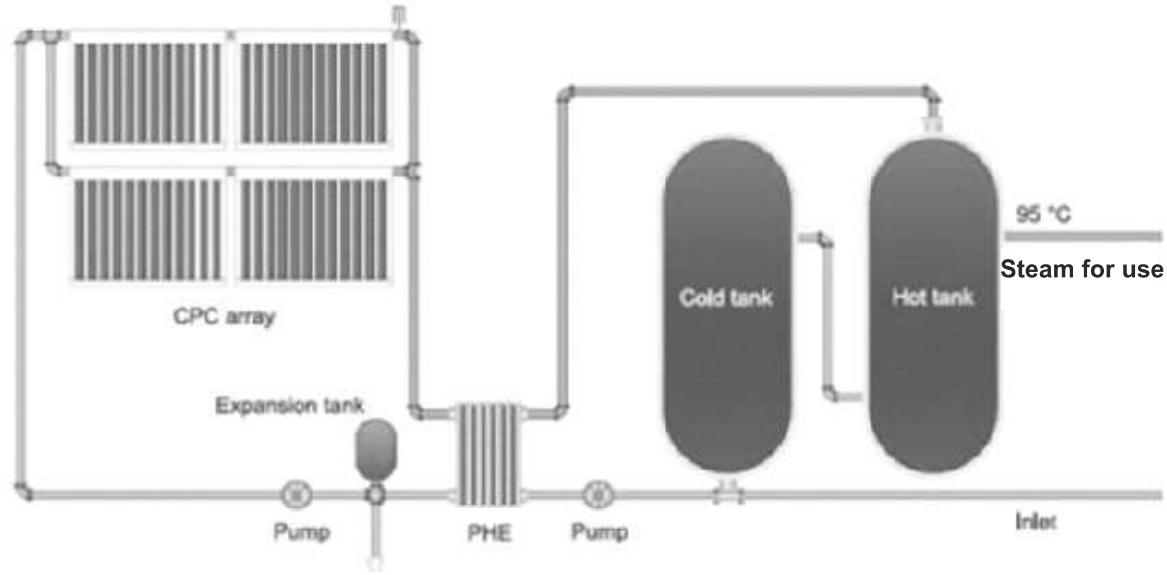
Efficiency comparison of various products

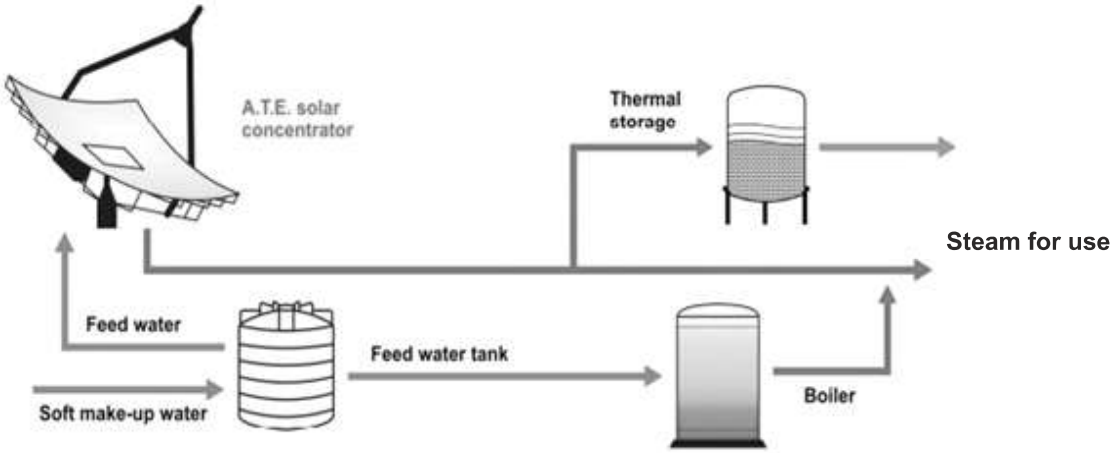
It would be instructive to look at the efficiency comparison of these products for a better understanding. To begin with, we need to understand the concept of concentration ratio which determines the efficiency of the solar thermal products.

Concentration ratio = Area of reflector/Area of focus

- Concentrate the solar radiation at one point to increase its intensity for further process use

- Temperature at the focus can be increased as per the requirement





Measuring and Monitoring

Currently, digital tools like Intelligence of Things (IoT) are available to measure parameters like real time solar radiation, steam pressure, ambient, inlet and outlet temperatures, fuel saved, etc. Such tools give clear visibility about the system efficiency, operational deficiencies, etc., helping to optimise the system.

Summary

Industrial process heating through solar thermal technologies for high temperature hot water and low-pressure steam can become a part of the bigger solution to climate change and can contribute to carbon emission reduction. Solar radiation is abundant in India and has the potential to make our country a better place to live in. It would be in the interest of the industries to adopt renewable energy sources in their operations as they drive towards business growth and profitability and be the flag bearers of sustainability, thus contributing to the fight against climate change! And moreover, the investment in renewable energy is a paying proposition in the long run, adding to the bottom-line.