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## Navigate the energy crisis Solar Thermal Technologies

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# The Role of Solar Thermal Technologies in Decarbonizing the Heating Sector

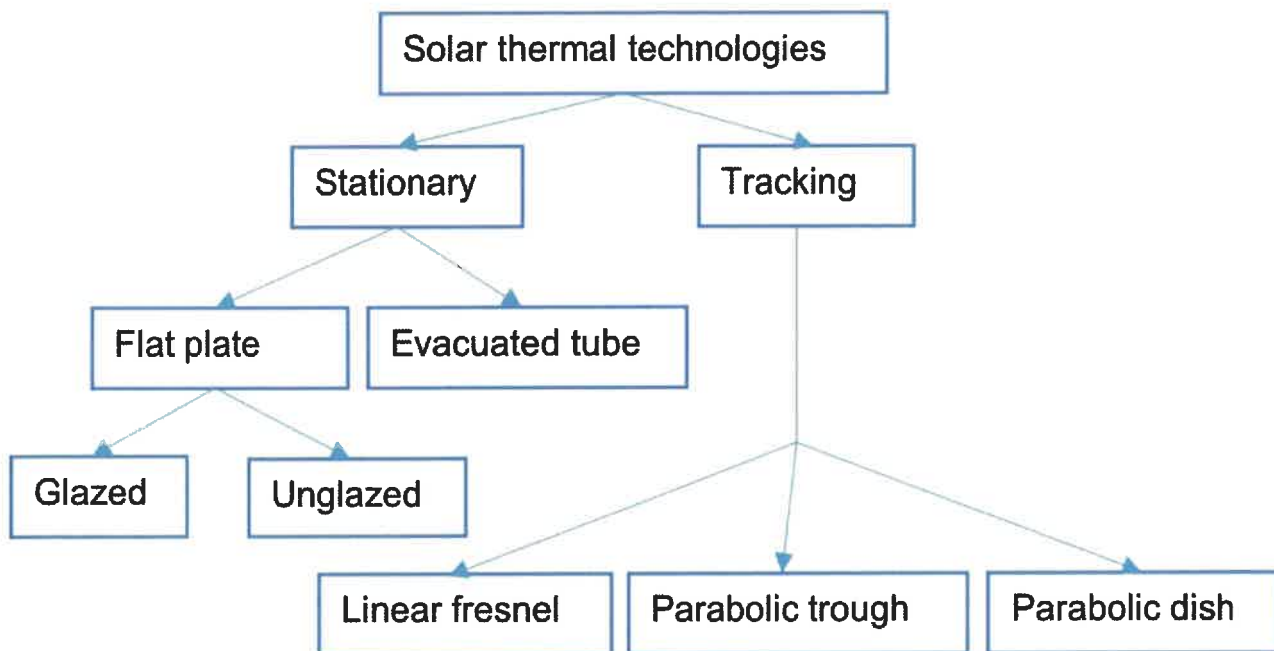
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**H**eat generation and utilization has a great role to play in transition to renewable energy. According to Renewables 2022 Renewable Heat Analysis and Forecasts to 2027 Report, the largest energy end use in the world, accounting for about half of total final energy consumption, is heating, with industrial activities accounting for 53% of the total energy used for heat while buildings for space and water heating as well as, to a lesser extent, cooking, account for 44%. The remaining portion is largely utilized in agriculture for greenhouse heating. Fossil fuels make up almost two thirds of the energy used for heating thus presenting a great opportunity for the heating sector to be decarbonised. Efficient and low-carbon heating technologies exist which can be used to decarbonise the industrial heating sector. However, the rate of deployment of these low-carbon heating or solar thermal technologies will have to be increased to align with the Net Zero Emissions by 2050 Scenario. Solar thermal technologies, coupled with favourable weather conditions present a great opportunity to the industrial, commercial, and

agricultural sector, as well as the residential sectors. South Africa is one of many countries with favourable solar resource potential. For example, many places in South Africa have a solar resource potential (Direct Normal Irradiation) of 1800kWh/m<sup>2</sup>/year, which is said to be a minimum solar resource potential for a concentrating solar-thermal (CST) technology like parabolic dish, parabolic trough and linear fresnel systems which can operate up to a temperature of 400°C. However, many processes, particularly, in the agricultural sector will not even require a CST technology but can make use of the conventional flat plate collectors (FPC) operating at 100°C and advanced evacuated tube collectors (ETC) operating at temperatures up to 250°C. This article will discuss in more detail some of the solar thermal technologies which can be used in industrial, commercial, and agricultural sectors, as well as the residential sector.

## **Solar thermal technologies**

Solar thermal energy technologies can be stationary without a tracking system or can be tracking the sun from east to west (see diagram below), thus maximising the energy



output. The diagram represents a simplified grouping, however, there are other solar thermal technologies which are not part of this article's scope.

Conventional flat plate and evacuated tube collectors as well as concentrating solar-thermal technology are discussed below.

### Conventional flat plate and evacuated tube collectors

Flat plate and evacuated tube collectors are the conventional water heating systems used for heating water. A flat plate collector is a solar panel device designed to absorb solar energy to generate thermal energy. It uses water as an operating fluid. Water is pumped through the heat absorbing plate and the water removes the heat from the flat plate collector's heat absorber as it passes through it. The average operating temperature of the collector is 100°C. The evacuated tubes collector system is made of rows of parallel transparent glass tubes connected to a header pipe where the heat transfer fluid circulates and absorb heat generated by tubes. The heat transfer fluid is then used to heat water. The evacuated tube collector system is very efficient even in cloudy conditions. Advanced ETC systems have been modified to operate up to 250°C (however, at a high cost), thus covering a wider range of processes. Both FPC

and ETC water heating systems are common in residential buildings, however, they can easily be employed in commercial and industrial settings where hot water is needed, such as in food processing and farming operations.

### Concentrating Solar-thermal technology

CST technologies like parabolic trough, parabolic dish and linear fresnel systems are the same systems used for power generation in utility-scale electricity generation. CST technologies use curved mirrors to reflect and concentrate sun's rays onto a receiver. The energy from concentrated sun's rays is used to heat a heat transfer fluid in the receiver. The thermal energy from the heat transfer fluid can be used in a heat exchanger to generate hot water or steam. For example, if a CST technology is used for low temperature below 50°C, a Flat plate heat exchanger can be used. For temperatures, above 50°C and below 150°C, a shell and tube heat exchanger can be used, whereas, for generating a steam, a solar steam generator can be used. Although the CST technologies have gained much traction in countries like China, USA, India, they are still uncommon in South Africa. However, in the Northern Cape, there are several power stations operating with CST technology.

The operation of small-scale CST technologies, particularly for industrial process heat still



**Figure 1: Parabolic Trough System, ARC-AE, Silverton Campus**

remains an untapped market although there is great potential. Hence, ARC-NRE initiated a project on the testing of parabolic trough collector (See Figure 1). The parabolic trough collector was integrated to an essential oil extraction system (Steam distillation process) and the results showed the system to be competing well with electric, gas and biomass boilers which are dependent on fossil fuels.

#### **Example of applications**

Processes which can benefit from the use of solar thermal energy technology include:

- 1. Dairy Industry:** Washing (60-90°C), Pressurization(60-80°C), Concentrates(60-80°C), Sterilizing(100-120°C)
- 2. Meat Industry:** Washing(60-90°C), Sterilizing(60-90°C), Cooking(90-100°C)
- 3. Beverages Industry:** Washing(60-80°C), Sterilizing(60-80°C), Pasteurization(60-70°C)

- 4. Tinned food Industry:** Sterilizing(110-120°C), Pasteurization(60-90°C), Cooking(70-90°C), Bleaching(70-90°C)
- 5. All industries:** Solar cooling (55-180°C), Heating of factory buildings(30-80°C), Preheating of boiler feed water(30-100°C)

There are many more industries that can be integrated to solar thermal energy technologies and they include: timber-by-products, paper, flour and by-products, bricks and blocks, textile, plastics as well as the chemical industry. Nearly 50% of these industries' processes operate in low- and medium- temperature, and these temperature requirements can easily be met by using solar thermal energy technologies.

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