Parabolic Trough Collectors

Factsheet 3: Integration of solar energy in district heating

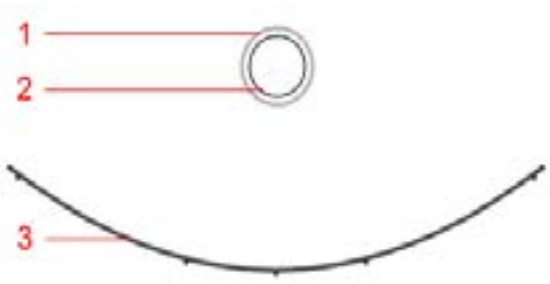
General Information

Two collector rows of the parabolic trough collector field in Brønderslev, DK. The 16.6MW/$_h$-Plant has an aperture area of 29'929 m² and is combined with a biomass-organic rankine cycle for combined heat and power generation. Foto: Brønderslev Forsyning.

General

Parabolic trough collectors (PTC) consist of long, curved mirrors arranged in a parabolic shape to focus sunlight onto a receiver tube located at the focal line of the parabola. Therefore, they reach elevated temperatures and provide extremely low heat loss in the collectors. In large concentrated solar power systems, they can reach up to 500°C. Smaller (e.g. rooftop) models can still reach 300°C, although the temperature used for district heating systems is much lower. To keep the focus on the absorber tube, a sun tracking support system, which moves the collector throughout the day is needed. PTC collectors are therefore able to follow the sun and reach better efficiencies at flat incidence angles in the beginning and the end of the day. Because of the focussing mirror, diffuse sunlight is not harvested, and PTC collectors are therefore suitable for regions with an elevated fraction of direct sunlight. furthermore, they have the advantage of being able to tilt the collectors downwards for cleaning, snow or hail protection, and can be de-focused when there is no energy demand.

Construction



1 Glazing
2 Absorber
3 Mirror

The mirrors of a PTC are coated with a highly reflective material to collect and focus the sunlight onto the absorber tube. Absorber tubes are protected from environmental influences and heat loss with a glass layer. Depending on the required temperatures, the gap between the glass and the absorber can be filled with gas or vacuum for a further minimization of heat losses. The temperature inside of the receiver tubes can reach values higher than 500°C; but are usually operated at lower temperatures of up to 150°C for district heating networks. The collectors are typically mounted along the north-south axis on a sun-tracking support structure. This structure changes the tilt of the collector throughout the day, ensuring that the mirrors are always focused on the receiver.

Area	0.5-5 m width, 4-12 m length
Investment cost [a]	120 - 500 CHF/m²
Temperature range	100 - 500 °C
Life expectancy	>30 years

[a] without planning and heat exchanger cost

Materials

Absorber	Metal	Ø 2-8 cm
Reciefer Cover	Glass	1.6-3mm
Insulation	Air or Vacuum	
Reflector	Aluminum or Coated Glass	

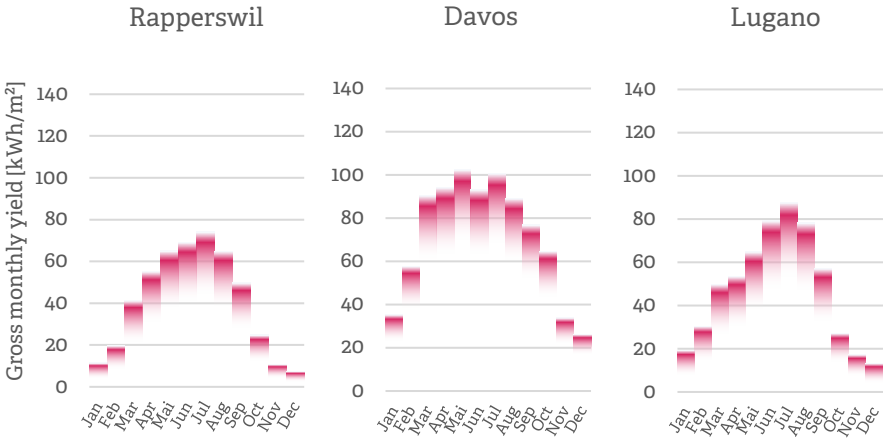
Advantages

- High temperatures possible
- Easy switch off by tracking system
- Output distributed over the whole day due to the tracking system

Disadvantages

- Mechanical tracking system needed
- Diffuse radiation not used
- Difficult roof integration
- Sensitive to soiling and dust

Typical collector output



Annual yield* [kWh/m²]

	50 °C	80 °C
Rapperswil	449	418
Davos	786	745
Lugano	525	489

* Yield of a good product at a constant average operating temperature for a tracked system with north-south orientation. Values refer to gross collector area.

Situation in Switzerland and worldwide

The main application of parabolic trough collectors is the generation of industrial process heat above 100 °C, for which there are many successful examples worldwide. Parabolic trough collectors are also used in the food industry in Switzerland, e.g. at CREMO in Fribourg. In recent years, some very large systems have been built to support district heating networks with high flow temperatures, with parabolic troughs sometimes being connected in series with flat-plate collectors.

Examples:

Name	Country	Area	Year
Bronderslev	DK	26'900 m²	2018
Högslätten	SE	3'000 m²	2023
CREMO Freiburg	CH	627 m²	2012

Collector manufacturers

- Absolicon
- Solarlite CSP
- Torresol Energy
- Solitherm
- SBP Solar
- Aalborg CSP

Relevant sources & further information

- Webpage *on solar district heating*
- IEA-SHC Task68: *Efficient Solar District Heating Systems*
- SolCAD: *Potentiel du solaire thermique dans les chauffages à distance en Suisse*
- BioSolFer: *Integration von Solarwärme in Biomasse Fernwärmenetze*

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