Evacuated Tube Solar Collectors

Factsheet 2: Integration of solar energy in district heating

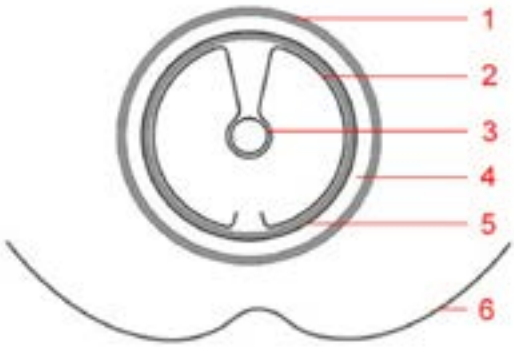
General Information

Evacuated tube collectors provide heat for the network of WLS in Schüpfen CH.

General

Evacuated tube solar collectors (ETC) consist of a series of glass tubes that are evacuated to create a vacuum, with a metal absorber tube located inside the glass tube. The selective coating on the absorber tube enhances the absorption of solar radiation and minimizes the amount of heat that is lost through thermal radiation. A vacuum insulation minimizes heat loss and allows the collector to maintain high temperatures even in adverse weather conditions. ETC are used to generate temperatures up to 150 °C, but can reach stagnation temperatures over 300 °C. When connected to district heating systems, they achieve annual energy outputs in the range of 500-800 kWh/m² (gross) under Swiss conditions.
The low thermal losses allow direct integration into a water-bearing network. To prevent freezing during cold winter nights, some energy is used to keep the collector field temperature above zero degrees. For district heating systems, special large scale collectors with a surface area of up to 15 m² are available.

Construction



1 Cover glass
2 Conductive sheet
3 Heat carrier
4 Vacuum
5 Absorber coating
6 CPC reflector

Vacuum tube solar collectors use vacuum inside a glass tube to reduce thermal losses. The most common collectors are based on the so-called Dewar principle, where a high vacuum exists between an inner and an outer glass tube. A selective layer, which absorbs the sunlight but emits little heat radiation, is usually applied to the inner glass wall. An aluminum sheet, which is no longer in the vacuum, touches the inner glass wall and conducts the heat to a fluid-carrying tube, usually made of copper. There are also vacuum tube collectors in which a metal absorber fin is placed directly in the high vacuum. Optionally, compound parabolic collectors are fitted with specially shaped reflective plates that reflect the radiation passing between the vacuum tubes back to the absorbers.

OST
SPF Institut für Solartechnik

Area	1 - 15 m²
Investment cost [a]	280 - 450 CHF/m²
Temperature range	60 - 120 °C
Life expectancy	>30 years

[a] without cost for planning and permits

Materials

Absorber	Alu/Copper	0.2 - 0.4 mm
Piping	Alu/Copper	12 - 40 mm
Cover	Low iron glass	3 - 4 mm
Insulation	Mineral wool	5 -10 cm
Casing	Metal (Alu/Steel)	

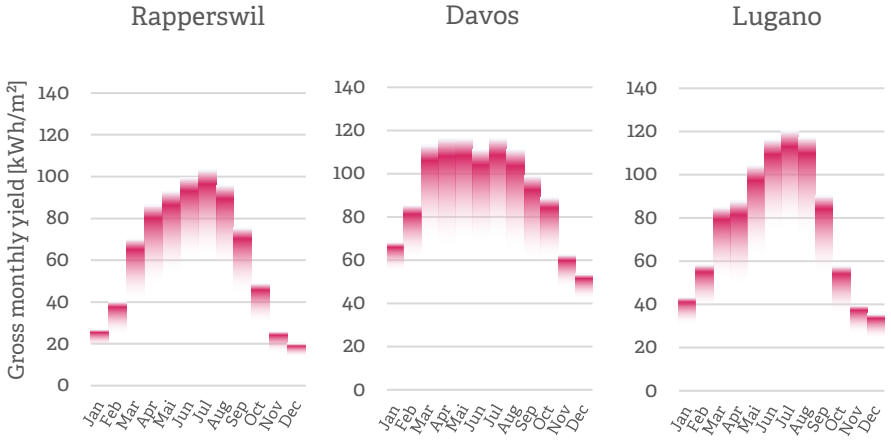
Advantages

- Low heat losses
- Elevated temperatures reachable
- Good harvesting of direct an diffuse radiation
- Elevated efficiency at flat incidence angles
- Horizontal installation on flat surface possible

Disadvantages

- Solar inactive header needed
- Glass tube production in far east

Typical collector output



Annual yield* [kWh/m²]

	50 °C	80 °C
Rapperswil	714	608
Davos	1038	905
Lugano	868	752

* Yield of a good product at a constant average operating temperature for a 30° tilted collector facing south. Values refer to gross collector area.

Situation in Switzerland and worldwide

Vacuum tube collectors dominate the global solar thermal market due to the Asian market for domestic hot water. Several large installations exist in Europe, including Germany's largest solar thermal field in Greifswald. Switzerland also has some large VTC installations in district heating networks, large building complexes or for process heat generation.

Examples:

Name	Country	Area	Year
Greifswald	D	18'800 m²	2022
Lemgo	D	9'200 m²	2022
TicTricTrac Zürich	CH	1'000 m²	2020
HUG Geneva	CH	510 m²	2023
Wärmeverbund Lyssbach	CH	460 m²	2012

Collector manufacturers

- Ritter XL
- Viessmann
- SUNDA
- Micoe

(not exhaustive list)

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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