

Solar Energy System of the Month:

Solar Magazine

- . [Solar energy for heating and cooling](#)
- . [The Combined Power Plant: first stage in providing 100 % power from renewable energy](#)
- . [PV-TEC – Research factory for solar cells](#)
- . [Solar power system offers protection against blackouts](#)
- . [Power for Africa: solar hybrid systems for rural electrification](#)
- . [Economic feasibility of PV systems in Germany: more than just a little sunshine](#)
- . [The world's largest photovoltaic solar power plant is in Pocking](#)

- . [Solar Report](#)
- . [Solar News](#)
- . [Solar Interviews](#)
- . [Solar News Archive](#)
- . [Solar Links](#)
- . [Solar Energy System of the Month](#)
- . [Solar Archive:](#)
 - . [Photovoltaics](#)
 - . [Solar heating](#)
 - . [Solar Building](#)
 - . [Fuel Cell](#)
 - . [Solar News Archive](#)

Solar energy for heating and cooling: the world's largest solar thermal vacuum tube collector system provides power for the largest adsorption cooling system worldwide

Festo AG & Co. KG (Esslingen) not only provides solutions for industrial and process automation. It also lives up to its innovation goals with its very own energy concept. At its head offices in Esslingen-Berkheim near Stuttgart in Germany, Festo runs the largest solar adsorption cooling machine of Europe, possibly of the world. At its production and logistics site St Ingbert (Saarland, Germany), Festo integrates state-of-the-art technologies such as fuel cells, combined heat and power units and photovoltaic systems to form an environmentally friendly energy mix. In Esslingen the solar thermal system cools and heats the office buildings. By incorporating the solar thermal system into the heating system, an annual amount of 500 MWh of primary energy will be saved – a significant contribution to the reduction of CO₂ emissions and to the protection of the environment and resources. "As an innovative company we also want to set benchmarks in protecting our environment," Dr Eberhard Veit, Head of Product and Technology Management and spokesperson of the board of Festo AG, emphasises.

As "Solar System of the Month" in March 2008 Solarserver hereby presents the large-scale solar-thermal plant and highlights the energy concept as well as its first operational experiences.



Solar heating and cooling: Field of solar collectors with a gross surface area of 1.330 m² on the roof of Festo AG & Co. KG in Esslingen. Photo: Paradigma Energie- und Umwelttechnik GmbH & Co. KG.

Solar Energy System of the Month as [PDF-Dokument](#)

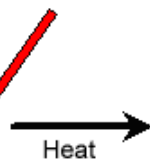
- . [Your Suggestion](#)



Solar-thermal process heat for buildings and production processes

Conventional air-conditioning systems and refrigerators work with electrically driven compressors that require more energy as the air that needs to be cooled gets warmer. The principle of solar cooling is to utilise the solar energy that is available in abundance during the hot months to cool buildings. The advantages of solar cooling are obvious – as soon as the demand for air-conditioning increases, the availability of solar energy also increases. Thus buffer storage units can be omitted or at least decreased in size in comparison to solar systems used only for heating purposes. A stagnation due to a low demand of solar energy can be largely avoided. Depending on the respective application, different processes can be used for solar cooling. For example, buildings and rooms can be cooled with open air-conditioning systems by extracting water from the warm air in the room through adsorption to suitable materials. In this process, the air heats up, is then generally pre-cooled with waste air through a heat exchanger and is then humidified and cooled through the evaporation of water in the inflowing air. The air-conditioning system used by Festo is a closed system that contains water as a refrigerant in its circulation system. The cooled-down air is then distributed in the building through a separate circulation system. To allow the adsorption materials to take up moisture again, they are dried through the heat provided by the solar collector. The solar thermal collector can be used for cooling in summer, as well as for supporting heating in winter.

Solar yield

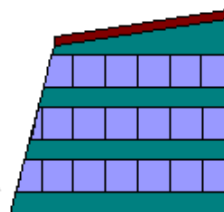


thermally driven
cooling process

Cold water

Conditioned air

Cooling load



Basic structure of a solar air-conditioning system. Source: Fraunhofer Institut für Solare Energiesysteme ISE

Besides heating and cooling residential and office buildings, solar-generated heat can also be used for industrial and commercial processes. In certain countries more energy is required for this purpose than for the heating and cooling of buildings. Solar process heat with temperatures of up to 250 °C can, for example, be used in chemical and textile industries in the manufacturing of paper or foodstuffs as well as in all other industries where vapour or hot water is used for washing, cooking or drying.

About 300 vacuum tube collectors support the largest adsorption cooling system of the world



[Gas Turbine Power Plants](#)

Buy/Sell Gas Turbine Power Plants. Save Time And Money Through IPPE!
IPPE.com

[Power plant water](#)

Alternative energy technologies Electricity generated from water
www.lenntech.com

[Solar Energy Great Prices](#)

Photovoltaic Solar Electric Systems Factory Direct Kits & Pro Installs!
www.SolarDirect.com

[Hot Stock Alert - GFET](#)

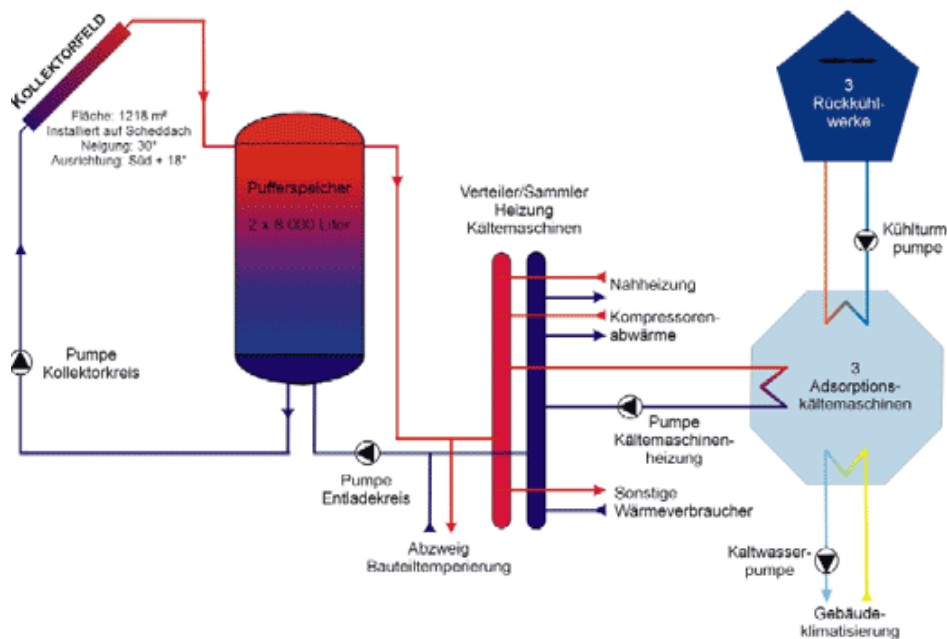
Ethanol, Biofuels, Alternative Green Energy Growth Stock.
www.GulfEthanolCorp.com

[Hydro turbines](#)

Repair, parts, testing water, power, industrial
www.weirservices.com

Head offices of Festo AG & Co. KG in Esslingen-Berkheim before the installation of the solar thermal system; aerial photograph of the collector field with a gross surface area of 1.330 m² (Photos: Festo AG & Co. KG; Paradigma Energie- und Umwelttechnik GmbH & Co. KG.)

With three MYCOM ADR-100 cooling machines that produce a nominal output of 353 Kilowatt (kW) each, Festo in Esslingen-Berkheim is currently running the largest adsorption cooling system of the world. The generated cold cools 26.760 m² of office space as well as three atriums with an area of 2.790 m². The cooling machines were thus far driven by heat from gas calorific value boilers as well as waste heat of compressors. As a third source of heat the solar system with vacuum tube collectors and an absorber surface of 1.218 m² were added which significantly decreased the gas requirement. The vacuum tube collectors are installed on a shed roof, are pitched at 30° to the horizontal and deviate from a southerly orientation to the west by about 17°.



Graphic presentation of the principles of a solar system. The collector field of 1.330 m² consists of 58 collectors of 3,29 m² each (CPC30) and 232 collectors of a gross surface area of 4,91 m² (CPC45). One CPC30 and four CPC45 respectively are switched in series. Graph: Hochschule Offenburg. [Wording of graph: Collector field; 1218 m² surface area installed on shed roof, 30° pitch, orientation south + 18°; Pump, Collector circuit; Buffer storage unit 2 x 8000 litres; Pump discharging circuit; Temperature control of components; Distributor/Collector, Heating, cooling machines; Proximity heating; Compressor waste heat; Pump cooling machine heating; Other heat consumption; 3 Re-cooling systems; Cooling tower pump; Adsorption cooling machines; Cold water pump; Air-conditioning of building]

The water in the collector circuit is heated by solar energy and is transported with a circulating pump to the two solar buffer storage units (of 8.500 litres each). The buffer storage units that are relatively small in comparison to the collector surface still store sufficient heat to cover the operation cycle of an adsorption cooling machine. The storage units are switched in series on the loading and unloading side. In winter, when the offices need no cooling, solar heat is used in support of heating the building. The combination of cooling and heating allows the price for solar energy to be decreased in comparison to when solar energy is used solely for cooling or solely in support of heating.



Solar storage units with a volume of $2 \times 8,5 \text{ m}^3$ in the solar centre of Festo AG & Co. KG in Esslingen. Photos: Hochschule Offenburg

A special feature of this system is the so-called AquaSystem with which only water is used as heat transfer fluid and the system is protected against frost with low-temperature heat. According to the manufacturer Paradigma, only 2 to 4 % of the annual solar energy yield is required for this purpose because of the low loss of thermal energy by the CPC vacuum tube collectors. A frost protection switch prevents the water from freezing in winter. This ensures that if temperatures drop below a certain specified value, warm water is pumped into the collectors. Some of the advantages of the water-only principle are that no heat exchanger is required to transfer the heat from the collector circuit to the heating system and that water has a higher thermal capacity than a water/glycol mixture.

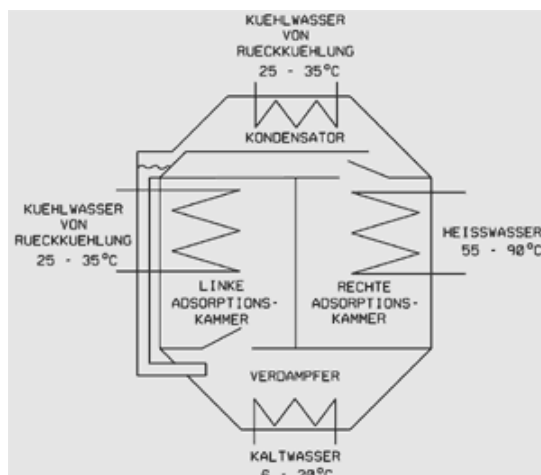


Photo: Paradigma Energie- und Umwelttechnik GmbH & Co. KG

Cooling machine evaporates water

In an adsorption cooling machine fluid (in Esslingen this is water) is evaporated in an evaporator. The energy required for this process (enthalpy of vaporisation) is drawn from the cold water circuit and this leads to the cooling effect. To ensure that sufficient amounts of water enter the gaseous phase at a low temperature already, a strong underpressure is generated in the cooling machine. The evaporated refrigerant is adsorbed on the adsorption agent (e.g. silica gel). The condensation heat being released in this process must be drawn off through re-cooling. If the silica gel is "loaded" with water the chamber is switched to desorption cycle. In this cycle the silica gel is heated to $55\text{-}90^\circ\text{C}$, water is freed from the silica gel (desorbed) and in the condenser it is transferred back to the liquid phase of the cooling machine. The condenser also needs to be re-cooled to draw off the condensation heat. The condensed water is fed back into the evaporator which closes the refrigerant circuit.

With adsorption cooling machines requiring only low temperature levels, they are particularly suitable for operation with heat from solar systems. The degree of solar utilisation depends on the temperature level of the system and is higher when temperatures are low.



Graph: Schematic presentation of a cooling machine; to ensure continuous operation of the cooling machine, two sorption chambers are required that alternate between adsorption and desorption cycles. Source: Hochschule Offenburg. [Wording of graph: Refrigerant water from re-cooling 25-35°C; Refrigerant water from re-cooling 25-35°C; Condenser; Hot water 50-90°C; Cold water 6-20°C; Left adsorption chamber; Condenser; Right adsorption chamber; Evaporator]

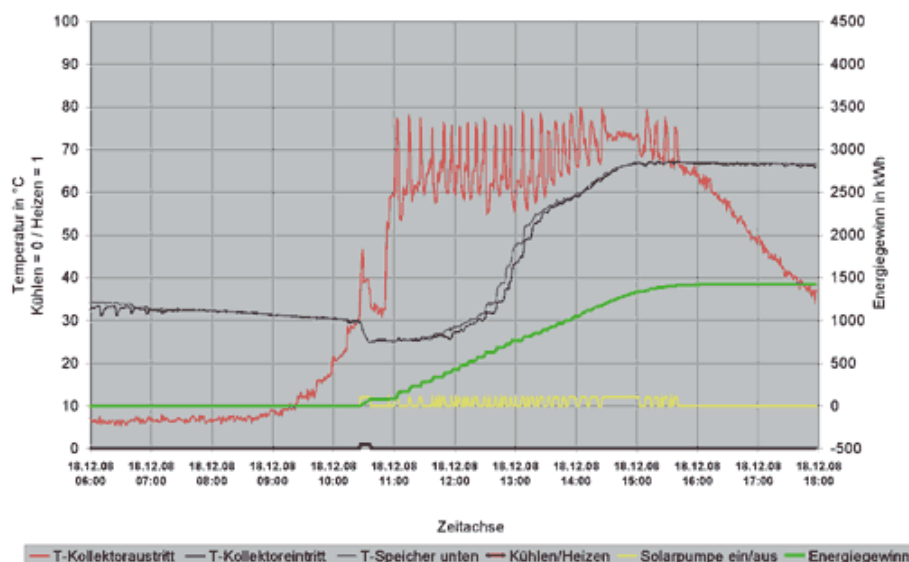
At an annual energy price increase of 12%, calculations of Paradigma show that the solar system will have been paid off after about 7,5 years already. Should the oil and/or gas price increase by “only” 6% per annum, the investment will have paid for itself after just under 10 years.

First operating experiences prove good performance, even on winter days

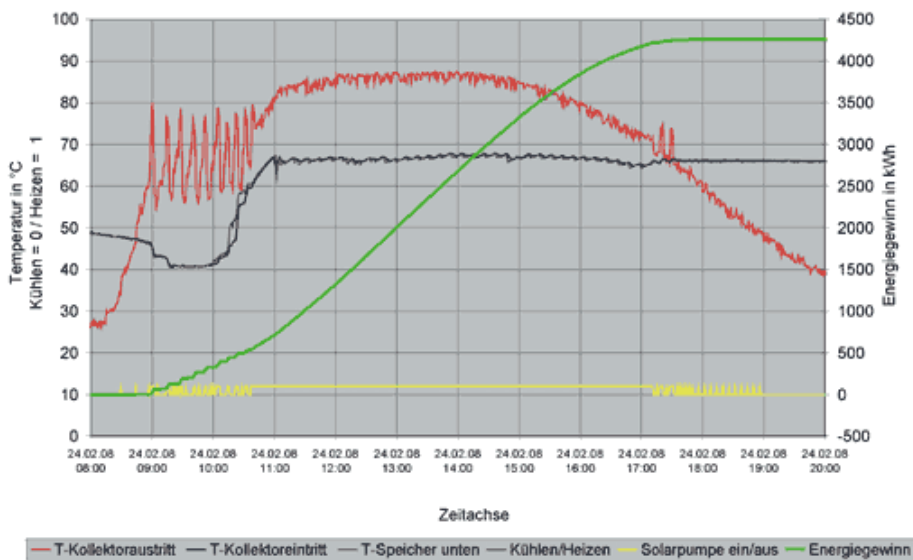
The solar thermal system was filled by a few specialists within half a day only and was put into operation. Many interested people had flocked together to witness this event: besides technicians from the companies Paradigma, FESTO and LEW representatives from the University of Offenburg were also present. This institution was appointed by the Federal Ministry of the Environment that supports the project financially to monitor the project.

The concept of “cockpit” filling and venting that can be carried out by only one person in the heating chamber without a single device being located on the roof, had already been proven possible in other solar thermal systems, but was a first for a plant of this size. No voltage came up and thanks to professional preparation commissioning went smoothly and unspectacularly, solar thermal experts from Paradigma emphasise. The venting of the pressure tanks was impressively loud, but took only a few minutes.

Recordings of operation on 18 Dec. 2007 – a frosty winter’s day with an outside temperature of a mere 5°C – show that it is easily and permanently possible to achieve the goal of 70°C and a thermal energy of almost 1,5 MWh in the storage units: a very good result for almost the shortest and coldest day of the year.



[Wording of graph: Temperature in °C; Cooling = 0 / Heating = 1; Energy yield in KWh; Time axis; T-Collector off; T-Collector on; T-Storage bottom; Cooling/Heating; Solarpump on/off; Energy yield] On 24 February 2008 conditions were even more favourable. At operating temperatures of far above 80 °C a total of almost 4,3 MWh could be fed into the storage unit. That amounts to a considerable 3,2 KWh per square metre of gross collector surface – a good result for a day in February. “Not a single flat collector would get these results, probably not even on a day in June,” Dr Rolf Meissner emphasises who is responsible for large-scale systems at Paradigma.



[Wording of graph: Temperature in °C; Cooling = 0 / Heating = 1; Energy yield in KWh; Time axis; T-Collector off; T-Collector on; T-Storage bottom; Cooling/Heating; Solarpump on/off; Energy yield]

Enormous potential for large-scale solar systems

Thus far solar thermics was virtually limited to small, private systems with a maximum thermal output of up to 10 KWh. In future more large-scale plants are to be utilised because these are economically more viable. On the one hand large-scale solar thermal plants have less specific thermal losses per square metre of collector surface, on the other hand they show more favourable statistic consumption profiles. Furthermore, they boast lower specific costs and a lower requirement of surface area (area for household technology per Kilowatt solar heat).



Left: Large-scale solar thermal system of a multi-storey apartment building near Katowice (Poland). Right: CPC collectors of an indoor and outdoor swimming pool in Ancona (Italy). Photos: Paradigma Energie- und Umwelttechnik GmbH & Co. KG.

With the large-scale solar-thermal plant in Esslingen Paradigma showed by way of an example how obstacles to large-scale solar thermal plants can be successfully overcome. With high-performance CPC vacuum tube collectors as "high-temperature motor", water as a heat transfer fluid and the solar regulator "SystaSolar Aqua" an astonishingly simple and thus attractive concept was made available to investors and fitters. Paradigma further points out that the noticeable demand showed that the market had waited for convincing collector solutions and concepts. By maintaining absolute sovereignty in the planning process of large-scale solar thermal plants with the AquaSystem, Paradigma ensures the highest possible degree of professionalism in each of these systems. On this basis Paradigma issues extensive manufacturer's warranties, including a five-year guarantee for yields and even a fifteen-year guarantee for damages caused by frost.

Some figures on the largest CPC vacuum tube collector system

| | |
|--------------------------|--|
| Solar energy utilisation | Solar cooling in summer with 75-95 °C Solar heating in winter with 50-70 °C |
| Collector surface | 1330 m ² gross surface area |
| Connecting pipes | 120 m, DN 100 |
| Volume flow | 30 m ³ /h |
| Heat storage unit[1] | 17 m ³ |
| Peak output | 1,2 MW |
| Max. permanent output | 0,65 MW |
| Guaranteed yield | 500 MWh per annum |
| Demand of electr. energy | 2,5 MWh per annum |
| Manufacturer's warranty | 10 years |
| Operating time | 20 years |
| Amortisation period | approx. 7,5 years at an annual energy price increase of 12% and/or approx. 9,3 years at an annual energy price increase of 6% (at 2,5% inflation, 3% capital interest rate and 2% operating costs) |



Photo: Paradigma Energie- und Umwelttechnik GmbH & Co. KG.

For further information:

- [Cooling with Solar Heat: Growing Interest in Solar Air Conditioning](#)

Author: Rolf Hug, Solarserver Editor. Material and photos: Paradigma Energie- und Umwelttechnik GmbH & Co. KG; Hochschule Offenburg

Project partners:

| | |
|--|--|
| Operator: | Sponsor: |
| Festo AG & Co. KG Ruiter Strasse 8273734 Esslingen Dipl.-Ing. Bernd Bruy (Head: Facility Management) Tel. 0711/347-2426 | Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) Sponsorship reg. no.: 032 9605F |
| Project site: | Project site: Planning and supply: |
| Festo AG & Co. KG Ruiter Strasse 82 73734 Esslingen | CPC-Vakuumröhrenkollektoranlage Paradigma Energie- und Umwelttechnik Ettlinger Str. 30 76307 Karlsbad Dr. Rolf Meißner Tel. 07202 922 182 |
| Planning (cooling systems, heating systems and construction site planning): | Scientific-technical assistance: |
| Ingenieurbüro Thurm & Dinges Lindenspürstrasse 3270176 Stuttgart Tel. 0711/22871-0 | zafh - zentrum für angewandte forschung an fachhochschulennachhaltige energietechnik Hochschule für Technik Stuttgart Schellingstrasse 24 Prof. Dr. Ursula Eicker Schellingstrasse 24 Tel. 0711 8926 2831 |
| Installation: | |
| LEW Automotive GmbH Steinbeisstraße 12/1 73660 Urbach Telefon 07181/99015-0 info@lew-automotive.com | Hochschule Offenburg Badstraße 24 77652 Offenburg Herr Prof. Elmar Bollin Herr Dipl.-Ing. (FH) Klaus Huber Telefon 0781/205-294 bollin@fh-offenburg.de klaus.huber@fh-offenburg.de |

Further Solar Energy Systems of the Month:

- . [Electricity and heat from the sun and salad oil](#)
- . [Sun, Light and Heat: Light Control and Optimizing EnergyBuildings](#)
- . [Solar Thermal Combination Systems: An Asset for Every New Building](#)
- . [Fraunhofer Institute for Solar Energy Systems \(ISE\) in New Quarters](#)
- . [Building with the Sun: Solar Facades Insulate with Sunlight](#)
- . [Power Generation with Perspective: Transparent POWER-Cells for Solar Architecture](#)
- . [Local Solar Heating Systems for the Eco-City](#)
- . [Solar Boats Turn into Tourist Attractions](#)
- . [CIS-Solar Cells From the Assembly Line](#)
- . [Follow the Sun: tracking solar power arrays can increase energy yield by up to 30%](#)
- . [Summer Sun all Winter: Seasonal Heat reservoir covers heating needs up to 100%](#)

[Banner Advertising](#) | [Bulletin Board](#) | [Events](#) | [Solar Magazine](#) | [Funding for Solar Energy](#) | [Companies](#) | [Solarstore \(G\)](#) | [Non-Profit Organizations](#) | [Lexicon](#) | [Basic Knowledge](#) | [Educational Institutions](#) | [Imprint](#) | [Contact Us](#) | [Home](#)

[up](#)

Last modified: 04/17/2008 12:27:51
[Webdesign Heindl Internet AG](#)