energy
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Current developments and examples of sustainable energy technologies

Solar heating – a technology of the future

Innovations from Austria

Austrian firms play an important part in the European market for solar thermal technologies. Almost one third of the solar collectors in place in Europe have been fabricated in Austria. And when it comes to using heat from the sun, Austria is among the front runners internationally. To maintain resp. improve this market position in the face of increasing competition, technological development and new business models are needed. Research and development in Austria are focussed on bringing costs down and opening up new areas of application.

Solar facility at Fleischwaren Berger, Sieghartskirchen, Lower Austria
Photo: Fleischwaren Berger

Photo: Climate and Energy Fund/ Ringhofer

Using heat from the sun – strategies for expanding solar thermal energy

Heat from the sun has tremendous potential, since it is available in virtually unlimited quantity and can be integrated satisfactorily both in existing and in future energy systems. At the end of 2011 the total area of solar collectors in place around the world came to 535 million m^2, with a rated capacity of 375 GW_{th}. In the international ranking Austria comes eighth; in relation to population Austria actually leads the field, with 430 kW_{th} per 1 000 inhabitants, ahead of Cyprus (425 kW_{th} per 1 000 inhabitants) and Israel (377 kW_{th} per 1 000 inhabitants). Source: www.nachhaltigwirtschaften.at/iea_pdf/reports/iea_shc_solar_heat_worldwide_ed2015.pdf

At the end of 2014 the total area of solar collectors in place in Austria came to 5.2 million m^2, with a rated capacity of 3.6 GW_{th}. On the basis of the Austrian heat mix , this corresponds to an annual saving of 440 898 t of carbon dioxide emissions. In the field of solar thermal systems Austrian technology is very successful internationally; in 2014 around 82 % of the thermal collectors manufactured here were exported.

Supplying hot water and providing additional heat in single-family houses account for a considerable share of the market for solar thermal applications. Combined facilities to provide additional heat in multi-storey housing, solar district heating, heat from the sun for commercial and industrial applications, and solar facilities for cooling and air-conditioning, are gaining in importance.

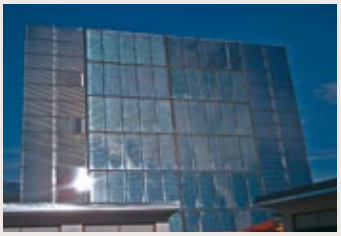
However, the European market for solar collectors has (by and large) been shrinking in recent years – this applies to Austria, too. There are various reasons for this: the regulations governing grants have changed, and competition between different renewables is increasing. The main competitors here are heat pumps (both for process water and for heating), pellet heating systems, and photovoltaic to generate electricity resp. heat.

Roadmap for heat from the sun

To avoid any further contraction of this market, strategies are needed for an early turnaround. On behalf of the Federal Ministries for Transport, Innovation and Technology (bmvit), Science, Research and the Economy (bmwfw) and Agriculture, Forestry, Environment and Water Management (BMLFUW), AEE INTEC drew up an Austrian roadmap "Solar heat 2025" in 2014; it contains an analysis of possible scenarios for 2025 and presents options in the areas "Sectoral Activities", "Research and Development", "Overall Framework" and "Ancillary Arrangements". In close consultation with solar thermal proponents more than a hundred separate measures to boost the relevant technology have been identified. At the national level the strategies are aligned with international recommendations such as those of the European technology platform "Renewable Heating and Cooling". In the field of solar thermal technologies the following research topics are classified as vital: "Solar Compact Hybrid Systems", "Solar Active House", "Solar Heat for Industrial Processes (SHIP)" and "Energy Storage Technologies".

The main challenge is to reduce the system costs of solar thermal facilities. The aim is to cut the cost of small facilities by up to 60 % and that of large facilities by up to 40 %. To achieve this, components and systems could be simplified, or the product range could be adapted resp. thinned out. Automating yield and quality assurance, and developing smart interfaces and applications and user interfaces matched to specific target groups, have also been identified as constructive actions. The important areas for research are: increasing the heat density of thermal storage units, monovalent heat supply systems, and specific developments in new application sectors (such as combined or hybrid systems, large facilities or applications in grid-based infrastructures). How solar heating develops in future will very largely depend on the business models employed. New approaches to sales and marketing, plus collaboration between individual firms and between sectors, are needed here.

With the support of bmvit and the Climate and Energy Fund a number of pioneering technologies and applications in the field of solar thermal energy are currently being researched and given practical tests. Below we present some of these seminal research projects. ◘



Renovated building Johann-Böhm-Straße, Kapfenberg; Photos: AEE INTEC

Renovating large-volume buildings with solar heating

Just how efficient solar heating can be in supplying heat is revealed by the innovative way a block of flats in Kapfenberg (Styria) has been renovated (architecture: Nussmüller Architekten ZT GmbH). The building dated from the 1960's; as part of comprehensive renovation it was equipped with novel active and passive façade elements (solar collectors and PV) largely developed by AEE INTEC (cf. eia 1/2013). The building's thermal envelope and the energy supply system are matched in such a way that, year on year, the building captures more energy than its occupants consume for space heating, hot water and domestic electricity. The solutions demonstrated in Kapfenberg for renovating large-volume buildings to the most demanding energy standards are a benchmark for future renovation projects involving buildings of that period.

Heating system based on heat from the sun

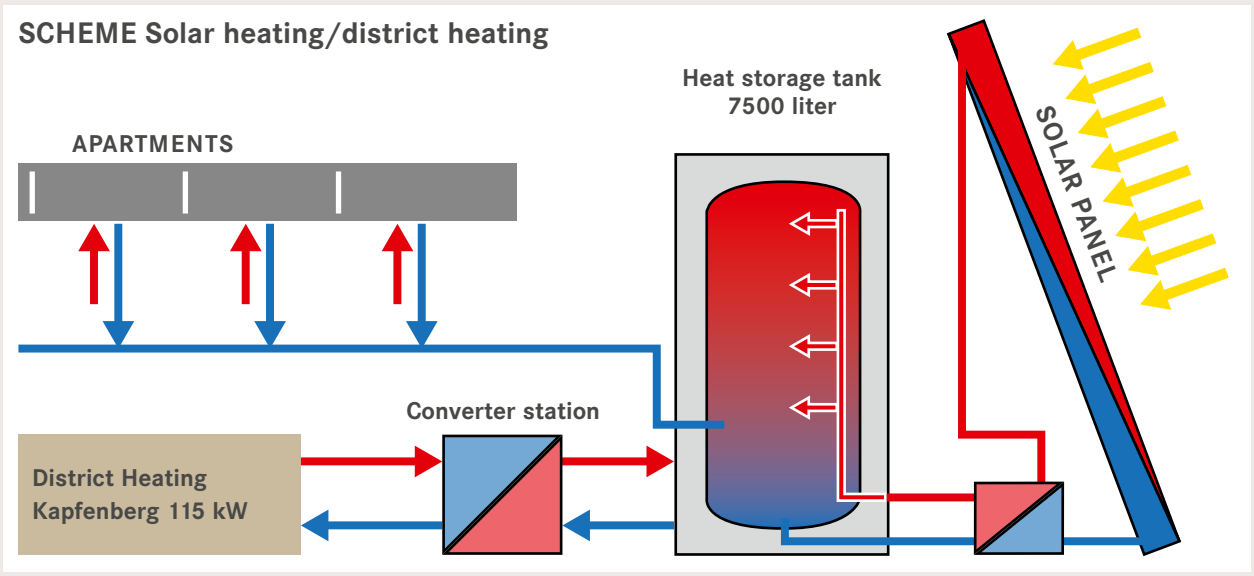
The building's base-load heat supply comes from solar collectors mounted on a spaced-off façade on the south face of the building. The nerve centre of the system is located beneath the façade.

A total of 144 m^2 of thermal collectors were installed, with a theoretical yield of 39 500 kWh per year. Residual energy is covered by the Kapfenberg district heating grid, largely by means of waste heat from a nearby steelworks (Böhler-Werke, a 100 % subsidiary of voestalpine AG). The heat exchanger in the heating substation has a rating of 115 kW.

Heat is stored directly in a central heat storage tank with a capacity of 7 500 liters; the tank is stratified into layers at differing temperatures by means of a layerwise charging pipe. This tank is located just beneath the solar collectors, which keeps the lines between the collectors and the tank short and thus minimizes heat losses. Heat from the tank is distributed throughout the building via a twin-pipe grid, in which a shared inflow and return line runs through the building; the heat transfer medium employed is hot water.

Domestic water for individual flats is heated in hot-water boilers, which are charged at fixed times (twice a day) as and when the need arises. This arrangement keeps heat losses in the distribution system low, since the maximum temperature of 55 to 60 °C in the distribution grid is needed only at these charging times.

At all other times the inflow temperature (at most 45 °C) determines the temperature in the grid. As the floor plans of the flats were altered in the course of renovation, the limited space required for the boilers could be taken into account. Because the standard of thermal insulation resulting from renovation is so high, heat is delivered in the flats via low-temperature radiators. Other systems, such as skirting-board radiators or panel heating units, would be equally suitable, but were ruled out in this case by the high investment cost involved. ◘



Graphic: Waldhör KG

InSun
Solar collectors for process heat in industry

Photos: Fleischwaren Berger

The EU project "InSun - Industrial Process Heat by Solar Collectors" (which has received funding from the EU's Seventh Research Framework Programme) is focussed on demonstrating large-scale solar thermal systems for use in industrial processes. The aim is to find out how satisfactory and reliable such systems are in providing low and medium-temperature process heat. Six partners from Austria, Italy, Spain and Germany are taking part in this joint project, in the course of which two solar thermal facilities (one each in Italy and Austria) have been erected, with a capacity of more than 1 MW, and integrated in production processes (brickmaking and food processing, respectively). In Austria a solar thermal system with high-performance flat-plate collectors from S.O.L.I.D. has been installed at Fleischwaren Berger. Since June 2013 this system has supplied detailed operating data; from 2013 to 2015 AEE INTEC monitored its performance.

Solar thermal system at Fleischwaren Berger

Fleischwaren Berger turns fresh meat into ham and sausages at its location in Sieghartskirchen, in Lower Austria. Every day around 100 t of meat products are produced. In 2014, within the framework of the Climate and Energy Fund´s programme "Solar Thermal – Large-Scale Solar Facilities", Fleischwaren Berger installed a solar thermal system with 1 067 m^2 of collector area and a 60 m^3 heat storage tank. The system features Gluatmugl HT flat-plate collectors supplied by S.O.L.I.D. Heat from this system is used in two ways in the production process: to generate process water at 40 to 60 °C for rinsing products, for drying processes and to clean crates and machinery (here consumption runs at 7 m^3/h), and to supply hot water at more than 60 °C to preheat make-up water for two steam boilers.

Results from monitoring

In the period under consideration the system performed reliably and delivered satisfactory solar yields. The total yield came to 408 kWh/m^2 per year, covering around 3.5 % of requirements (in line with forecasts). Roughly 83 % (314 MWh) of the total solar yield were used to heat process water in the period under consideration. The system supplies 11 % of annual energy consumption for providing process water; this share rose to around 60 % in summer. 64 MWh were used to preheat make-up water for boilers – roughly 0.7 % of total energy consumption for supplying steam.

To increase the amount of heat supplied to the boilers, a parabolic trough collector array with an area of 122 m^2 and a maximum capacity of 60 kW was added in 2015 to act as a temperature booster for the flat-plate collectors. As part of the scientific supervision programme these two different types of collector are being compared as regards function, yield and cost-benefit ratio.

Using heat from the sun enables Fleischwaren Berger to save up to 46 500 l of fuel oil per annum, thus cutting carbon dioxide emissions by 150 t a year – a saving of 4 to 5 % on the company's total fuel oil consumption. ◘

International collaboration in research

Austrian experts are active in the field of solar process heat within the framework of the IEA's (International Energy Agency) research tasks. IEA Solar Heating and Cooling Task 49/IV is lead-managed by AEE INTEC; it is focussed on process heat collectors and their applications, process integration, process intensification and actions to improve market penetration.
www.nachhaltigwirtschaften.at/iea/results.html/id7245
(abstract in German, report and deliverables in English)

Photo: Fleischwaren Berger

Photo: Fleischwaren Berger

"For years we had toyed with the idea of launching an environmental project in order to demonstrate that solar energy can be utilized effectively for process heat in the meat industry, too. The system completed in 2014 proved its worth after only one year's operation. The following year a facility extension with 121 m² of parabolic trough collectors was planned, and completed by the end of 2015. Instead of consuming natural gas we put our money on heat from the sun – an idea has come to fruition, and I'd like to thank everyone concerned for that."

Rudolf Berger
CEO Fleischwaren Berger

BIG SOLAR
20 % solar energy for district heating in Graz

Today district heating covers 39 % of the demand for heat in Graz (around 1 000 GWh in 2013). It is planned to expand the district heating grid considerably. The heat for the grid is largely supplied from cogeneration facilities burning fossil fuel. The deadline set for closing down the conventional power stations which currently deliver about 70 % of the heat for Graz' district heating requirements is 2020. The city of Graz is thus facing the challenge of redesigning the entire urban district heating system. In the future heat from the sun is to make a major contribution to the city's district heating needs.

A consortium headed by S.O.L.I.D. carried out a feasibility study to define the technological and economic prerequisites for making use of solar heat in the Graz district heating grid on a large scale. The target, based on experiences in Denmark, was a 20 % solar contribution to the district heating grid.

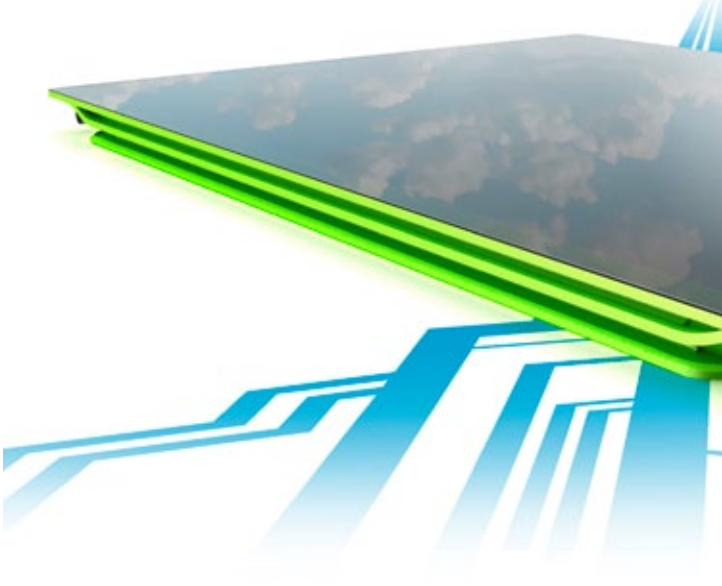
A primary focus of the survey was on evaluating suitable locations for collector arrays and storage facilities, using simulation techniques to fine-tune engineering and analysing economic aspects in detail. The results indicate that the approach planned has a great deal of potential. From the analysis it is clear that a solar system with around 150 000 to 650 000 m² of collector area, capable of covering 9 to 26 % of Graz' current district heating demand, is economically competitive. These findings provided the basis for working out a business case which was submitted to the decisionmakers early in 2016.

If this large-scale, pioneering showcase project were implemented, Graz and all the stakeholders involved would become international pioneers for solar heating in towns and cities. ◘

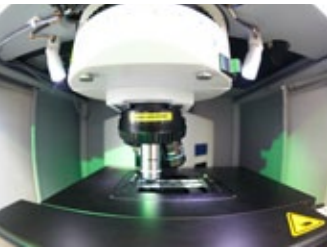
2014 installed field of solar collectors (2 480 m²) at the area of AEVG-Fernheizwerk Graz, Photo: S.O.L.I.D.

Key project data

- Ultra-efficient large-scale collectors: 450 000 m²
- Seasonal heat storage facility: 1 800 000 m³
- Absorption heat pumps: 6 x 16 MW
- Solar yield: 245 GWh/a
- Solar heat rating: 250 MW
- Solar contribution: around 23 %
- Total investment: 189 million EUR
- Retrievable heat at 85°C at any time



SolPol
Polymer-based innovations for solar technology



Photos: Climate and Energy Fund/Ringhofer

Photo: Greiner Technology & Innovation GmbH

SolPol is the largest research initiative anywhere in the world concerned with polymer-based innovations for solar technology. Since 2009 scientists at Johannes Kepler University (JKU) Linz have been researching into using polymers for solar thermal systems and for PV. Cross-linking research into plastics and solar energy will catalyse further development in both these technologies.

The market for solar thermal systems is currently stagnating and can be revitalized only if the purchase price of these systems for the final customer is significantly reduced. At the moment the collectors in pumped solar thermal systems account for roughly 10 to 20 % of total system cost. The aim is to halve total system cost. Here polymer science plays a key part: the idea is to develop competitive integrated all-in-all systems while replacing high-cost individual components and materials such as copper and aluminium with innovative new materials. Since polymers can be processed flexibly and automating this is straightforward, they are very suitable for fabricating complex functional components.

SolPol-1 achieved the scientific and methodological prerequisites for developing innovative plastic-based collector systems, and analysed the ecological and economic effects to be expected; **SolPol-2** was concerned with industrial research into developing novel polymer materials, with fabricating prototype collectors with a high proportion of plastics, and with plastic compounds for solar thermal applications.

SolPol-4/5, the current energy research flagship project, is focussed on developing highly integrated so-called "Plug & Function" elements (components and subassemblies) that are much cheaper to install. Both pumped and passive resp. compact systems (all-plastic or largely plastic) have the following characteristics:

> extensive prefabrication and optimised integration of functions
> reduction in collector weight and straightforward installation (Plug & Function)
> reliability and long service life
> more attractive design
> reduced cost/price and improved cost/benefit ratio

A number of scientific and business partners are involved in the major research project SolPol. As part of the project, the Upper Austrian green technology company SUNLUMO is developing low-cost solutions for plastic-based solar systems by customizing materials for and approaches to membrane absorbers and storage collector foils, and testing polymer fastening elements for use in solar thermal applications.

SUNLUMO also contributes its design know-how for pumped systems, which would be an attractive alternative to thermosiphon systems (currently standard around the world). ◘

International collaboration on research

Research was also conducted into applying polymer materials for solar thermal applications as part of the IEA (International Energy Agency) technology initiative "Solar Heating and Cooling", Task 39 (lead management: Institute for Polymeric Materials and Testing, JKU Linz). Here potential applications of advanced polymer technologies to solar thermal systems of novel design were explored, and opportunities of cutting costs, ways of developing markets and the potential of polymer-based solar thermal technologies were evaluated. Key results for Task 39 were achieved in the projects SolPol 1 and 2 at JKU Linz.
www.nachhaltigwirtschaften.at/iea/results.html/id5109 (abstract in German, report and deliverables in English)

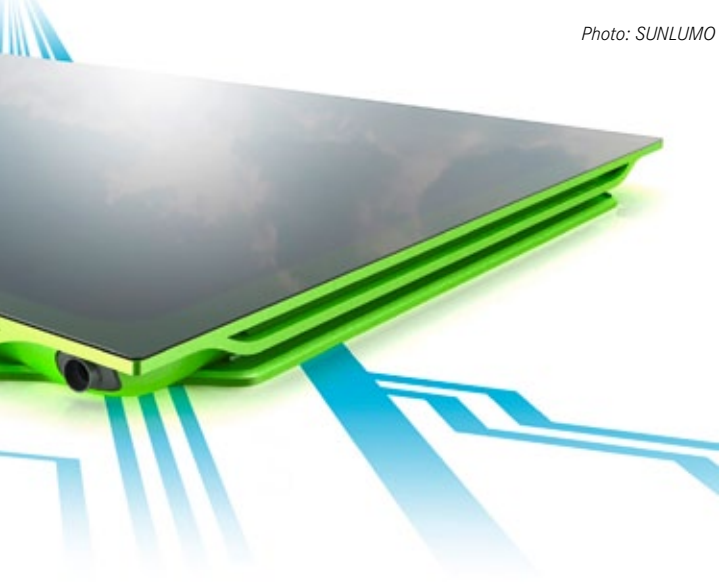


Photo: SUNLUMO

Low-cost solar systems to supply energy worldwide

The Austrian technology company SUNLUMO is currently at work on getting a low-cost, plastic-based **"One World Solar Collector"** to the market. This resource-conserving alternative to conventional collectors is free of metals such as copper and aluminium, and is particularly suitable for use in developing and emerging countries.

The all-plastic collector won the German Ecodesign prize in 2015. It has no adhesive joints, so the various components and layers can be separated cleanly by material category at the end of the product's service life. The polymers employed keep the collector's weight down; it is easy to install and low in cost. The various components of the One World Solar Collector are currently in production at external suppliers' locations in Italy, Austria and Germany; a pre-production run will be assembled in Austria.

Automated fabrication

To minimize production costs SUNLUMO is developing an approach to automating collector fabrication – from processing the plastic granulate via fabricating the components all the way to assembling the complete solar collector. In future SUNLUMO aims to provide **turnkey production facilities** for fabricating the new collector. To match the individual customer's requirements, facilities with production capacities between 100 and 350 MW_{th} can be supplied. SUNLUMO supervises production from facility startup to the final product, including training, functional testing and quality control.

Photo: SUNLUMO

Research for other plastic components

Research is currently in progress on components for all-plastic pump subassemblies. The aim here is to make **low-cost all-plastic solar systems** feasible. ◘

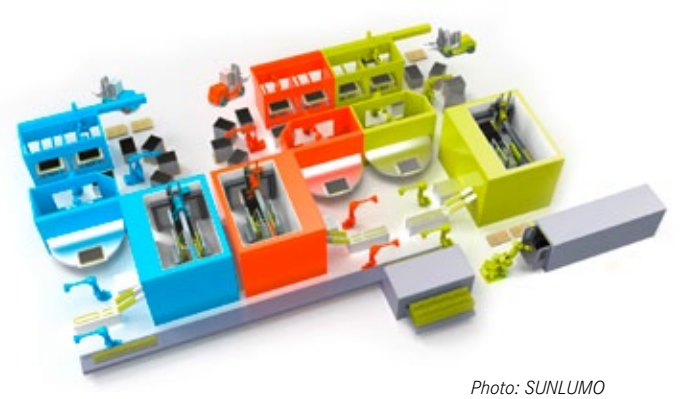


Photo: SUNLUMO

Photo: SUNLUMO

"We strongly believe in open communication in the dialogue between scientists and business people. Research projects like SolPol encourage creativity and a spirit of innovation. Our shared aim is to find solutions for market-related challenges and to point out new possibilities. I'm convinced that innovations arise through networking, and exchanging experience is an important aid to generating forward-looking solutions. That's why we welcome every opportunity of contributing our knowledge and know-how as part of various national and international collaborative projects, such as our participation in the international level in the Renewable Heating and Cooling Platform, or in IEA SHC Task 54 to reduce the price of solar thermal systems."

Robert Buchinger
CEO SUNLUMO


Photo: S.O.L.I.D.

Interview with an expert: Sabine Putz, Head of R&D at S.O.L.I.D. Solar Installation and Design

With its know-how for large-scale solar facilities S.O.L.I.D. is one of the leading companies in the solar technology sector. How do you see the solar thermal market developing in future?

As we all know, the market for small systems is difficult, because of absence of grants and system costs are still far too high in this area. The market for large systems looks quite different – here the industry expects increases in turnover, due to largescale facilities that will supply district heating grids. So in spite of some slight decline there will be continual growth overall. Since 2000 the global market has expanded from 62 GW_{th} to 406 GW_{th}; China is still dominating the market, and there is a widespread trend to megawatt and gigawatt facilities.

Where are research and development needed in the field of large systems?

Research is needed in the areas of smart integration and control for large solar facilities in district heating grids, lowering back flow temperatures, large-scale heat storage, certification for complete systems and developing business models for large facilities.

Which new technologies and areas of application do you see as having the most potential?

I regard absorption heat pumps as a very promising new technology to make solar thermal systems work better; they make it possible to tap seasonal heat storage more efficiently, so solar yields go up and less storage is needed – total system cost goes down and net system performance improves.

You are also involved as an expert in the IEA technology-initiative "Solar Heating and Cooling". What international trends are noticeable?

China is continually improving the quality of its large-scale systems with an emphasis on supplying district heating grids. Since the 2015 world climate summit in Paris we have noticed that cross-linking is starting between various IEA programmes (e.g. between Bioenergy and Solar Heating and Cooling (SHC), or between District Heating and Cooling and SHC). Joint strategies are being developed across programme boundaries. There is an unmistakable trend to the carbon-free economy 2030/2050.

What opportunities do you see for Austrian firms in international markets?

Austria, and particularly Styria, are among the solar thermal pioneers. A handful of firms have succeeded in securing a place in this difficult market. The trend towards megawatt and gigawatt facilities will help Austrian collector manufacturers and solar equipment developers to increase turnover, not just in Austria but around the world.

energy innovation austria presents current Austrian developments and results from research work in the field of forward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Transport, Innovation and Technology and the Climate and Energy Fund. **www.energy-innovation-austria.at** **www.nachhaltigwirtschaften.at** **www.klimafonds.gv.at**

INFORMATION

Roadmap "Solar heat 2025"
AEE INTEC
Contact: Christian Fink
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www.nachhaltigwirtschaften.at/iea_pdf/1442_roadmap_solar-waerme_2025.pdf (in German)

Renovation to achieve an energy surplus building in Kapfenberg
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InSun - Industrial Process Heat by Solar Collectors
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