Solar houses: On the way

Photo 1: The Promassivhaus group took a design draft from German solar architect Georg Dasch to develop a turnkey solar house given the name »Straubing». It is one of five houses for at least 50 % solar heating which the company has had on offer since 2005. The variant with saddle roof and a full cellar costs from approx. € 259,000 (variant: Regensburg).

Photo: Georg Dasch

Not long ago, solar houses were something for dreamers. In the meantime, ready-to-occupy homes are on offer at competitive prices.

Just a few years back, you still needed a detective to find solar houses. In most cases, they were private houses with which environmentalists, architects or solar experts sought to fulfil a dream or set a demonstrative example. The average homebuilder considered them too expensive, or quite simply too exotic. A handful of pilot projects were also realised by institutes or enterprises from the branch. In the wake of the oil crises of the 1970s, they had begun to conduct research in the field of solar technologies. Homes promising energy self-sufficiency were built, and in some cases even whole solar communities. Their acceptance on the general market, however, was limited, as they were still scarcely affordable. At the same time, the initial »solar enthusiasm« dwindled as the oil price fell back.

The German legislation on grid-input remuneration, and later the Renewable Energies Act (EEG), lent new impetus to the photovoltaic market, and with remuneration rates for solar electricity which actually covered costs, established the necessary prerequisites for plus-energy houses. Attention has been focussed on large-area photovoltaic installations which produce more electricity than is consumed in the building. The sun has also gained importance with regard to heating. Driven by the debates on global warming and by increasing oil

Name of building: Sonnenhaus Straubing

Type of building:	• 65 % solar-heated detached house • block-built without additional insulation (Poroton T8)
Location:	Ruhmannsfelden, Bavarian Forest, Germany
Living space:	208 m^2
Heating system:	• 45 m^2 collector area, 75° roof • 9.36 m^3 solar storage tank • additional heating via tile stove using water
Year built:	2006
Built by:	Brixel family
Also involved:	Georg Dasch (architect)

to a mass market

Photo 2: According to German Solifer managing director Timo Leukefeld, the »Energetikhaus 100« is the first turnkey »affordable all-year solar house«. The first house built, which has been occupied since 2006, was able to cover 97 % of its heating demand from its solar systems during the first winter. The consortium which designed this house also offers a semi-circular variant and a traditional design with a saddle roof.

Photo: Solifer / Energetikhaus 100

prices, solar thermal systems are in ever more frequent demand for the heating of buildings.

The governments in many countries are supporting this development with guidelines on energy-efficient building and modernisation, financial incentives and low-interest loans. Companies and associations are following a similar path with research and marketing initiatives. The German Solar Industry Association (BSW), an alliance of around 650 German solar companies, for example, announced already in 2005, that housing with 100 % active solar heating should become a construction standard by 2030.

The latest development is the entrance of prefabricated housing suppliers into the market. Together with solar companies and manufacturers, they are offering ready-to-occupy solar houses at normal market prices. Alongside these market campaigns, however, there are still various individuals and smaller business catching the public eye with bold innovative projects.

We would here like to introduce a number of solar houses from Germany, Austria, Switzerland, Spain, Italy, Great Britain, Norway, Japan, Canada and the USA, ranging from former pilot projects to »off-the-shelf« homes. For the purposes of this overview, a solar house is defined as a house with high thermal insulation which covers at least 50 % of its energy demand from the sun.

Name of building:	**Energetikhaus 100**
Type of building:	95 % solar-heated detached house
Location:	Berthelsdorf near Freiberg, Saxony, Germany
Living space:	137 m²
Heating system:	• 69 m² solar collectors on south roof, at an inclination of 68 ° • additional stove heater • 28,000 litre buffer storage
Year built:	2005/2006
Built by:	Uhlmann family
Also involved: (from Germany)	• Fasa AG (building contractor – overall concept) • Solifer Solardach GmbH (solar and heating system) • Ziegelwerk Freital Eder (heat insulation tiles) • TU Berg akademie in Freiberg (concept optimisation)

The solar idea for domestic heating

Whenever discussions turn to solar-heated houses, there is one name which never fails to earn a mention: that of solar pioneer Josef Jenni from Switzerland. In 1989, he built a purely solar-heated home alongside his compa-

Photo 3: Swiss solar pioneer Josef Jenni caused quite a stir in 1989 with a house heated all year round by the sun. 84 m² solar collectors are installed in the 45° south-facing roof. The house is still today heated exclusively with solar energy.

Photo: Jenni Energietechnik

Name of building:	Oberburger Sonnenhaus
Type of building:	100 % solar-heated detached house
Location:	Oberburg, Switzerland
Living space:	130 m²
Heating system:	• 84 m² solar collectors • 118 m³ storage capacity (92, 13, 13 m³)
Year built:	1989
Built by:	Josef Jenni

ny in the canton of Berne. The fact that he was able to heat the whole house exclusively with solar energy, and in fact even produced a surplus, became something of a media spectacle. In winter 1990, he invited the world to come swimming in his solar-heated pool (see photo 3). The photo made the newspapers all over the world. The installation is still functioning today. In the meantime, however, he and his brother, who lives in the house with his family, also know that the installation with 84 m² solar collectors and 118 m³ storage capacity was massively overdimensioned.

Josef Jenni has since supplied 350 storage tanks for buildings with at least 50% solar heating. That has not always earned him recognition. Mockers like to describe

Photo 4: Architect Andreas Karlsreiter took just four months to plan and realise this plus-energy house. It is built of wood to passive-house standards and integrates a photovoltaic system which produces more electricity than the occupants use. The thermal installation heats sufficient domestic water for two adults and two children.

Photo: Uwe Kroiss

Name of building:	Kroiss plus-energy house
Type of building:	• detached plus-energy house • wood-built to passive-house standards
Location:	Thening, Upper Austria
Living space:	150 m²
Heating system:	• 17.4 m² solar thermal system (warm water) • controlled ventilation of living areas with heat recovery
Solar power generation:	10.35 kW_p system
Year built:	2001
Built by:	Karin and Uwe Kroiss
Also involved:	Andreas Karlsreiter (architect)

Photo 5a: Plus-energy houses in Freiburg, South Germany: Architect Rolf Disch built a whole community of 58 super-insulated houses with PV installations on the south-facing roofs. *Photo: Rolf Disch*

Photo 5b: German solar architect Rolf Disch has specialised on building with photovoltaics. In his extremely well-insulated and sun-aligned plus-energy houses, the PV systems produce more energy than the house consumes. The project »Heliotrop«, which Disch himself uses as a home and office, was the first to attract wider interest in his construction concepts in the early 1990s. *Photo: Rolf Disch*

Photo 6: Japanese MSK technology reaches Canada: This historic MacLellon House has a roof-integrated PV system from Suntech-MSK and is designed with vents on the roof cap for passive solar heat capture and maximised energy efficiency. *Photo: Suntech-MSK*

his solar houses as »storage tanks with residential annex«, as the water tanks, after all, can easily reach a capacity of 38 m^3 for a detached house with fully solar heating. Their volume thus corresponds to a room with a floor area of 13 m^2 and a ceiling height of 2.9 m. Josef Jenni stands above such criticism. »We have no time to lose and must do everything possible to protect our climate« is his credo.

He is all the more pleased, therefore, that his solar building and heating concept has been adopted by two German suppliers as the basis for new homes. Since the end of 2005, the Saxon company Solifer and its partners have been offering the »Energetikhaus 100« (see photo 2). The price for a house with 137 m^2 living space and up to 95 % solar heating is quoted at € 213,000, though this may still vary according to region and the individual components. »We wanted to offer an affordable option,« says Solifer managing director Timo Leukefeld. The next target is to at last break through the 100% barrier for solar heating. At the moment, however, that is still not a cost-effective proposition. The first Energetikhaus, which was handed over to its new owner last year, was able to cover 97% of its heating energy demand with the solar system during the first winter. Two more houses are being built right now, and a further five are on the drawing board.

Name of building:	Heliotrop
Type of building:	plus-energy house (residential and office)
Location:	Freiburg, Germany
Living space	257 m^2
Heating system:	• vacuum-tube collectors • geothermal heat exchanger
Solar power generation:	6.6 kW_p
Year built	1993/1994
Built by:	Rolf Disch (German architect)

Name of building:	MacLellan House
Type of building:	historic Canadian home (see photo above on the right)
Location:	Waterloo, Canada
Solar power generation:	8 kW_p
Also involved:	Suntech-MSK

Photo 8: This low-energy housing community Sun-City Leoben in Austria uses solar energy both actively and passively. Generous glass façades and south-facing conservatories allow light and warmth to flood into the 70 homes. The 1.2 metre high collector stands, at an angle of 70 °, are ideal to harvest the low winter sun. The collectors extend over the whole length of the houses, coming down to the ground at the sides above a room for the technical installations. *Photo: AEE Intec*

Photo 7: One-litre house: The »Klimahaus Gold« home of the Mazzarol family boasts an annual heating energy demand of max. 10 kWh/m², and could thus be heated with just one litre of heating oil per square metre per year. The South Tyrolean Klimahaus is also available in the categories Klimahaus A and Klimahaus B with a marginally reduced insulation standard.

Photos (2): Klimahaus agency

Name of building:	Mazzarol House
Type of building:	• Klimahaus Gold • annual heating energy demand: 4 kWh/m²
Location:	Schabs, South Tyrol / Italy
Living space	135 m²
Heating system:	• 21.5 m² solar thermal system • 2,000-litre buffer storage tank with integrated 200-litre warm water tank
Year built:	2004
Built by:	Mazzarol family

The »Promassivhaus« group, a partnership of some 50 construction companies in Germany, is taking a slightly different approach, with a range of houses designed by architect Georg Dasch on the basis of the Jenni concept. Promassivhaus offers five different variants: including detached houses with saddle or single-slope roof (see photo 1). All have one thing in common: They are heated to at least 50 % by solar energy. The remaining heating demand is covered with a wood or pellet burner. »Six houses are under construction,« says group manager Klaus Brünger, who has already established further contacts to Austria and Italy.

Name of building:	Sun-City Leoben
Type of building:	• low-energy housing community 70 residential units • less than 50 kWh/m² annual heating energy demand
Location:	Leoben – Hinterberg, Austria
Heating system:	• terraced houses with 3 homes: 45 m² collector area, 3 m³ buffer storage tanks • terraced houses with 5 homes: 65 m² collector area, 5 m³ buffer storage tanks
Built by:	Gemeinnützige Leobener Wohnbau Gesellschaft
Also involved:	AEE Intec (energy planning) Werner Nußmüller (architect)

Plus-energy houses with photovoltaics

Whereas Solifer and Promassivhaus base their offers on solar heating as a means to save energy, the German solar architect Rolf Disch from Freiburg in the Black Forest has made a name for himself with plus-energy houses. Disch works predominantly with photovoltaics, and with his rotating »Heliotrop« (= Greek, meaning »turned

Photo 9: Prototype in Great Britain: The »Lighthouse« is a joint project of the British prefabricated home suppliers Kingspan Off-Site and Chinese PV manufacturer Suntech-MSK Europe.

Photo 10: Solar power installation as a trademark: Suntech-MSK integrated a 1 kW_p PV system into every roof in this Japanese solar housing community in Hokkaido. *Photos (2): Suntech-MSK*

Name of building:	Lighthouse
Type of building:	net-zero carbon home
Location:	Big Build Innovation Park area of the Building Research Establishment Offsite 2007, Great Britain
Living space:	93 m^2
Year built:	2007
Built by:	Kingspan Off-Site
Also involved:	Suntech-MSK Europe and others

to the sun«) has demonstrated the possibilities in impressive fashion (see photo 5b). His combined home and office building stands on a slewing ring with swivel bearing, driven by an electric motor. During the heating period, the glass façade of the cylindrical house can be turned to follow the sun. If the weather is hot, on the other hand, it can be turned out of the sun. According to the architect, the 6.6 kW_p photovoltaic installation produces two to three times more electricity than the house consumes. To minimise the heating energy demand, the house is designed with triple heat-insulation glazing on one side and with a super-insulated wooden façade on the other. All the rooms are heated by the sun. Any remaining heating or heating energy demand is covered by vacuum tube collectors and a geothermal heat exchanger. Three Heliotrops have been built since the mid-1990s, maintaining the example of the experimental original. On the same basis, Disch developed a plus-energy house with a full photovoltaic roof as a standard offer, as is to been seen in the award-winning German Schlierberg solar community (photo 5 a).

In the neighbouring countries, too, there are various experiments with home-integrated photovoltaics to be noted. In Upper Austria, for example, architect Andreas Karlsreiter designed what they claim to be »the first plus-energy house in Austria« for the Kroiss family in 2001 (see photo 4). Wood-built to passive house standards, it achieves an annual consumption of just 12.8 kWh/m^2. The façade carries 17.4 m^2 solar collectors, and a solar power capacity of 10.35 kW_p is installed on the roof. For the owner, it is not just a home, but also a showcase for his company, which is specialised on energy-efficient modernisation in the commercial sector. This plus-energy house is yet to be copied elsewhere.

Another one-off project is the Austrian low-energy community Sun-City Leoben (photo 8). Here, a non-profit-making housing association erected 70 residential units with quite evident active and passive solar energy utilisation. Generous glazing and conservatories were integrated into the south façades. The collector area begins above a room for the technical installations at the side of each building and then runs as a continuous band over the whole length of the roof. With collector areas between 45 and 65 m^2 for each building, a solar input of over 50 % can be achieved for warm water and supplementary heating.

The Italian »Klimahaus«

In Italy, or more precisely in South Tyrol, it is the »Klimahaus« concept which dominates energy-saving construction. The Italian Klimahaus corresponds more or less to

Photo 11: Kurt Haefeli, collector manufacturer and proprietor of the solar company Sela Solar, Spain, wanted to prove that energy could also be saved in a house built in the traditional manner. He began to convert his existing home in 1996 and has cut his annual energy consumption from 26,000 kWh to just 5,000 kWh.
Photo: Sela Solar

Name of building:	Haefeli Solar House
Type of building:	converted detached house
Location:	Dénia (Alicante), Spain
Heating system:	combi-system with 16 m^2 collector area
Solar power generation:	solar roof tiles with a total of 1 kW_p
Year built:	conversion from 1996
Built by:	Kurt Haefeli

Name of building:	Pana Home community
Type of building:	100 detached houses
Location:	Kobe, Japan
Solar power generation:	PV roofs
Built by:	Pana Home
Also involved:	Kyocera (PV manufacturer)

Photo 12: Strong cooperation: Kyocera supplies PV roof modules for Japanese prefab housing specialists Pana Home in Kobe, Japan.
Photo: Kyocera

the German passive house, which uses heat insulation to reduce energy consumption to a minimum and thus to render a heating system superfluous. »First we reduce the consumption, then we see what is necessary to cover the remaining lower energy demand,« is how Gebhard Platter from the Klimahaus agency characterises the state-aided building concept. The top-of-the-range »Klimahaus Gold« returns a heating energy demand of 10 kWh/m^2 per year. A solar thermal system here makes an additional contribution (see photo 7). According to Platter, the Klimahaus is proving to be quite an export earner, in this case referring the increased demand from all over Italy. The concept is also to be presented to the EU in Brussels in the near future.

In countries like Spain and Norway, it is still architects, small solar businesses and private individuals who are championing the idea of solar houses. Kurt Haefeli, a collector manufacturer and proprietor of the company Sela Solar near Alicante, for example, recently modernised his own house to meet low-energy standards (photo 11), and is developing this further into a solar house concept for Spain. »We need a different concept to what is viable in Germany or Switzerland. It is important that we prevent overheating due the solar input surpluses in the summer,« says Swiss-born Haefeli.

Prefab builders and PV manufacturers cooperate

Great Britain is able to point to a large-scale international cooperation. In June, the »Lighthouse« was presented (photo 9). According to the Chinese solar cell and module manufacturer Suntech Power, the »net-zero carbon home« is the first house which produces enough solar electricity to comply with the »Code for Sustainable Homes Level 6«, which is scheduled to come into force from 2016. According to the definition of the British government, these houses will have to be completely zero carbon, i.e. zero net emissions of carbon dioxide from all energy use in the home.

The house with 93 m^2 living space is a joint development of the British prefabricated home builder Kingspan Off-Site, Suntech, through its associate MSK, which supplies integrated PV solutions, and a number of other partners. Suntech expects that 200,000 new »Code Level 6-compliant homes« will be built in the UK each year from 2016. The solar roofs from Suntech-MSK were also used for a solar community in Hokkaido in North Japan (photo 10), where 1 kW_p solar roofs were in-stalled on 500 houses in 2005/2006. The homes were sold at prices corresponding to those for a conventional house.

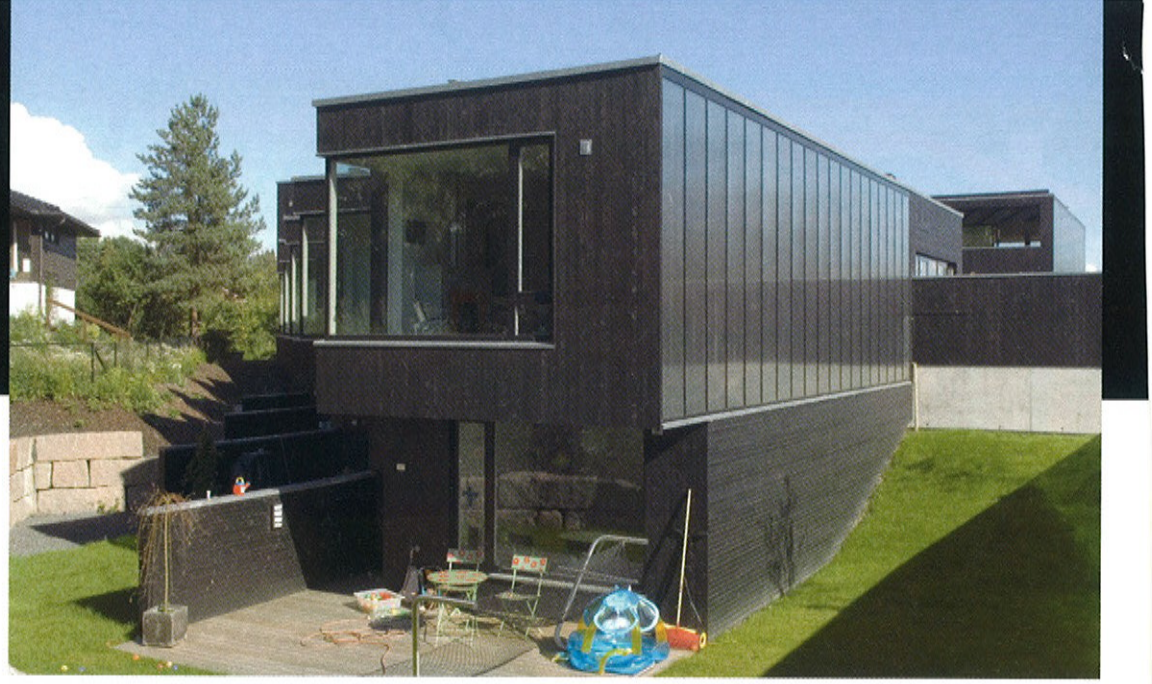

Photo 13: Model project in Norway: The multi-family house in Bjørnveien in Oslo has woken the Norwegians up to the idea that solar technology is also a meaningful option in northern Europe. Even on 8th January this year when the weather was slightly overcast and the outdoor temperature was 8 degrees below zero, the panels where operating and supplying a heating contribution to the households. *Photo: Solarnor*

Name of building:	Bjørnveien (Photo above)
Type of building:	terraced houses (with 8 flats)
Location:	Oslo, Norway
Living space:	1,700 m² (building)
Heating system:	97 m² solar collector façade for solar domestic hot water and space heating
Year built:	2005
Also involved:	• Dahle / Dahle / Breitenstein AS (architects) • Solarnor AS (collector manufacturer)

Photo 14: Integrated approach: The US architect Steven J. Strong designs and engineers the solar systems together with the building, as an integrated effort. The »Maine Solar House« has a reduced energy demand of about 40 % of the requirements of a typical home of similar size in northern New England. 500 square feet (46 m²) of solar thermal collectors and 4.5 kW_p are roof-integrated to create a single, uniform, glass plane for the south roof. *Photo: Solarhouse*

Name of building:	Maine Solar House
Type of building:	zero-energy detached house
Location:	Maine, USA
Living space:	2,900 square feet (270 m²)
Heating system:	• 500 square feet collectors (46 m²) • two 500 gallon tanks (2,273 litres)
Solar power generation:	4.5 kW_p
Year built:	1994
Built by:	William and Deborah Lord
Also involved:	Steven Strong (architect)

According to its own reports, MSK has already sold over 4,000 building-integrated PV systems since 1994. The Japanese, who were taken over by Chinese PV manufacturer Suntech last year, have now also found a partner in Canada (photo 11). Arise Technologies has already left its mark. In the first »solar neighbourhood« in Waterloo, Ontario, 12 new buildings are being equipped with a total of 42 kW_p roof-integrated PV installations.

The Japanese PV manufacturer Kyocera has also contributed to a solar community (photo 6), together with prefabricated housing specialists Pana Home, one of several cooperation partners in this sector. The Japanese city of Kobe had organised a design competition, which was won by Pana Home. Photovoltaic systems from Kyocera were installed on the roofs of the 100 energy-efficient homes of the Pana Home community. This will probably remain one of just a few major projects of this kind in Japan. Kyocera is currently concentrating on the development of roof-mounted systems suitable for all roof forms.

Kyocera's European manager Mitsuru Imanaka confirmed the trend towards cooperation between builders and PV manufacturers. »Currently, major Japanese house builders offer houses with preinstalled PV systems as differentiation from rival companies, driving the upward trend and a growing awareness of environmental issues. The sales method is becoming increasingly popular.« In the meantime, this is true not only in Japan, but also on many other markets.

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Further information:

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