

“BIPV” or The Beauty of Photovoltaics

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“Photovoltaics is ugly!” - a bias still present in the minds of architects and planners. But ever since the well-known PV company BIOHAUS built their new office building in Paderborn, Germany in 2004, one thing has become quite clear: the combination of solar power generation and attractive design is possible. The three-storey building features 13 different solar power systems which have been installed on and in the building in the most appealing ways.

The solar module fulfills three functions:

- **Aesthetics**
- **building envelope**
- **Power generation**

This opens up a world of possibilities, especially for architects. The integration of solar modules provides the building with an added value, visually extremely pleasing solutions are possible.

As one of the main components of the PV modules, glass plays a big part in this: as tempered glass it fulfills safety standards, with or without an AntiReflex surface it gives leeway to the design. The type of PV technology sets the visual agenda: the intense blueish surface of the most commonly used crystalline cells dazzles, the monocrystalline version provides a more serene and homogeneous appearance. The so-called thin-film technology provides a special visual feature: because of the electrical contacts, amorphous silicon such as CIS is characterised by a pinstriped surface. When these modules



Daylighting & Solar Architecture

are part-dielectrically lasered, interesting light and shade forms emerge and create semi-opaque lighting effects.

Both, crystalline as well as thin-film modules, can be used in so-called solar roof tiles and serve as a weather-proof covering. BIOHAUS focusses on thin-film technology: in the past two years, the company has developed three solar roofing systems all based on thin-film technology. The BIOSOL XXL, BIOSOL PV Plate and BIOSOL UniPro systems are for the most part used in industry and agriculture. All three systems have one thing in common: not only do they generate power in an environment-friendly way, they can also be integrated into the building in a visually appealing style and on top of that have a protective function.

Clean Power From Well Designed Roofs

Over the last few years, these kinds of clever solutions have taken a back seat. The cost-oriented feed-in tariff for solar power led to a shortage of supply for modules and solar silicon as well. For many manufacturers, solar roof tiles were eclipsed by the sought-after solar cells which were used for traditional modules for on-roof mounting or for open space installations. However this did not impair the efforts to find technically and aesthetically well designed solutions for the integration of solar power generation into the building envelope - efforts which have been made ever since the initial stages of photovoltaics. As demonstrated beforehand, nowadays the trend has moved on from small solar roof tile plants to large surface solar roofing systems.

For some time now, solar power plants on the roofs of listed buildings or on buildings owned by aesthetically demanding building-owners have been examples of considerate integration of photovoltaics. This includes the vast number of solar roof tiles made by European manufacturers. These roof tiles did not manage to create a mass market, but they are impressive showpieces of the solar power technology. In the beginning, small solar roof tiles based on the design of traditional roofing tiles or slates were primarily made with externally purchased modules by tile manufacturers. To date, these tiles have been developed into large solar roof tiles with capacities of up to 200 Wp and they replace traditional roofing materials.



Excursus:

In a narrower sense, solar roof tiles are conventional tiles made from clay which have solar cells attached to them. In a more broader sense, the term is now also used for solar roof stones or solar roofing elements made from other materials, such as slate, metal or synthetic material. BIOHAUS' thin-film solar roof tiles are proof that, from a design standpoint, solar building materials can in fact compete with traditional roofing materials. The powerful BIOHAUS modules with thin-film technology based on Uni-Solar laminates, with black coated sections and mounting brackets, replace the traditional roofing material and make up complete solar roofs.

First projects with bended glass using pv cells are realised by BRS Structural Glazing in the Netherlands. One of these is a very interesting project covering a railway station in Utrecht under the name freeformglass. This is cold bendable laminated glass which makes it possible to erect constructions at building sites in free forms for a very competitive price. In the mean time PV-Solarcells can be integrated in these glass constructions.

Buildings featuring solar roof tiles can be found all over Europe, mainly in Germany, Switzerland and Austria, but also in France. Many of the plants are prototypes: in 2002, a solar roof in Fußach, Vorarlberg (Austria) won EUROSOLAR's Austrian solar award for stylish and unobtrusive PV integration. Also in 2002 the in-roof PV plant of the Rudolf-Steiner-Werkgemeinschaft (work community) in Schloß Hamborn (Hamborn Palace) near Paderborn, Germany was awarded the Northrhine-Westphalian solar prize.

The Initial Stages - Small But Excellent

In 1999, the Gebrüder Laumans GmbH & Co. KG from Brüggem garnered much praise when they introduced a visually especially appealing clay tile, since it allowed for a considerate integration of photovoltaics even in listed building. Since 2000, the size of solar roof tiles has been continually growing - today, 1.4 square meters are already a standard size. Because of price erosion and intense development of synergies within the system,

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today the installation costs of in-roof PV plants starting from mid-size are the same as that of roof parallel plants. And another prejudice has long been rebutted in practice: field tests by Schott Solar and BIOHAUS have shown that yields from in-roof plants are by no means lower than yields from conventional systems.

PV Roofs Continually Growing In Size, Solar Roofing Systems Becoming Ever More Trendy

In future, the “real” i.e. small solar roof tiles will probably still have their place, but the major, unshaken trend today is the solar roof: highly-developed mounting systems such as Schweizer Metallbau’s “SOLRIF” or BIOHAUS’ XXL modules allow for solar roofing with PV laminates in a grand scale. Proof of this is the solar power world record achieved in Hessian Bürstadt: the worldwide largest PV solar roof with a photovoltaic capacity of 5 MWp was mounted onto bitumen membranes, it protects the roofing and minimises thermal fluctuation. Both - XXL as well as Bürstadt - are based on framed standard laminates, Uni-Solar laminates for the former, BP Solar laminates for the latter, in both cases mounted by customised SOLRIF frames. The framing system SOLRIF was developed by Swiss companies ENECOLO and Schweizer Metallbau as part of an EU project and in principle can be used for all unframed modules.

Thin-Film Technology And Building Integration - An Ideal Partnership

Because of their extremely low weight, new types of systems, such as BIOSOL PV Plate, made from flexible thin-film laminates on carrier plates, are used in great quantity on bitumen membranes or trapezoidal sheet metals of trade buildings whose static properties do not allow for the weight of classic PV Systems. The currently largest Belgian PV plant can be found in Halle, near Brussels. The plant on discounter Colruyt’s logistics centre building makes use of BIOHAUS’ BIOSOL PV Plate system. The triple junction cells in the flexible adhesive laminates made by US manufacturer Uni-Solar utilise a particularly wide spectrum of light irradiation (also diffuse irradiation). These Uni-Solar laminates are also used for solar PV roofing systems by well-known roofing manufacturers such as Alwitra, Corus and Thyssen. ODERSUN in Frankfurt/





The only way the predicted growth of the PV industry will actually occur, is to combine the industrial use of economies of scale for the main components with the reduction of (additional) system costs by using available roofs as substructures and the synergies mentioned above. There are huge potentials in this: according to a survey, based on the buildings available in Central Europe 19 m₂ per inhabitant are suitable for crystalline PV technology, i.e. southern orientation plus/minus 45° and inclinations from 22 to 60°. The use of thin-film systems with the advantages described (high yields for flat roofs and in spite of unfavourable orientation) would mean a raise by a factor of 1.5. The large surfaces of slightly tilted industrial roofs are extremely suitable for these systems, especially with a north-south alignment of the roof-ridge.

All over Europe, the course is well set for this utilisation of industrial surfaces: Italy recently

Oder, Germany and FlexCell, developed by the university in Yverdon-Les-Bains in Switzerland are two outstanding examples for manufacturers currently developing new brands of flexible thin-film cells especially for use in BIPV.

A New Trend For Solar Roofs: Heat Production

Solar roofs completely covered by solar thermal collectors are starting to play a major role. Solar roofs by Saxonian company Solifer have been on the market for a long time - pioneer work, that has set today's standards. Large collector surfaces are needed to efficiently support the heating system or even provide 100% of the heating. This is no problem in the case of trade and industrial buildings, roof surfaces of a few hundred or thousands of square meters are readily available. If these roofs are put to use with a well-advised combination of functions such as roofing, power generation and aesthetics, undreamed-of possibilities are the result.

The Huge Potential of Solar Roofs

These kinds of hybrid plants are a severe boost for the profitability of solar roofs. An important aspect, given the enormous price erosion the German PV industry is currently facing. When standard plants reach their limits of cost effectiveness, solar roofs which in addition to power generation cover other functions as well, are a clever alternative.



introduced a feed-in tariff of up to 49 ct/kWh for roof-integrated PV plants, France offers 55 ct for BIPV solutions instead of 30 ct/kWh for standard plants and this way created an enormous demand for the corresponding systems.

It remains to be seen if the review of the German Feed-In Act due this year will recognise the figures from the neighbouring states and introduce similar regulations for roof-



integrated systems. A 10% payment raise for roof integration and a 25-30% raise for facade-integration would be reasonable and desirable. It would strongly influence the development of said systems and maybe even produce a lasting interest in photovoltaics from architects and the construction industry. An important step on the way for solar energy and climate protection solutions, a huge new field for the glass industry to contribute to, and to make the motto "PV makes buildings look beautiful" come true.