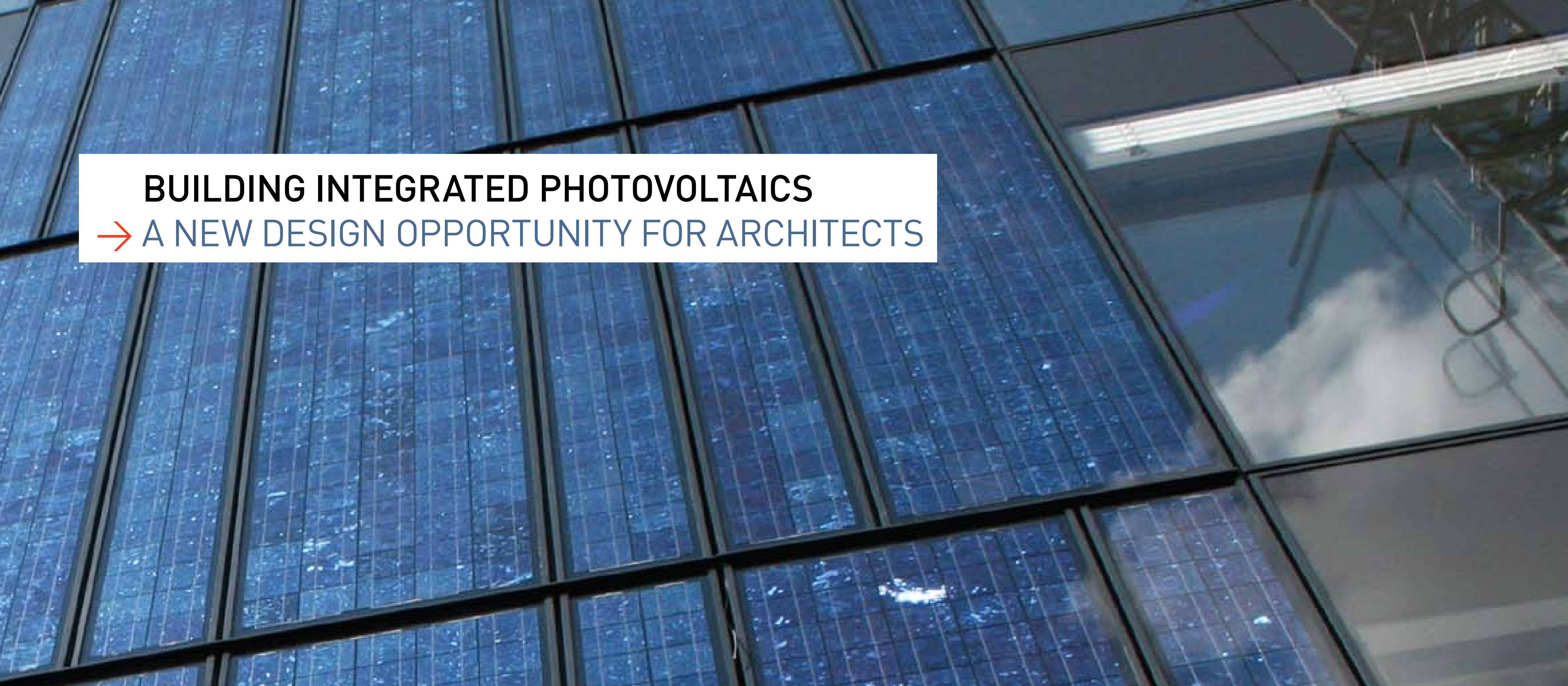
BUILDING INTEGRATED PHOTOVOLTAICS
→ A NEW DESIGN OPPORTUNITY FOR ARCHITECTS



→ WHY BUILDING INTEGRATED PHOTOVOLTAICS (BIPV)?

Photovoltaics (PV) convert light into electricity directly, without emissions and when it is needed. The system can be used decentralized. This means it can be deployed in close proximity to the user avoiding energy looses by long transportation.
PV that is integrated into the fabric of a building has become very popular in Europe. Known as Building Integrated Photovoltaics (BIPV) they can be used on both new and existing buildings. Their use in the building envelope is very varied and opens many opportunities for creative designers.
Many architects have already integrated PV successfully in their buildings.

› Front and back cover image: Energie AG, Linz, Austria - www.ertex-solar.at

› Lehrter Bahnhof, Berlin – Germany - www.scheutensolar.com

› Future energy use in buildings

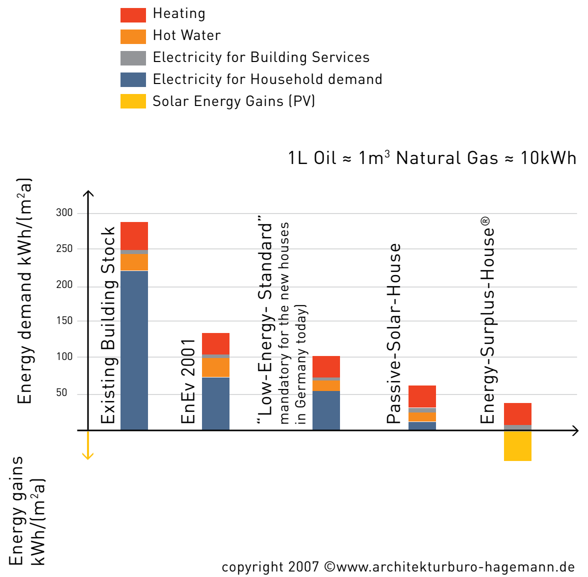
The public is becoming more and more sensitive to the economic and ecological consequences of global warming and environmental devastation. The objective is to replace the use of fossil fuel energy with renewable forms of energy, and to move in the direction of rational energy use. In the domain of building construction, this leads to new legislation frameworks and radical changes in how we design our buildings.
Design strategies and techniques to make use of solar energy and cut down total energy demand are under development worldwide. Many "zero energy" homes and offices have already been built.
On an average year these buildings do not need any outside sources of energy while they are in use. However, energy is still required to construct the buildings and to pull them down at the end of their lifetime.

To create truly sustainable buildings our long term goal must be to design and construct buildings that do not need more energy over their entire life than they can produce. For this reason our buildings need to be converted from energy users to energy producers!

Steps in this direction are:

1. Conserve as much energy as possible
2. Increase energy efficiency
3. Use active solar systems, such as solar thermal and photovoltaics

BIPV systems are able to contribute significantly to meet the goal of true sustainable building design. Electricity will be the only power source needed in our future sustainable buildings. A building integrated PV system is therefore a future-oriented investment!



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› Capilla del Hombre, Ecuador - Isofoton

› Framework conditions for the use of BIPV Systems

A BIPV system will be integrated successfully if it is incorporated into the building fabric with good design and structure and with a sensible energy concept. Increasing façade performance expectations have led to the envelope to become a more complex and multifunctional element of a building.
New technological developments allow radical changes to the design of façades and roofs.
While designing the building exterior we need to be aware that the use of PV as part of the envelope is important. But it is only one aspect out of a long list of building envelope performance expectations which need to be considered. To accomplish all these building performance expectations PV building products should not only produce electricity, but also be able to fulfil other functions.
PV buildings products can be truly multifunctional.

› PV: a new design element for buildings

Today PV can be used in the building envelope to provide :

- Weather protection
- Heat insulation
- Sun protection
- Noise protection
- Modulation of daylight and
- Security

Furthermore, PV systems can also be used as small stand-alone power units. They can be used to regulate the intake of daylight to a building by powering an automatic sun-blind, operate an engine-driven ventilation opening or even as emergency lighting.

PV also acts as a public demonstration of a building-owner's green, ecological and future-oriented image.

› Kindergarden Remerschen, Luxemburg - Alwitra

EXAMPLES OF ARCHITECTURAL SUCCESSFUL BIPV APPLICATIONS

Our built environment allows for many kinds of PV applications to be integrated into different parts of the building fabric. PV is applied to:

- Roofs
- External building walls
- Semi-transparent façades
- Skylights
- Shading systems

› Roofs

Roofs are ideally suited for PV integration. Usually there is less shadowing at roof height than at ground level. Roofs often provide a large, unused surface for integration. A distinction between pitched and flat roofs must be made.

› Pitched Roofs

PV modules can easily be fixed on top of pitched roofs. This type of low-cost application is often used for private homes and existing roofs and is known as Building Adapted PV (BAPV). A more elegant way to integrate PV is to use PV Shingles or PV Tiles. The PV module is mounted like any shingle or tile and the work can be carried out by a roofing contractor.

› Flat Roofs

Flat roofs have the advantage of good accessibility, easy installation and provide a free choice for the orientation of the PV units. Care must be taken during the fixing of the array to avoid breaking the integrity of the roof. The added weight of the PV array on the roof must be considered, as must the uplifting force of the wind, which can blow the modules away.

› Herne Hill school, UK - www.solarcentury.com

› ThyssenKrupp, Duisburg-Beeckerwerth, Germany – Thyssen Solartec

› External Building Walls

PV modules can be added to existing walls to improve the aesthetic appearance of the façade. They are simply added on to the structure. There is no need to provide a weather-tight barrier as this role is already performed by the structure underneath the modules.

PV modules can also be an integral part of the building façade. Glass PV laminates, replacing conventional cladding material, are basically the same as tinted glass. They provide long-lasting weather protection and can be tailor-made to any size, shape, pattern and colour. PV modules can be also configured as a multifunctional building element.


› Oekotherm, Schörflingen, Austria - www.ertex-solar.at

› SCHOTT Ibèrica SA, Barcelona, Spain - www.gipv.de

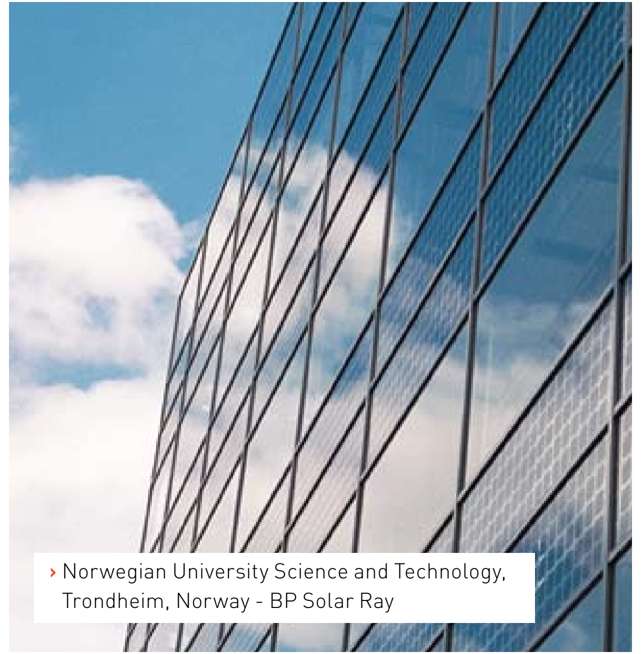
› Semi-Transparent Façades

Glass PV laminates can be applied to windows providing a semi-transparent façade. The transparency is normally achieved using either of the following methods:

› The PV cell can be so thin or laser grooved that it is possible to see through. This will provide a filtered vision to the outside. Semitransparent thin-film modules are especially appropriate for this application. Another option is to use semi-transparent crystalline solar cells.

› Crystalline solar cells on the laminate are spaced so that partial light filters through the PV module and illuminates the room. Light effects from these panels lead to an ever changing pattern of shades in the building itself. The room remains shaded, yet not constrained.

Adding layers of glass to the base unit of a semitransparent PV glass module can offer for example thermal and acoustic insulation. Other special requirements can also be designed according to the individual requirements of each application. Such PV glass modules are truly multifunctional building components.

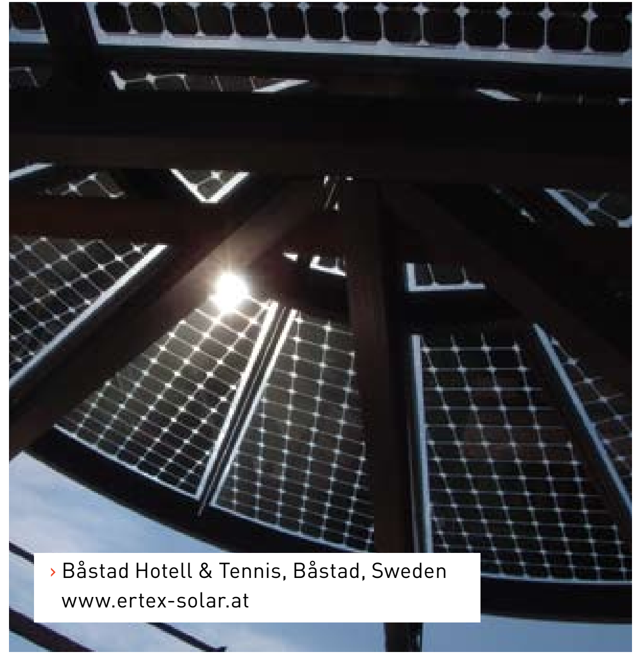


› Norwegian University Science and Technology, Trondheim, Norway - BP Solar Ray

› University of East Anglia, Norwich, UK - BP Solar

› Skylights

Skylight structures are usually one of the most interesting places to apply PV. They combine the advantage of light diffusion in the building while providing an unobstructed surface for the installation of PV modules or laminates.
In this type of application, PV elements provide both electricity and light to the building. The PV modules and support structures used for this type of application are similar to those used in semi-transparent glass façades. The structures, which may be unspectacular from the outside, produces fascinating light hallway walks and floors and allow a stimulating architectural design of light and shadow.

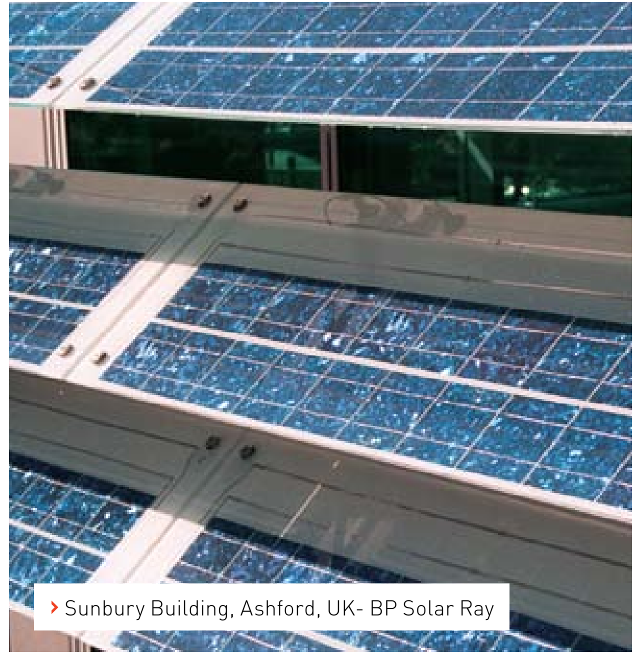


› Båstad Hotell & Tennis, Båstad, Sweden
www.ertex-solar.at

› Sunbury Building, Ashford, UK- BP Solar Ray

› Shading Systems

There is a growing need for carefully designed shading systems due to an increase in the use of large window openings and curtain walls in today's architecture.
PV modules of different shapes can be used as shading elements above windows or as part of a overhead glazing structure. Since many buildings already provide some sort of structure to shade windows, the use of PV shades should not involve any additional load for the building structure. The exploitation of synergy effect reduce the total costs of such installations and create added values to the PV as well as to the building and its shading system. PV shading systems may also use one-way trackers to tilt the PV array for maximum power while providing a variable degree of shading.

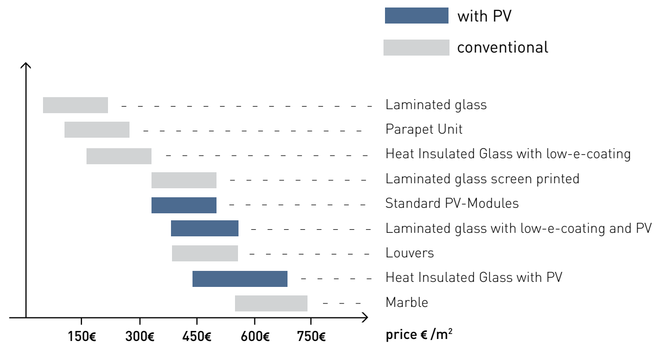


› Sunbury Building, Ashford, UK- BP Solar Ray

› Eden Project, Cornwall, UK - www.solarcentury.com

FACTS ABOUT BIPV

- BIPV systems are highly reliable in the long term. The average guarantee for this type of building product is 20-25 years.
- PV will be cost competitive with retail electricity prices in Southern Europe by 2015. Central and Northern Europe will follow five to ten years later.
- The energy-payback time of PV systems is between 1 and 3 years depending on cell type and location.
- PV modules are almost maintenance-free.
- PV modules is a strategic business area with very high growth potential, especially in the building sector.
- The Average Economic Pay back time of a PV system is about 10 years when adapted support schemes are in place. Afterwards, the annual return of investment is approximately 7% of the initial investment.
- PV modules, unlike any other building materials, produce energy and therefore allow a building owner to recover the initial cost of their investment.



SUMMARY

PV is ready for many building applications today. In the long term it will become indispensable. The debates of the past, often emotionally charged, frequently overestimated the short-term potential of Building Integrated Photovoltaics. Today the long-term potential of BIPV in the building sector is still underestimated!
By designing buildings as power suppliers with numerous façades and roofs integrating PV, a vision of a city that powers itself without emissions is in reach. Innovative built examples, such as the "Solarsiedlung am Schlierberg", in Freiburg, Germany, provides already the proof, that it will be possible to put such a vision into practice on a large scale.

FURTHER INFORMATION RESOURCES

› Webpages

ARCHITEKTURBÜRO HAGEMANN
www.gipv.de
European Photovoltaic Industry Association
www.epia.org
European Photovoltaic Technology Platform (Fact Sheets)
www.eupvplatform.org
IEA Photovoltaic Power Systems Programme (PVPS)
www.iea-pvps-task10.org
International Energy Agency (IEA)
www.pvdatabase.com
PV Database
www.pvdatabase.org

› Books

› Abbate, Cinzia (Ed.) "L'integrazione architettonica del fotovoltaico: experienze compiute". "Progetti dal Case Studies report del Task 7, International Energy Agency". Roma: Gangemi Editore. 2002. ISBN 88-492-0336-5
› Bouwmeester, Henk. "Bouwen op de zon. Eindeloze energie in een duurzame wijk/ Building Solar Suburbs. Renewable energy in a sustainable city". Boxtel: Æneas. 1999. ISBN 90-75365-19-5
› DGS (Ed.). "Planning and installing photovoltaic systems: a guide for installers, architects and engineers". London: James & James / Earthscan. 2005.
› Hagemann, Ingo B. "Gebäudeintegrierte Photovoltaik. Architektonische Integration der Photovoltaik in die Gebäudehülle". Köln, Rudolf Müller. 2002. ISBN 3-481-01776-6
› Humm, Ottmar; Toggweiler, Peter. "Photovoltaik und Architektur - Die Integration von Solarzellen in Gebäudehüllen". Basel: Birkhäuser. 1993. ISBN 3-7643-2891
› Prasad, Deo; Snow, Mark. (Ed.) "Designing With Solar Power". Mulgrave: Images Publishing. ISBN 1-876907-17-7

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