

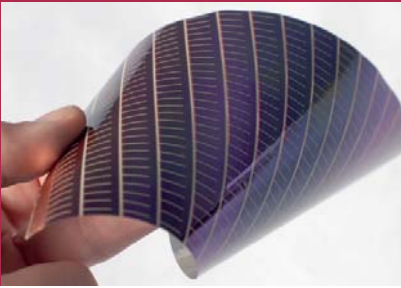


## PV Flexibles

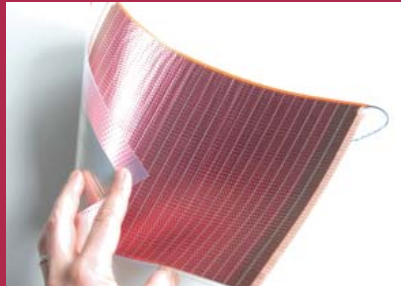
### **Solar Power in Its Most Flexible Form**

**Photovoltaics integrated in translucent and transparent membranes for roofs, facades and canopies**

PV-technology: a-Si thin-film on polymer substrate



PV Flexibles: Photovoltaic film encapsulated in transparent Fluoropolymer foils



Atrium roofing with PV Flexibles on ETFE-membrane cushion



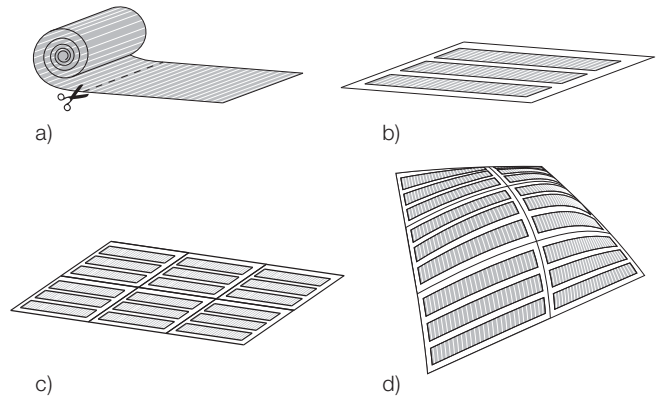
## PV Flexibles - Solar Technology for Membranes

A new generation of highly flexible thin-film solar cells has reached the maturity phase. Using a special plasma process, a very thin layer of amorphous silicon is applied on a 50 µm thick, transparent polymer substrate foil. In a large-scale lamination process this coated substrate foil is encapsulated in two layers of fluoropolymer-foil. Being used in the building sector for decades fluoropolymers have proved their value through long-term durability and a self-cleaning surface. The high light transmittance of the fluoropolymer-encapsulation ensures the highest energy output of the photovoltaic cells possible.

The degree of shading is dependant on the chosen membrane material. Conventional shading systems might become dispensable and therefore can be omitted. The heating up of the building due to solar irradiation and the resulting cooling loads in the summer are minimised.

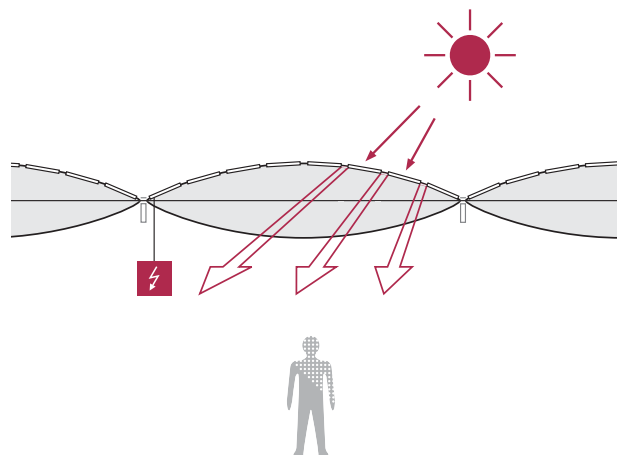
PV Flexibles are produced in a roll-to-roll process in a very economical way. The width of the photovoltaic film is 30 cm at a length of currently 3 m maximum.

### The principle process: PV Flexibles on ETFE membranes



- a) The Photovoltaic film roll
- b) The laminate: ETFE-Photovoltaics-ETFE
- c) The joined laminates
- d) PV Flexibles on a synclastic membrane structure

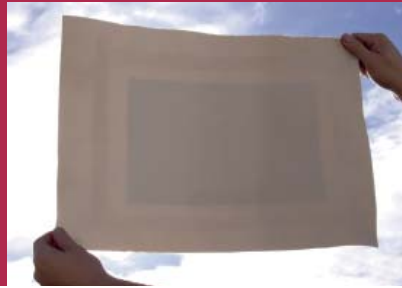
### Principle of integration: PV Flexibles on a membrane cushion structure



PV Flexibles on PTFE/glass fabric



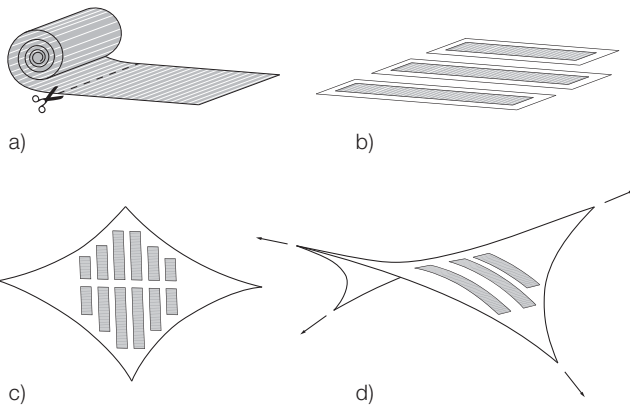
PV Flexibles on PTFE/glass fabric - view from the back



Four point sail with PV Flexibles as entrance canopy



### The principle process: PV Flexibles on PTFE/glass fabric



- a) The Photovoltaic film roll
- b) PV-laminate
- c) Laminates applied on PTFE/glass fabric
- d) PV Flexibles on an anticlastic membrane structure

Building with membranes has become more and more popular worldwide for years. PV Flexibles integrated in transparent or translucent membrane materials are highly qualified for intelligent building envelopes and roofs. The almost arbitrary arrangement of PV Flexibles on building envelopes allows for unlimited design possibilities.

PV Flexibles are suited for multilayer membrane cushion structures as well as large-scale, mechanically pre-stressed tensile membrane structures. With a particularly developed joining technology PV Flexibles are assembled to large-scale membrane modules.

Wide span roofs and facades with filigree steel-, wire- or wood structures can be composed to light-flooded rooms. Thereby PV Flexibles are providing a clean energy production, integrated shading and a unique architecture at the same time.

Gottlieb-Daimler-Stadium, Stuttgart, Germany  
(Status Quo)



Gottlieb-Daimler-Stadium, Stuttgart  
(with PV Flexibles, Computer Simulation)



## Basic Calculation for a Sample Stadium Roof (Gottlieb-Daimler Stadium, Stuttgart)

|  |  |
|--|--|
| <b>PV Flexibles Technology</b>                                 | flexible a-Si thin-film modules (PV Flexibles) integrated in a mechanically stressed membrane roof |
| <b>Power/m<sup>2</sup></b>                                     | ~45-50 Wp  |
| <b>Roof Area (Total)</b>                                       | 34,000 m <sup>2</sup>  |
| <b>Area suitable for PV Flexibles</b>                          | 80 % (27,200 m <sup>2</sup> )  |
| <b>Area used for PV Flexibles (active module area)</b>         | 75 % (20,400 m <sup>2</sup> )  |
| <b>Installed Power</b>   | ~918 kWp   |
| <b>Average Annual Global Solar Irradiation (for Stuttgart)</b> | 1,100 kWh/m <sup>2</sup>   |
| <b>Estimated Annual Power Output</b>                           | 730,000 kWh/year<br>at approx. 800 kWh/kWp   |
| <b>Feed-in Payback (43.99 Ct/kWh)*</b>                         | ~322,000 Euro/year   |
| <b>CO<sub>2</sub>-Reduction*</b>                               | ~650 t/year  |

(\* Figures for Germany, 2008)

## PV Flexibles Key Data

### Characteristics of PV Flexibles (laminated)

- lightweight
- flexible
- preserves resources
- energy-saving production
- economical

### Technical data:

- flexible a-Si thin-film modules
- width of rolls: 30 cm
- laminate size currently max. 3,0 m x 1,5 m
- nominal capacity: 45-50 Wp/ m<sup>2</sup>
- low weight < 1 kg/ m<sup>2</sup>

### Characteristics of the surface

- long life expectancy > 20 years
- durable
- lasting high transparency
- very low weight
- flame resistant (B1 according to DIN 4102)
- self-cleaning surface

### Possible applications:

- ETFE-membrane-structures
- PTFE-membrane-structures

### Appearance:

- width PV Flexibles: 30 cm
- length PV Flexibles: currently max. 300 cm

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