Solar Power in Its Most Flexible Form

Photovoltaics integrated in translucent and transparent membranes for roofs, facades and canopies
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
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.
Basic Calculation for a Sample Stadium Roof  (Gottlieb-Daimler Stadium, Stuttgart)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>PV Flexibles Technology</td>
<td>flexible a-Si thin-film modules (PV Flexibles) integrated in a mechanically stressed membrane roof</td>
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<tr>
<td>Power/m²</td>
<td>~45-50 Wp</td>
</tr>
<tr>
<td>Roof Area (Total)</td>
<td>34,000 m²</td>
</tr>
<tr>
<td>Area suitable for PV Flexibles</td>
<td>80 % (27,200 m²)</td>
</tr>
<tr>
<td>Area used for PV Flexibles (active module area)</td>
<td>75 % (20,400 m²)</td>
</tr>
<tr>
<td>Installed Power</td>
<td>~918 kWp</td>
</tr>
<tr>
<td>Average Annual Global Solar Irradiation (for Stuttgart)</td>
<td>1,100 kWh/m²</td>
</tr>
<tr>
<td>Estimated Annual Power Output</td>
<td>730,000 kWh/year at approx. 800 kWh/kWp</td>
</tr>
<tr>
<td>Feed-in Payback (43.99 Ct/kWh)*</td>
<td>~322,000 Euro/year</td>
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<tr>
<td>CO₂-Reduction*</td>
<td>~650 t/ year</td>
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(* Figures for Germany, 2008)

PV Flexibles Key Data

Characteristics of PV Flexibles (laminate)
- 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/ m²
- low weight < 1 kg/ m²

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

in co-operation with VHF-Flexcell

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