



## Energy Production on Firestone Rooftops

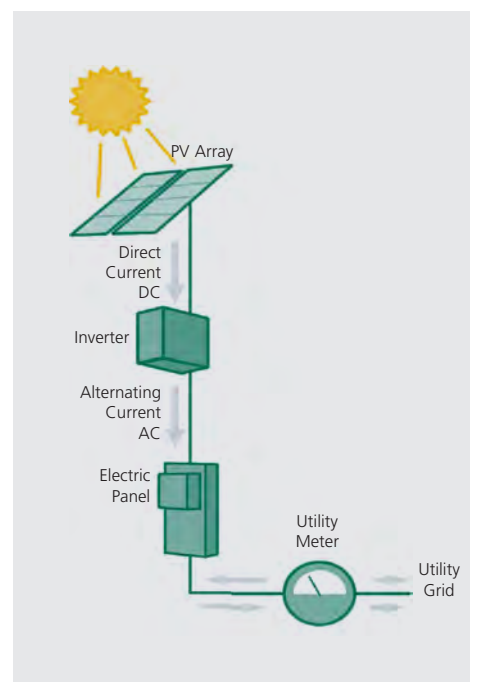


### How does a PV solar installation work?

The term 'photovoltaic' comes from the Greek 'φως' (phos) meaning 'light', and 'voltaic', from the name of the Italian physicist Volta, meaning 'electrical'.

Photovoltaic (PV) cells are made up semiconductors. An example would be silicon, which is currently the most commonly used semiconductor. Silicon is the second most abundant element in the earth's crust, after oxygen. The sun's Solar Energy (in the form of photons) is converted into electricity through the absorption of the photons by this semiconducting material. The solar energy loosens electrons, allowing them to move freely. The PV cells contain an extra electric field that forces electrons that have been loosened, to move in one direction, and this creates a current. By placing metal on both sides of the cell, we can collect the current and use it outside of the cell.

The photovoltaic effect produces DC (Direct Current) electricity. This DC power is converted to AC (Alternating Current) electricity by an important system component called the inverter. The solar array and inverter are engineered for efficiency and compatibility. The AC electricity can then be used to power your home, office or industrial building or processes.



# PV installations



## PV installations come in different forms and use different mounting systems to be installed on rooftops:

- **Penetrating system:** a rack support system penetrates the membrane. Detailing becomes critical to ensure watertightness of the roofing system. (picture 1 + 2)
- **Non-penetrating system:** a rack support system is installed on top of the membrane without anchoring, sometimes held in place using ballast. No extra detailing is required. (picture 3)
- **Laminates:** PV strips are adhered to the membrane. Membrane needs to be compatible. (picture 4)

## There basically exist 2 different types of PV installations:

- **Mono- or poly-crystalline panels** (Schüco, Kyocetera, Sanyo, Sharp, Sunpower,...)
- **Thin films** (amorphous silicon - UniSolar, CIGS - Solyndra,...)

Structural Panels (Mono-crystalline)	Thin Film	
	Amorphous silicon - UniSolar	CIGS - Solyndra
<b>Highest efficiency</b> per m <sup>2</sup> , up to 23%	Lowest efficiency per m <sup>2</sup> at approx. 8%	Highest efficiency in thin film
Non shade tolerant, less m <sup>2</sup> of panels per roof area	<b>Shade tolerant</b> , almost entire roof area can be covered	<b>Shade tolerant</b> , almost entire roof area can be covered
Can be installed on <b>zero slope roofs</b>	Minimum slope is required to avoid loss of efficiency due to ponding water	Minimum slope is required to avoid loss of efficiency due to loss of membrane reflectivity
Rack-mounted system <b>allows to air cool</b> the panel	Direct attachment to membrane creates heat build-up	<b>Lower temperature operation</b> with greater solar PV output due to increased wind flow throughout solar array
<b>Membrane remains accessible</b> under PV panels	Membrane is covered	<b>Membrane remains accessible</b> under PV panels
Support needs to carry additional weight	<b>Lightweight (&lt; 5 kg/m<sup>2</sup>)</b>	Moderate weight (> 10 kg/m <sup>2</sup> )
Rack mounted system is <b>compatible with all roof types</b>	Peel & Stick panels compatible with EPDM and TPO systems	Requires white reflective membrane for optimum performance
Glass cover susceptible to hail damage	<b>Durable</b> , less susceptible to damage (no glass)	Glass tubes are susceptible to damage
Visible from the ground	<b>Low profile</b> , not visible from the ground	<b>Low profile</b> , not visible from the ground
Anchoring or additional ballast required	<b>Films are adhered to membrane</b>	Aerodynamically designed to reduce wind uplift of panels
No roof penetrations in case of ballasted racks	<b>No roof penetrations</b>	Self ballasted panels and mounts, <b>no roof penetrations</b>

## A choice has to be made both with regards to the type of PV as well as the most appropriate mounting system, taking into account:

- roof surface available
- energy output required (efficiency of the panels in combination with the surface available)
- supporting structure and the maximum added weight

# Firestone EnviroReady™ Roofing System

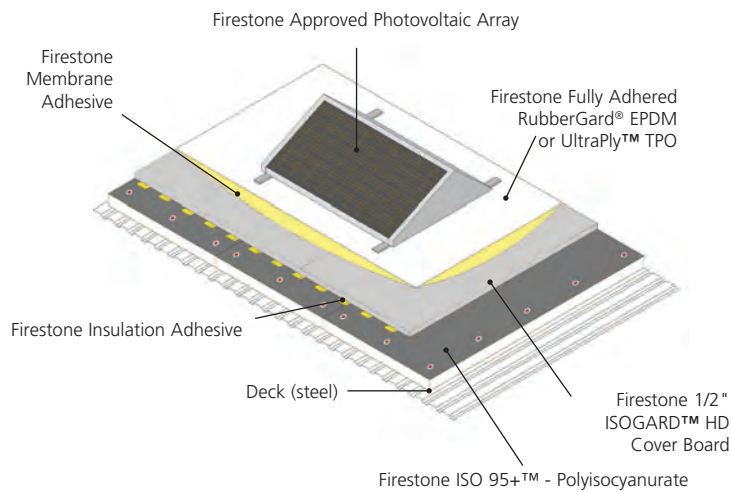
**The Firestone EPDM and TPO Roofing systems are compatible with all of the above PV systems.**

The Firestone membranes offer excellent weathering performance, outstanding durability and can withstand high temperatures. The Firestone Roofing Systems contain an important selection of accessories that can be used to treat the most complex details associated with PV panel installation. Support racks can be flashed in using uncured QuickSeam FormFlash and QuickPrime Plus, in case of EPDM, and Unsupported Flashing or pre-molded accessories, in case of TPO.

In order to guarantee the long term performance and watertightness of the roof, Firestone has developed the **EnviroReady™ Roofing concept.**

The EnviroReady Roofing System takes into account:

- Possible damage to the membrane because of traffic on the roof during the installation of the PV system and its maintenance. **Firestone proposes to use a 1.5 mm thick membrane with higher puncture resistance.**
- Damage to and crushing of the insulation boards, due to lack of long term compressive strength and/or traffic on the roof during the installation and maintenance of the PV system. **Firestone proposes the use of rigid insulation boards with high compressive strength or use of a high density cover board.**
- The requirement for a smooth and flat support in case of film laminates. **Firestone proposes to fully adhere the membrane** onto a compatible support and to use Firestone insulation adhesive (or approved insulation plates and fasteners) to attach the insulation boards.



This is today the biggest mono-crystalline PV roof installation in Belgium.

- Location: Duffel, Belgium
- System: Fully adhered EPDM
- Roof surface: 16.000 m<sup>2</sup> of which 10.000 m<sup>2</sup> is covered with 3.072 PV panels
- Output: 584 kWp producing 500 MWh

**Reynaers Aluminium, Belgium**



# PV installations on Firestone Roofing Systems

Firestone has participated in the design and installation of prestigious PV rooftop installations. Please find hereafter a few examples of different types of PV installations installed on our roofing systems.

## Penetrating Systems



**Green Shop, United Kingdom**

- Location: Bislely, United Kingdom
- System: Fully adhered EPDM
- Roof surface: 250 m<sup>2</sup>



**Teknox, Serbia**

- Location: Belgrade, Serbia
- System: Mechanically attached TPO
- Roof surface: 3.000 m<sup>2</sup>

## Non-penetrating Systems



**Gosselin, Belgium**

- Location: Duffel, Belgium
- System: Mechanically attached EPDM (RMA) over PIR insulation
- Roof surface: 14.500 m<sup>2</sup>



**MDZ, Germany**

- Location: Regensburg, Germany
- System: Mechanically attached TPO
- Roof surface: 8.500 m<sup>2</sup>

## Laminates



**Colruyt, Belgium**

- One of the biggest UniSolar PV installations in Europe.
- Location: Lot, Belgium
  - System: Fully adhered EPDM
  - Roof surface: 80.000 m<sup>2</sup>
  - Output: 2.5 MW



**SCI 2008, France**

- The largest UniSolar PV installation in the North of France.
- Location: Bondues, France
  - System: Fully adhered EPDM
  - Roof surface: 2.122 m<sup>2</sup>
  - Output: 104 kW

**Firestone**

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