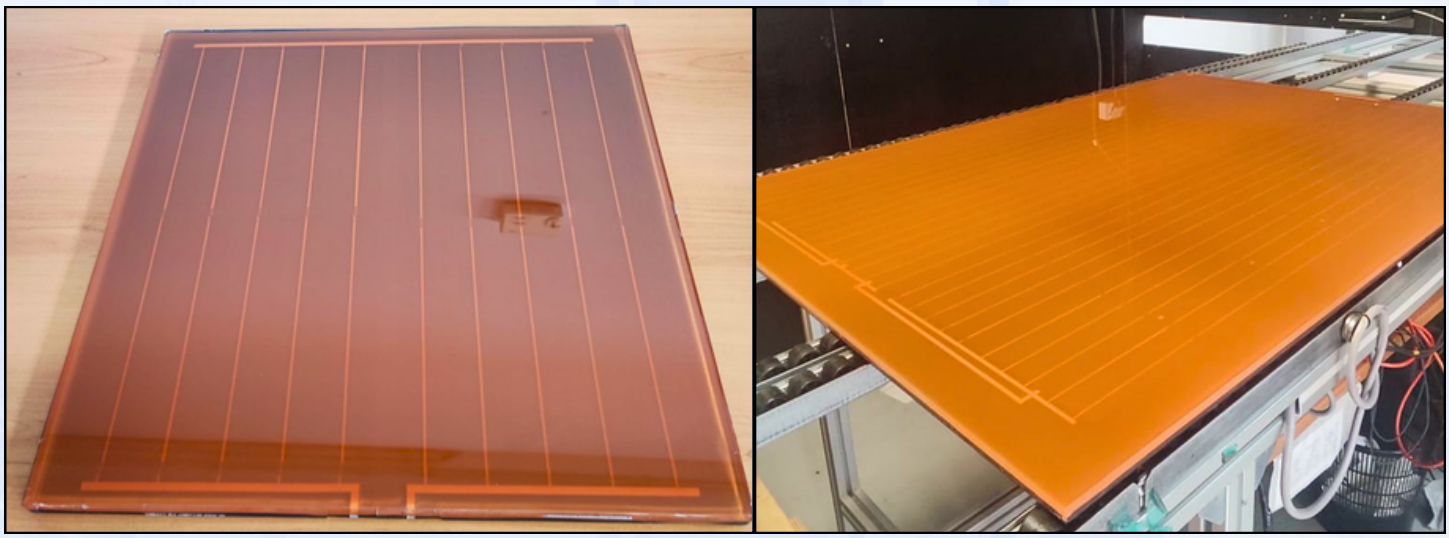
Seamless-PV drives the implementation of new integrated photovoltaic (IPV) solutions in different market sectors. The objective is to develop advanced manufacturing equipment, processes and digitalisation strategies focusing on glass-glass lamination as well as lightweight composite and polymer-based technologies.

Facing at real industrial environments and different market demands and opportunities, Seamless-PV sets up six pilot line levels and 11 different IPV demo cases across Europe, divided between integration in noise barriers, buildings, electric vehicles, and agriculture.

New functional BIPV samples

The Seamless-PV project has presented the preliminary characteristics and design of the various functional IPV prototypes, covering technological progress, material and process development, and the necessary pre-qualification tests to validate safety, reliability, and durability. The work carried out covers the development of distinct products with unique features. In this results summary we are introducing the BIPV samples realized



▲ *Figure 1: (Left) Active sample (360 mm x 360 mm) of four c-Si solar cells manufactured at ONYX, (Right), BIPV module under the ONYX's solar simulator. Source: Onyx Solar*

Colored Films and Modules

A new polymeric material has been developed for colored intermediate layers in BIPV modules to ensure a uniform and homogeneous appearance and prevent wrinkles/bubbles during lamination. The material, is being tested in different glass-glass configurations

Customizable Size BIPV Modules

Expanding the product portfolio to offer BIPV modules meeting high aesthetic standards, including various geometries, sharp angles, antiglare finishes, and color options. 3S produced colored and coating glass, testing different techniques such as Digital Ceramic Printing (DCP), Chemical Vapor Deposition (CVP) and satin finishes. Adapting the 3S solutions to the new range of G12 half-cut cell modules, the module sizes and modules with customized geometries have been improved: For façade solutions (Glass/glass) the formats available are now from 452x614 mm up to 1650x1190mm; the largest format for custom roof shapes (glass/backsheet) is also 1650 x 1190mm.

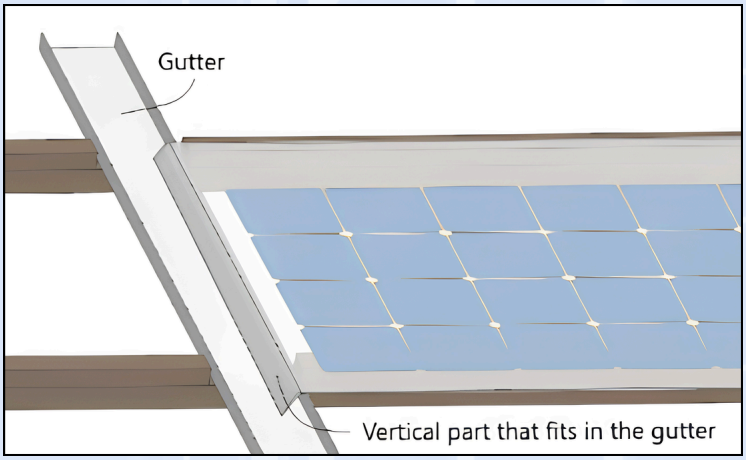
Lightweight Roof Shingle

Another product designed and developed within Seamless-PV is the solar shingles system, which incorporates several characteristics.

The samples present an aesthetic full-black design, achieved with back-contact solar cells and black paint. Their simple integration enables the removal of a single element, by using commercial tile fixing hooks and an adequate tile geometry.

The samples have a high degree of adaptability to different roof geometries, by placing cut-up dummy modules.

Watertightness is achieved with the gutters and joints, as well as the tile geometry, which makes it possible for the tiles to fit in with each other.



▲ *Figure 2: Scheme displaying the setting of the shingle and the Gutter system. Source: Tecnalia*

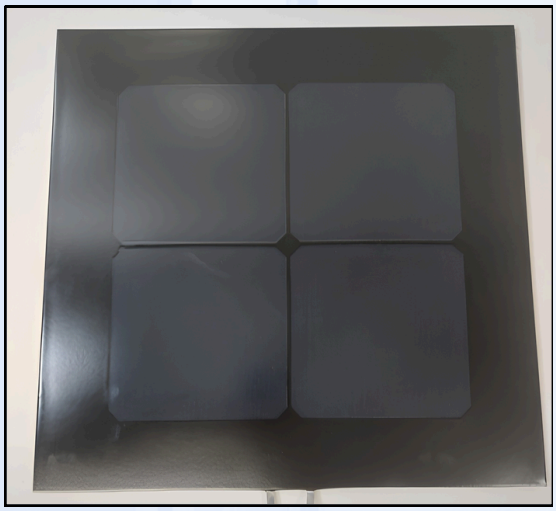


Figure 3: Full black sample using back-contact Maxeon3 solar cells. Source: Tecnalia ▶

BIPV Façade Cladding System with Integrated Insulation (PIZ Cladding)

The PIZ cladding system, which combines rock mineral wool (MWR) insulation with reinforced mortar, was improved to use thinner glass 2mm + 2mm and lightweight PV layers. A silicone adhesive was selected as the most suitable for coupling the mortar and glass (or resin for lightweight PV) based on temperature resistance and elongation at break.

Pre-qualification tests confirmed the e-PIZ prototype achieves the required front glass resistance (Category III) and fire reaction class B, s1-d0, essential for the Italian demo site of the project.



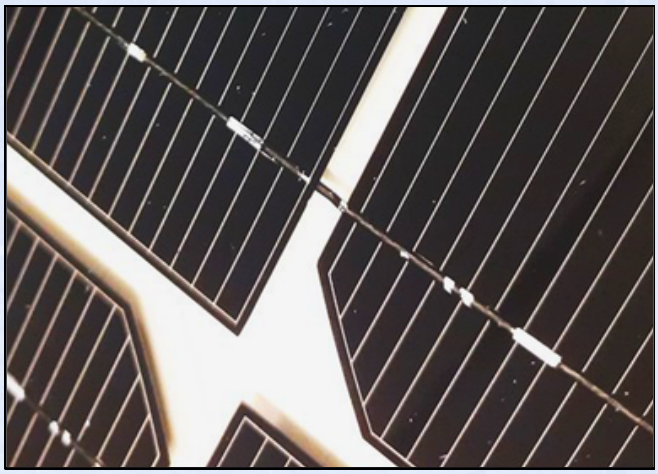
▲ *Figure 4: The PIZ-prototype, you can see the insulation panel below the PV module.*

Therefore, the PV glass layers were finally produced with 3 mm fully tempered front glass (ESG) and 2,1 mm semi tempered rear glass (TVG).

High-Efficiency Full Black Glass-Glass Module with Pre-lamination



▲ *Figure 5: Medium size modules manufactured with black ribbons, Source: CEA.*



▲ *Figure 6: an example of coating debonding. Source: CEA*

The objective of this sample was to create a full black module using colored ribbons combined with a pre-lamination approach based on Electrically Conductive Adhesives (ECA). Ready-made black ribbons (BRR) caused coating detachment and performance issues after aging tests.

An alternative solution that provided a good, uniform aesthetic was the manual application of black adhesive tapes onto the conductive ribbons, though slight deformation was observed due to high pre-lamination temperatures.

Another alternative is the use of narrow ribbons or wires that are not visible from a distance above 1m for a person.

The black tapes probably absorb more energy and reach higher temperature during the prelamination process. Slight deformation of the tape has been observed, but no bubbling occurred, unlike with the BRR ribbons.

When using oversized tapes, the metallic ribbons remain 100% covered. In the next phase, we will work with strings based on wire interconnexion in order to compare the aesthetic appearance of these two solutions.

LEARN MORE check out all the **materials** and **results** available on **seamlesspv.eu**

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