



D3.6 Design of semi-automated manufacturing line for e-PIZ BIPV modules

T3.8 Automated manufacturing for BIPV veture kit



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SEAMLESS-PV PROJECT

A novel manufacturing process for integrated photovoltaics

Integrated photovoltaics (IPVs) have demonstrated their success and impact in their use as building-integrated photovoltaics. They are also considered promising in several other sectors. Their adaptation to other industries or devices could offer surprising benefits. Unfortunately, the very need for adaptable IPV solutions hinders their expansion as their current manufacturing processes cannot create IPV solutions customised to each sector. The EU-funded SEAMLESS-PV project aims to tackle this by developing revolutionary tools for photovoltaic manufacturing as well as new IPV products that offer improved efficiency, adaptability and integrability while at the same time showcasing their cost-effectiveness in comparison to competitors.

The title of SEAMLESS-PV project is *“Development of advanced manufacturing equipment and processes aimed at the seamless integration of multifunctional PV solutions, enabling the deployment of IPV sectors”*. SEAMLESS-PV is a Horizon Europe Innovation Action started in January 2023 that will continue through December 2026.

More information can be found at:

<https://www.seamlesspv.eu/>

<https://cordis.europa.eu/project/id/101096126>

EXECUTIVE SUMMARY

This document contains the description of the process of PIZ Srl to produce the e-PIZ panels (cladding system with PV integrated) and showing the improvements done at some machine and processes within the SEAMLESS project to improve product quality and reduce the cost of the PV product. The pilot line is an automated process to produce PIZ panels. The works related the coupling of PIZ panels at the PV layers were done mainly in a manual way by an operator. The improvements concern the addition of tools in the existing machines to perform some works with automated tools/process reducing significantly the cycle time and manpower need.

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1 INTRODUCTION

1.1 Description of the deliverable content and purpose

This document contains the description of the actual pilot line to produce e-PIZ panels and the measures and improvements done whitening SEAMLESS-PV project to achieve the project goal to have a better quality of the BIPV product and to reduce the production cost.

1.2 Reference material

Not applicable.

1.3 Relation with other activities in the project

Table 1.1 depicts the main links of this deliverable to other activities (work packages, tasks, deliverables, etc.) within SEAMLESS project. The table should be considered along with the current document for further understanding of the deliverable contents and purpose.

Table 1.1 Relation between current deliverable and other activities in the project

Project activity	Relation with current deliverable
T3.8	Automated manufacturing for BIPV veture kit. Task of the present deliverable.
T6.4	Standardised low-cost multifunctional BIPV facade cladding system with integrated insulation.
T6.9	Prototypes manufacturing for indoor and outdoor testing. The prototypes will be made using new tools and machine of the pilot line.
T6.11	Indoor performance validation and testing to support market deployment.
T6.12	Outdoor performance testing activities.
T8.1	Pilot lines definition, installation, ramp-up and validation of Kpis in relevant manufacturing environments.
T8.3	Design of demonstration installations and use cases.
T8.5	Prototypes manufacturing for Demo.

1.4 List of acronyms

Table 1.2 List of acronyms

Acronyms	Meaning
PV	Photovoltaics
BIPV	Building Integrated Photovoltaics
GA	Grant Agreement
JB	Junction box
IPV	Integrated Photovoltaics
LCA	Life Cycle Assessment
PL	Pilot Line
WP	Work Package

2 PILOT LINE PIZ VETURE KIT

2.1 General description of pilot line (before SEAMLESS Project)

PIZ pilot line is destined for manufacturing of insulating façade cladding system and multifunctional BIPV cladding system.

The current product process consists in an automated line for the production of PIZ panel (standard cladding system) integrated by manual working area for the coupling of PIZ panels with PV layers to produce the final e-PIZ panels.

The production can be divided in seven different working areas / phases:

1. Storage raw material
2. Casting area
3. Curing area
4. Cutting area
5. PIZ drying area
6. e-PIZ coupling area
7. e-PIZ storage

The first five steps were the ones done by automated line and the last two by manual works.

2.2 EQUIPMENT AND PROCESSING EVALUATED IN SEAMLESS PROJECT

Within the SEAMLESS project has been changed some process to reduce the production cost of e-PIZ panels or improving the product quality or performance. Some improvements are obtained adding new tools at the machines of the existing pilot line, other changing the process of a single work task or changing the product specs or dimension.

The equipment and processes involved are:

- Vibrating power screed
- Cutting machine No. 1
- Cutting machine No. 2
- Gluing station

2.3 Advantages

The SEAMLESS-PV pilot line will allow to automate the works related the final e-PIZ process improving the following steps:

- Implementation of new control meters to reduce the defects had during casting process, or rather increase the flatness of the mortar surface.
- Implementation of new tools in the cutting machines to cut the panels for the allocation of the junction box and cables.
- Modification of the gluing process to couple the PV layer at the PIZ panel (currently it is a semi manual work).

The new processes will allow to reduce the production time and increase the quality of the final product.

In the next chapters will be described more detailed each single improvement in the different production sectors.

3 VIBRATING POWER SCREED

3.1 Machine description

The hopper is the machine that cast the mortar on the insulation to form coupled slabs. Straight after, the vibrating power screed levels the mortar to have a flat finishing. At the end of the process the mortar is coupled with the insulation in big slabs.

3.2 SEAMLESS project improvements

To achieve a better flatness of the PIZ panel mortar have been evaluated three aspects of the power screed tool that influence the finishing:

- Direction and typology of vibration;
- Inclination of the blade;
- Blade's shape
- Blade's position (panel height).

3.2.1 Direction and typology of vibration

The production line had two vibrating screed bars to level the mortar surface. Different tests were done changing the way of vibration: different power, direction and using also two motors coupled.

The power of the motor changes the strengthens of the bar on the mortar, the direction of the motor changes the direction of vibration of the screed bar and the use of two coupled machine makes the vibration one directional (see example below).

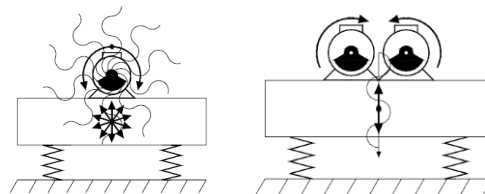


Figure 1. Vibration's modes

3After different tests has been found that the actual configuration is the best to have the best flatness.



Figure 2. Mortar finishing after power screed resetting

3.2.2 Inclination of the blade

An inclinometer was added to support the operator on the setting of the blade inclination. This was connected to the engine rotor and gives the inclination of the blade based on the rotor gears. An additional inclination meter was used to configure the final inclinometer.

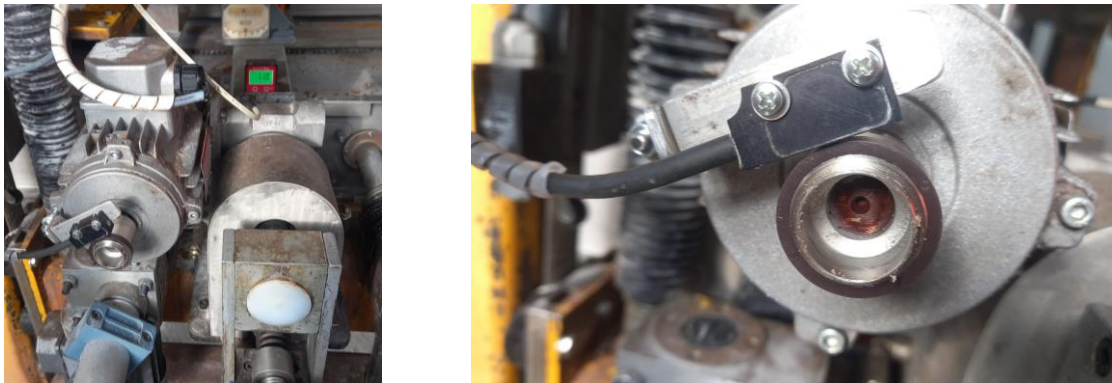


Figure 3. Configuration of inclinometer and inclinometer on the rotor

The blade is subject to wear and tear and has therefore been ground to eliminate any imperfections.

Depending on the consistency of the mortar it is possible have different mortar thickness using the same blade height. To eliminate this defect, distance sensors have been installed so that the operator is able to measure the thickness precisely and change the blade height. For information, it is not possible to measure the height of the panels with a calliper because the mortar is not solid.



Figure 4. Distance sensors

3.3 Conclusions

Thanks to the improvements done within the SEAMLESS Project it is possible cast the panels having a flatness tolerance minor than ± 1 mm. This tolerance is considered suitable for e-PIZ production.

4 CUTTING MACHINE No. 1

4.1 Machine description

The cutting machine n. 1 cut the coupled slabs (mineral wool with mortar) in the final dimension of the custom-made PIZ panels. It has three circular saws to cut the panels in longitudinal way and one to cut the panels in transversal way.

4.2 SEAMLESS project improvements

Within the SEAMLESS project, the machine has been integrated with the crown milling machine to carry out the core drilling to position the JB of the PV panel. The positioning is carried out by numerical control by implementing the existing software of the machine.

This operation significantly reduces the work previously performed manually by an operator

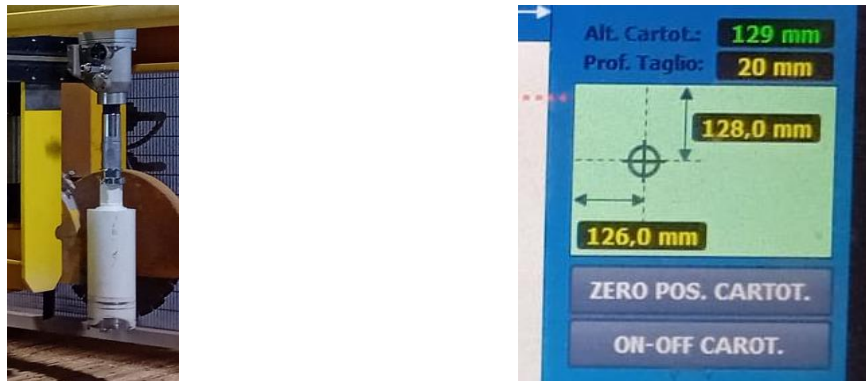


Figure 5. Cutting machine No. 1 with core drill and new drill core software



Figure 6. PIZ output PIZ panel from cutting machine

4.3 Conclusions

Thanks to the improvements done within the SEAMLESS-PV Project it is possible cut the panels and drill the hole for the JB in one automatic step. The automation of this work task reduces significantly the time process.

5 CUTTING MACHINE No. 2

5.1 Machine description

The cutting machine n. 2 mills in the mortar grooves to create the slots used to fix the panels on the aluminium profiles.

5.2 SEAMLESS project improvements

The machine has been modified by replacing the existing sides with new numerically controlled ones and adding a blade to mill the housing for the electric cables of the panel. Thanks to these improvements the machine is adjustable before proceeding to cut the panels with different dimensions in a faster way. Furthermore, the cutting operation for the electric cables significantly reduces the manual work by an operator, also improving the quality of the cut and of the final product.

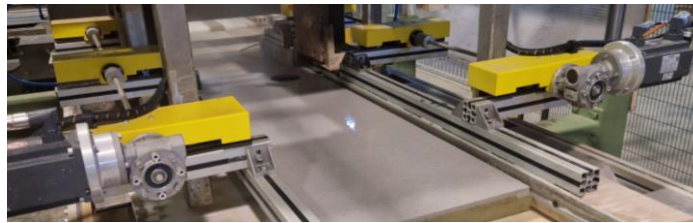


Figure 7. Cutting machine No. 2 after SEAMLESS Project



Figure 8. Cutting machine No. 2 in action and output PIZ panel after cutting machines

5.3 Conclusions

Thanks to the improvements done within the SEAMLESS-PV Project, it is possible to mill the grooves needed for the passage of the electric cables, eliminating the time required to do them manually. The automation of this part of the production process reduced the cycle process to zero because the work is done automatically while the machine is doing also the milling in the mortar.

6 GLUING STATION

The gluing process to couple the PV layers at the PIZ panels is done in a manual way in a dedicated area.

The PIZ panel is coupled with a PV panel using silicone adhesive. A laser projector

Figure 9. Laser projector for projecting image of cells and JB over PIZ panel projects the positions of the solar cells and of the junction box over the module.



Figure 9. Laser projector for projecting image of cells and JB over PIZ panel

Silicone adhesive is applied on the mortar surface using a time-controlled dosage system

Figure 10. Time controlled dosage system



Figure 10. Time controlled dosage system

After applying silicone at all cell positions, cables of the PV module will be passed through the passage created inside the wool rock insulation, glass-glass module will then be placed over the PIZ surface and gently pressed down to spread the adhesive uniformly under the cells. Silicone will then be applied along the edges of the BIPV module to seal the gap between the glass and mortar surface. Uniform weight in form of an Iron plate will be placed over the glass then it will

be moved to the temperature and humidity-controlled room where It will be left there for 24 hours to let silicone adhesive complete its polymerization process.

The last step is to check the modules for any physical defects and the packaging of modules for transportation. We will use the same packaging procedure as adopted for PIZ panels with some added safety measures.

6.1 SEAMLESS project improvements

The proposal within the SEAMLES Project was to implement the gluing station with an automatic machine but the work was not done due high cost faced to produce the machine as expected.

6.2 Conclusions

It is ongoing the evaluation of the new process to apply the glue on the panels. The idea is to spread it on the glass reducing as maximum the amount needed and keep the distance between glass and mortar as much uniform as possible.

7 CONCLUSIONS

Thanks to SEAMLESS Project the pilot line has been implemented with new tools able to raise the quality of the product.

Also, the main processes done manually have been replaced with automated process able to reduce significantly the cycle process and the manpower needed.