

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 691768



Samples for validation testing of CIGS-based BIPV design solutions

Project report

FLISOM, BEAR

August 2017

Summary

This document describes the samples needed for verification and testing of the chosen BIPV design solutions. In addition to standard samples, design selective samples were made to verify specific production and design issues. The samples have been manufactured and partially already been tested. It is expected that the following deliverables D4.1/4.2 “Roofing tiles and façade elements prototypes with 10% - 14% efficiency” and D4.7 “Prototypes for test benches and experimental building” can be finalized in time, as activities have already started.

Acknowledgements

The work described in this publication has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 691768.

The present report was mainly prepared by PVSITES project partner FLISOM, with additional contributions from BEAR. The report was originally submitted to the European Commission as Project Deliverable D4.5 in August 2017.

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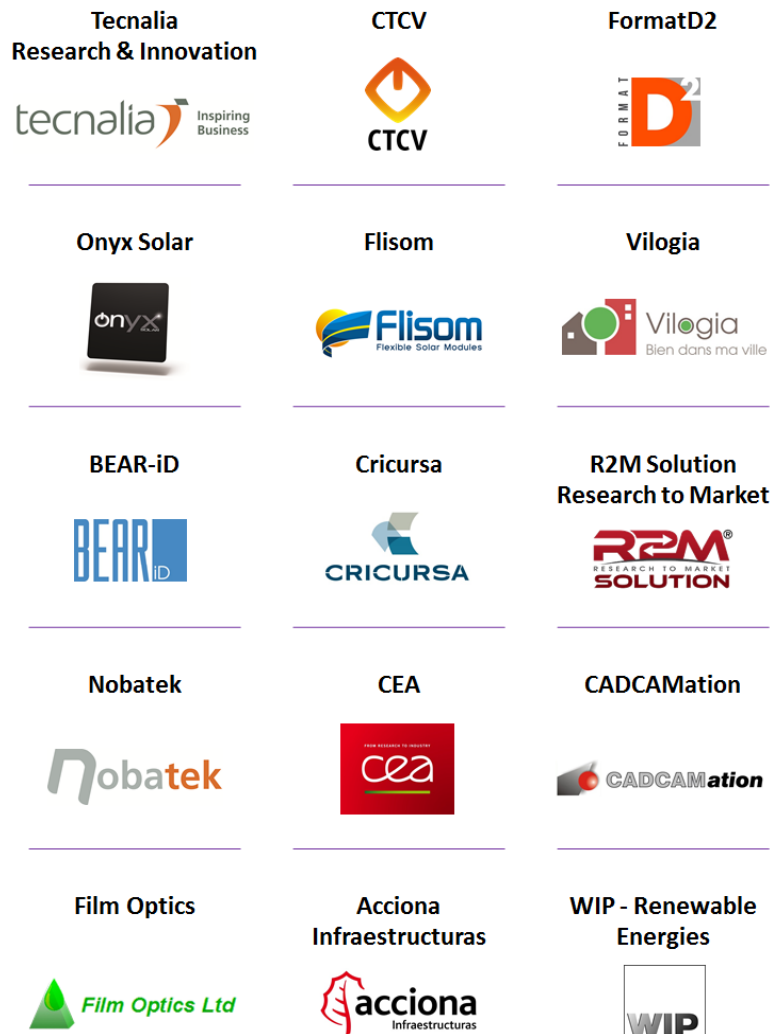
About the PVSITES project

PVSITES is an international collaboration co-funded by the European Union under the Horizon 2020 Research and Innovation program. It originated from the realisation that although building-integrated photovoltaics (BIPV) should have a major role to play in the ongoing transition towards nearly zero energy buildings (nZEBs) in Europe, the technology in new constructions has not yet happened. The cause of this limited deployment can be summarised as a mismatch between the BIPV products on offer and prevailing market demands and regulations.

The main objective of the PVSITES project is therefore to drive BIPV technology to a large market deployment by demonstrating an ambitious portfolio of building integrated solar technologies and systems, giving a forceful, reliable answer to the market requirements identified by the industrial members of the consortium in their day-to-day activity.

Coordinated by project partner Tecnia, the PVSITES consortium started work in January 2016 and will be active for 3.5 years, until June 2019. This document is part of a series of public reports summarising the consortium's activities and findings, available for download on the project's website at www.pvsites.eu.

The PVSITES consortium:



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1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

The purpose of deliverable 4.5 is to deliver samples to verify and test the CIGS-based BIPV design solutions chosen. Critical functions such as lamination of “thick” (up to 20 mm) building elements have to be tested and optimized. The designs need to be tested for safety, mechanical properties and weathering conditions (DH tests). This document contains a description of the samples produced for deliverable 4.6 “Results on performance validation testing of CIGS modules” activities. It focuses on the samples needed to verify the specific design solutions. Given that some components, as the encapsulation materials and front sheets, are identical for all products, some tests can be combined and are not listed for each product individually. According to the envisaged final TRL 7 (see Figure 1.1) in some cases (e.g. wind load) assessment is done via numerical calculations and no test samples are foreseen.

1.2 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 PVSITES 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
WP1	Deliverable D1.3 from WP1 established the standardization needs for every product to be developed and demonstrated within the project.
WP4	The samples described herein are the subject of performance validation testing of task 4.4. The results of the testing activities will be fully detailed in D4.6 (month 27).

1.3 Reference material

D1.3 “Standardization needs” is the basis for the test sample manufacturing.

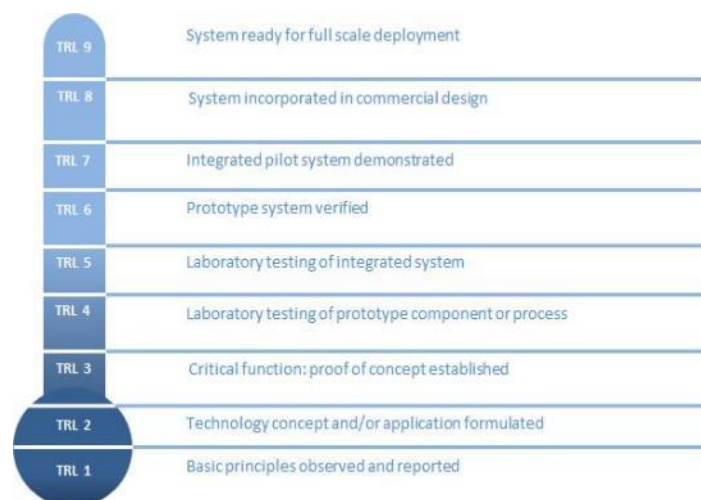


Figure 1.1: Technology readiness scale. According to table 4 on page 12 of the proposal all Flisom products should reach TRL7. The figure is given here for reference.

1.4 Abbreviation list

DH	Damp heat test, if not defined differently: 1000 h at 85°C 85% relative humidity
HiPot	High potential test. If not defined differently 5kV for 1 minute
n/a	not applicable
P1	Product 1: Roof-tile, will be installed at demo site Format D2 in Belgium
P2	Product 2: Carport Panel, will be integrated into carport
P3	Product 3: Metal panel, will be mounted on demo site Cricursa
P4	Product 4: Façade element, will be mounted on demo site EHG
WP	Work Package

2 SAMPLES PRODUCED

Test samples were manufactured based on the needs identified in D1.3. In section 2.1 of the current document, the need for samples specific to design and manufacturing issues is described, such as impact of building element thickness on lamination temperature. In section 2.2, the need for samples according to specific needs for building integration is summarized.

2.1 Samples for design qualification type approval and manufacturing issues

For each of the different products aimed within the project, samples were manufactured in order to test the functionality, production compatibility, durability and safety. An overview over the produced samples is given in the table below.

Table 2.1: Overview, required test samples for verification of the specific designed solutions.

Product	Corresponding Demo site	Back-sheet material DH test	Lamination / peel test samples	Bending Lamination test samples	HiPot final prototype testing
P1 Roof-tile	D2 Belgium	done	done	done	n/a
P2 Carport Panel	Carport	done	done	n/a	n/a
P3 Metal panel	Cricursa Barcelona	done	done	Started 07.08.2017	done
P4 Facade	EHG	done	done	n/a	done

2.1.1 Roof tile

The roof-tile which is foreseen for the Format D2 building in Belgium is challenging due to its thickness regarding the lamination process. Due to its complicated bending process, lamination is a must for this product. This makes it the most critical product in terms of manufacturability. To test compatibility with Flisom lamination process, 5 test tiles with dimension of 560 mm x 860 mm were produced. In order to avoid deformation during lamination process, the tile was supported by honeycomb aluminium. The honeycomb was chosen instead of pure aluminium due to handling issues and the thermal mass of a full metal solution impacting the lamination temperature profile.

In order to check the impact of the honeycomb on the lamination temperature, the test sample was equipped with a temperature indicator sticker. The usual lamination temperature was missed by 7 degrees, which is considered acceptable as up to 10°C lower was tested and found to be acceptable. The roof tile lamination prototype #2 is shown in Figure 2.1 below.



Figure 2.1: Roof tile lamination prototype. This prototype was used to verify the lamination process compatibility for temperature and mechanical stability.

The mechanical support of the honeycomb was also found to be sufficient as no deformation occurred. In total, 4 samples were laminated for temperature and mechanical test purpose. Special samples for HiPot tests of the design are not foreseen as the backsheet material, the stack design and the layout of the panels and also all used materials are the same as for the flat metal panel. Each roof tile in production will be HiPot tested for safety.

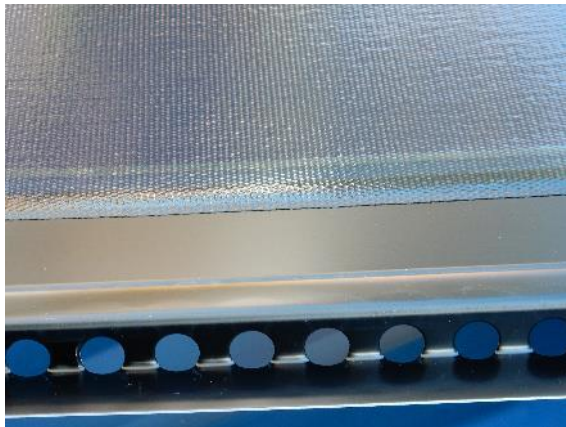


Figure 2.2: Prototype number 4 first full functional prototype. Verifies busbar positioning, bubble free lamination, spacing and junction box position.

2.1.2 Carport panel, Metal panel Cricursa, Façade Element

For the steel roof at Cricursa demo site and also for the steel based carport and the façade in Geneva, steel will be used as back sheet material. Painted galvanized steel is the most cost effective option. The main function to be tested for these modules is the damp heat compatibility and the sticking of the materials on the paint. Therefore, samples for damp heat and peel test were produced. The samples can also be used for the high potential leakage test, while this test needs to be repeated with each production panel. The samples for lamination testing onto bent prototype for Cricursa demo site are finished, together with the corresponding support matrix needed before the tests could start. The tests were started in the second week of August.

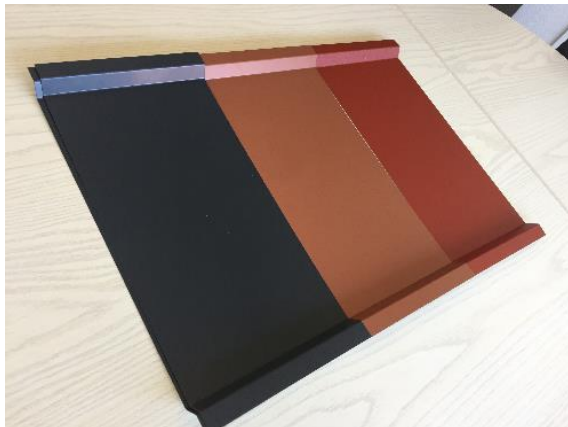
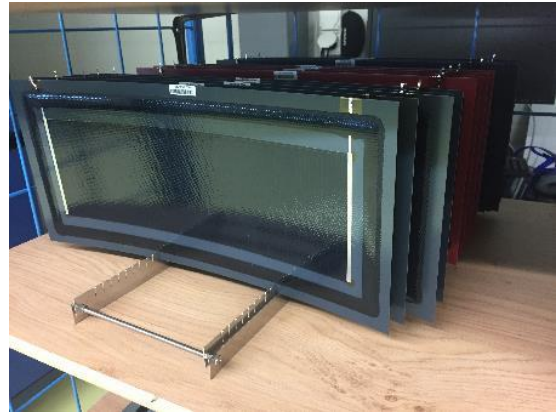


Figure 2.3: Samples for lamination tests of metal panel for Cricursa. The testing is needed in order to check that the laminator membrane can follow the curvature and a bubble free lamination can be achieved.

For the carport panels no special verification samples are planned as the mechanical properties are asset by simulations. Mounting tests are done by the carport manufacturer Swiss-carport who is taking care of the module clamping.

2.2 Samples for building specific testing in accordance with EN50583 “PV in buildings”

Referring to Annex 2 of deliverable 1.3, several tests are needed for the different products to comply with the BIPV standard. The required samples to test compliance with this standard are available.

- Rain penetration tests (50583-2) are not foreseen for designs 1,2 and 4, as the products are based on existing and already tested building elements which are not modified in their primary function. The test samples for design 3 are ready.
- Fire test samples are available. It is foreseen to summarize the tests as the specific bindings and length, width changes of the modules should not impact the flammability. However, the specific mounting solution, orientation and building part integration does impact the classification.
- Load test samples have been manufactured and several tests are already done.
- Resistance to wind load has already been tested via computer simulation. Wind load tests in a wind channel are not foreseen. Simulation seems sufficient to reach the envisaged TRL 7 as defined in Table 1.1.

3 SUMMARY

The samples for verification and testing have been manufactured. Several tests were started ahead of schedule. DH tests are already finished, bending tests have been performed and the lamination tests for the roof tile are also already finished. The lamination tests for the metal panel Cricursa had to wait for the support matrix to be finalized and are currently in progress.

4 RISK MITIGATION

The tests conducted so far did not identify any “showstopper”. According to already performed tests the designs are performing as expected. The upcoming tests are not expected to put the designs themselves into question. The expected risks which could imply negative results in the upcoming tests are summarized in Table 4.1 below.

Table 4.1: Risk mitigation table for problems which might be identified during the following tests. The designs are numbered according to Table 2.1.

Test	Product to be tested	Date	Possible negative result	Solution / impact
Lamination tests	P1	Done	Lamination not compatible with laminator (pass already)	Show-stopper. After lam bending not possible for this product.
			Lamination temperature insufficient or bubble formation (pass already)	Change recipe for lamination
	P3	Partially done from 07.08.2017	Bubble formation, incompatibility with laminator (pass already)	Bend after lamination (plus one more transport required)
DH tests	P1 ,P2, P3, P4	Done	Electrical or visual fail (pass already)	Change metal and or coating (time consuming)
HiPot tests (EN 61730)	P3,P4	Partially done / 14.08.2017	Fail (unlikely)	Change design ad insulation layer (can be done within days)
Mechanical load tests (Simulation + tests)	P1, P2, P3, P4	Partially done, ongoing	Stability insufficient for snow/ wind load (possible)	Increase material thickness / add more support
Fire tests	P1, P2, P3, P4	To be confirmed	Needed fire class not reached (possible)	Design modification
Rain penetration tests	P3	To be confirmed, waiting for roof sample	Mounting solution leads to leakage (unlikely)	Change mounting solution