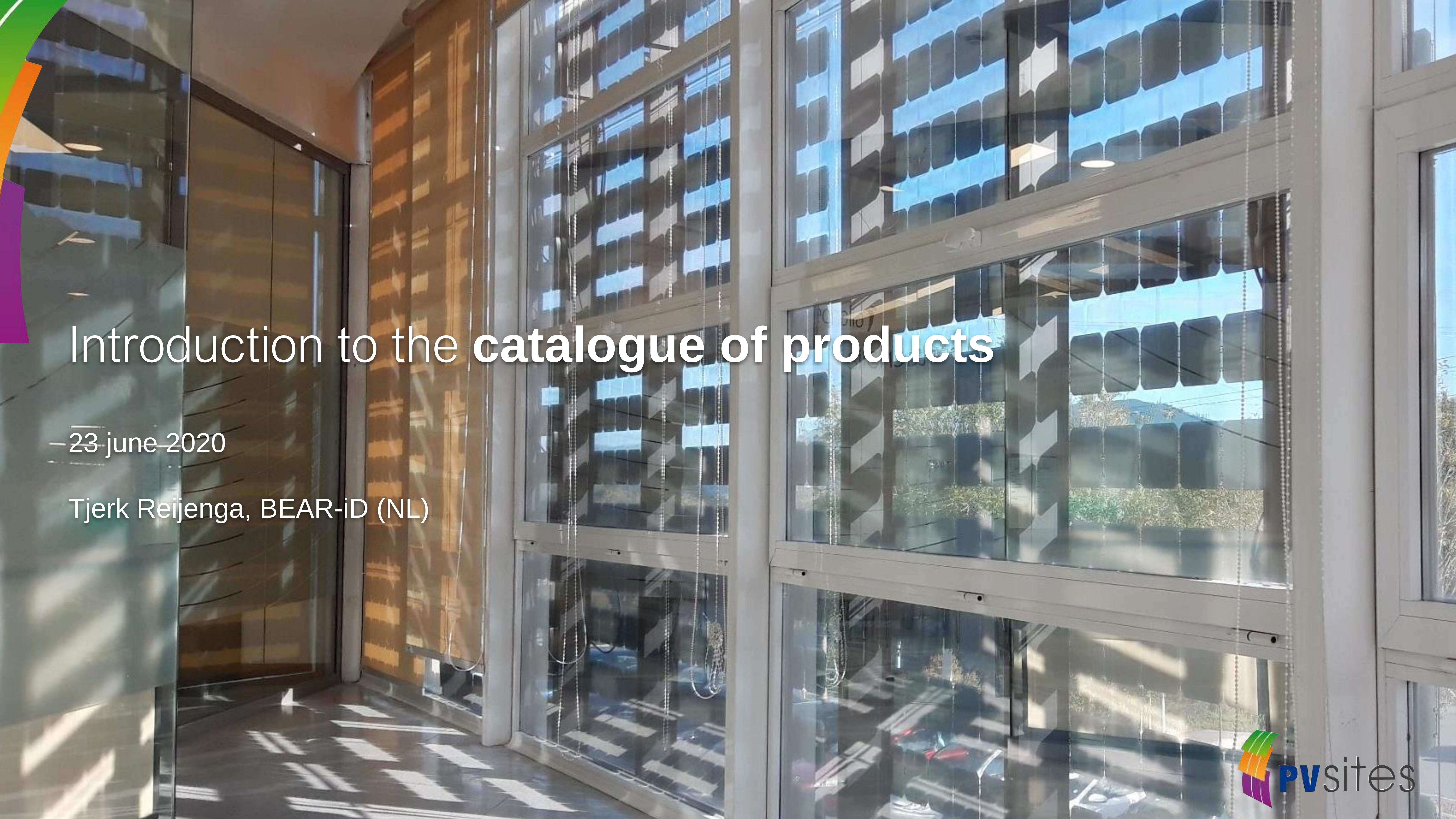


Introduction to the **catalogue of products**

23 june 2020

Tjerk Reijenga, BEAR-iD (NL)

PVsites

Introduction

- Within the PVSITES project a portfolio of
  - 10 BIPV products and
  - 2 inverters is developed.
- Software is developed
  - to support the design process and
  - To apply the products in building projects.

- To make all products accessible, an **online catalogue of products** is developed.

- This catalog will be filled with other BIPV products

  to make a large **online catalogue of products.**

Introduction to the webinars

- 23 July 2020 (BEAR 20 minutes)
  - Introduction to the catalogue of products
  - Overview of commercial products and demonstration
  - Product catalogue (pdf)
- 24 July 2020 (BEAR 10 minutes)
  - Introduction to the catalogue of products
  - Overview of non-commercial products and test benches
- 25 July 2020 (BEAR 10 minutes)
  - Introduction to BIPV design - need of digital tools to support design and design
  - Design process and use of software

Overview of Inverter products

DC-Coupled PV Storage Inverter
applied in Stambruges and Lille.

SiC based inverter
applied in a factory in Granollers near Barcelona.

Availability

The PVSITES product portfolio will be accessible in different ways:

1. the online catalogue of products
2. a PDF book with data and guidelines
3. the PVSITES website with all research reports and results.

Free printable download available at www.pvsites.eu
after 15 July 2020.

PVsites

Task 9.8 Productportfolio D9.17

20 June 2020

PVsites

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 691768

Disclaimer

PVSITES project

Building-integrated photovoltaic technologies and systems for large-scale market deployment.

PVSITES is a European funded project that recognizes the vast potential of Building-integrated photovoltaics and provides robust BIPV technology solutions that comply with the key demands from the market. Essentially, related to the flexibility in design and aesthetics considerations, lack of tools integrating PV and building performance, demonstration of long-term reliability of the technology, compliance with legal regulations, smart interaction with the grid and cost effectiveness.

PVSITES addresses these needs by means of identifying the main driven factors of the BIPV market and regulatory framework, developing and demonstrating an ambitious portfolio of building-integrated solar technologies and systems in real buildings in terms design and simulation, architectural integration, performance, cost effectiveness, grid integration, energy management, LCA, training and awareness. Finally, developing a software tool that helps the end users to integrate BIPV in the design, construction and management of their buildings.

As a result, PVSITES is driving the BIPV technology to a large market deployment led by the EU industry.

Acknowledgements.

This project has received funding from the European Union‘s Horizon 2020 research and innovation programme under grant agreement No 691768.

1. Introduction

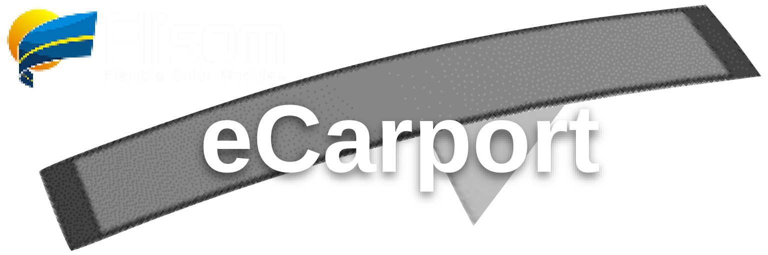
This deliverable D9.17 is the PDF book about the PVSITES BIPV product portfolio based on deliverable D2.9 and D8.5. Starting point is the PVSITES product but it is presented in the context of the demo projects. (See overview on the next pages.) This deliverable is not a copy of D2.9 but the it gives the useful information to select the optimum product at project design level. The full technical description of the products can be found in D2.9.

For each product there are three different types of information described:

2. Product overview

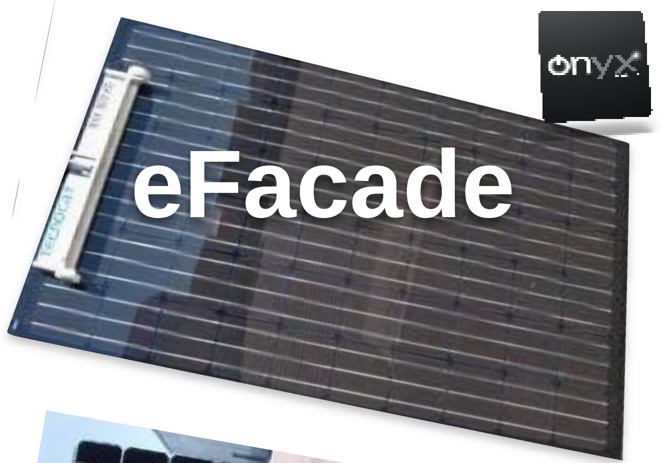
eRoof shingle - Flisom
A BIPV roof shingle demonstrated in Stambruges, (BE).

eRoof industrial - Flisom
A BIPV roof element for use on existing roofs. Demonstrated on a factory roof outside of Barcelona.

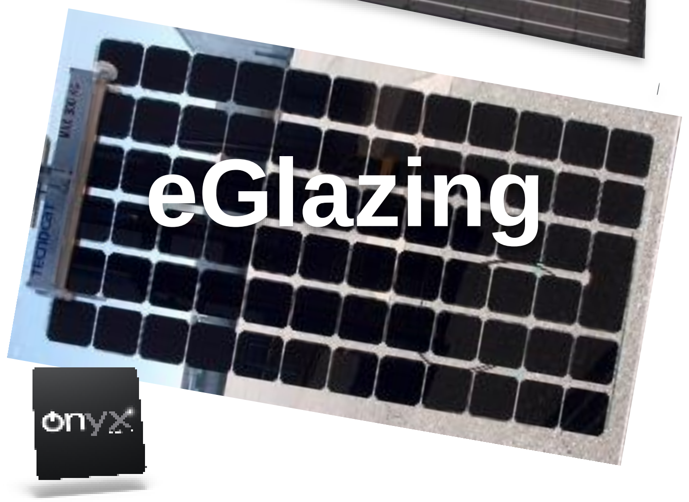


eCarport - Flisom
A BIPV carport roof element with a big span. Demonstrated in two locations in Zürich.

eFacade - Flisom
A BIPV metal facade cladding element. Demonstrated in the Ecole Hotelier in Geneva.



eFacade - ONYX
A BIPV glass facade cladding element. Demonstrated in a housing block in Lille.



eGlazing - ONYX
A BIPV glass double facade for renovation. Demonstrated in an office in San Sebastian.

3. Demosites overview

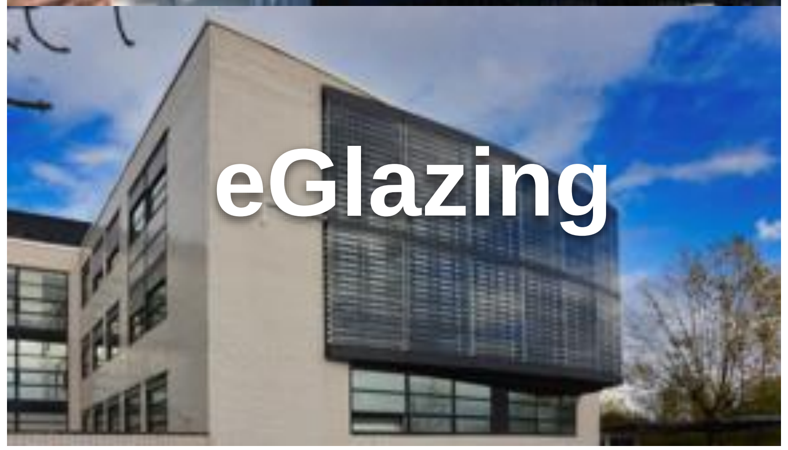
A BIPV roof shingle demonstrated in Stambruges, (BE).

A BIPV roof element for use on industrial roofs. Demonstrated on a factory roof in Granollers near Barcelona.

A BIPV carport roof element with a big span. Demonstrated in two locations in Zürich.

A BIPV metal facade cladding element. Demonstrated in the Ecole Hotelier in Geneva.

A BIPV glass facade cladding element. Demonstrated in a housing block in Lille.



A BIPV glass double facade for renovation. Demonstrated in an office in San Sebastian.

4. Design process

The design process in different countries

	Spain	France	Belgium	Switzerland
Brief	Programa	Programme	programma van eisen	Grundlagenermittlung
Concept design	Diseño conceptual	Concept de design	voorlopig ontwerp	Vorplanung
Preliminary design	Diseño final	Conception finale	definitief ontwerp	Entwurfsplanung
Detailed design	Planos de construcción	Conception détaillée	constructie tekeningen	Ausführungsplanung
Tender	Oferta	Appel d'offre	aanbesteding	Vergabe
Construction	Construcción	Construction	uitvoering	Konstruktion
Commissioning	Entrega	Mise en service	oplevering	Inbetriebnahme

5. Introduction to the PVSITES software

The PVSITES software is developed by Swiss partner CADCAMation and it can be found on the website of BIMsolar (bim-solar/ecatalogues). BIPV Design software towards the integration with digital twin model based on BIM AEC process

The attractiveness of BIPV is to large extent depending on aesthetical aspects that are closely linked to performance output. During the design stage of the PVSITES project, the following recommendations were noted in order to fully capture both considerations:

Consider energy efficiency while assessing other functional aspects such as shading or daylighting impact on buildings.

Give fully attention to geometrical arrangement of modules and profiles.

Make fixtures as invisible as possible. The detailing of surface edges and rims is paramount to ensure an harmonious integration with surrounding elements.

Make clever use of transparency in BIPV materials.

The PVSITES software has been developed taking into consideration: design, customization and planning aspect of BIPV projects. The project has released a fully-functional beta version of the PVSITES software. It has been designed as an enhanced website accessible for free to all users on a dedicated webServices platform available at www.pvistes.eu

Features include:

1. Import of building 3dBIM compliant models from various formats, including: .skp (TRIMBLE SketchUp), ifc. (openBIM), gbXML(Green Building) and .idf (EnergyPlus). AutodeskTM RevitTM plugin
2. Selection of project location and built-environment of corresponding weather data.
3. Visualization of irradiance on all surface of the 3D model.
4. Import of existing BIPV products as BIM objects in the software, or assisted self-design of products.
5. Easy, flexible layout of BIPV modules and surfaces in various configurations (roof, façade, canopies, etc.)
6. Inverter selection and stringing of modules, either manual or automated.
7. Precise simulation of PV performance including losses by shadowing and other factors.
8. Financial analysis to evaluate the project viability under different scenarios, including net-metering and self consumption electricity.

6. eRoof BIPV roof shingle - Flisom

Data

6.1 eRoof BIPV roof shingle - Data

Description
The roofing shingle module is a semi-flexible and lightweight solar panel designed for BIPV roof tile installations. The layers from back to front are: Mild steel backsheet with PVDF coating (RAL 9005), encapsulant TPO 0.4 mm, CIGS PV film with electrical contacts, encapsulant TPO 0.4 mm, barrier film 0.4 mm.

Mounting system
The roof structure is made of wood. The modules will be screwed on horizontal bats. Each module has a 25 mm overlap with the next module. Modules are connected in vertical direction with a click-connection. Mounting start with the lowest module and then goes up to the ridge.

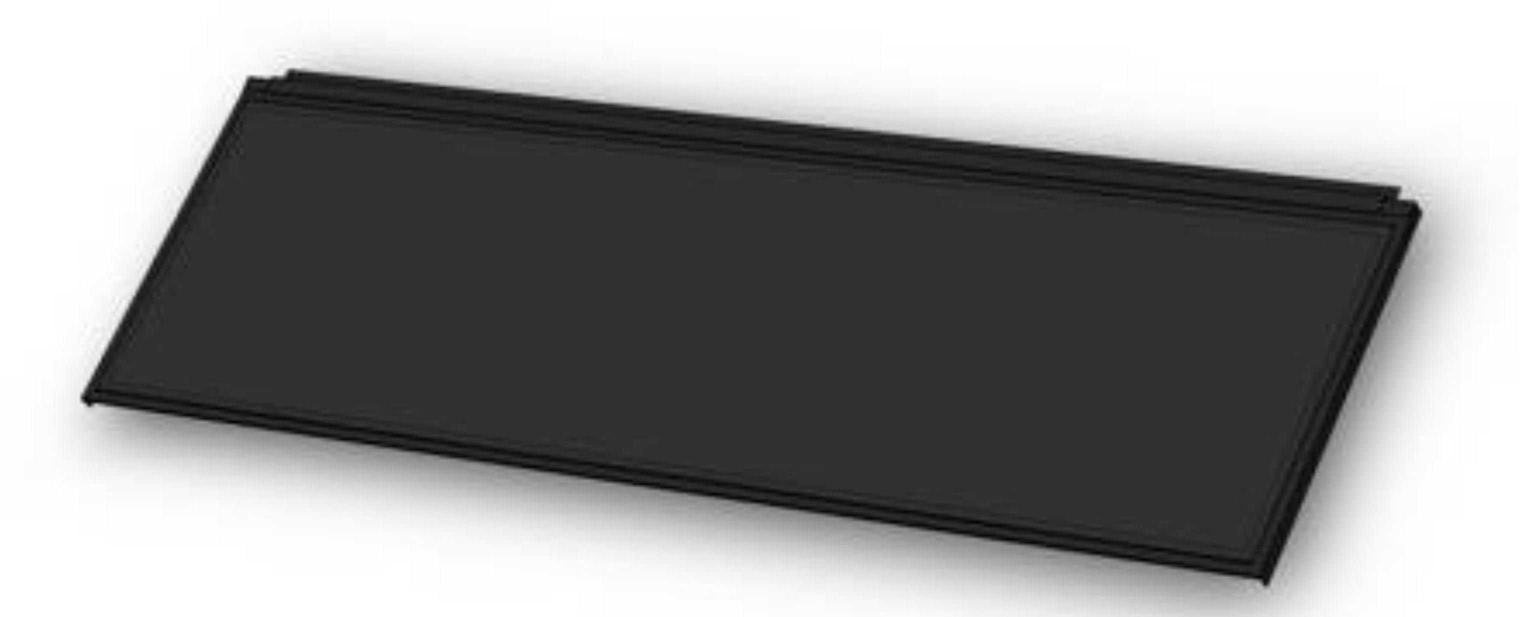
Dimensions
Rectangle 1575 x 489 x 21 mm

Weight
6 kg/unit

Rigidity
Semi-flexible

PV power
50 - 60 Wp/unit

Field of application
The BIPV roof shingles can be used for new roofs and for renovation of existing roofs.



PVSITES code **X1a**

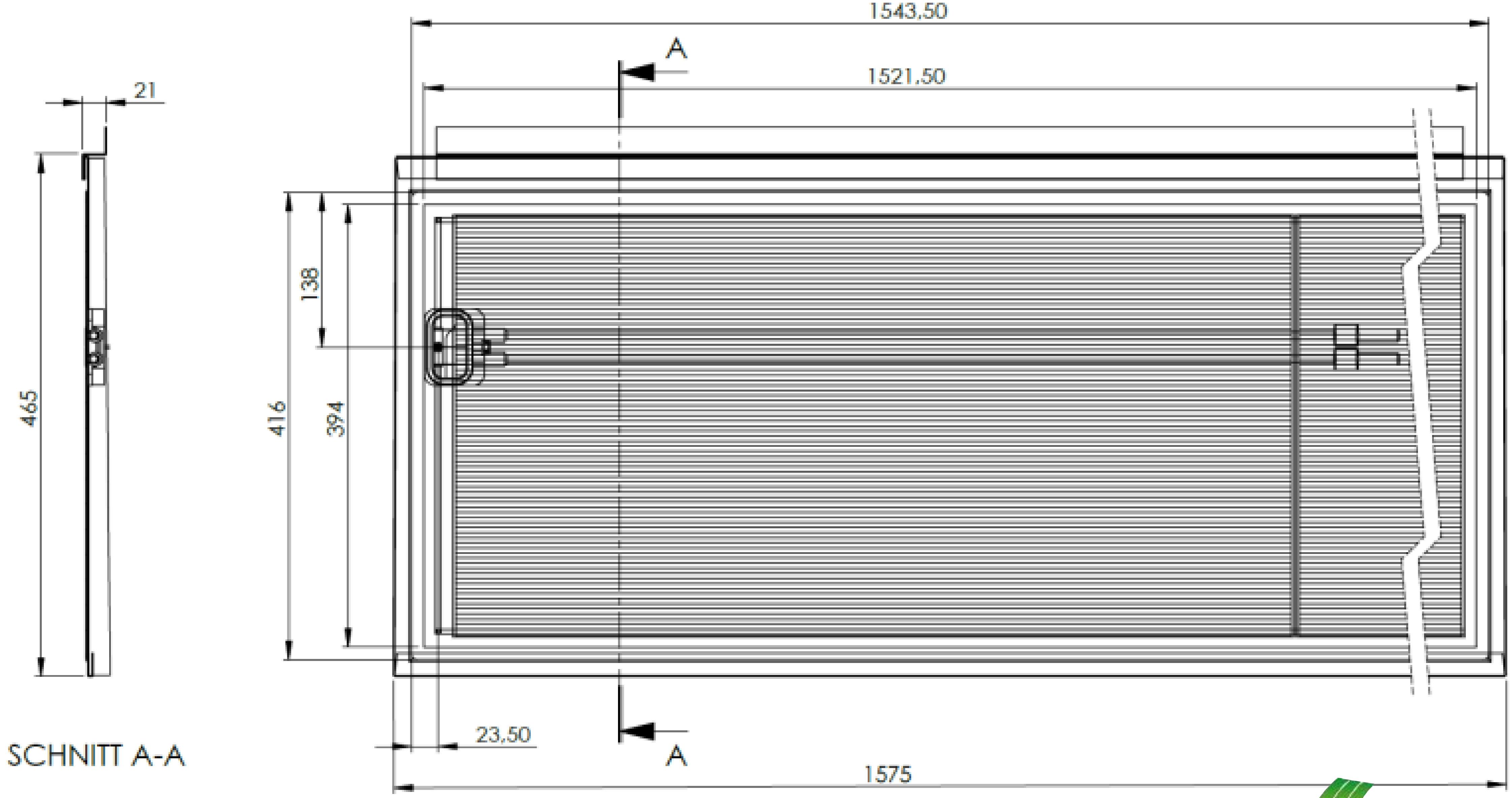
6.1 eRoof BIPV roof shingle - Data

Electrical characteristics	
Vpm: max. power voltage	34 - 36 V
Ipm: max. power current	1.47 - 1.66 A
Voc: open circuit voltage	46 - 48 V
Isc: short circuit current	1.72 - 1.91 A
Isc (α) Temp. coefficient	0.01 %/°C
Voc (β) Temp. coefficient	-0.3 %/°C
P (γ) Temp. coefficient	-0.35 %/°C
Inverter	Tecnalia 10 kW DC-Coupled PV Storage Inverter. Dimensions 840 x 740 x 280 mm.

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

6.2 eRoof BIPV roof shingle - Drawing

Drawing nr. B-0027314



PVsites

Design

6.3 eRoof BIPV roof shingle - Design

The 280 m^2 demo-house in Stambruges, Belgium is designed by Dominique Deramaix, owner of FORMAT D2.
The construction was finished in 2015.
The design is based on the Passive House principles with a max.energy use of 60 kWh/m^2.year. The structure is done in laminated timber (GLULAM), thermal insulation around U = 0.18 and cladding with stucco, wood and Rockpanel.
The large roof (13.4 x 7.9 m) was covered with slate tiles and had only one interruption by the chimney.

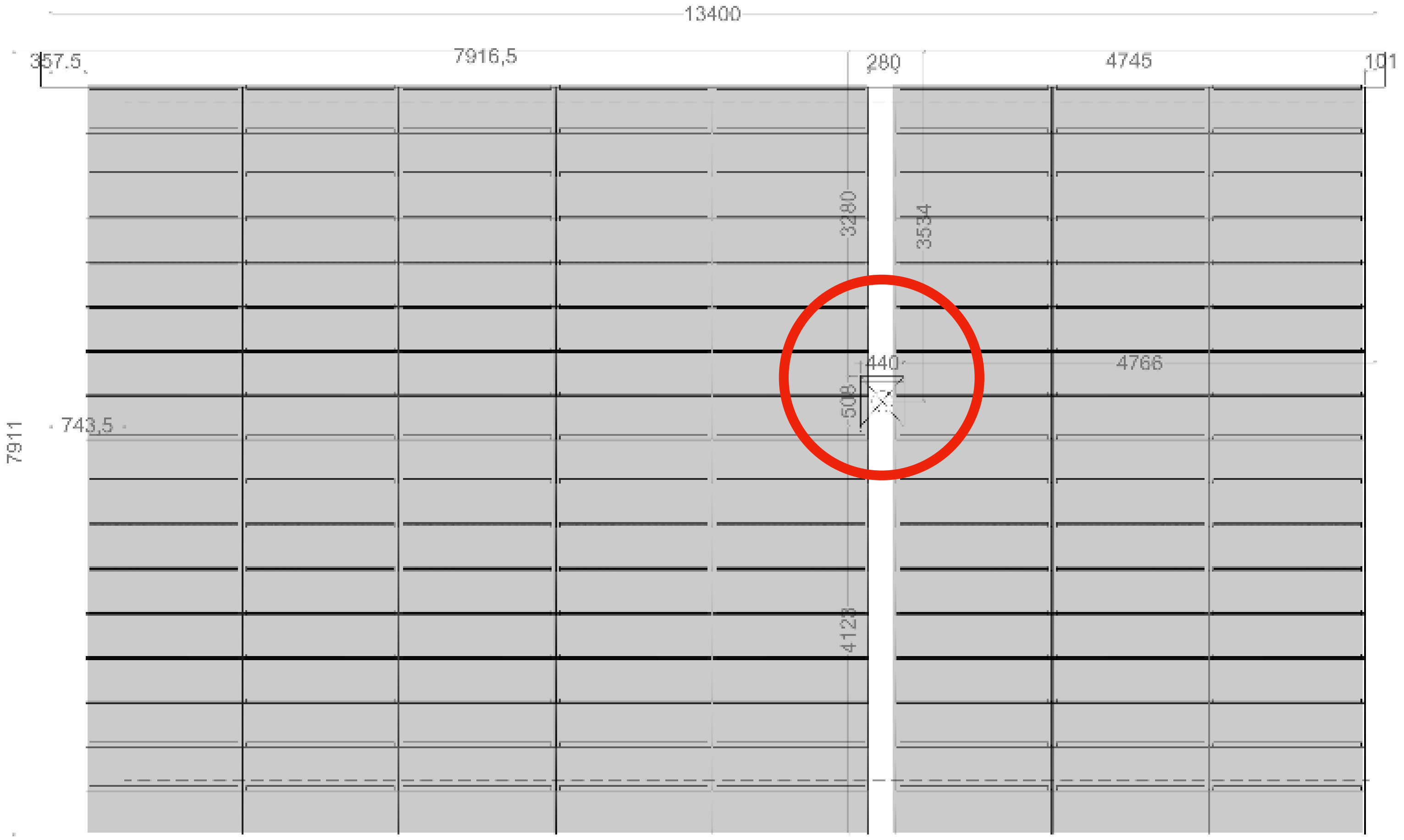
The FLISOM eRoof shingles are big BIPV tiles (489 x 1575 mm). When mounted at the roof the visible part is 465 x 1590 mm. The first idea was to cover the roof with a rectangle consisting of 136 eRoof tiles (8 rows of 17 tiles). On both sides is some space left over that has to be covered with a metal plate in the same colour while around the chimney some non-electric tiles are used.

A more detailed study of the roof dimensions showed two other possibilities. It was possible to move the tiles around the chimney to both sides and to create a 280 mm space for the chimney (option A). The second possibility was to divide the tiles in a 3-2-3 configuration to create two vertical gutters. One gutter was used for the chimney while the second gutter was introduced for the aesthetic balance in the roof (see next page).
In general it is easier to adjust any BIPV system on a roof that has overhangs as it gives some flexibility in the detailing of the BIPV system.

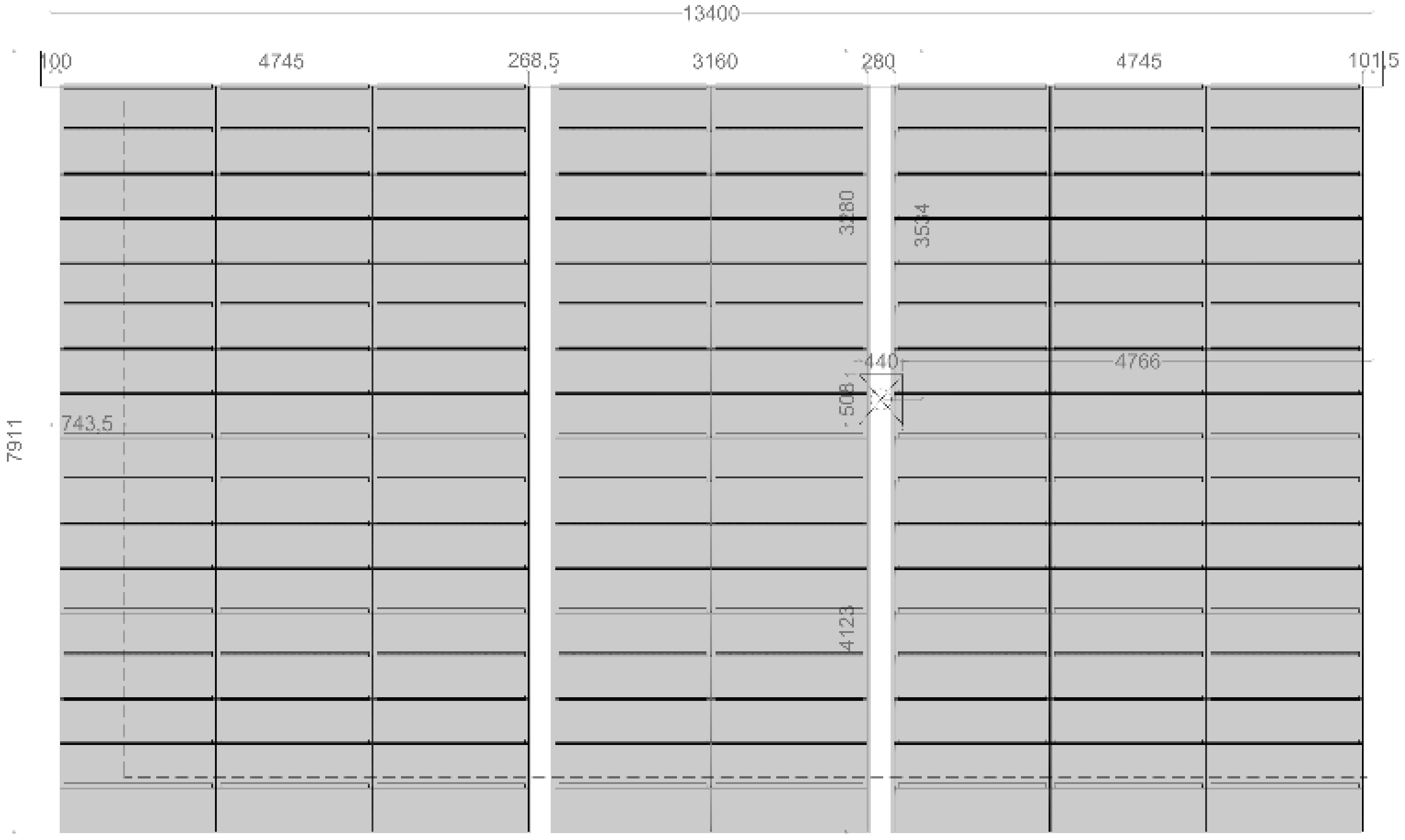
The aesthetic quality of a BIPV roof is highly conditioned to the size and shape of the modules, joints between modules, fixing elements, roof edge, rims and other adjacent elements and material, textures and colour of each part.
A study was done within the PVSITES project about the aesthetic quality of roofs (see “Formulation of architectural and aesthetic requirements for the BIPV building elements to be demonstrated within the project”. Good points that increase the aesthetic quality, are:
• the whole roof is covered with modules;
• the vertical connection between modules and the roof construction is hidden;
• the horizontal connection to the roof is done with a hidden gutter/profile under the modules.

6.3 eRoof BIPV roof shingle - Design

Roof layout
Two different alternatives for the original design. Option B is chosen.



Option A



Option B

6.3 eRoof BIPV roof shingle - Design

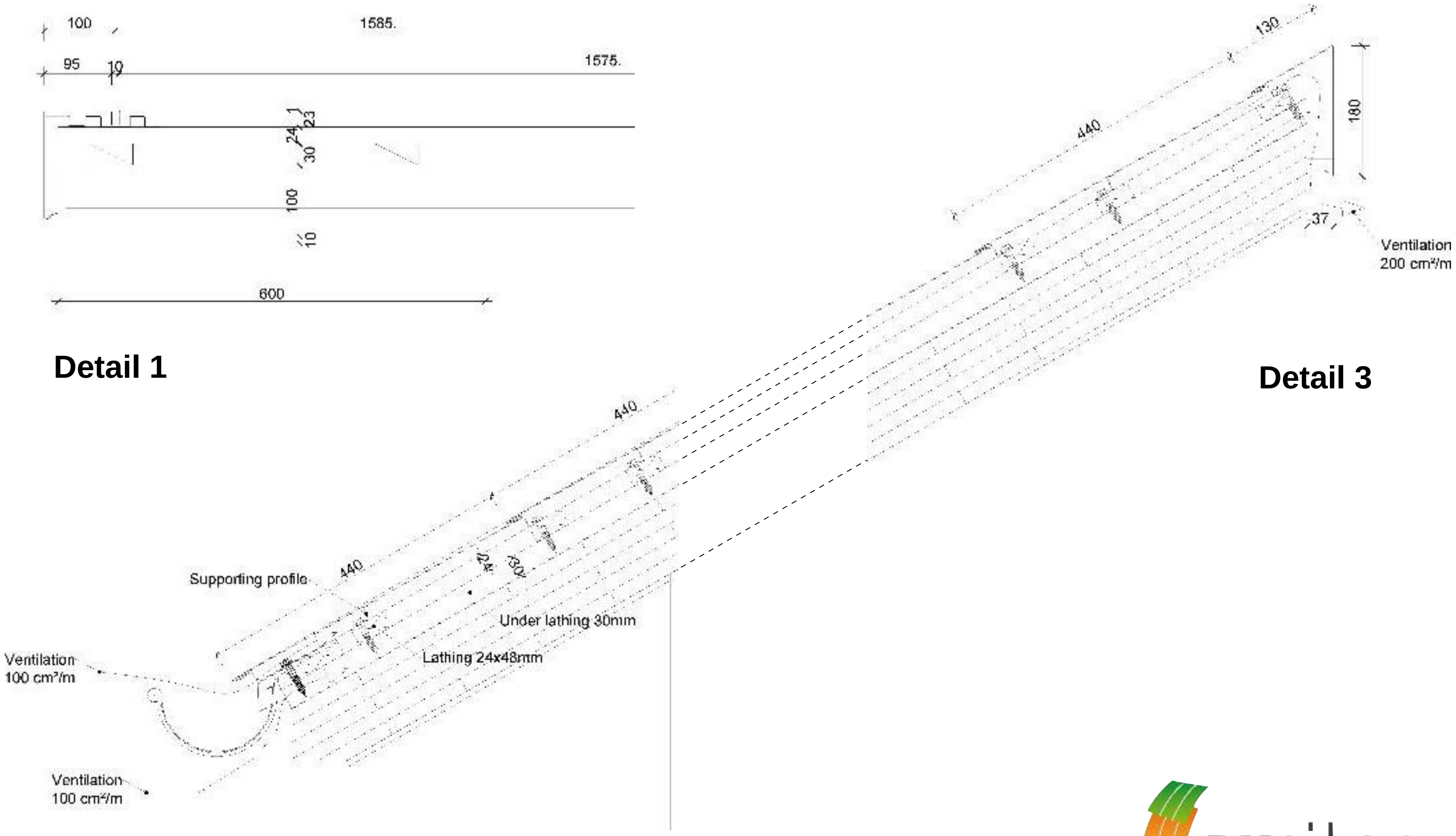
Roof details

Like most common tiles, the eRoof shingle has different connections in horizontal and vertical direction.

The vertical connection is a click system that starts with placing the lowest BIPV shingle in the row first. Then work op to the ridge and start the second row. See detail 2 and 3.

To get the bottom line of the tiles straight, it is more easy to line out the bottom shingles first before working up to the top.

Between the rows is a hidden gutter or gutter profile (detail 1) that can collect the rainwater and bring it down to the main gutter.

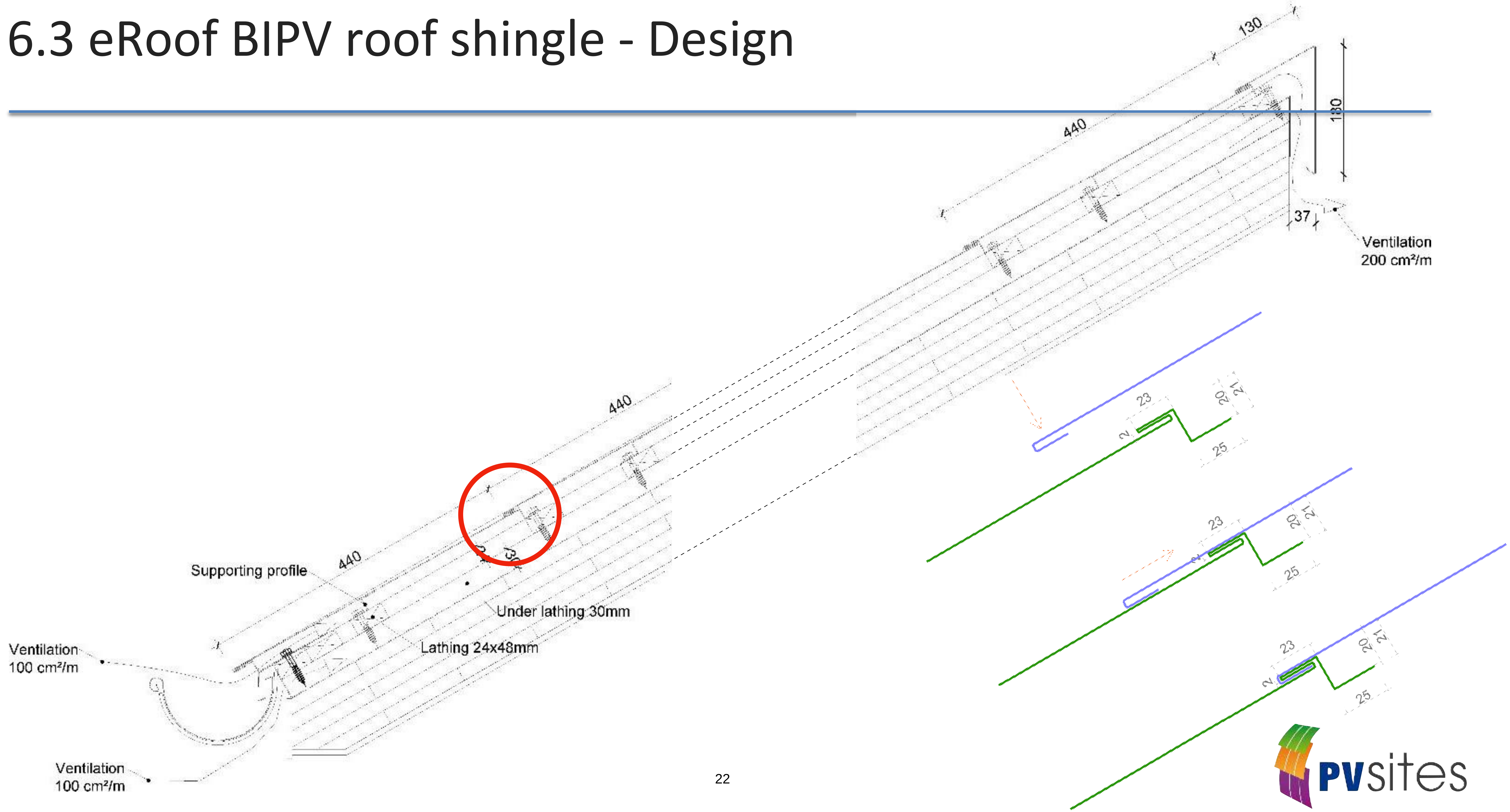


Detail 1

Detail 3

Detail 2

6.3 eRoof BIPV roof shingle - Design



6.4 eRoof BIPV roof shingle - Electrical design

The 136 BIPV modules are divided in xx strings.
For elevated areas irradiation can be higher than at STC. Therefore, multiply ISC- and VOC- values with a factor of 1.25 for the electrical layout of cables, fuses and converters (worst case scenario). For a serial connection the voltage of a single module is multiplied by the number of modules to calculate the system voltage. Make sure that you are always within the limits of the maximum system voltage. Use an adequate device for over-current protection (fuse, blocking diode). Maximum Isc multiplied by a factor of 1.56 to protect a string in parallel configuration.

The maximum number of modules connectable in series is calculated by adding Voc of each single module multiplied by 1.25 up to the maximum system voltage which you can find on the label.
Back-sheet of Flisom PVSITES modules are made of metal and have to be connected to the ground. Also ground the support structure and arrange an adequate lightning protection. Do not use materials which can cause corrosion. The hole for the grounding cable can be drilled anywhere in the edges of the module frame as in fig. 1. If the back-sheet of the module and the support structure/clamps are conductive it is not necessary to ground every module. The grounding of the support structure is sufficient. Make sure that you do not damage the edge seal or front-sheet.
In general, the modules can be mounted either in portrait or in landscape mode. Orientation of the shadow on the active surface is crucial: the module may only be installed with shadow on the short side. If the complete length is shaded, the shadow will negatively affect the power.

6.4 eRoof BIPV roof shingle - Electrical design

Inverter
The inverter used is the DC-coupled PV storage inverter developed by Tecnalia for the PVSITES project.
This is a high efficiency, low cost and flexible 10kW three-phase DC-coupled PV storage inverter. It can be easily extended in parallel to make larger systems up to hundreds of kW and offers a wide DC input range to cope with different BIPV generators and battery packs. It communicates with the Building Energy Managment System (BEMS) in order to provide monitoring data about the PV storage inverter performance and it receives the required commands to implement required energy management strategies.
The Multilevel symmetrical topology is used for the DC-DC converter for battery and PV source management.

Both converters and the 3-phase DC-AC converter are coupled in a high-voltage DC link. The control unit is composed of a DSP controller (TMS320F28335) and FPGA for managing the power transfer inside the converter and provide external communication.

In the house in Stambruges, a 10 kW inverter is used. The dimensions are 0.84 x 0.74 x 0.28 m.
Mount vertically on the wall or on a solid surface with tilted backwards by max 15ºC. The location needs to be accessible and well ventilated. About 0.3 m around the inverter is needed to guarantee a good ventilation (see data sheets in chapter 11).

6.5 eRoof BIPV roof shingle - Software

Use of the PVSITES web tool

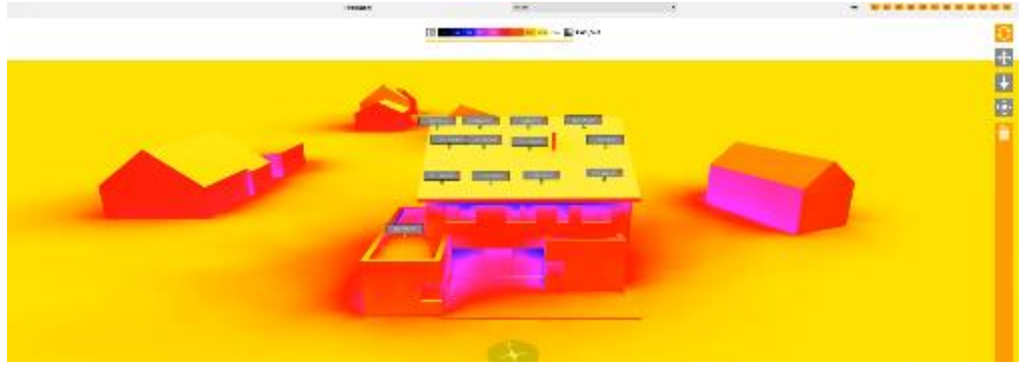
The software can be found on the pvsites.eu website.

An overview of steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen

1

7



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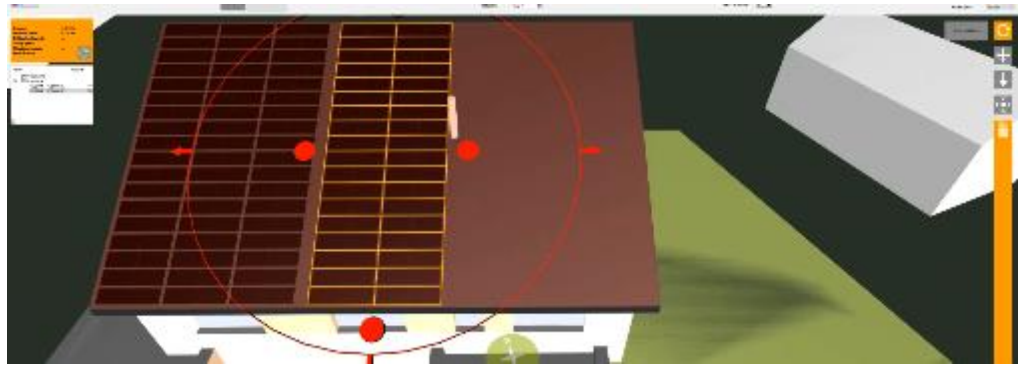

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6

9

6.5 eRoof BIPV roof shingle - Software

Use of the PVSITES web tool

Many values are visible now:

10.Output for one module.

11.Output for one string

12.Output for the whole roof

13.Output for each month

14.Detailed output

http://www.pvsites.eu

http://wp.bim-solar.com/en/bimsolar-4/

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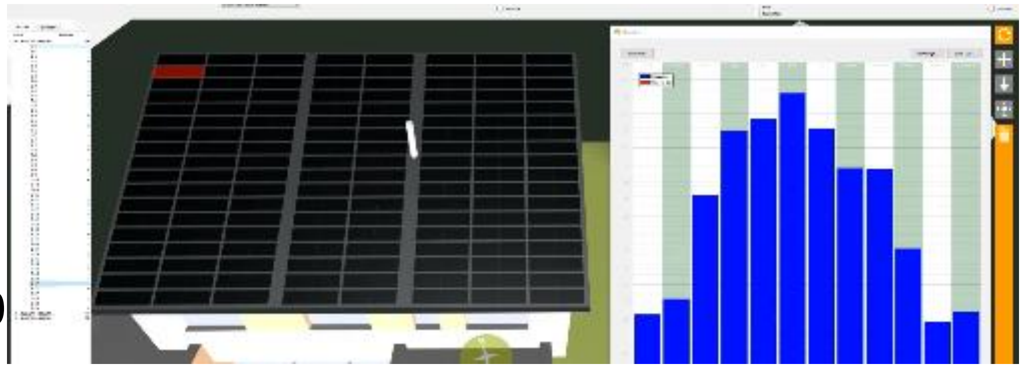

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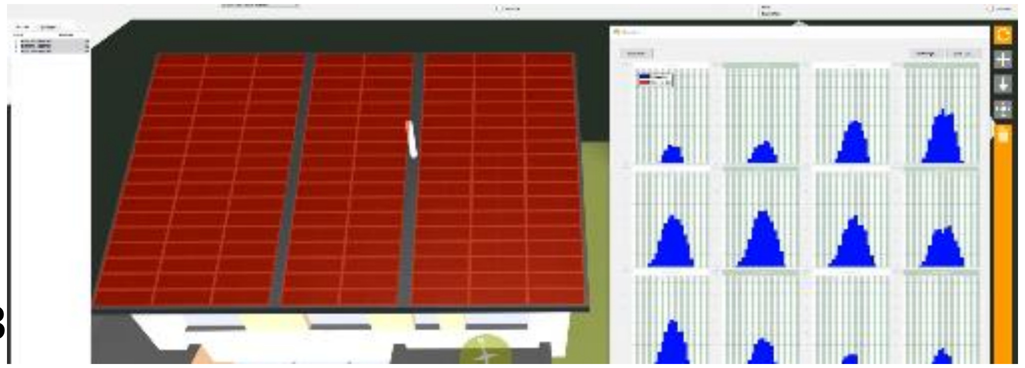

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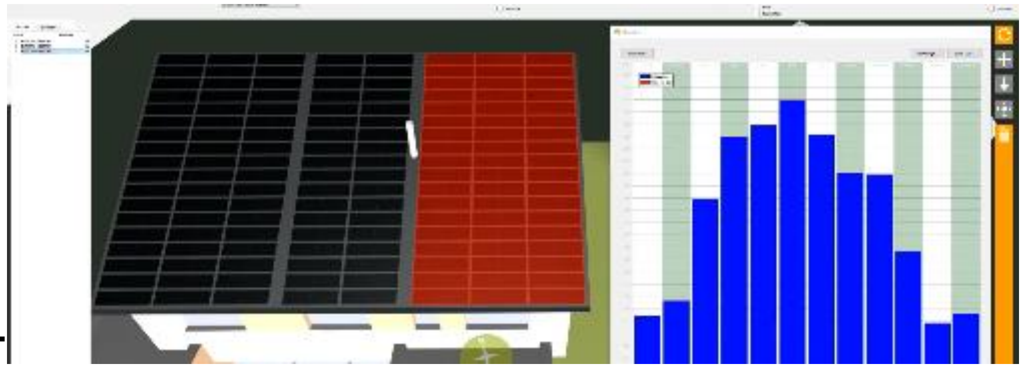

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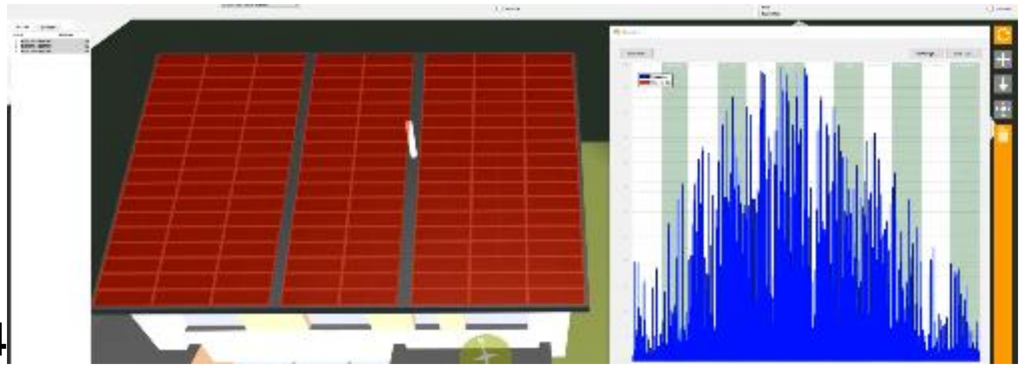

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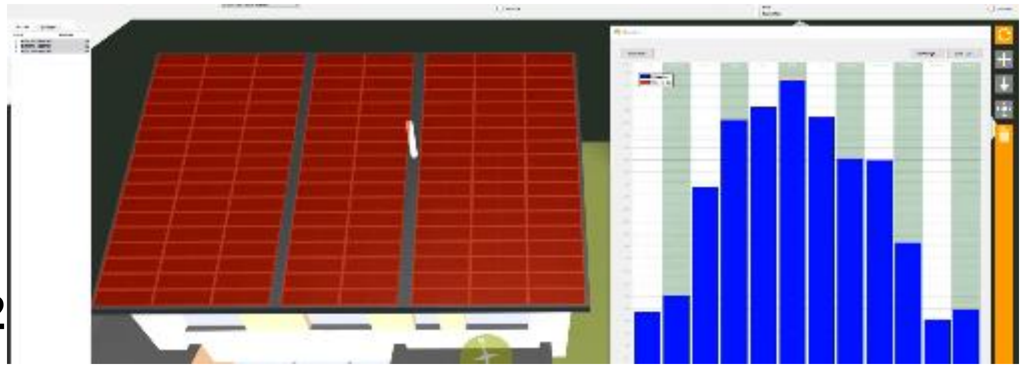

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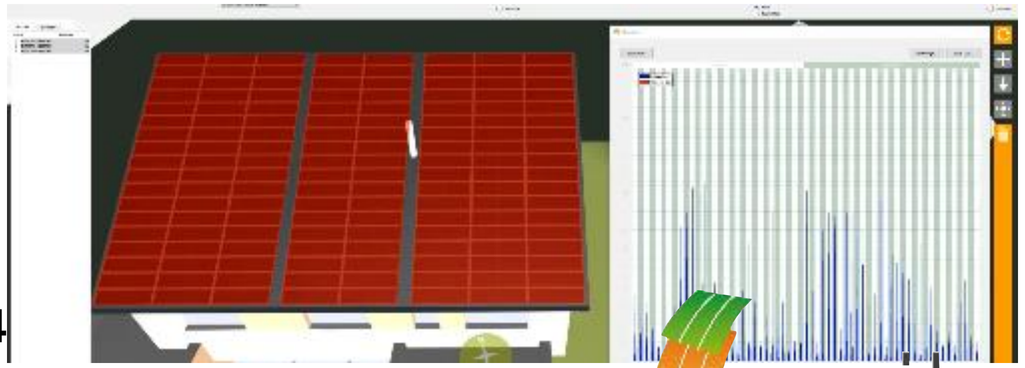


6.6 eRoof BIPV roof shingle - Commisioning

The commissioning was relatively simple.

A special agreement with the grid manager was achieved to use a **non-commercial inverter**, because all the material used should be checked according to the Belgian regulation.
The existing temperature sensor monitoring the temperature flow after the boiler (not necessarily for the project) was relocated into the boiler, to have the real temperature in the tank in order to pilot the relay installed to turn on/off the boiler when producing extras.
Once established all connections, the installation must be controlled by an accredited organisation.
Actually, the injection to the grid is permitted without being sold the surplus (by means of balance production/consumption) but currently, from the 1st of January 2020, a tax for the kW reinjected into the grid must be paid.

Installation

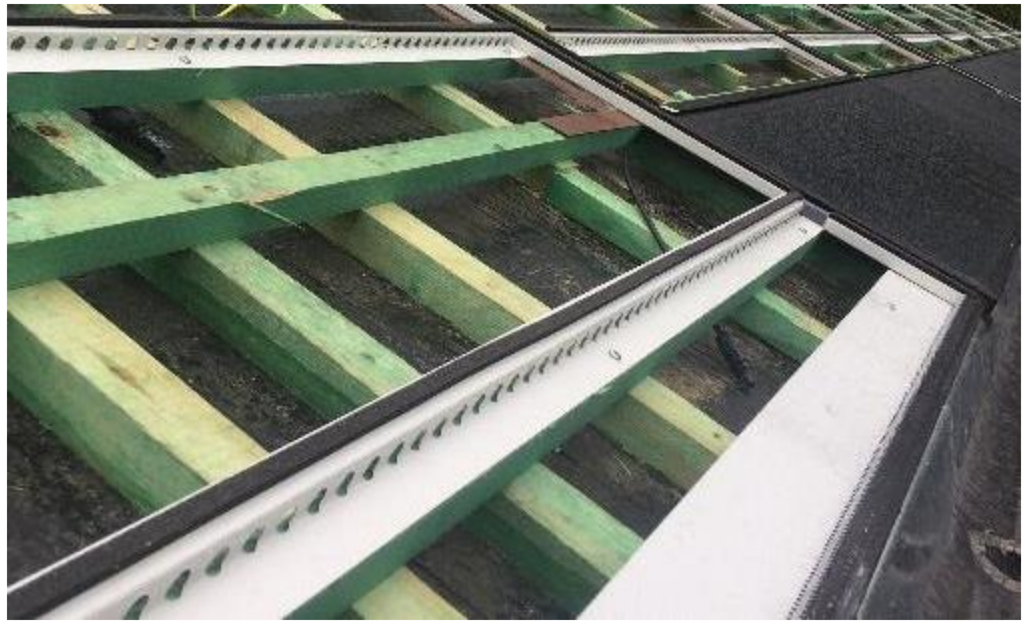
PVsites

6.7 eRoof BIPV roof shingle - Installation

The BIPV roof installation at the dwelling in Stambruges (Belgium) started with taking off the tiles.
After placing the scaffolding and taking off the old tiles and lathing, a new under-roof that resists more than 100 °C (in case of overheating under the panels) was placed.
Due to the structure of the roof (complete massive CLT panels 0.1 m height), the placement of the under-roof and lathing was very easy. The vertical lathing (every 0.6 m) is a 38 x 45 mm profile which makes it possible to have a ventilated air gap.
The greatest difficulty was to start the horizontal lathing (32 x 38 mm every 0.44 m and the intermediate support at 0.16 m) correctly because the shingles do not have the possibility to be adjusted. The upper corner part is fixed; so, only the positioning of the first line of tiles above the gutter can be adapted in order to end with an entire number of panels in the height.
The calculation and the installation of all the profiles needed to install the shingles took the most relevant time. On the other hand, only two days were necessary to place the shingles.
Other works that took some time (two days for one worker) was the opening of the upper fold of assembly of the shingles with the help of a proper tool (profiled aluminium plate), the placing of the tiles and bands "compriband" on the various finishing elements. The BIPV shingles has to be sorted (by power) in order to balance the strings electrically.
Previous to the installation of the shingles, the grounding for every shingle, the metal strip support and the intermediate ventilated support were placed on the lathing.

6.7 eRoof BIPV roof shingle - Installation

According to the electrical connection scheme, one string is composed by two rows of eight shingles (16 shingles in total). There are 18 shingles in a row, so there are nine shingles delivering 2 A and 750 V. At the end (144 shingles), the final current will be 18 A, by connecting all the strings in series. For the electrical connection, cabling of 6 mm² section with MC4 connectors were used to accomplish with allowed DC losses.
Six temperature sensors were placed: three at the bottom of the roof and three at the upper part, one on the membrane, one in the middle of the air gap and one at the back of the panel.
The strings were connected in a connection box with fuses, diodes, a general disconnecting switch DC and a lightning rod protection.



6.8 eRoof BIPV roof shingle - Maintenance

Flisom gives the following general guidelines for inspection and maintenance:

It is recommended to have a visual check on a regular basis (every 3 months). Plan check-ups according to the given environmental and safety conditions and regulations.

Maintenance:

a. Remove dust and dirt (sediments, leaves, pollen, bird droppings, etc.) from the surface.
b. Do not use aggressive cleaning agents or scrubbing materials for cleaning.
c. Do not use steam blasting for cleaning.
d. Use soft (rain)water to avoid chalk stains.
e. Soft sponges can be used.
f. Check if connectors and grounding are tight and without corrosion and if the insulation is not damaged also check for loose mechanical or electrical contacts.
g. Check if the junction box is securely attached and that no deep scratches are penetrating the front sheet.

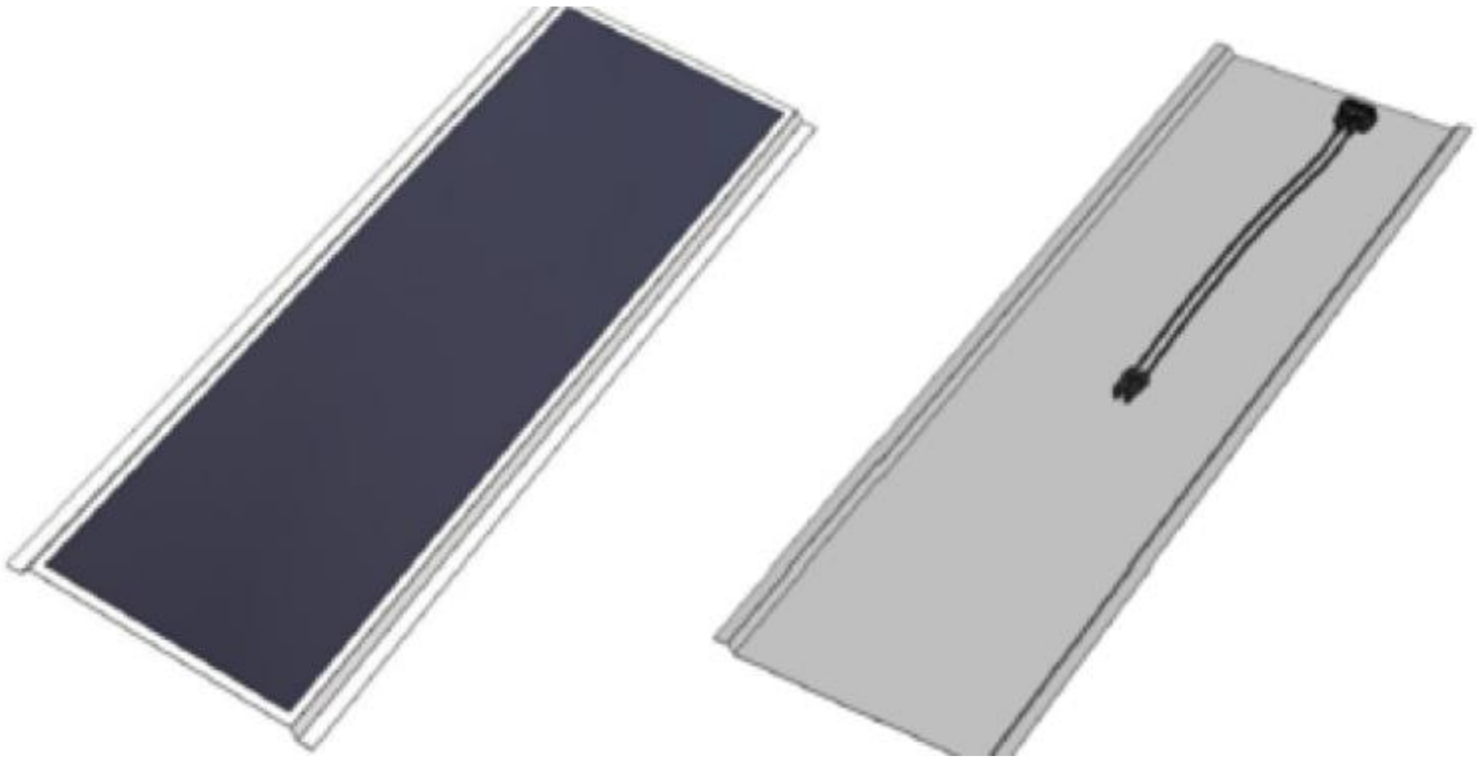
Cleaning the roof is recommended because of the environment with tall trees. Easiest way is to use a garden hose and spray with water using the water pressure. Rainwater is available in a cistern.
Electric cables outside are hidden and can not be inspected.
The system is permanently monitored so any technical failure of the system will be noticed.

7. eRoof BIPV element - Flisom

Data

7.1 eRoof BIPV element - Data

Description	The industrial roof module is a semi-flexible and lightweight solar panel designed for installation at an existing Industrial roof. The layers from back to front are: 0.7 mm mMild steel backsheet with PVDF coating, black RAL 9005; encapsulant TPO 0.4 mm; PV film CIGS grown on polyimide with Mo and ZnO electrical contacts; encapsulant TPO 0.4 mm; barrier film 0.4 mm; the module is sealed with edge seal ~1cm width.
Dimensions	Rectangle 1585 x 520 x 21 mm
Weight	5.8 kg/unit
Rigidity	Semi-flexible
PV power	50 - 60 Wp/unit
Field of application	The BIPV roof elements can be used for new roofs and for renovation of existing roofs.
Mounting system	The roof modules will be screwed on vertical profiles from the underlying (steel) structure or roof structure. Between the modules a 5 mm gap is needed for thermal expansion. In this case the edges are overlapping.



PVSITES code	**X4**

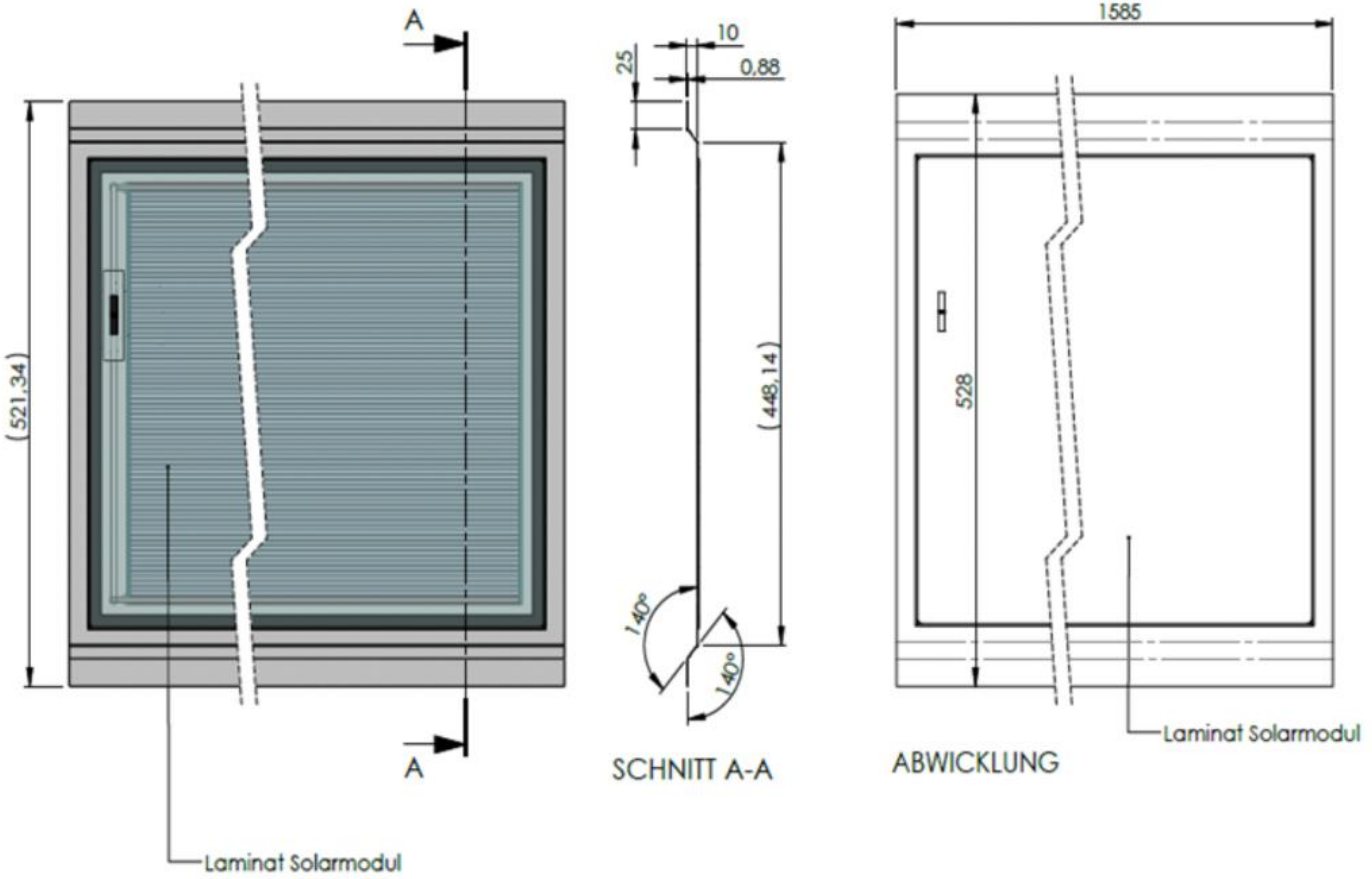
7.1 eRoof BIPV element - Data

Electrical characteristics	
Vpm: max. power voltage	34 - 36 V
Ipm: max. power current	1.47 - 1.66 A
Voc: open circuit voltage	46 - 48 V
Isc: short circuit current	1.72 - 1.91 A
Isc (α) Temp. coefficient	0.01 %/°C
Voc (β) Temp. coefficient	-0.3 %/°C
P (γ) Temp. coefficient	-0.35 %/°C
Inverter	Two SMA VSI 6000TL inverters and two PVSITES CEA inverters.

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

7.2 eRoof BIPV element - Drawing

Drawing nr. B-0027301



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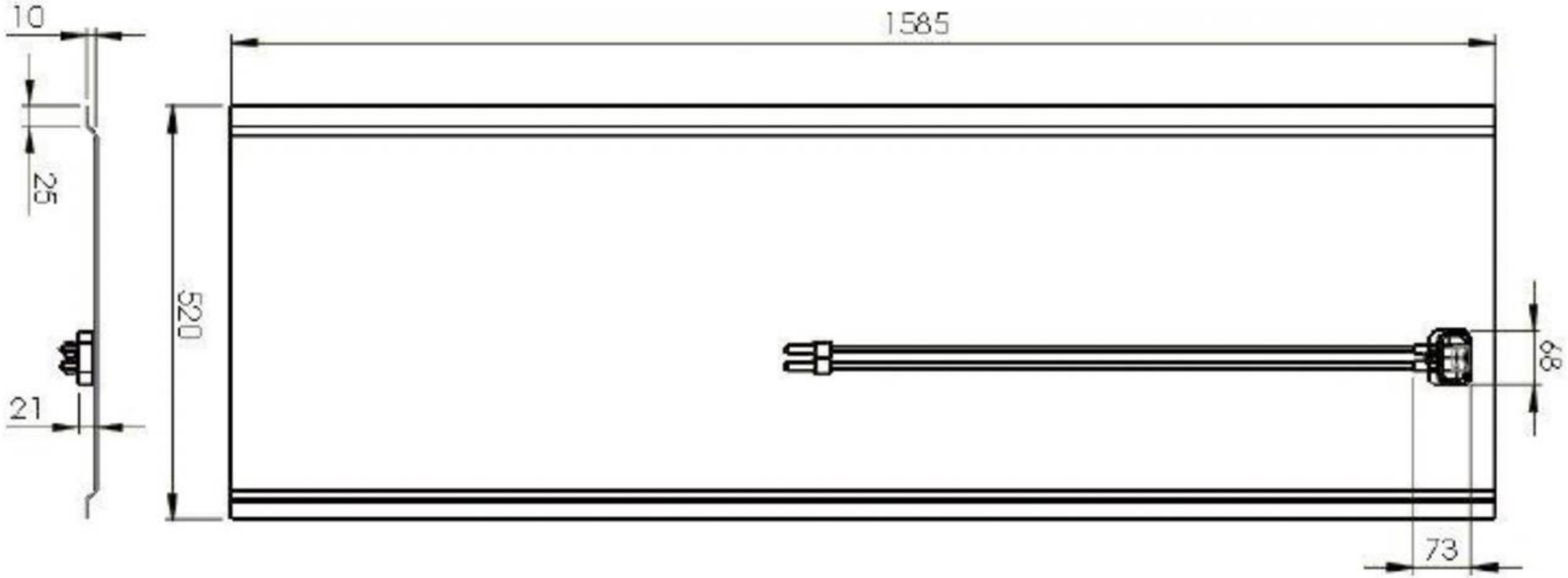
7.2 eRoof BIPV element - Drawing

Drawing nr. B-0027301



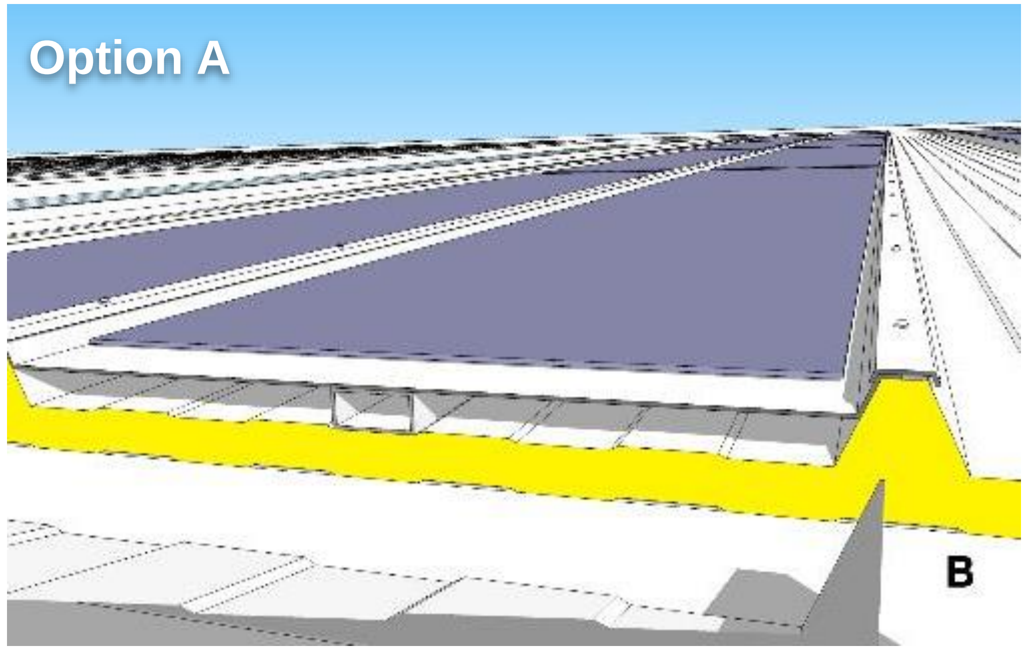
Design

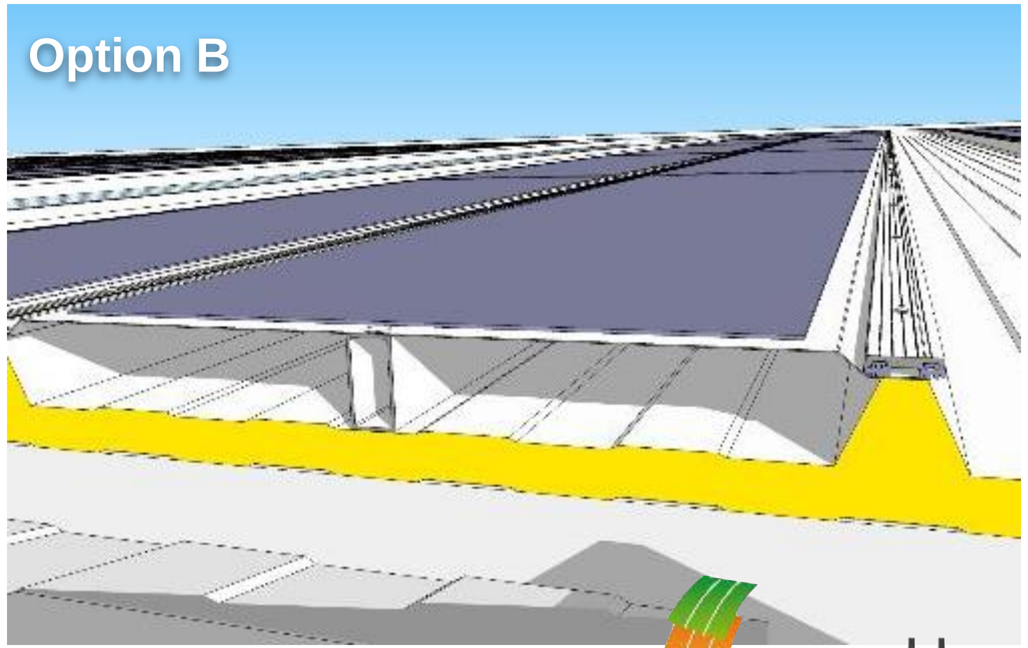
7.3 eRoof BIPV element - Design

The BIPV system proposed for this demo-site consists of a PV integrated metal roof module designed and manufactured by FLISOM. The module has a double functionality as a passive cooling solution and a renewable energy generation system. The edges of the steel sheet are bended to increase stiffness and the possibilities to mount the modules. The cell colour is dark black-blue and the metal sheet is white (RAL 9010) like the existing roof.
The roof sandwich-panels (see next page) are produced by Panelais and have three ribs with a width of 500 mm. Total roof panel width is 1000 mm. In between are transparent areas with plastic panels.
The modules produced by FLISOM need to follow these dimensions for an easy construction.
Two options have been proposed in this regards; the second one has been chosen:

Option A: the module positioned below the highest point of the roof sandwich panels. In this case the production process for FLISOM is more complicated, as the cells have to be laminated before the sheets are bended in the right shape.

Option B: the module is positioned higher than the highest point of the roof sandwich-panels. This is easier for FLISOM as the sheets can be produced, painted and bended before the cells are laminated. Another advantage is that, in this way, the cavity between the modules and the sandwich-panels is larger and good ventilation of the air chamber is possible.
This option has been chosen.





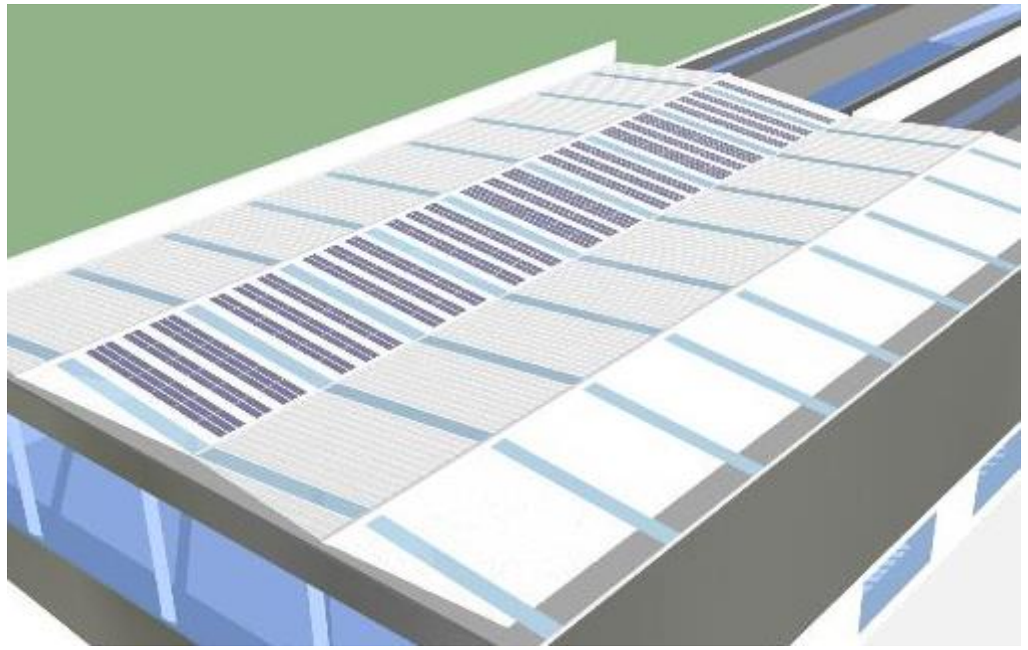
7.3 eRoof BIPV element - Design

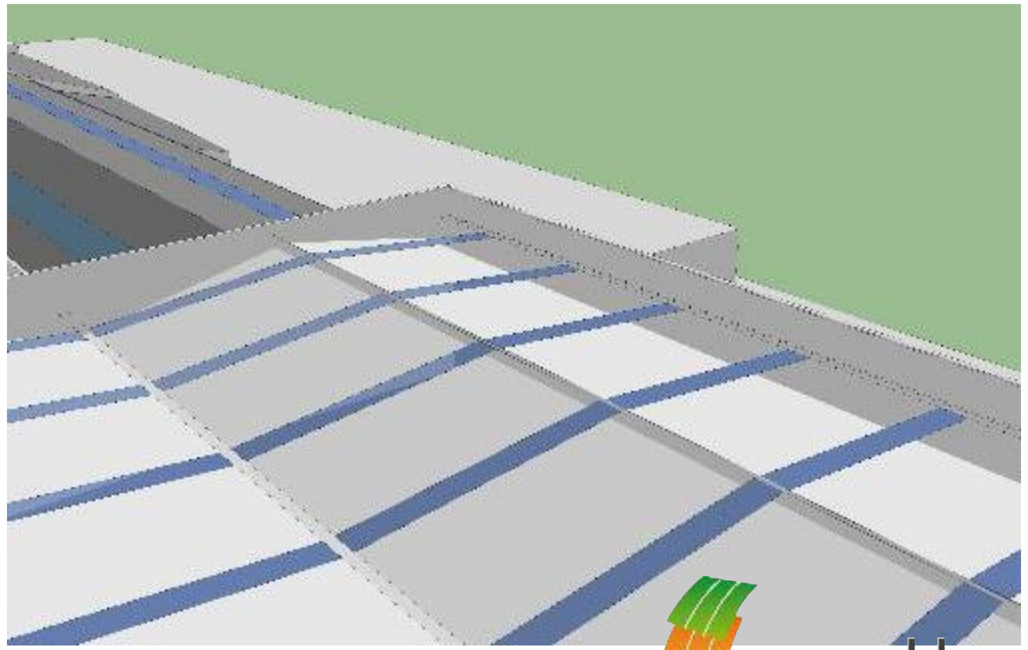
The BIPV roof system will be placed in the south facing slope of a double-sloped roof (orientation: +2°; tilt 6°). This location has no hindrance from shadows by the roof parapet on the front and back façades.
The building's roof is divided into sections made up of polyurethane panel AIS-3G of 50 mm of different width separated by flat transversal skylight elements Arcoplus 1000.

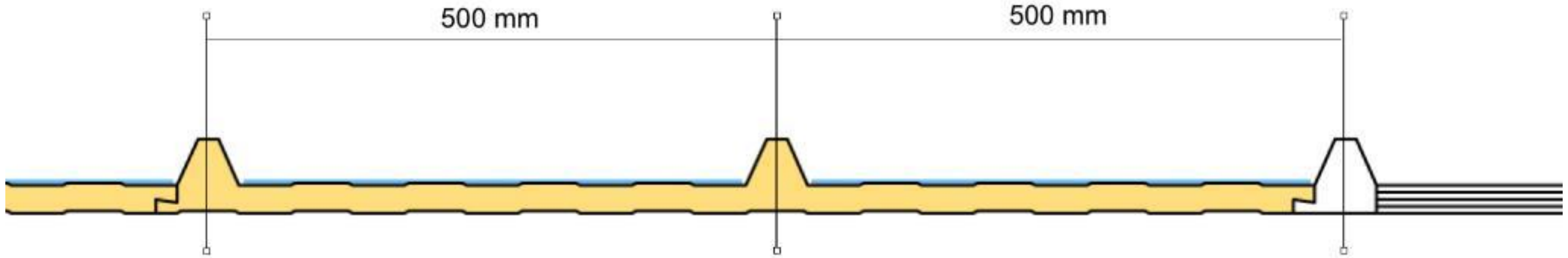
Roof length is about 9.940 m, so that 6 modules can be mounted in a row.

The BIPV system will be composed of 336 PV modules of, approximately, 60 Wp (real module power will range between 56-62 Wp, depending on the production batch). The total power will be 20,2 kWp, and the total occupied area will reach 276,9 m^2.

From an architectural point of view, the BIPV roof will perform as a tropical roof, based on the double layer concept. In this regard,



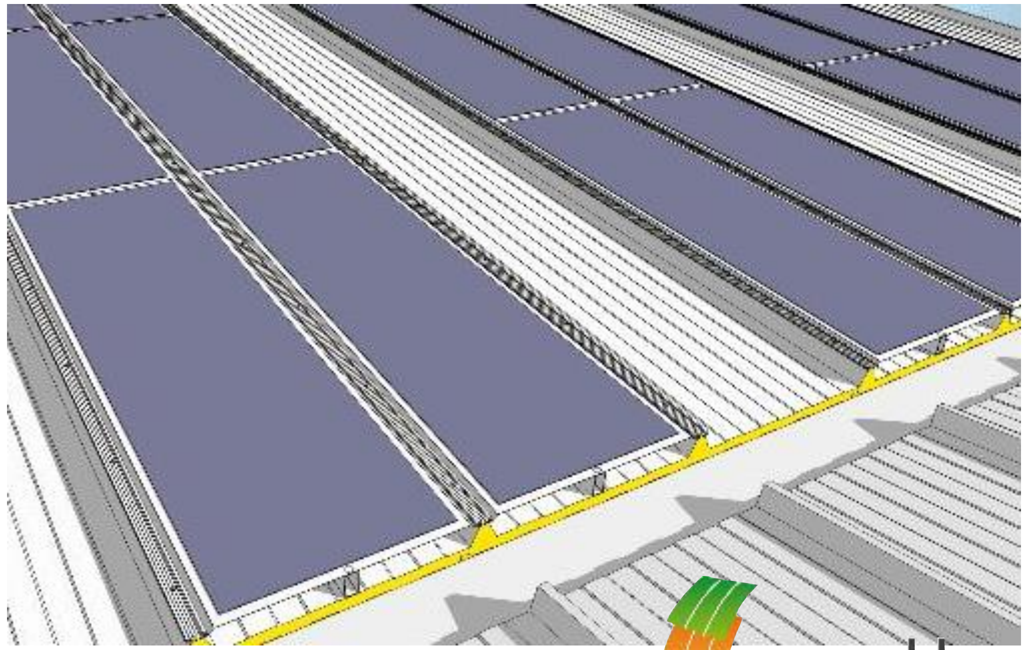


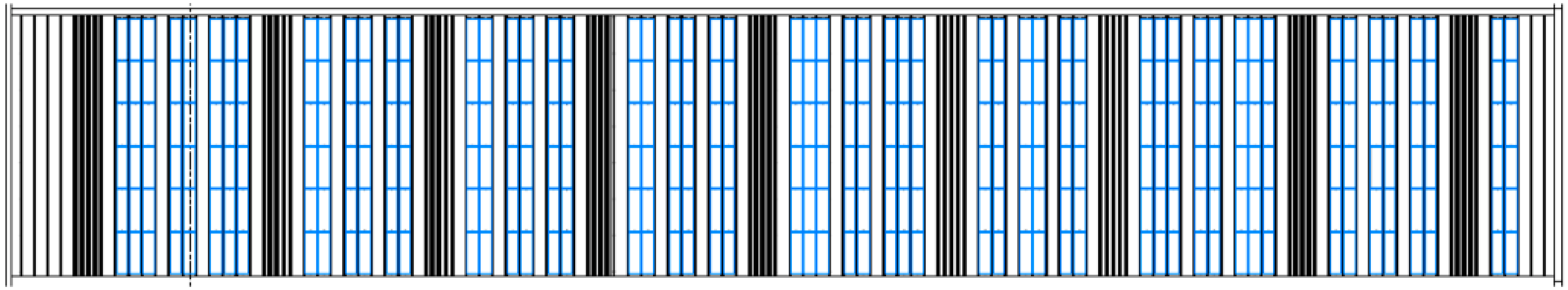


7.3 eRoof BIPV element - Design

The solar field will be divided in eight sections separated by the existing skylights and one final row at the end of the roof. Every section will consist of several rows of modules, arranged in pairs or trios.

The total amount of modules is 336 modules.



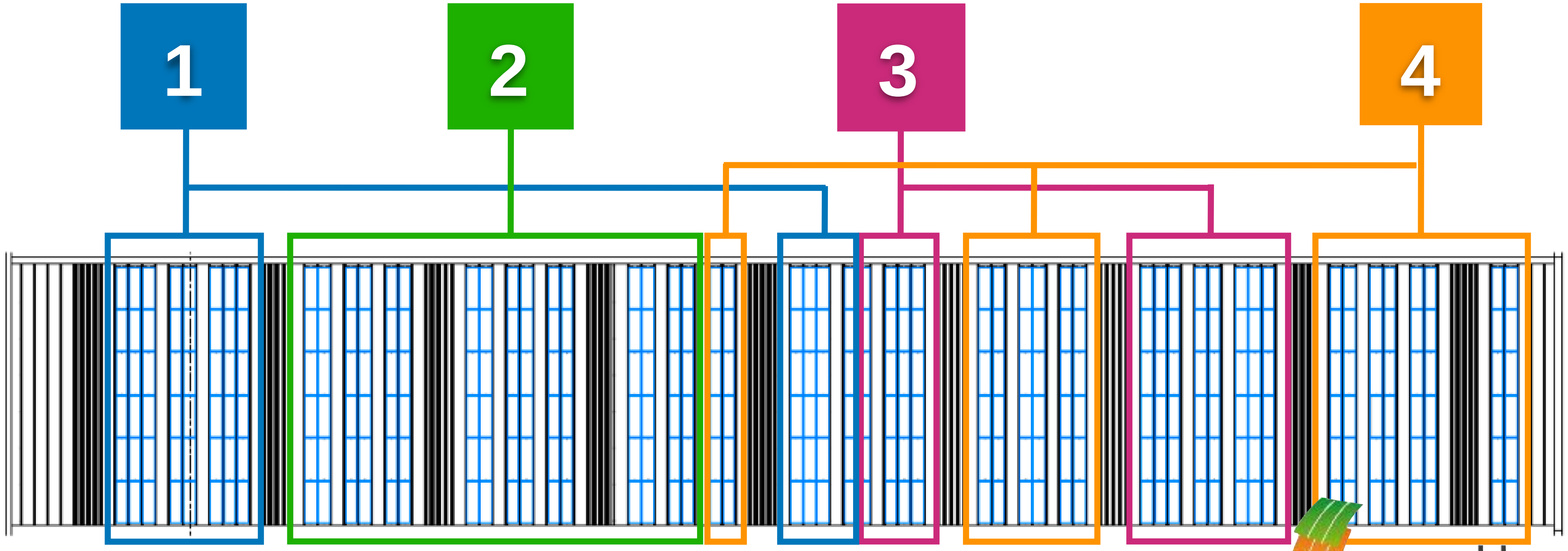


7.4 eRoof BIPV element - Electrical design

There are solar 9 sections and every section will consist of several rows of modules, arranged in pairs or trios; each of them will constitute an electrical string managed by the same Solar Edge MPP trackers micro-converter.
The 336 BIPV modules in 34 strings are connected to 4 inverters. The total installed power is 20.2 kWp.

Inverters
There will be two commercial inverters SMA 6000TL and another two inverters developed within the project by CEA.
At first there will be two SMA 5000TL inverters as well to be replaced by the CEA SiC inverters.

1. Inverter PVSTES SiC 9 strings x 8 modules
2. Inverter SMA 6000TL 8 strings x 12 modules
3. Inverter PVSTES SiC 9 strings x 8 modules
4. Inverter SMA 6000TL 8 strings x 12 modules



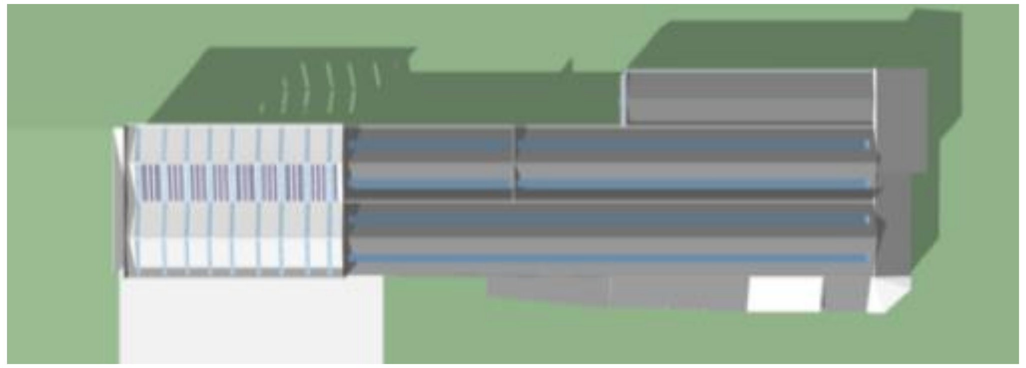
7.5 reRoof BIPV element - Software

Use of the PVSITES web tool

The software can be found on the pvsites.eu website.

Steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen



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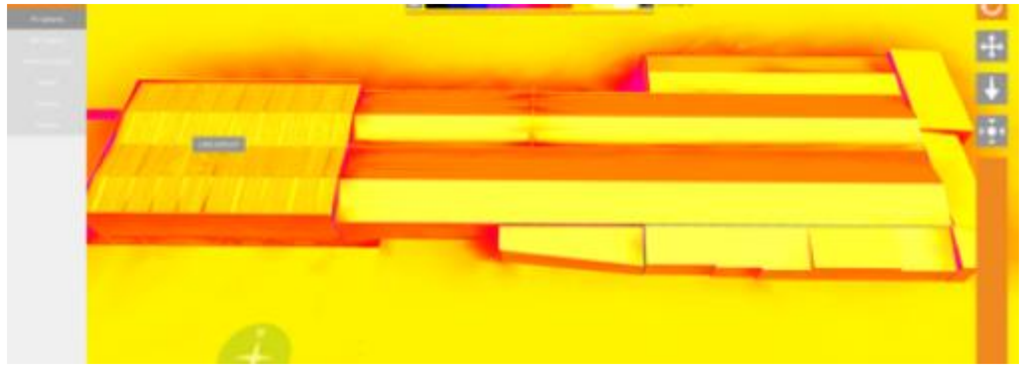

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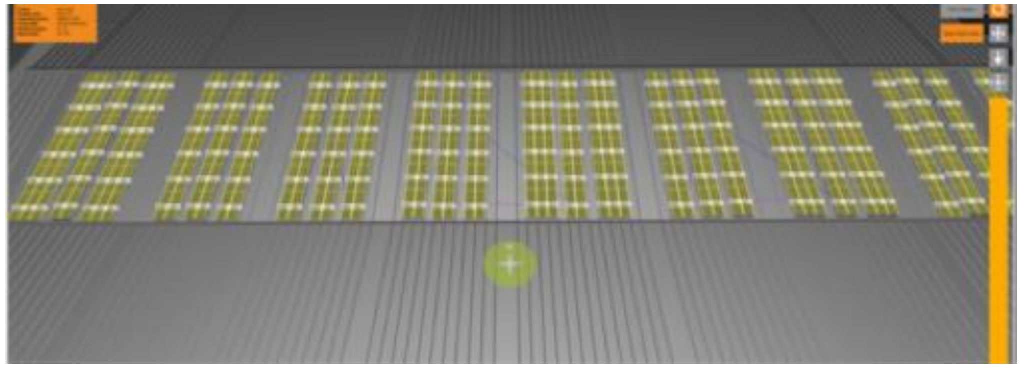

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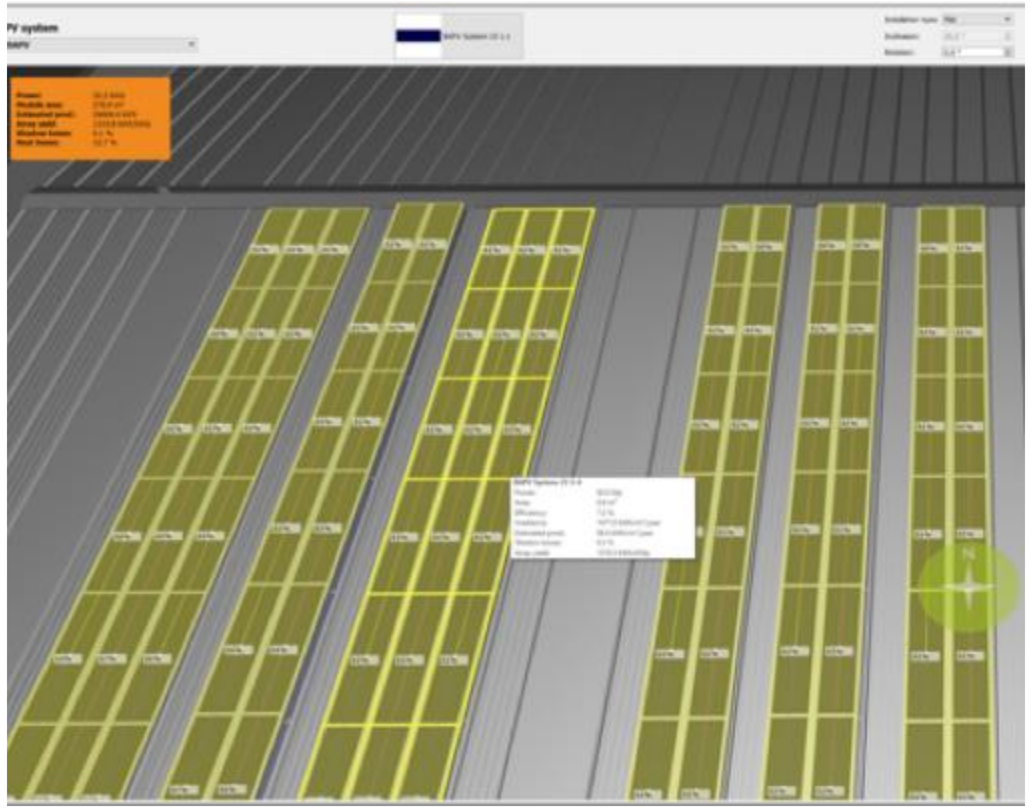

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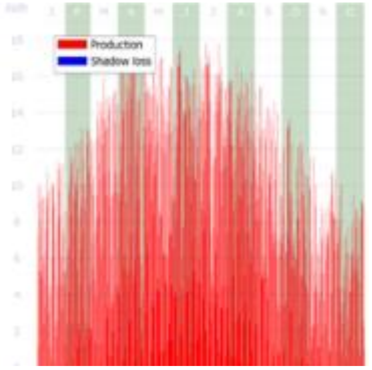

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7.6 eRoof BIPV element - Commissioning

Regarding the permitting process, all the permissions required by the electrical company ENDESA were received in 2018. A “zero-injection” device is used under a “self-consumption without energy surplus injection” regimen, according to the possibilities offered by the new Spanish regulation (2019).
The construction permit for minor work was given by the city hall about the end of 2018.

Regarding the grid connection some issues has still to be clarified:
1. If the excess of energy is intended to be injected into the grid, the electricity distribution company (ENDESA) has to make a previous study about the state of the network considering the new installed power. This would be a slow process which might cause unacceptable delays in the project. In order to solve meanwhile this inconvenient, a certified device preventing the discharge of energy to the distribution network could be installed.

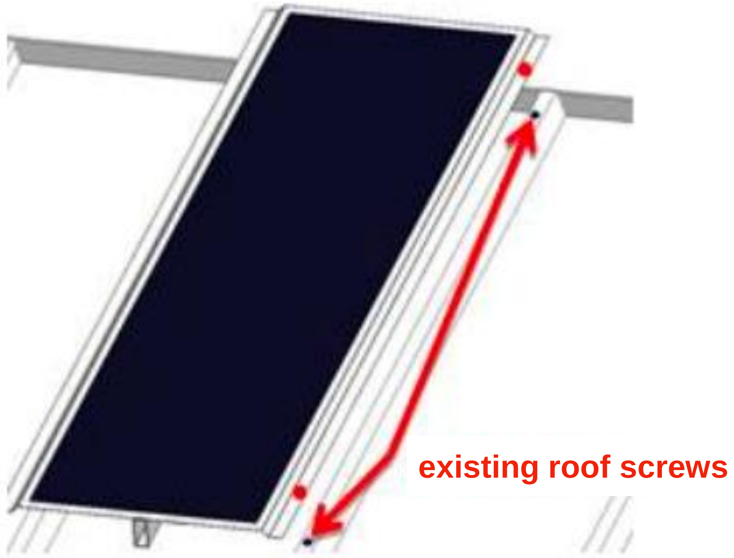
2. Selection of the most suitable inverter and batteries system. The final selection is this regard has been a monophasic battery LGChem RESU10 5KW, 63Ah, and 10Kwh; The inverter of battery will be the SMA SUNNY ISLAND 6.0H which is remotely controllable via communications protocol MODBUS Rs-485.

Installation

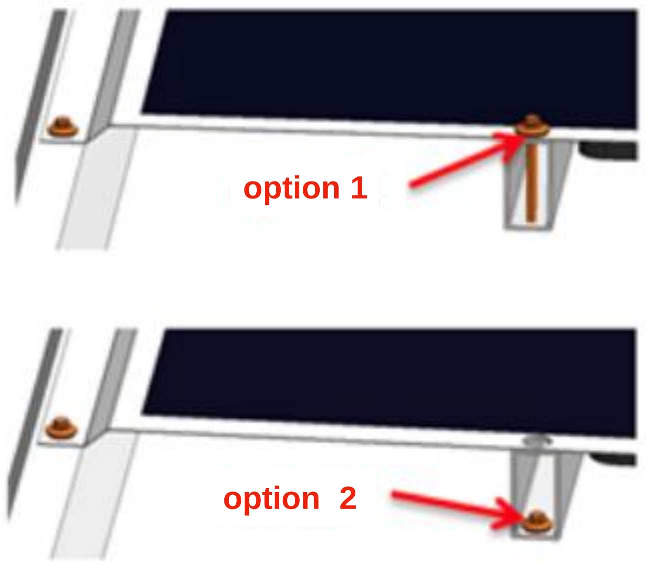
7.7 eRoof BIPV element - Installation

Installation:
Because of the possibility for expansion, a profile with rubber is added to the sandwich before screwing the modules.
1. Position the first module and mark the position of the existing screws; add the EPDM rubber.
2. Stamp out holes on the marked positions. The holes should be bigger than the screws diameter to have enough tolerances and expansion;.
3.Place the module and check that the stamped out holes are placed over the existing roof screws.
4. Screw the module 4 times on one side on the roof.
5.Screw the middle of the module on the roof using the support profile.
6.Install the rest of the modules in this row and connect the cables. Start the next module row and screw them together with the first row module on the roof.

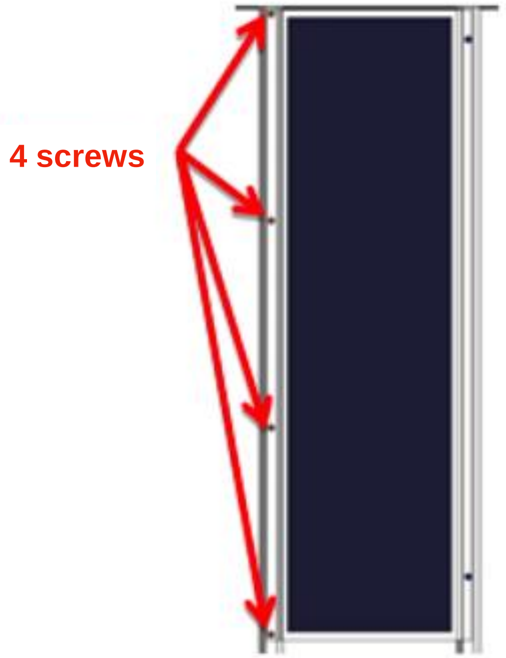
Step 3.



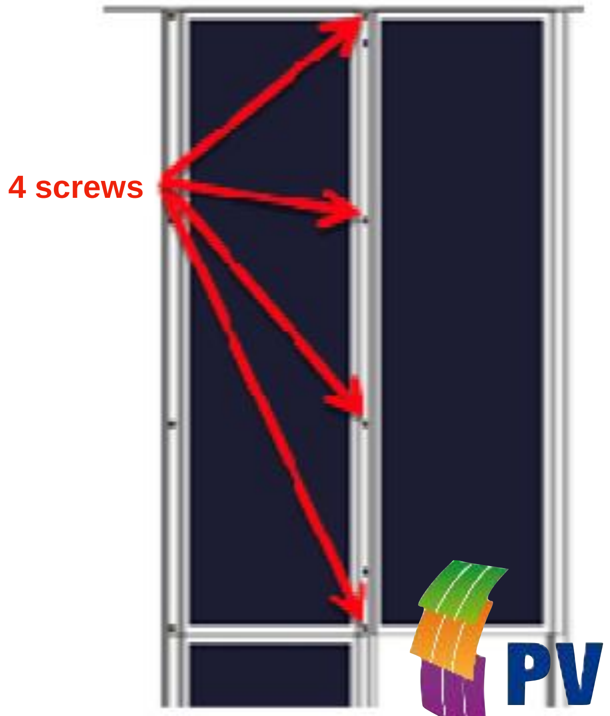
Step 5.



Step 4.

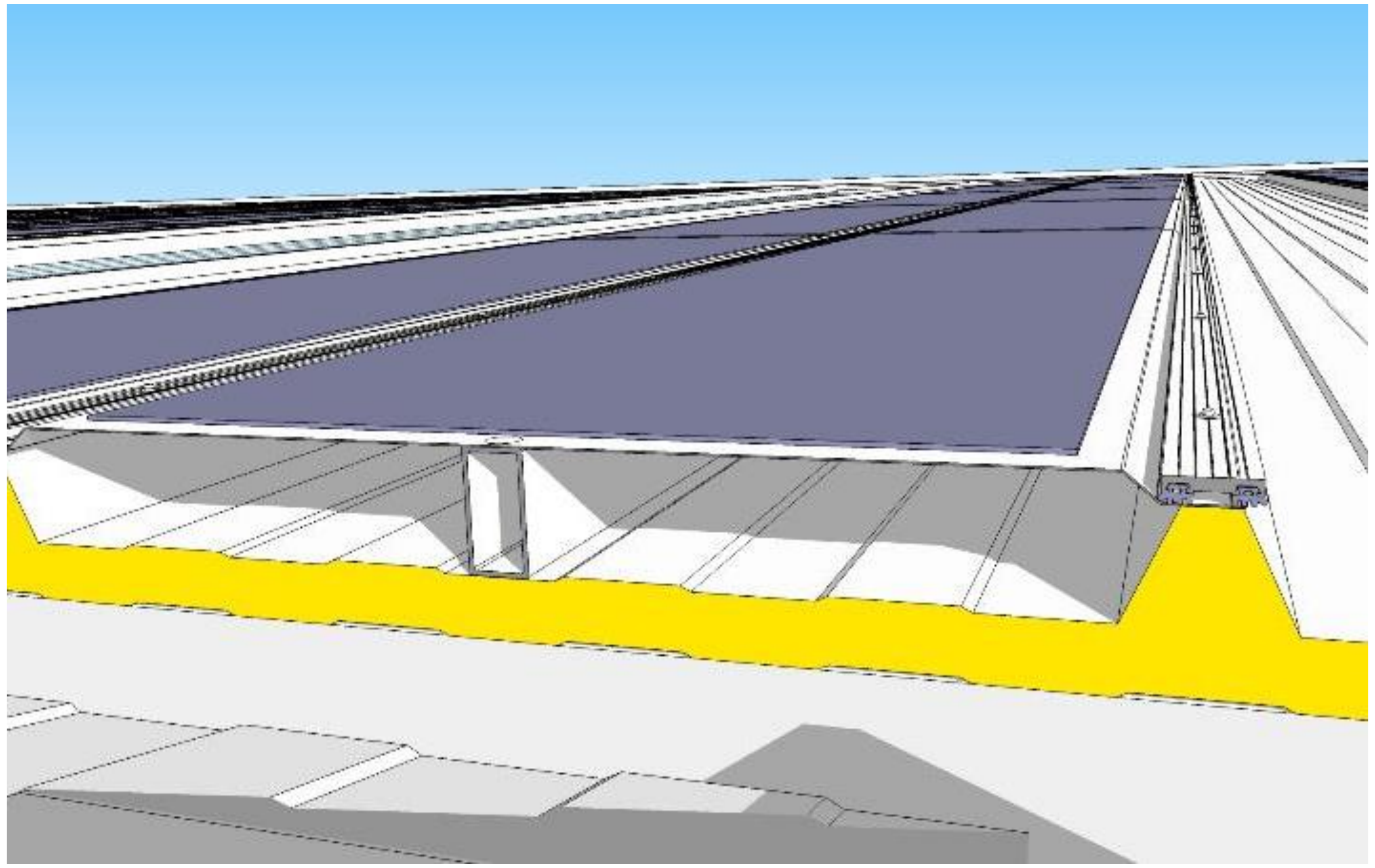


Step 6.



PVsites

7.3 eRoof BIPV element - Design



7.8 eRoof BIPV element - Maintenance

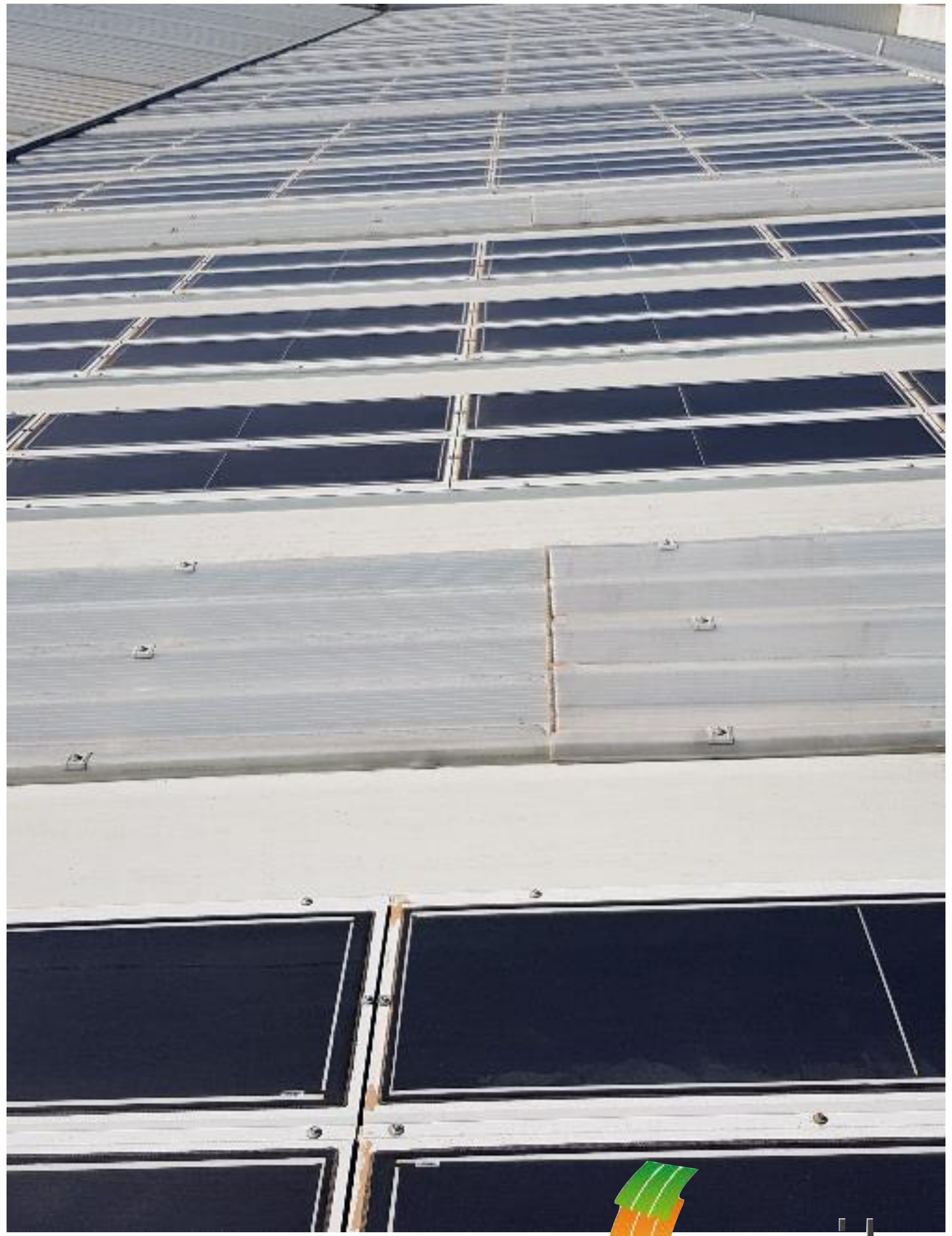
Flisom gives the following general guidelines for inspection and maintenance:

It is recommended to have a visual check on a regular basis (every 3 months). Plan check-ups according to the given environmental and safety conditions and regulations.

Maintenance:

a. Remove dust and dirt (sediments, leaves, pollen, bird droppings, etc.) from the surface.
b. Do not use aggressive cleaning agents or scrubbing materials for cleaning.
c. Do not use steam blasting for cleaning.
d. Use soft (rain)water to avoid chalk stains.
e. Soft sponges can be used.
f. Check if connectors and grounding are tight and without corrosion and if the insulation is not damaged also check for loose mechanical or electrical contacts.
g. Check if the junction box is securely attached and that no deep scratches are penetrating the front sheet.

Cleaning the roof is recommended because of the environment with tall trees. Easiest way is to use a garden hose and spray with water using the water pressure. Rainwater is available in a cistern.
Electric cables outside are hidden and can not be inspected.
The system is permanently monitored so any technical failure of the system will be noticed.



8. eCarport BIPV carport element - Flisom

Data

8.1 eCarport BIPV carport element - Data

Description

The carport module is a semi-flexible and lightweight solar panel designed for a carport installation. The layers from back to front are: Mild steel backsheet with PVDF coating, black RAL 9005; encapsulant TPO 0.4 mm; PV film CIGS grown on polyimide with Mo and ZnO electrical contacts; encapsulant TPO 0.4 mm; barrier film 0.4 mm; the module is sealed with edge seal ~1cm width.

Dimensions

Rectangle 2519 or 3263 x 458 x 21 mm

Weight

5.9 kg/m^2

Rigidity

Semi-flexible

PV power

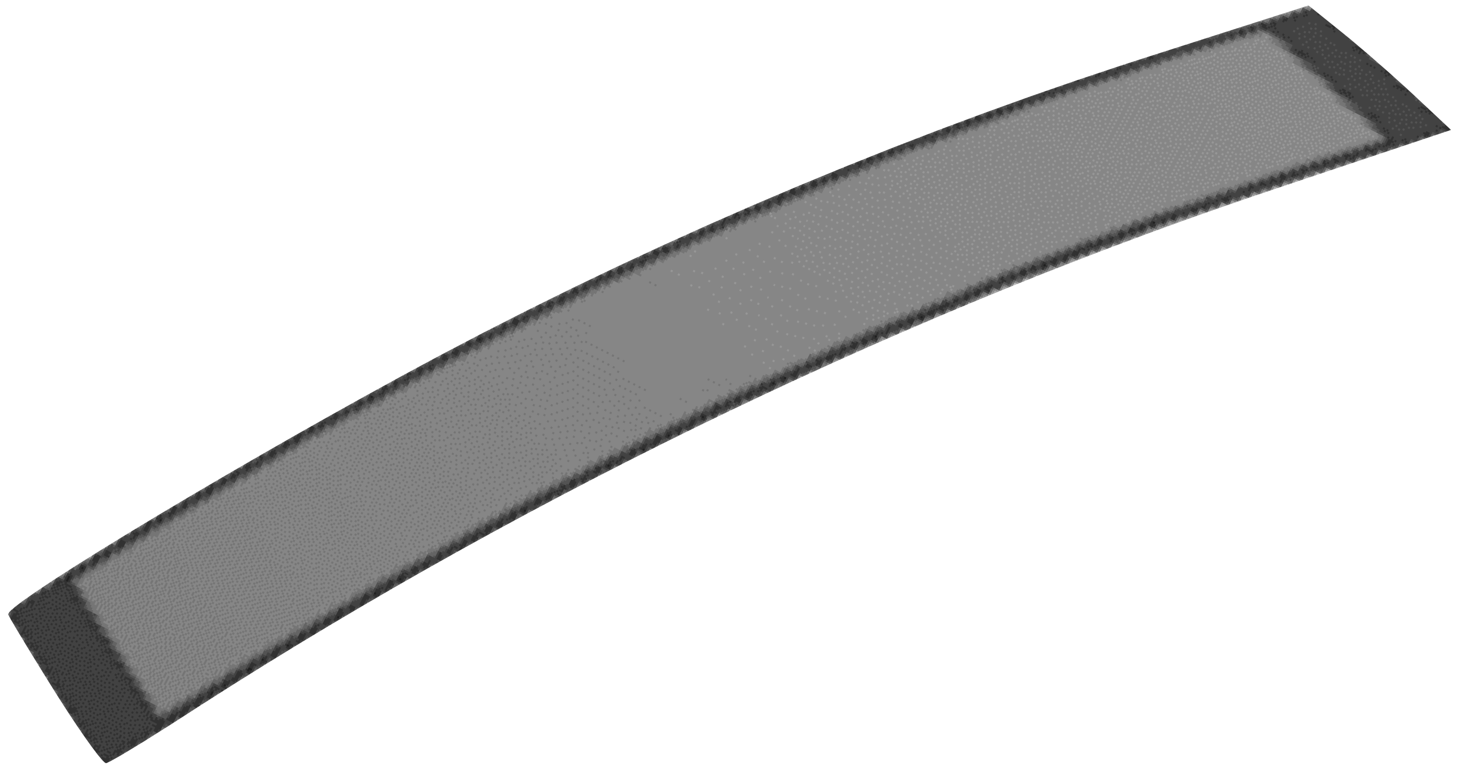
84 or 110 Wp/unit (2519 mm or 3263 mm unit.

Field of application

The carport module can be used for new roofs and for renovation of existing roofs.

Mounting system

The carport modules are riveted together to one big module of 5.7 m length and will be clamped on profiles with a rubber gasket. Between the modules a 5 mm gap is needed for thermal expansion.



PVSITES code **X1b**

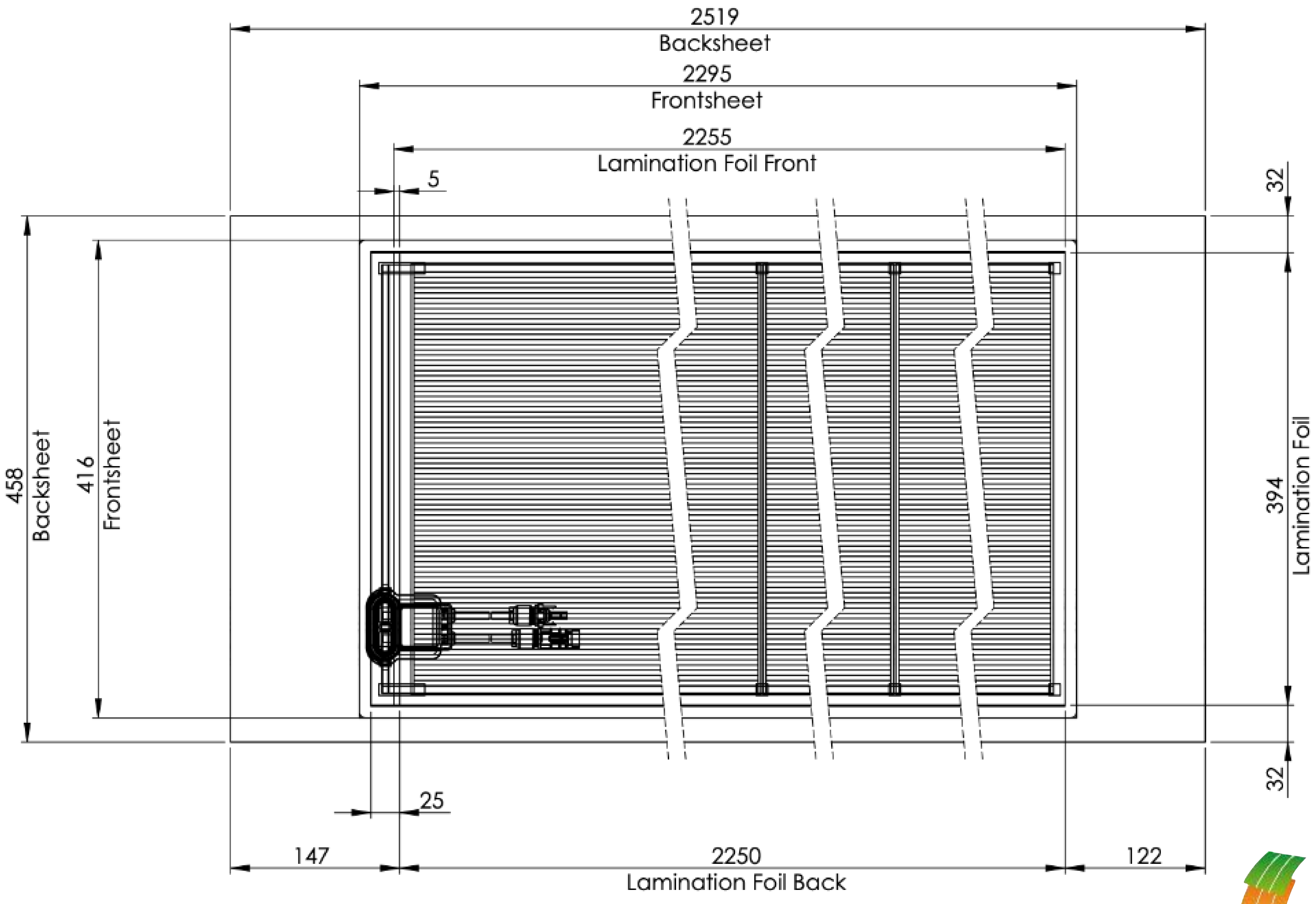
8.1 eCarport BIPV carport element - Data

Electrical characteristics	
Vpm: max. power voltage	34 - 38 V
Ipm: max. power current	2.22 - 3.16 A
Voc: open circuit voltage	46 - 50 V
Isc: short circuit current	2.47 - 3.40 A
Isc (α) Temp. coefficient	0.01 %/°C
Voc (β) Temp. coefficient	-0.3 %/°C
P (γ) Temp. coefficient	-0.35 %/°C
Inverter	Solaredge SE 9 kW inverter with MPP tracker P300 (both carports the same inverter).

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

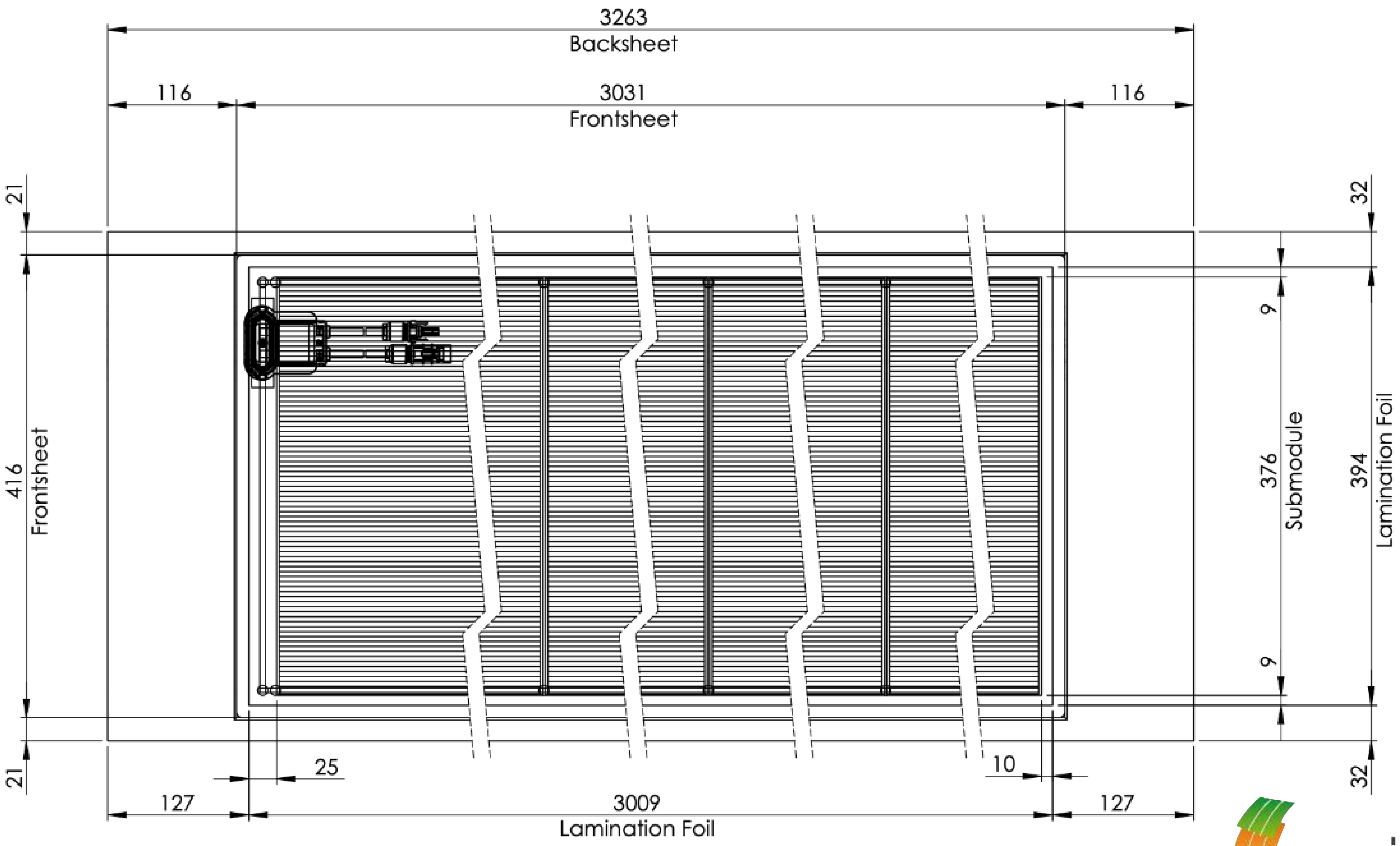
8.2 eCarport BIPV carport element - Drawing

Drawing nr. B-0027348-a
Module length 2519 mm



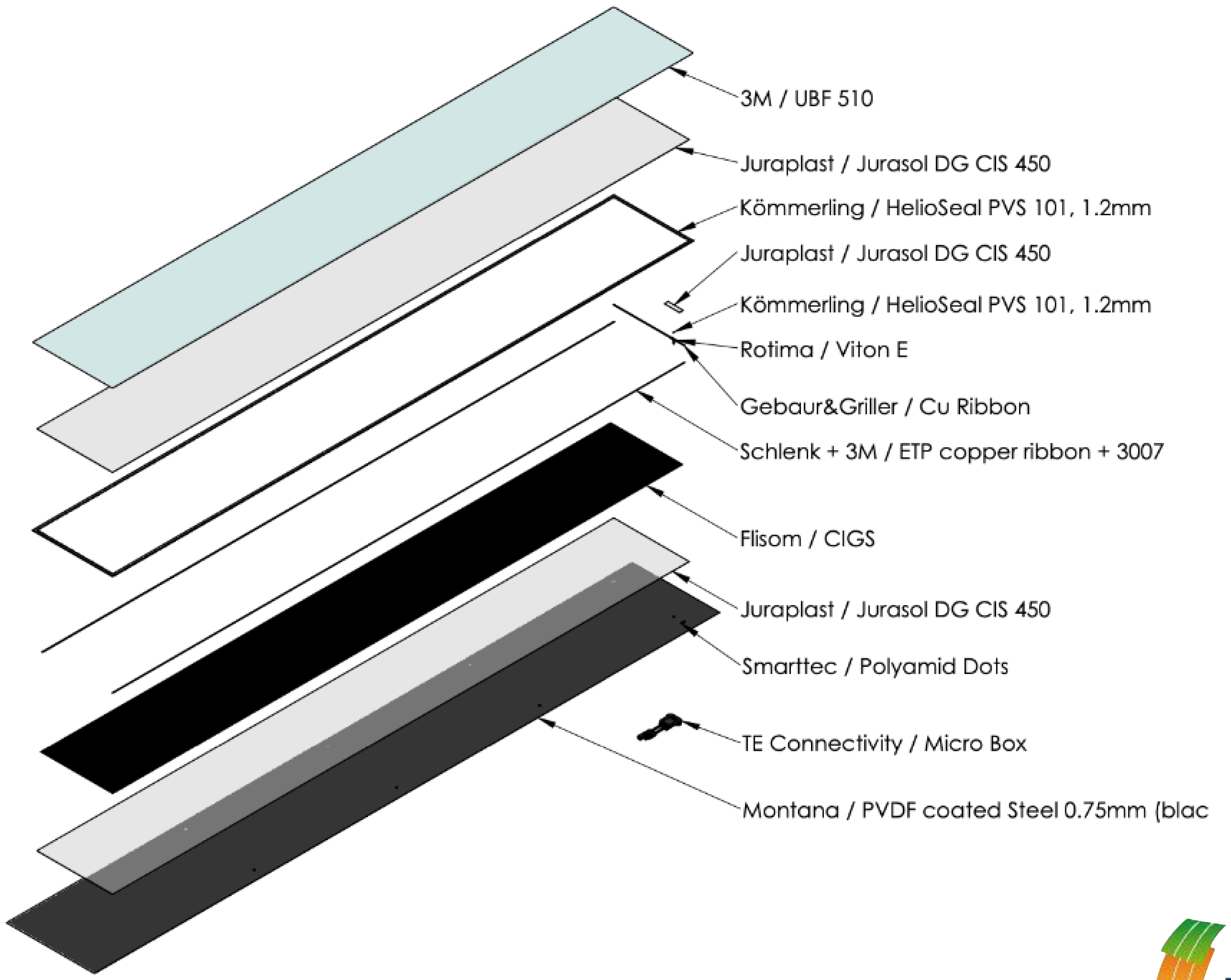
8.2 eCarport BIPV carport element - Drawing

Drawing nr. B-0027337-a
Module length 3263 mm



8.2 eCarport BIPV carport element - Drawing

Drawing nr. B-0027337-c
Module length 3263 mm

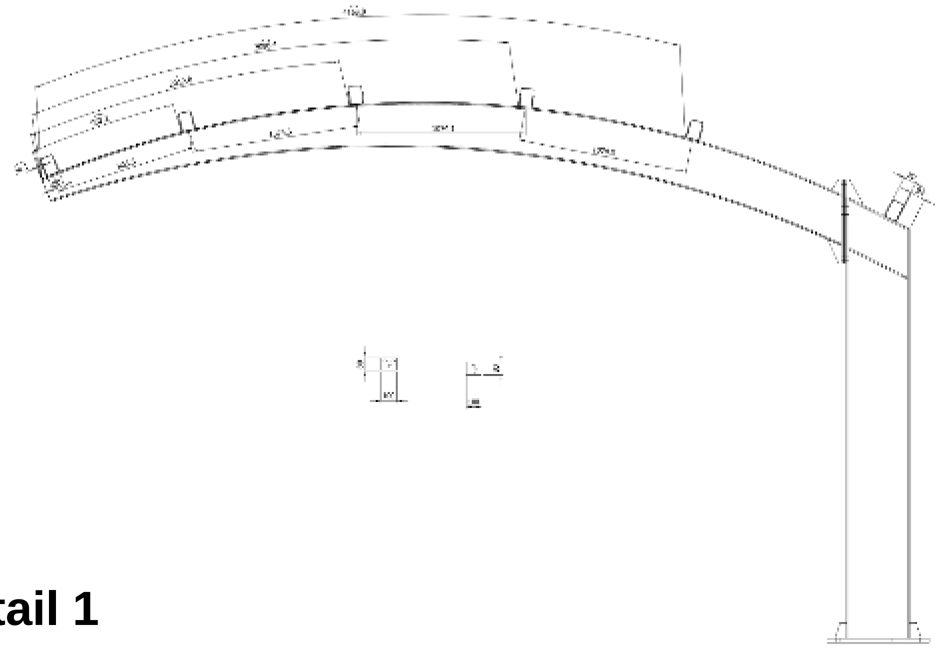


Design

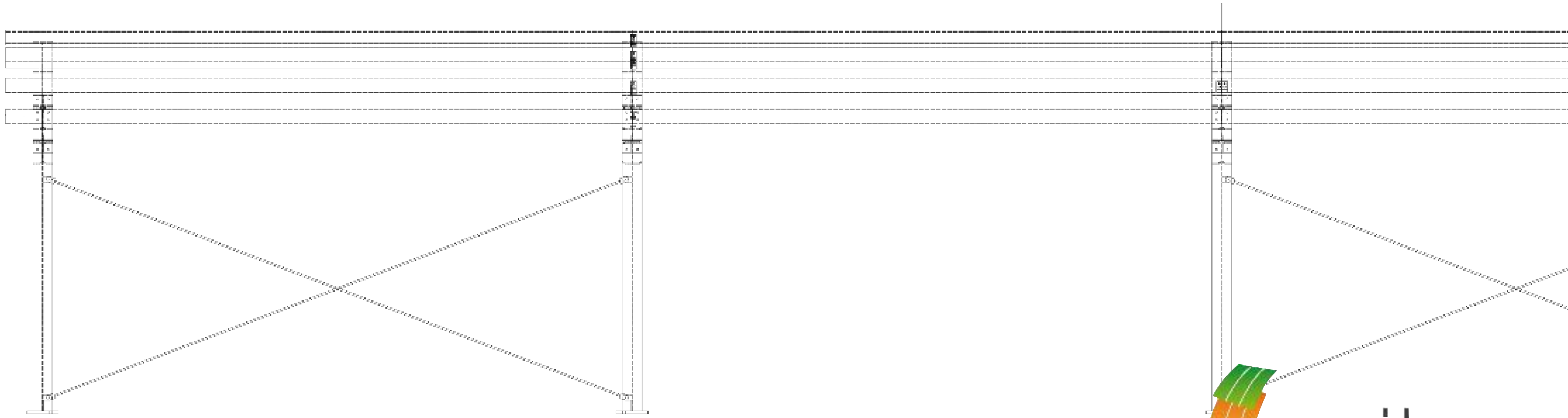
8.3 eCarport BIPV carport element - Design

Carport design

An existing design for the carport is used from company xx.
This design is based on aa asymmetric steel construction. The steel structure is designed as a steel pool with a beam. The pole is at the back and the beam is bended.
The beams are connected with horizontal beams (purlins) that make the roof stiff and stable. The small BIPV element (2519 mm) spans three beams and the larger element (3263 mm) spans 4 beams.
In the middle where both elements come together, the electrical cables are collected.
At the lower part is a small gutter to collect the rainwater.



Detail 1



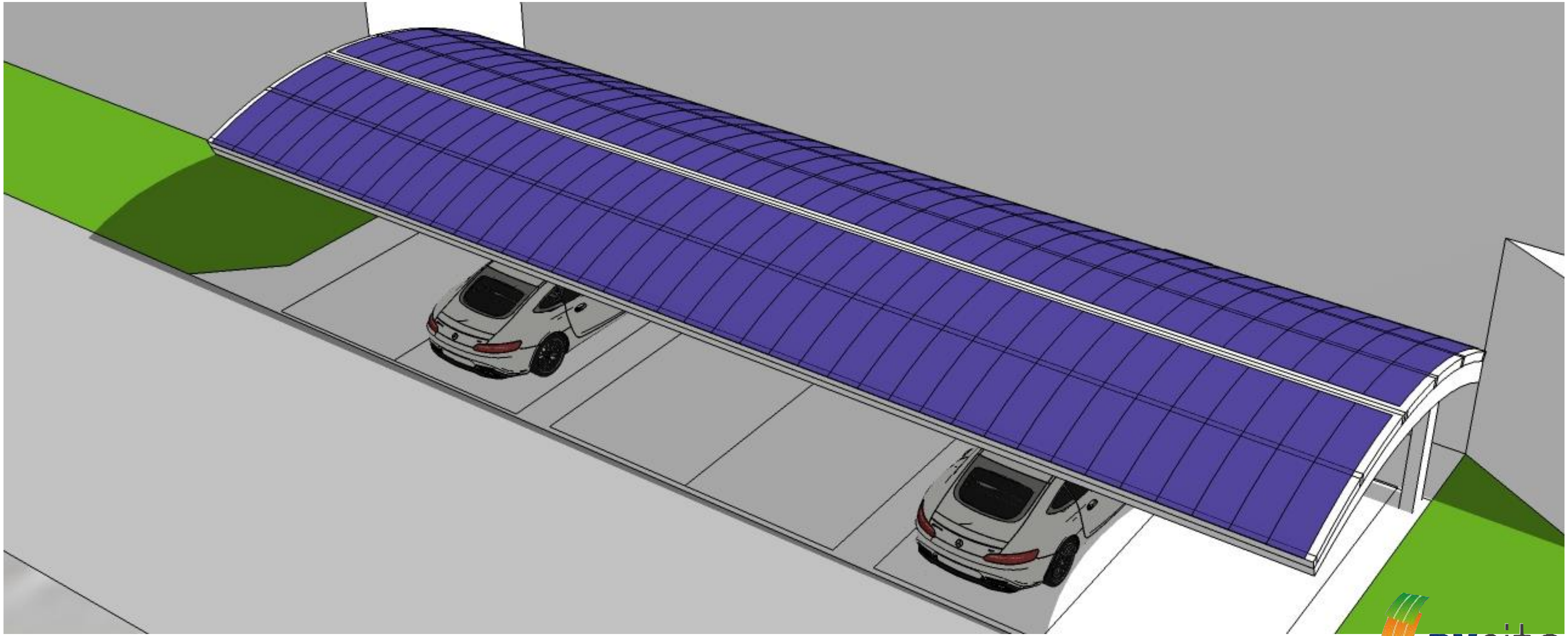
Detail 2

8.3 eCarport BIPV carport element - Design

EKZ site

8.3 eCarport BIPV carport element - Design

EMPA site



8.4 eCarport BIPV carport element - Electrical design

For elevated areas irradiation can be higher than at STC. Therefore, multiply ISC- and VOC- values with a factor of 1.25 for the electrical layout of cables, fuses and converters (worst case scenario). For a serial connection the voltage of a single module is multiplied by the number of modules to calculate the system voltage. Make sure that you are always within the limits of the maximum system voltage. Use an adequate device for over-current protection (fuse, blocking diode). Maximum Isc multiplied by a factor of 1.56 to protect a string in parallel configuration.
The maximum number of modules connectable in series is calculated by adding Voc of each single module multiplied by 1.25 up to the maximum system voltage which you can find on the label.
Back-sheet of Flisom PVSITES modules are made of metal and have to be connected to the ground. Also ground the support structure and arrange an adequate lightning protection. Do not use materials which can cause corrosion. The hole for the grounding cable can be drilled anywhere in the edges of the module frame as in fig. 1. If the back-sheet of the module and the support structure/clamps are conductive it is not necessary to ground every module. The grounding of the support structure is sufficient. Make sure that you do not damage the edge seal or front-sheet. In general, the modules can be mounted either in portrait or in landscape mode.

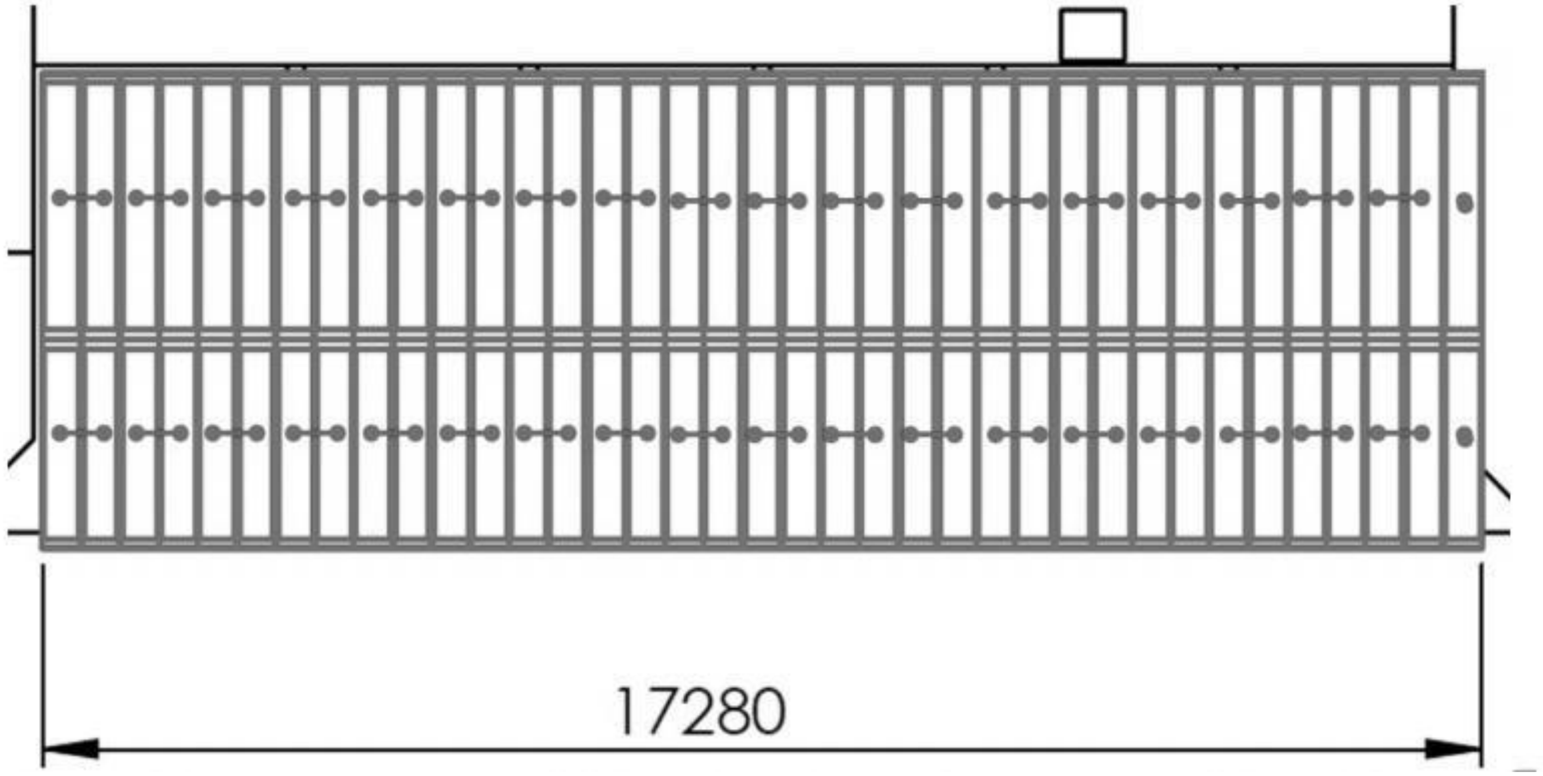
Orientation of the shadow on the active surface is crucial: the module may only be installed with shadow on the short side. If the complete length is shaded, the shadow will negatively affect the power.

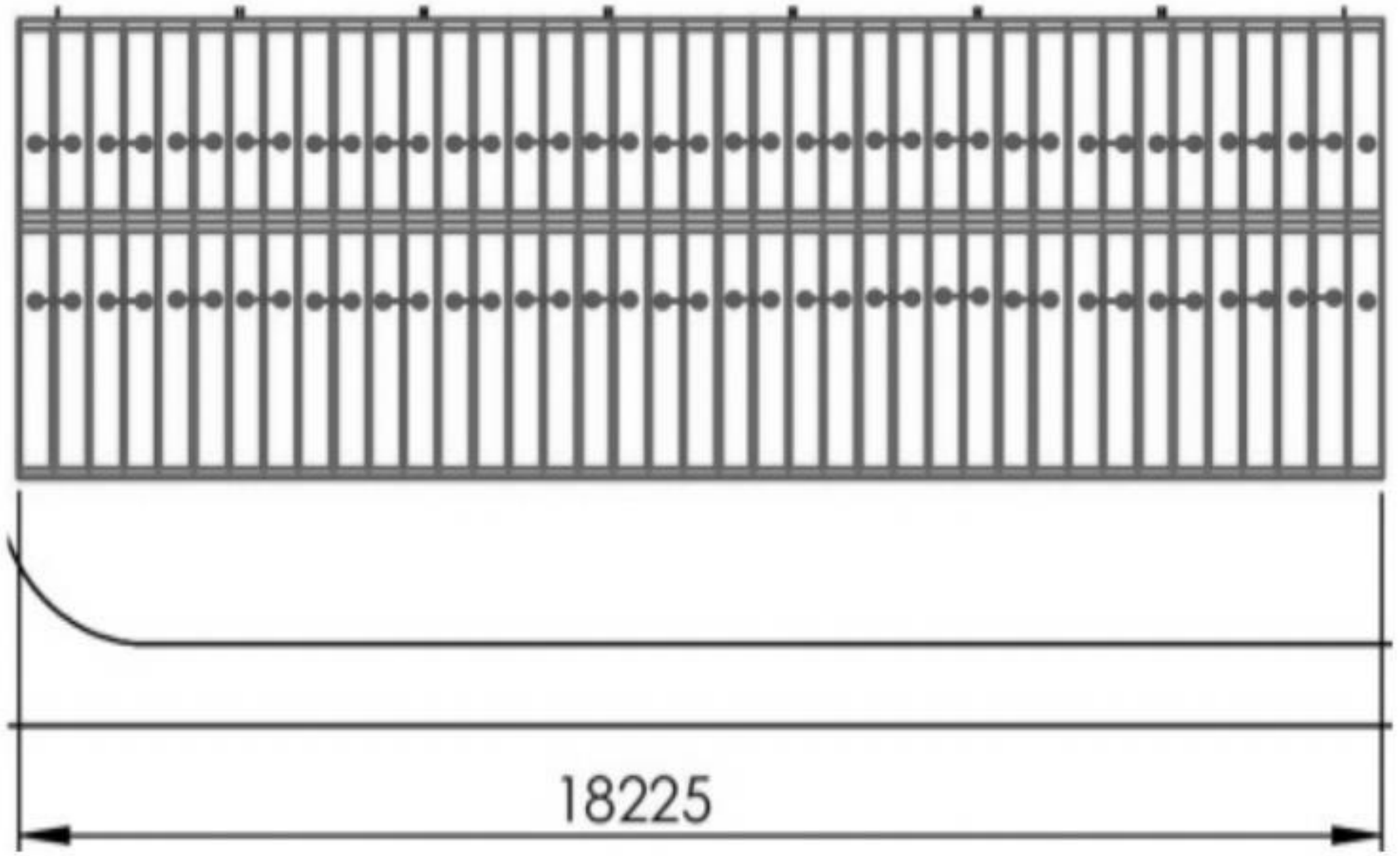
Inverter
Regarding the power conditioning, a "Solaredge SE 9 kW" inverter with "P300 MPP trackers" will be used for these demo-systems. Thus, connection of modules must be carried out in pairs, together with a common MPP tracker.
The generated power will be used to cover the EV charging stations' demands. The EMPA demo-site has already an Electric Vehicle (EV) charging station; a new one will be shortly installed in EKZ facilities. There will be batteries in the EMPA carport.

8.4 eCarport BIPV carport element - Electrical design

The EMPA carport (left) has 74 elements (37 short and 37 long elements). Total area is 98 m^2 and power is 7.2 kWp.

The EKZ carport (right) has 78 elements (39 short and 39 long elements). Total area is 103.3 m^2 and power is 7.6 kWp.





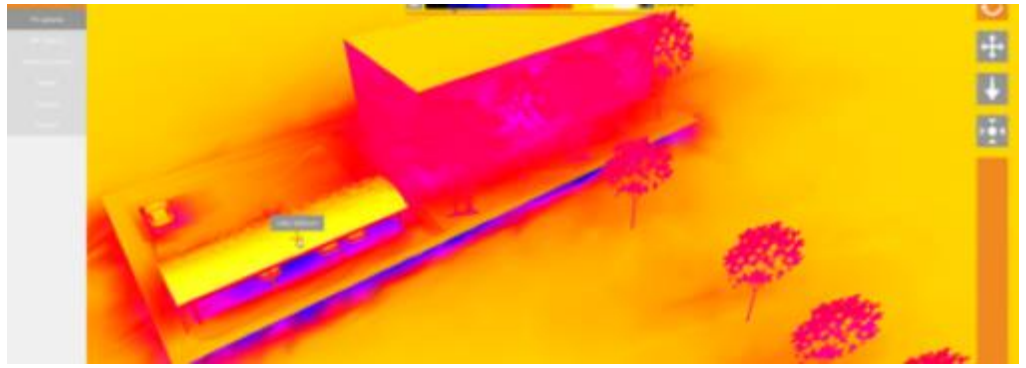
8.5 eCarport BIPV carport element - Software

Use of the PVSITES web tool

The software can be found on the pvsites.eu website.

Steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen



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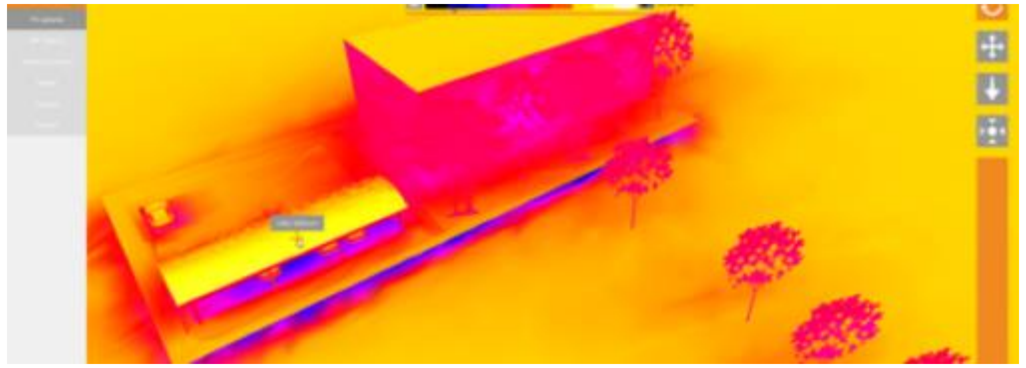

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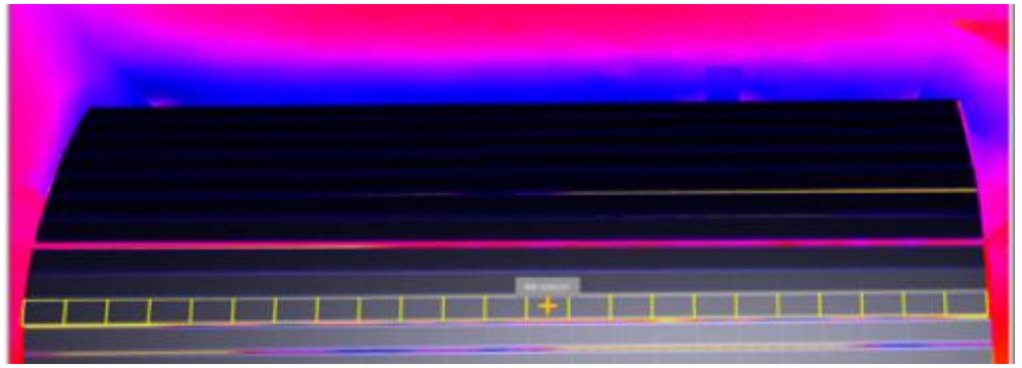

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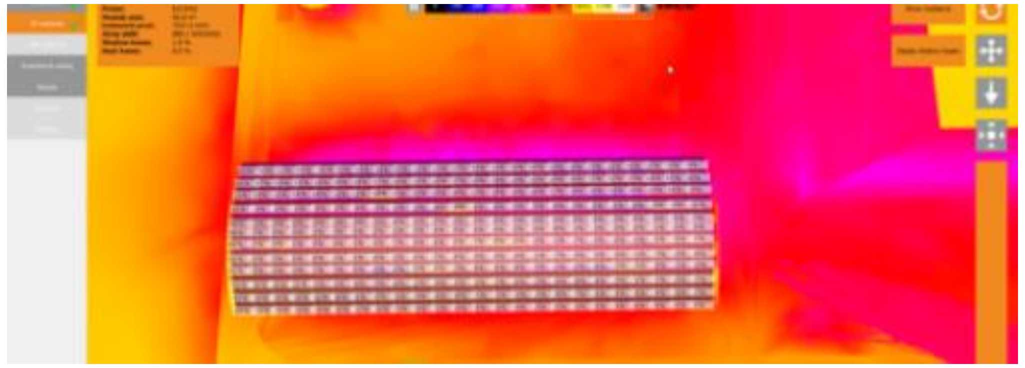

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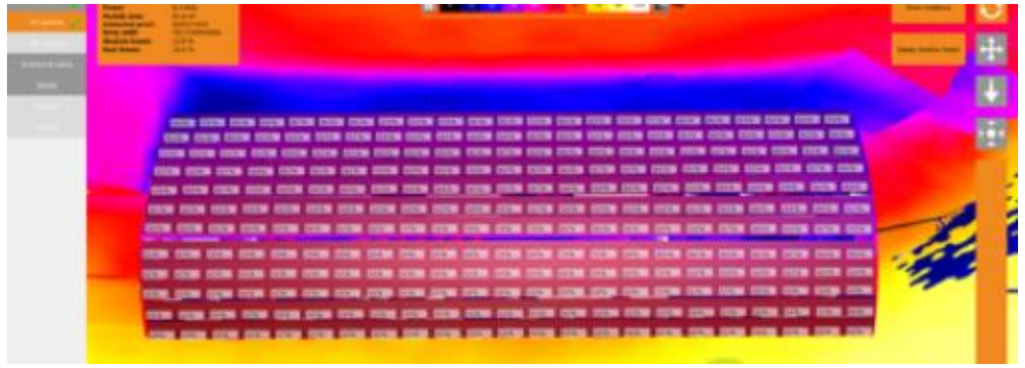

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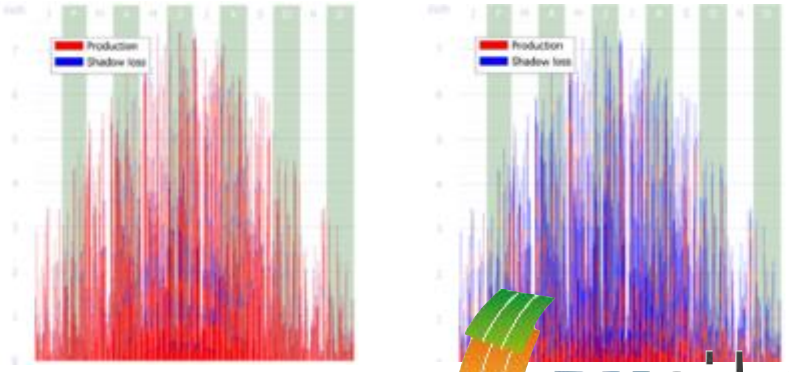

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8.6 eCarport BIPV carport element - Commissioning

EKZ’s carport in Zurich, Switzerland: The first permit requested was denied by the municipality with the argument that it is too close to the road. After demonstrating that the place is preferable due to a better irradiation and further back on the parking there is shadowing, permission was finally got with this argument, in view to prioritize renewable energy generation (from the municipality was proposed a position away from the street where yearly production is estimated around 6.7 MWh/year; the location suggested by Flisom, and finally accepted by the municipality, close to the and street and with less shadowing, provides a higher generation value around 7.3 MWh/year).

3 companies were involved for both carports: Eberhard did the ground construction and foundation work, put the tubes for cables and restored the parking after setting foundation, Zumstein AG delivered and mounted the metal construction, and Flisom delivered the modules. Zumstein AG mounted and connected the modules. Commissioning was carried out as planned.

EMPA’s carport in Zurich, Switzerland: As the carport is on the EMPA campus and not close to a public road or private households, there were no objections from the municipality. Thus, permission was given within 4 weeks with no delay.

Construction same as carport at EKZ. Commissioning was carried out as planned.

Installation

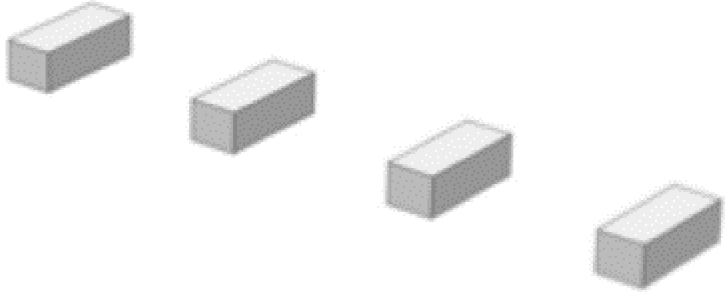
PVsites

8.7 eCarport BIPV carport element - Installation

Carport structure
Below are the main steps to construct the carports. After the steel structure is mounted on the concrete foundation, the installation of the roof modules is done within one day.

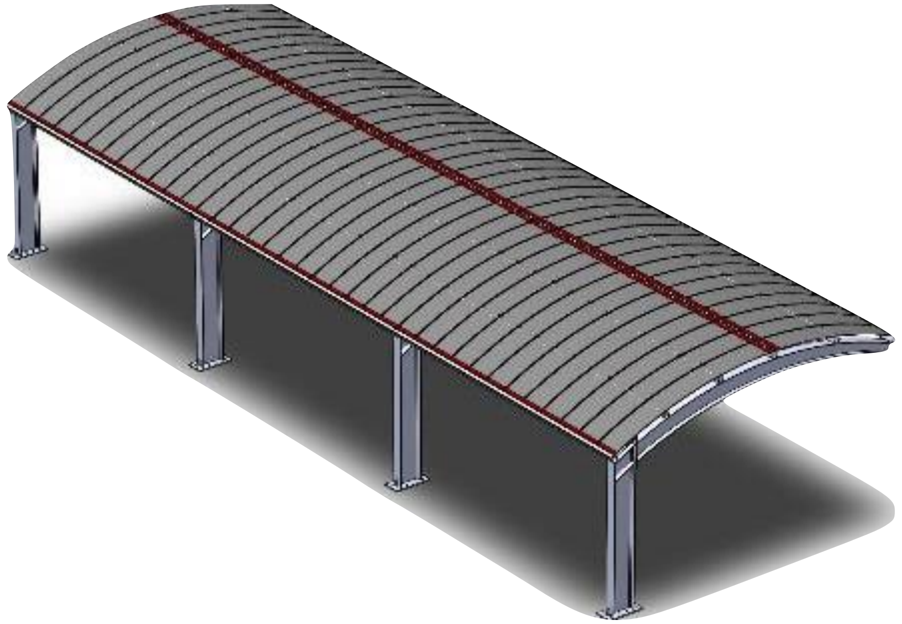
Step 1. Concrete foundation.
Step 2. Steel poles and beams are mounted
Step 3. Horizontal profiles (purlins) are mounted.

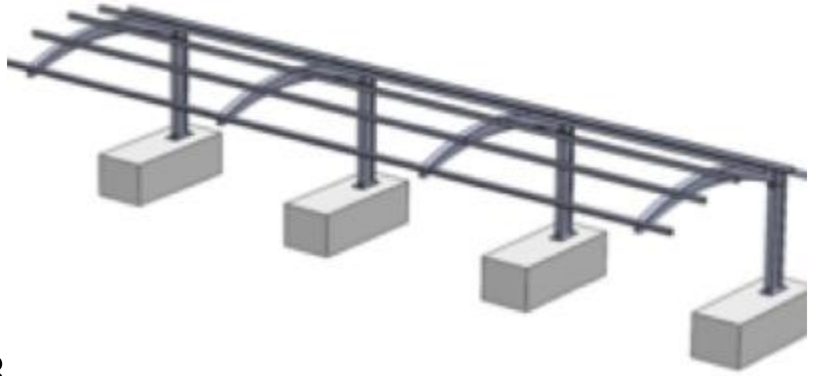
Step 4. First module is positioned and mounted.
Step 5. Other modules are mounted and connected.



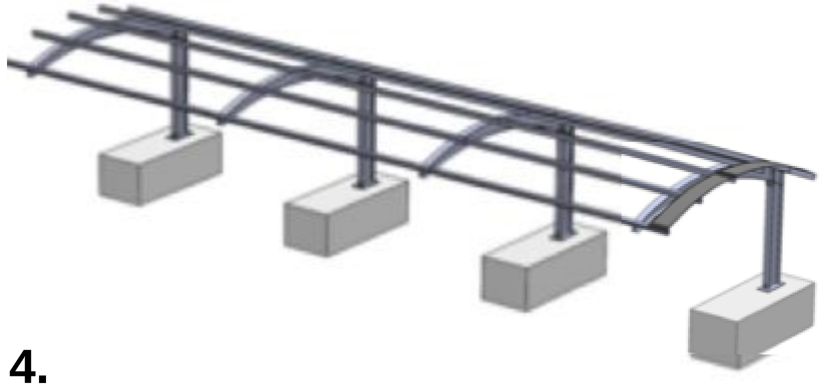
Step 1.

Step 2.





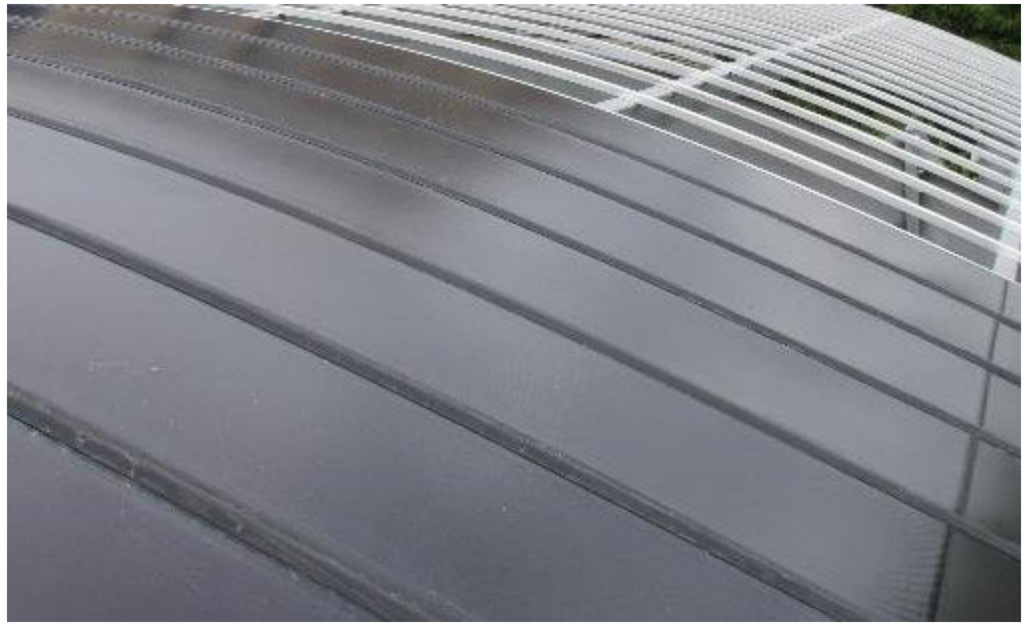
Step 3.



Step 4.

Step 5.

8.7 eCarport BIPV carport element - Installation



8.8 eCarport BIPV carport element - Maintenance

Flisom gives the following general guidelines for inspection and maintenance:

It is recommended to have a visual check on a regular basis (every 3 months). Plan check-ups according to the given environmental and safety conditions and regulations.

Maintenance:

a. Remove dust and dirt (sediments, leaves, pollen, bird droppings, etc.) from the surface.
b. Do not use aggressive cleaning agents or scrubbing materials for cleaning.
c. Do not use steam blasting for cleaning.
d. Use soft (rain)water to avoid chalk stains.
e. Soft sponges can be used.
f. Check if connectors and grounding are tight and without corrosion and if the insulation is not damaged also check for loose mechanical or electrical contacts.
g. Check if the junction box is securely attached and that no deep scratches are penetrating the front sheet.

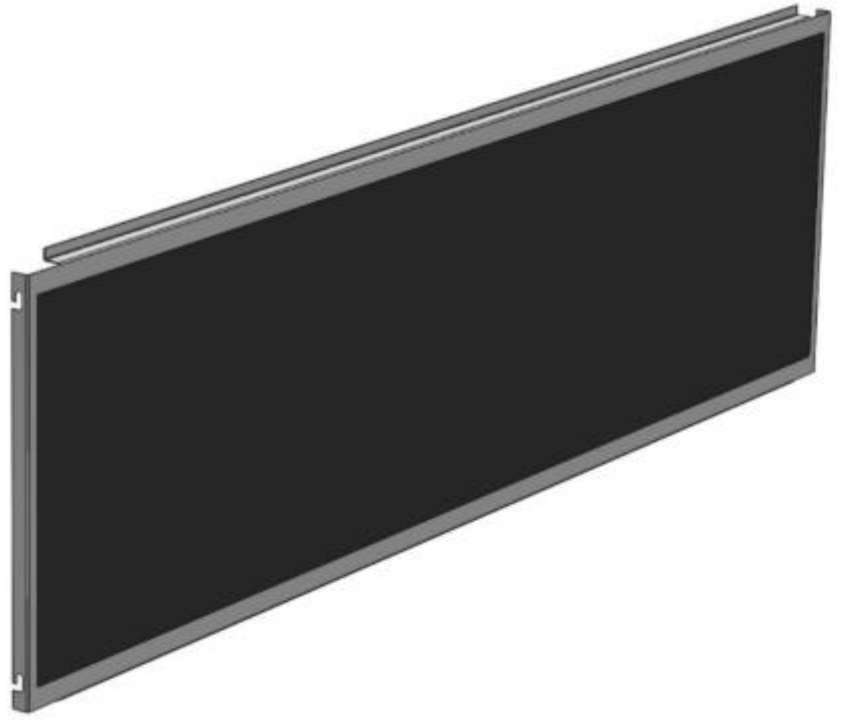
Cleaning the roof is recommended because of the environment with tall trees. Easiest way is to use a garden hose and spray with water using the water pressure. Rainwater is available in a cistern.
Electric cables outside are hidden and can not be inspected.
The system is permanently monitored so any technical failure of the system will be noticed.

9. eFacade BIPV facade element - Flisom

Data

9.1 eFacade BIPV facade element - Data

Description	Semi-flexible and lightweight solar panel designed for BIPV installations on facades. The layers from back to front are: Aluminum black elox (RAL 9005), encapsulant TPO 0.4 mm; CIGS PV film with electrical contacts, encapsulant TPO 0.4 mm; barrier film 0.4 mm; the module is sealed with edge seal ~1cm width.
Dimensions	Rectangle 1574 x 479 x 20 mm
Weight	2.5 kg/unit
Rigidity	Semi-flexible
PV power	50 - 60 Wp/unit
Field of application	The BIPV facade elements can be used in new buildings and for retrofitting buildings.
Mounting system	The facade elements are hanging on an aluminium back frame system. Additional elements are made to cover edges.



PVSITES code	**X2**

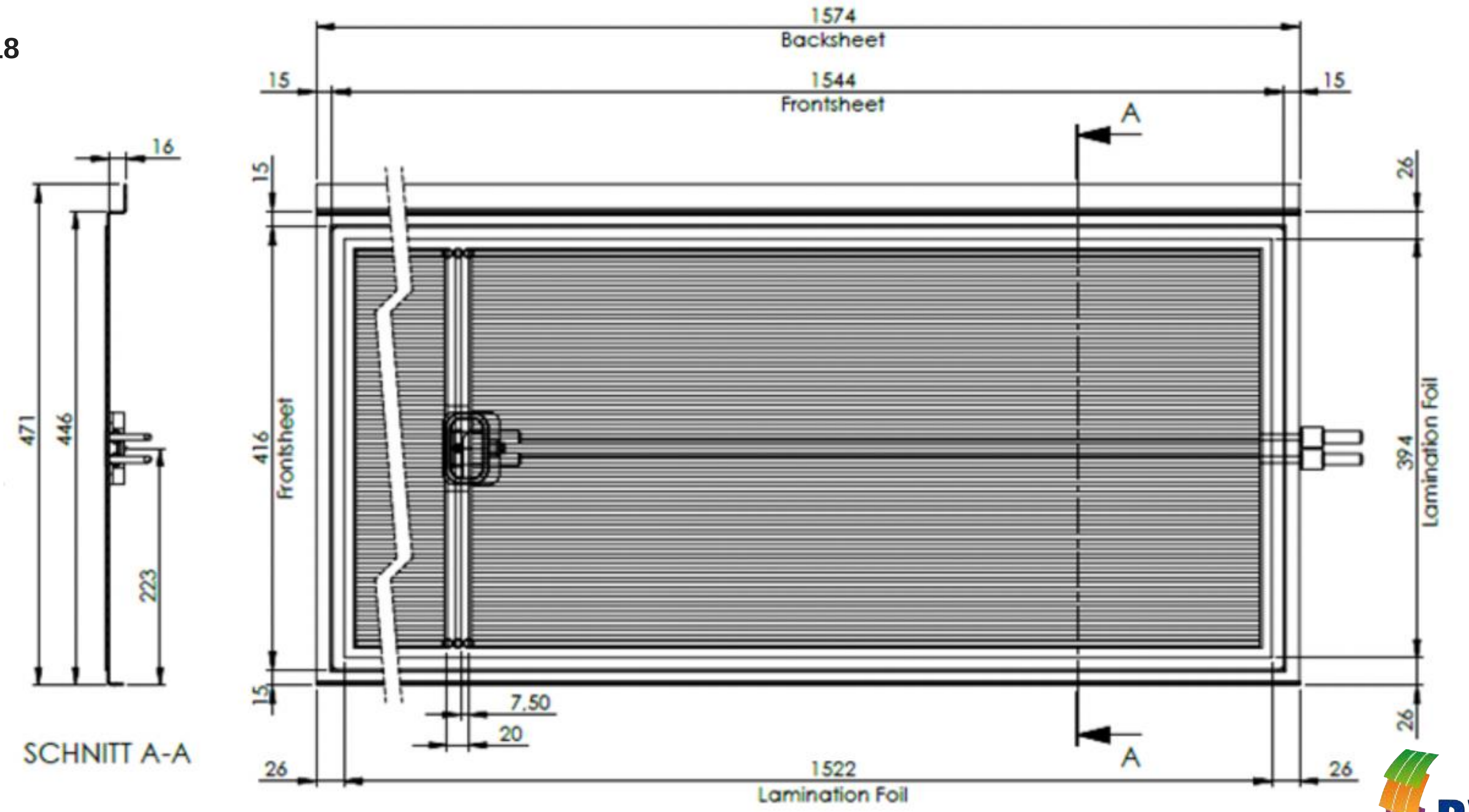
9.1 eFacade BIPV facade element - Data

Electrical characteristics	
Vpm: max. power voltage	34 - 36 V
Ipm: max. power current	1.47 - 1.66 A
Voc: open circuit voltage	46 - 48 V
Isc: short circuit current	1.72 - 1.91 A
Isc (α) Temp. coefficient	0.01 %/°C
Voc (β) Temp. coefficient	-0.3 %/°C
P (γ) Temp. coefficient	-0.35 %/°C
Inverter	ABB UNO-2.5-I-OUTD-S (Pavilion 1) and ABB TRO-5.8_TL_OUTD-S-400 (Pavilion 2)

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

9.2 eFacade BIPV facade element - Drawing

Drawing nr. B-0027318



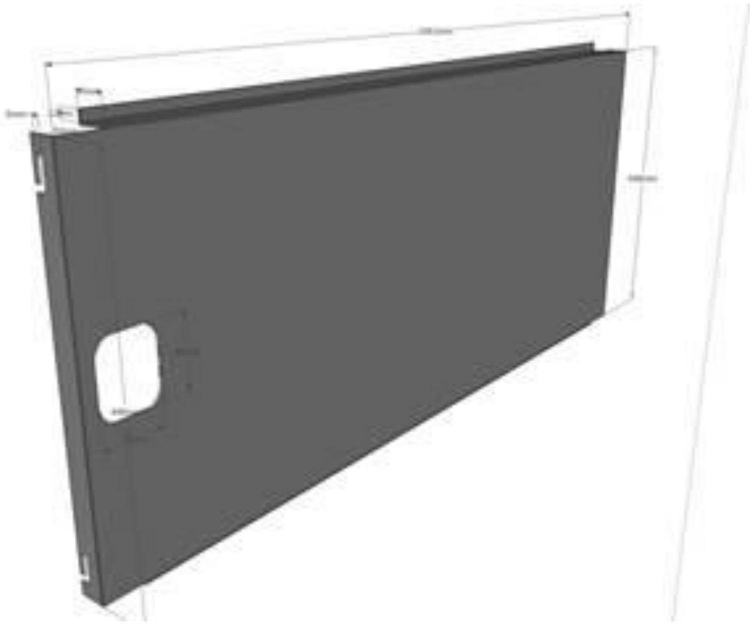
Design

9.3 eFacade BIPV facade element - Design

The École Hôtelière de Genève is located at the Avenue de la Paix in Geneva (CH). The school has a main entrance building including the restaurant and supporting buildings (pavilions) with educational spaces on both sides. The pavilions are connected underground with the main building.
Pavilion 1 (left as seen from the garden) has the east facade available for a BIPV system while the pavilion 2 (right) has the west facade available.
The existing facade has a red industrial brick combined with black window frames. The BIPV cladding will cover the red brick and change the image of the pavilions. This was accepted by the client and by the municipality.
To cover the whole area in an aesthetic way, tailor made pieces of cladding are needed to cover small areas.

9.3 eFacade BIPV facade element - Design

The company Ernst Schweitzer Metalbau AG designed a system to hang the BIPV modules on the facade.
The system consist of vertical profiles on the facade with pins. The modules are hanging in the profiles and are fixated with the pins.
1. Overview of the BIPV cladding system;
2. Detail of the pins;
3. Back of the module with junction box.



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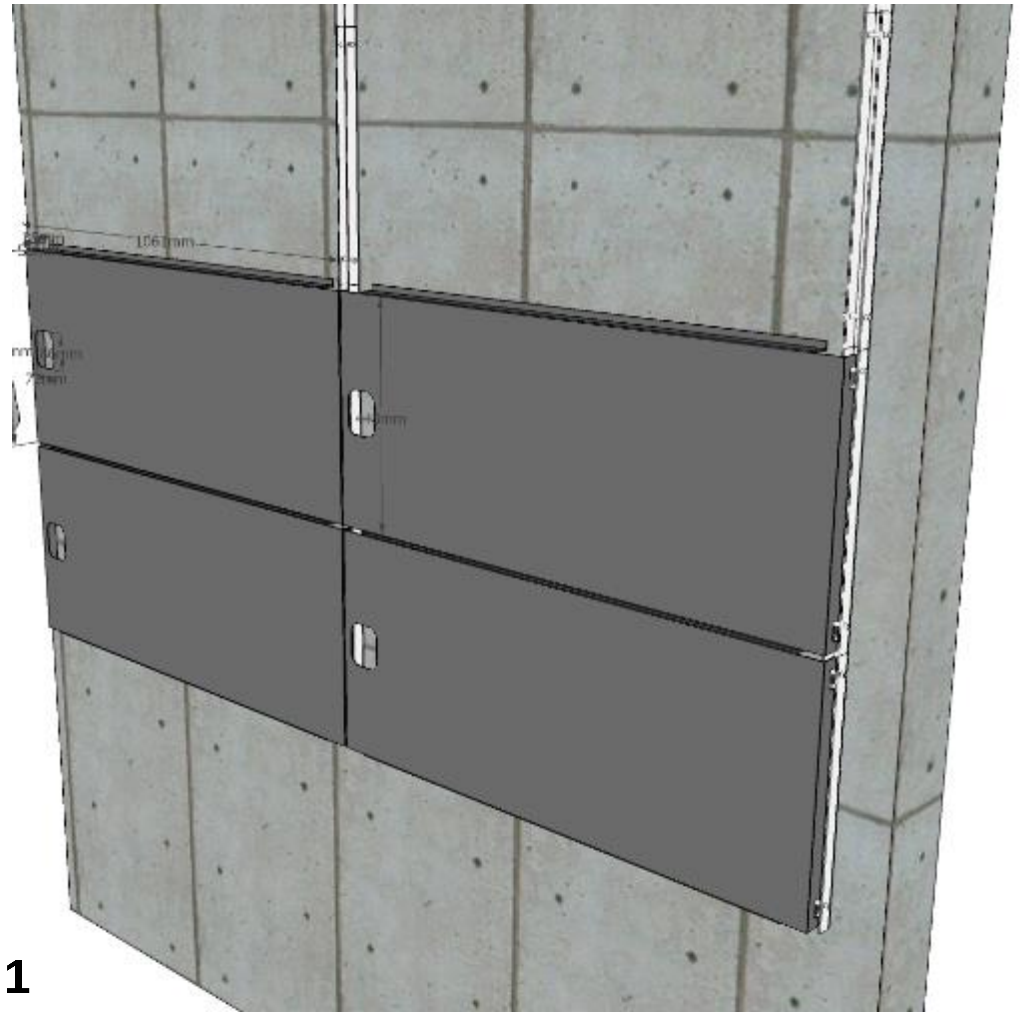

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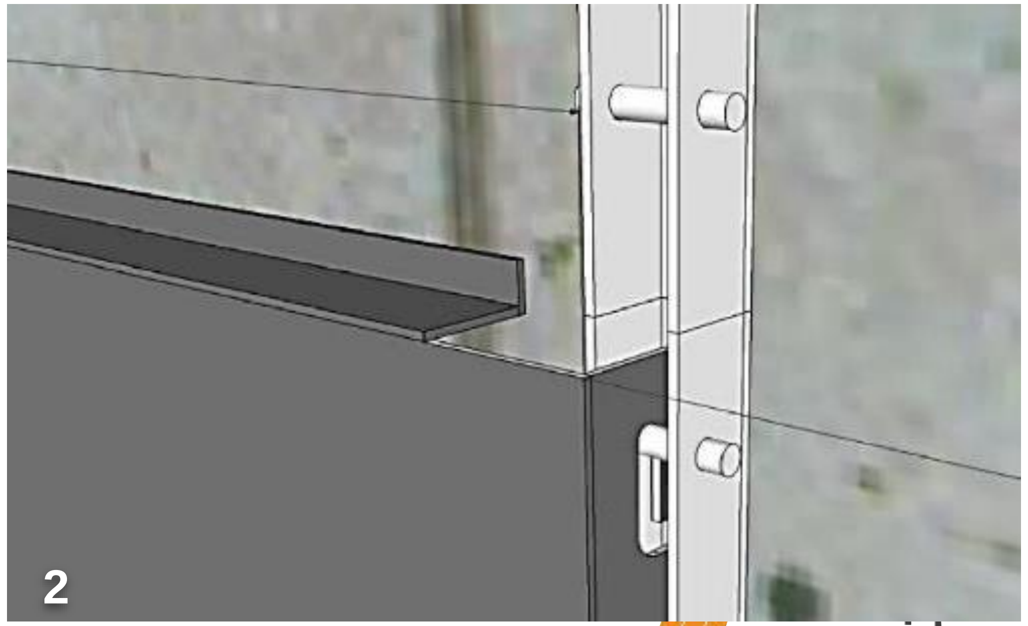

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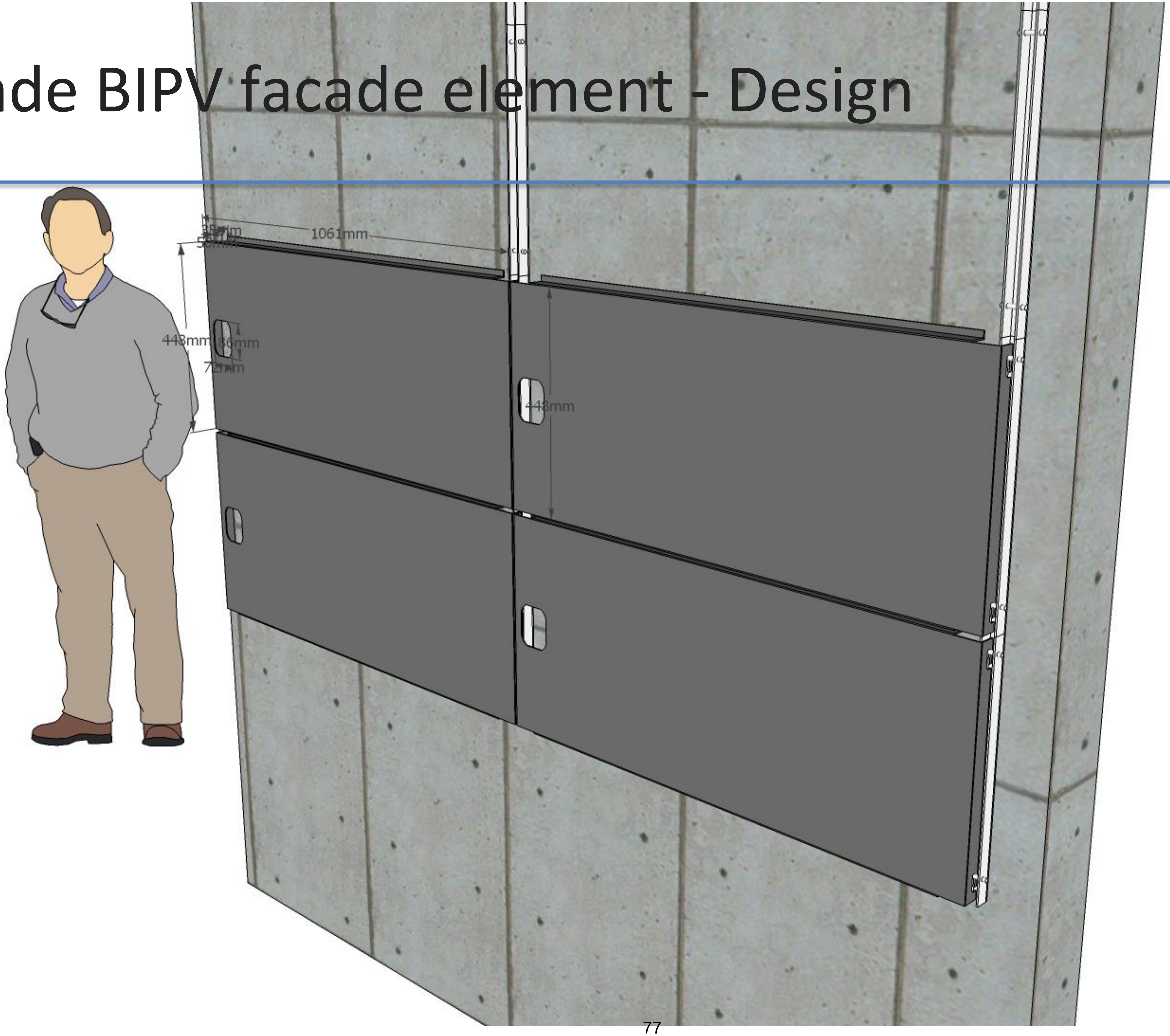
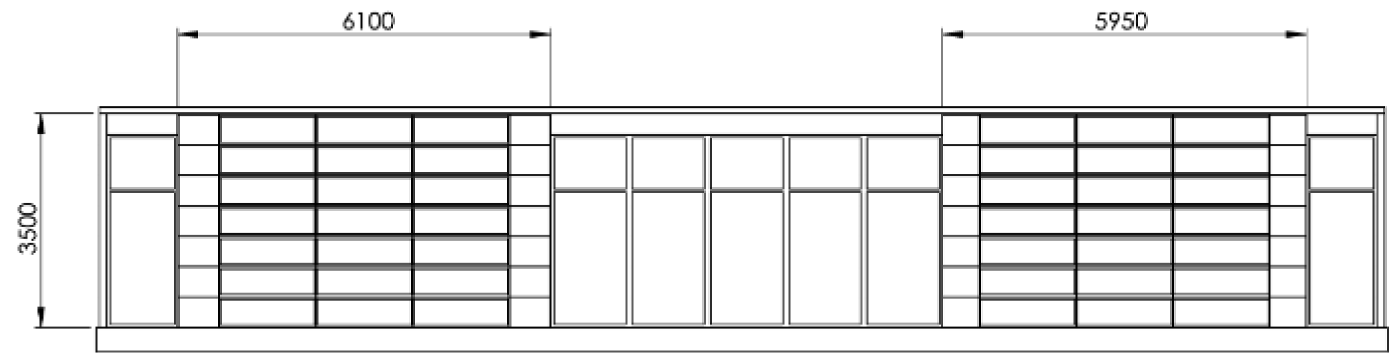
9.3 eFacade BIPV facade element - Design



9.3 eFacade BIPV facade element - Design

Facade layout
Facades of both pavilions.



Pavilion 1 **East**

Pavilion 2 **West**

Option A

Option B

9.4 eFacade BIPV facade element - Electrical design

The 146 BIPV modules are divided in 42 modules facing east (pavilion 1) and 104 modules facing west (pavilion 2).

For elevated areas irradiation can be higher than at STC. Therefore, multiply ISC- and VOC- values with a factor of 1.25 for the electrical layout of cables, fuses and converters (worst case scenario). For a serial connection the voltage of a single module is multiplied by the number of modules to calculate the system voltage. Make sure that you are always within the limits of the maximum system voltage. Use an adequate device for over-current protection (fuse, blocking diode). Maximum Isc multiplied by a factor of 1.56 to protect a string in parallel configuration.
The maximum number of modules connectable in series is calculated by adding Voc of each single module multiplied by 1.25 up to the maximum system voltage which you can find on the label.
Back-sheet of Flisom PVSITES modules are made of metal and have to be connected to the ground. Also ground the support structure and arrange an adequate lightning protection. Do not use materials which can cause corrosion. The hole for the grounding cable can be drilled anywhere in the edges of the module frame as in fig. 1. If the back-sheet of the module and the support structure/clamps are conductive it is not necessary to ground every module. The grounding of the support structure is sufficient. Make sure that you do not damage the edge seal or front-sheet.
In general, the modules can be mounted either in portrait or in landscape mode. Orientation of the shadow on the active surface is crucial: the module may only be installed with shadow on the short side. If the complete length is shaded, the shadow will negatively affect the power.

9.5 eFacade BIPV facade element - Software

Use of the PVSITES web tool

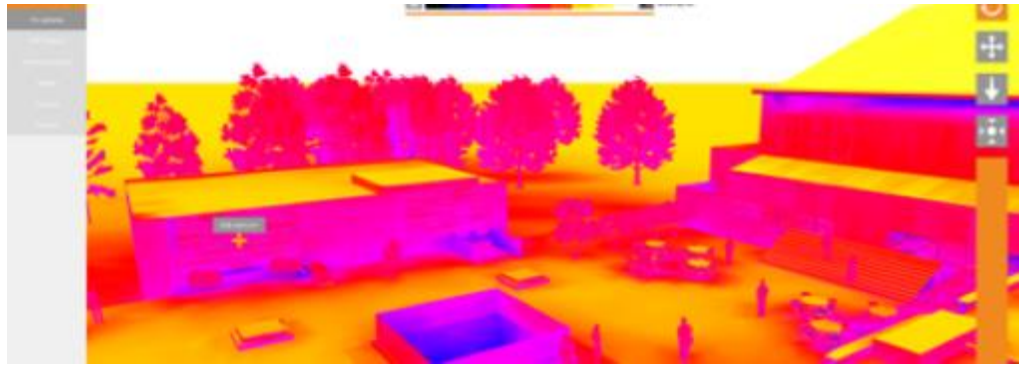
The software can be found on the pvsites.eu website.

Steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen

1

7



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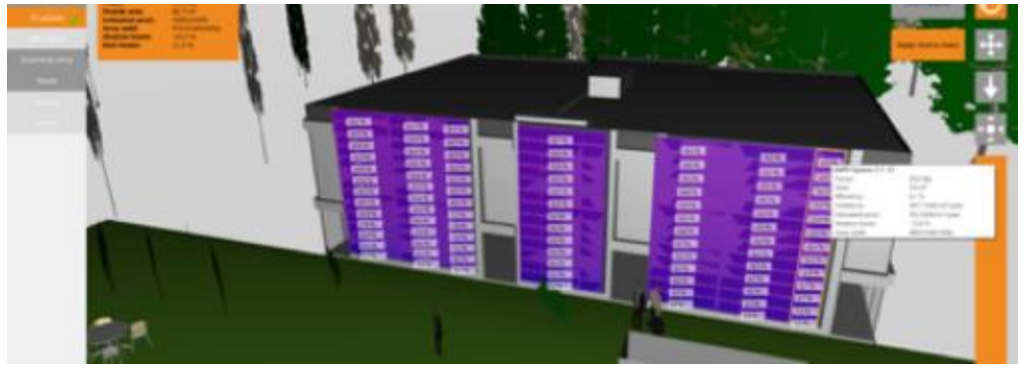

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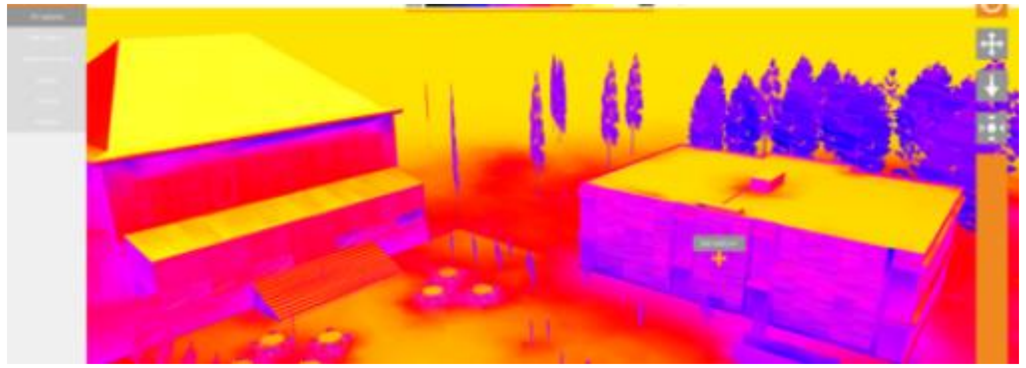

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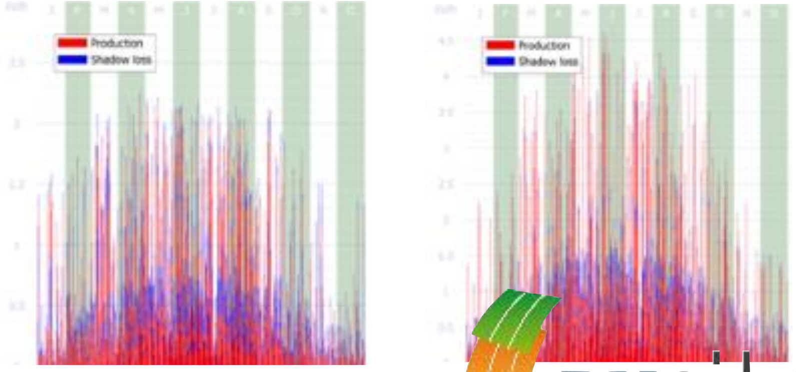

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9.6 eFacade BIPV facade element - Permitting

Permitting process
Permitting process for achieving the construction allowance was long and difficult for this demo-site, which delayed the process of installing and monitoring the system.
Initially the urbanism committee wanted to preserve the red colour of the building. A specialised consultant was hired to support the process and three rounds of discussion were needed to get the permission. A 5-year limited construction allowance was finally achieved in January 2019.
The internal discussion with EHG was also time consuming (see 9.7) so that installation started in October 2019 and was finished in December 2019.

The final commissioning was relatively simple without problems.

Installation

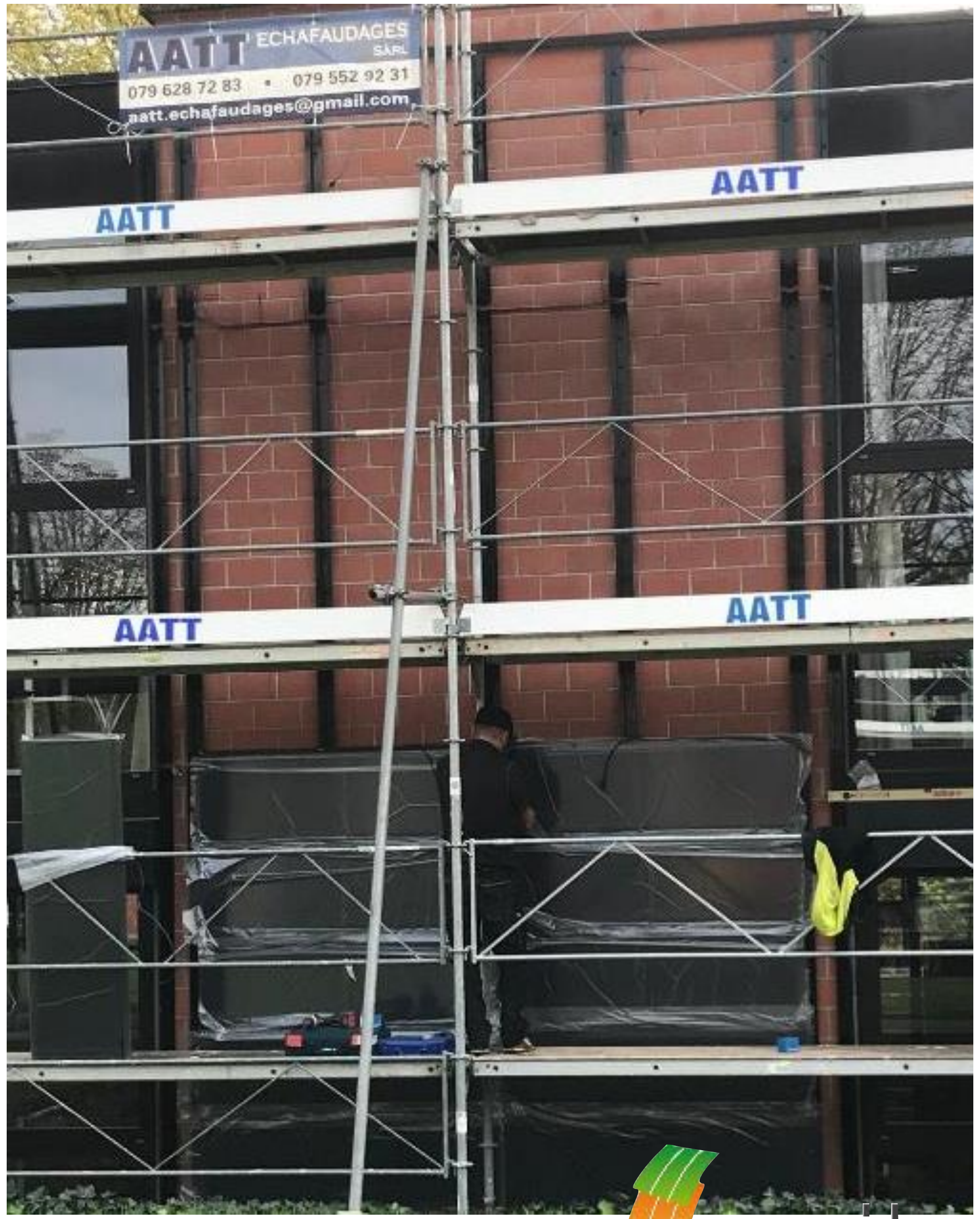
PVsites

9.7 eFacade BIPV facade element - Installation

The start of the installation was a challenge due to some additional issues, such as the language barrier and not having an authorized contact within EHG.
To smoothen the installation works and to create awareness a kick-off meeting was organized in June 2019.

Once the timeline of the project was agreed, installation works were scheduled for the end of June 2019.
On two occasions the work had to be stopped: first a problem with the trees, they obstructed the access to the facade. EHG did not allow to cut any branches. As a solution the: trees were bended back without being damaged.
Second, the exams sessions started and construction works had to be postponed due to noise emission.
Finally, a new installation date was established, and works started on 21 October, 2019.

All façade elements were delivered with a protection foil to not being scratched at further processing or mounting stages.
Installation works basically consisted of:
1. Installation of vertical rails on the brick walls. Screws were fixed between the bricks in order to not damage the facade.
2. PV panels were mounted bottom up, being able to be assembled to the vertical rails, and stringed together upwards, thanks to the specific shape of their edges.
3. The solar inverters were placed on the roof in order to minimize its visual impact.
4. The modules protection foil was removed as last step.



5.8 eRoof BIPV roof shingle - Maintenance

Flisom gives the following general guidelines for inspection and maintenance:

It is recommended to have a visual check on a regular basis (every 3 months). Plan check-ups according to the given environmental and safety conditions and regulations.

Maintenance:

a. Remove dust and dirt (sediments, leaves, pollen, bird droppings, etc.) from the surface.
b. Do not use aggressive cleaning agents or scrubbing materials for cleaning.
c. Do not use steam blasting for cleaning.
d. Use soft (rain)water to avoid chalk stains.
e. Soft sponges can be used.
f. Check if connectors and grounding are tight and without corrosion and if the insulation is not damaged also check for loose mechanical or electrical contacts.
g. Check if the junction box is securely attached and that no deep scratches are penetrating the front sheet.

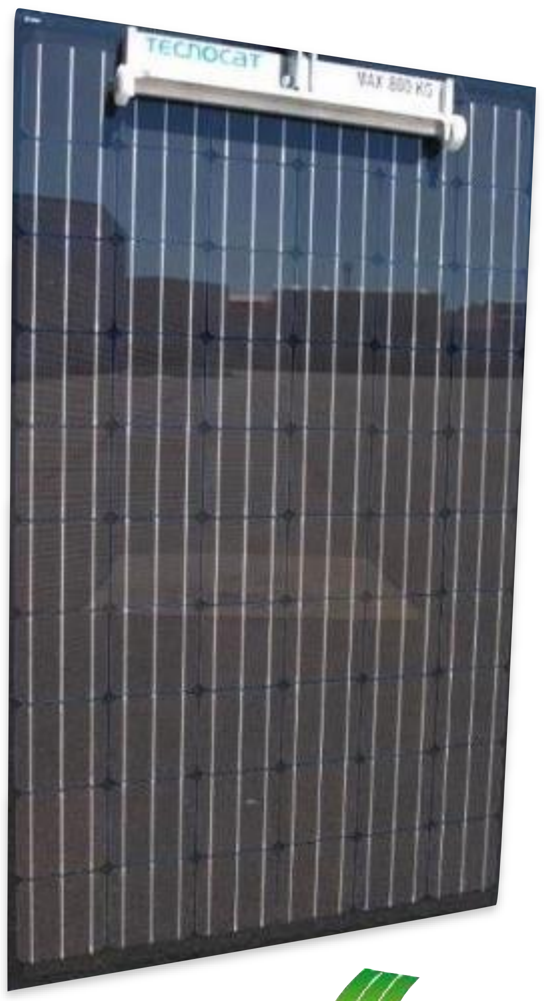
Cleaning the roof is recommended because of the environment with tall trees. Easiest way is to use a garden hose and spray with water using the water pressure. Rainwater is available in a cistern.
Electric cables outside are hidden and can not be inspected.
The system is permanently monitored so any technical failure of the system will be noticed.

10. eFacade BIPV facade cladding - ONYX

Data

10.1 eFacade BIPV facade cladding - Data

Description	Curtain wall C-Si glass modules with hidden L-interconnections. The layers from back to front are: 6 mm Extraclear tempered glass; 1.8 mm EVA,;c-Si solar cells; 1.8 mm EVA; 6 mm black frit patterned glass
Dimensions	Rectangle 1280 x 910 x 13.8 mm
Weight	34,94 kg/unit
Rigidity	Rigid
PV power	151 Wp
Field of application	The BIPV curtain wall modules can be used for new and for renovation application.
Mounting system	The modules are mounted on a vertical main structure and fixated with a horizontal profile.
PVSITES code	**X5**



10.1 eFacade BIPV facade cladding - Data

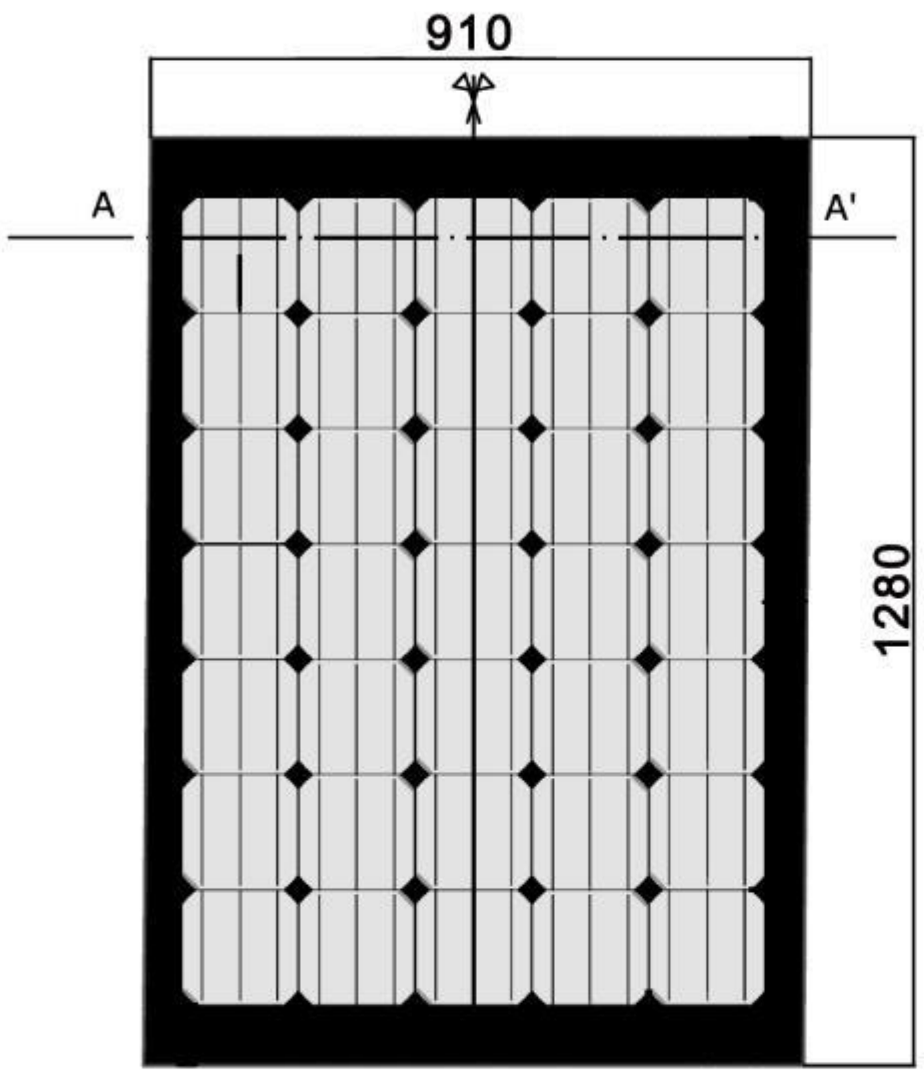
Electrical characteristics	
Vmpp: nom. power voltage	18.34 V
Impp: nom. power current	8.26 A
Voc: open circuit voltage	22.22 V
Isc: short circuit current	9.05 A
Isc (α) Temp. coefficient	0.08 %/°C
Voc (β) Temp. coefficient	-0.361 %/°C
P (γ) Temp. coefficient	-0.451 %/°C
Inverter	Tecnalia 10 kW DC-Coupled PV Storage Inverter. Dimensions 840 x 740 x 280 mm.

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

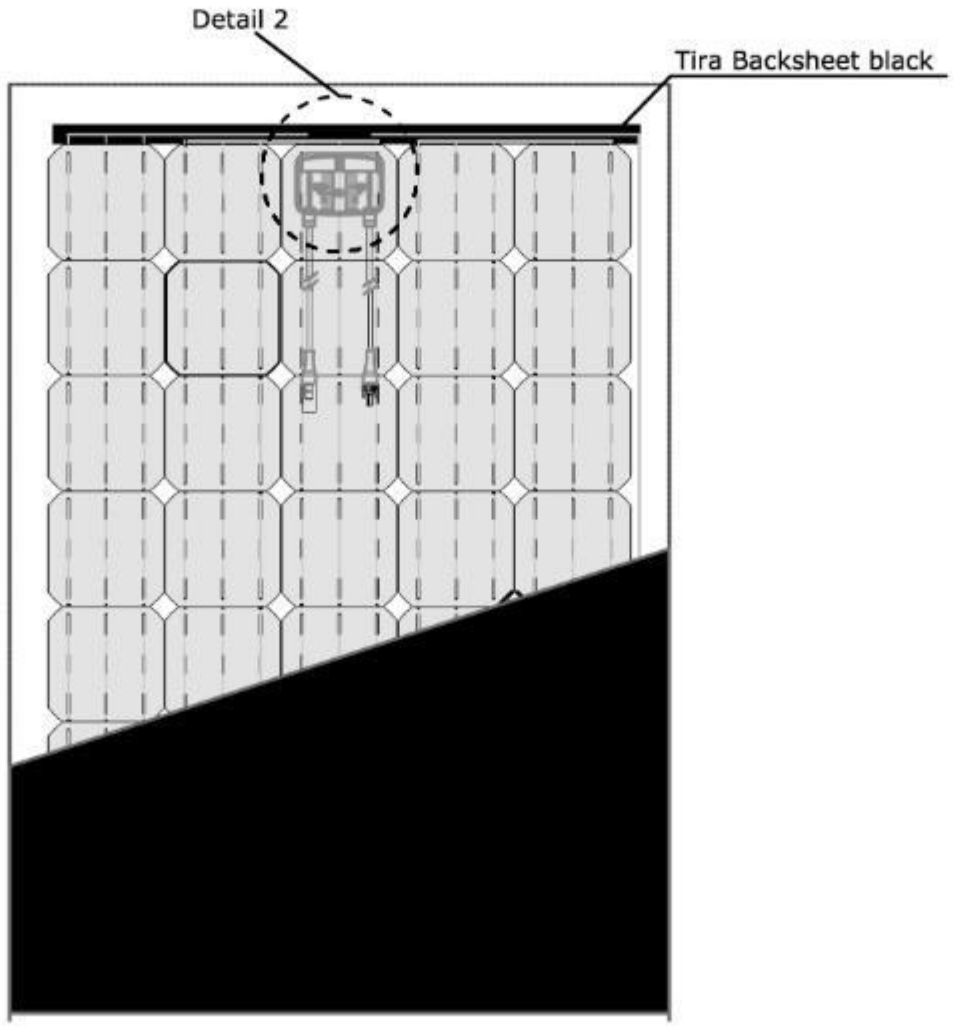
10.2 eFacade BIPV facade cladding - Drawing

Drawing nr. 6M388-01 rev1

Front view



Back view



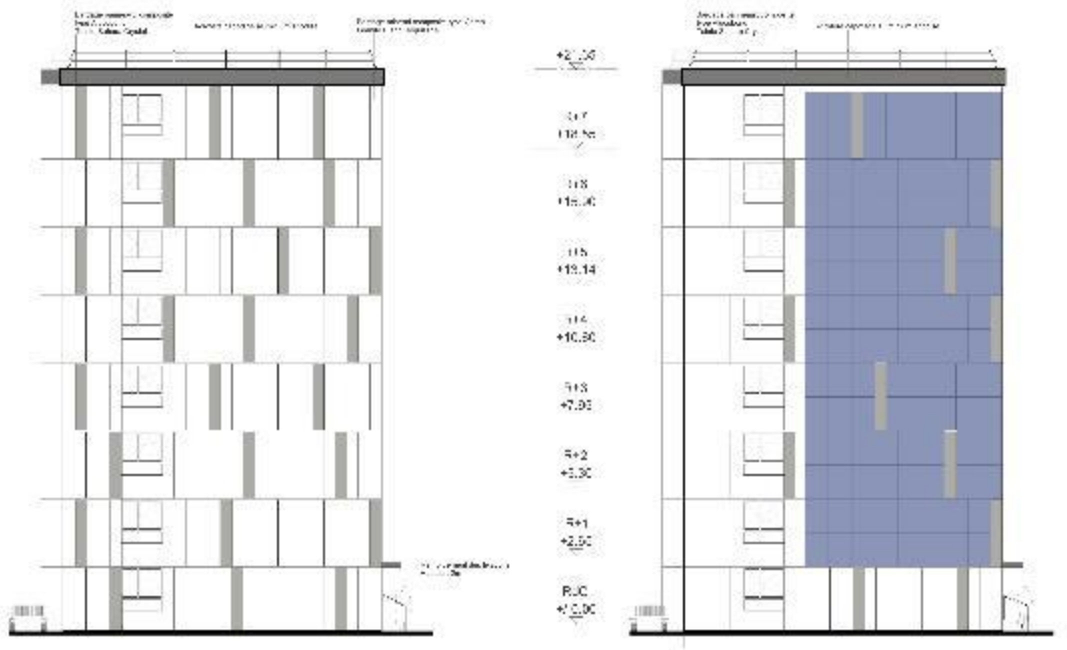
Cross-section A-A´

Design

10.3 eFacade BIPV facade cladding - Design

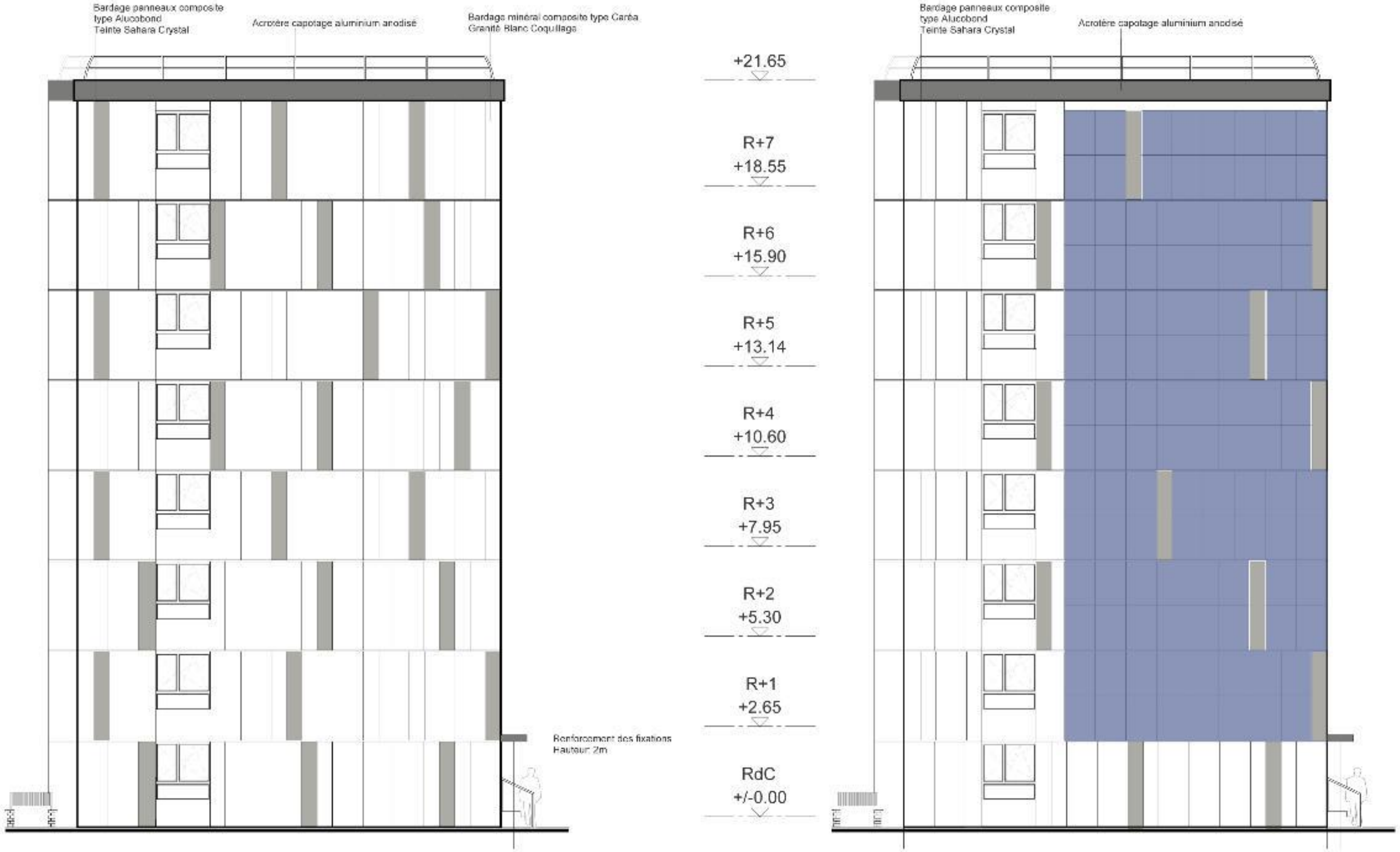
The social housing building in Wattignies, Lille, which includes 48 apartments, will get a thermal renovation. The brick facade will be replaced for a well insulated cladding facade. The installation for the BIPV facade had to be done in 2019 while the rest of the building will be renovated in 2020.
The architect who made the design for the renovation of the facade for the whole building, introduced different sizes of cladding and also in different colours.
The initial design for the BIPV cladding was designed with horizontal BIPV modules. It was difficult to connect this idea with the idea of the renovation architect.
So the design for the BIPV facade was adapted to the renovation design.

Renovation proposal



Transformation to the BIPV facade

10.3 eFacade BIPV facade cladding - Design

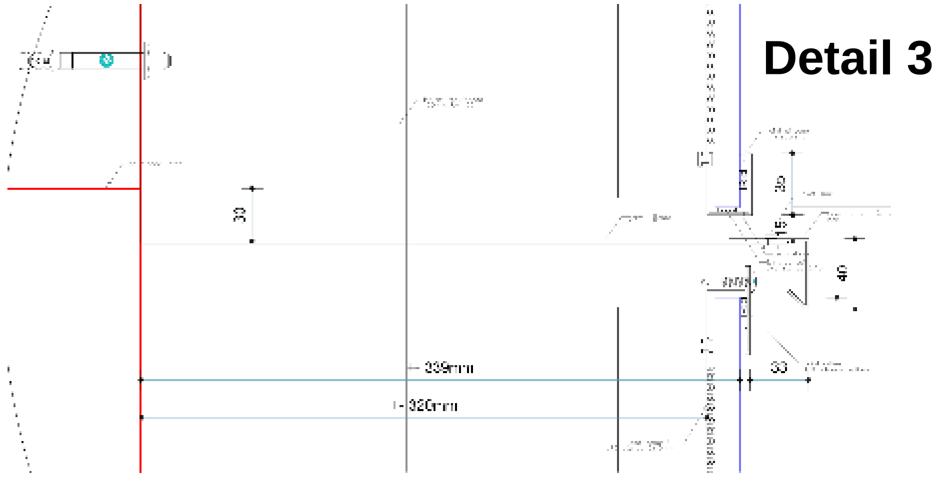


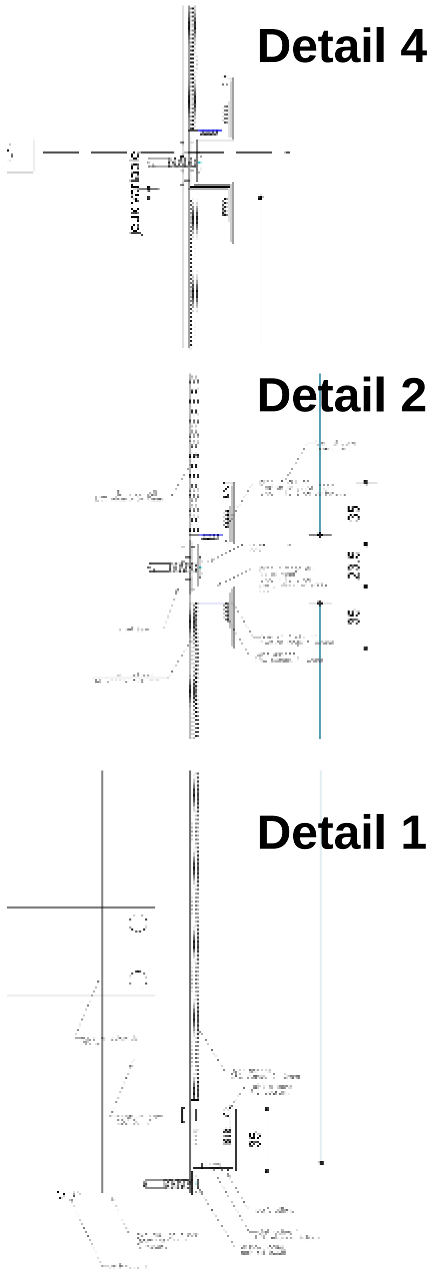
10.3 eFacade BIPV facade cladding - Design

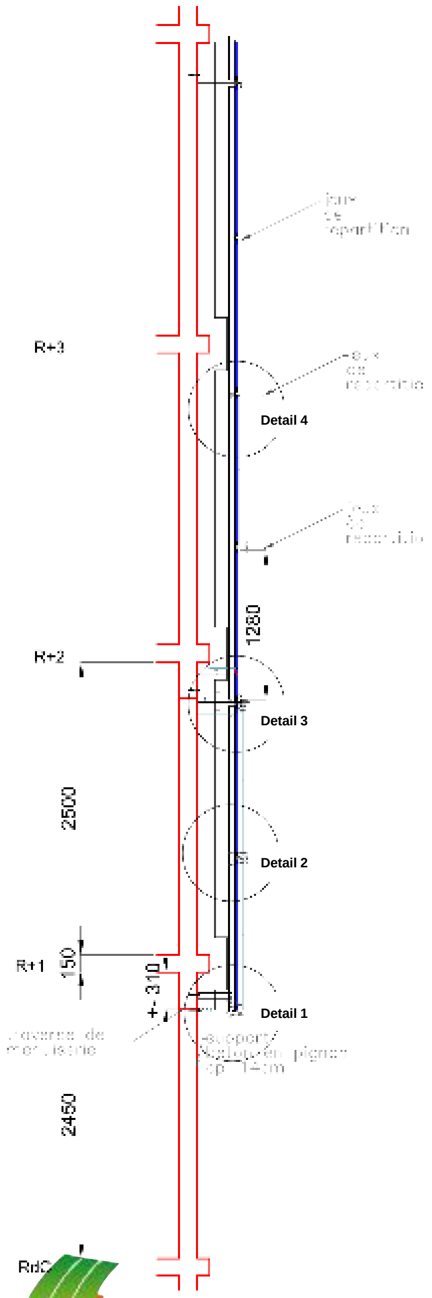
The 112 BIPV modules are build up from the 1st floor to the top of the building (eight floors). The total area of PV modules is about 130 m^2. The width of the area is 8 modules (7.36 m) and the height is 14 rows of modules (18.39 m).
Every 2 rows of modules has a random panel, half the width of a module to make the facade look more random. The same type of panel will be used in the other facades to integrate the BIPV modules with the other cladding.

The owner of the building, Vilogia, has to maintain the building and wants a construction which can easily replace modules (in case of damage). To adapt the BIPV design to the overall renovation design, the dimensions of the modules was changed to 1280 x 910 mm.

The construction is based on vertical profiles mounted on brackets. The modules are fixated with horizontal profiles on the vertical profiles. The space between wall and modules (320 mm) is partly filled with thermal insulation. There is an air cavity behind the modules. Every 4 rows of modules there is a special profile for ventilation of the cavity and to keep rainwater out of the construction. The other rows have U-profiles to fixate the modules







10.3 eFacade BIPV facade cladding - Design

It was needed to find a technical room near the BIPV facade. The building does not provide a lot of space and it was difficult to find a good spot. The first choice was the basement but because of humidity and water risk, the technical room was build in the corridor near entrance 14.

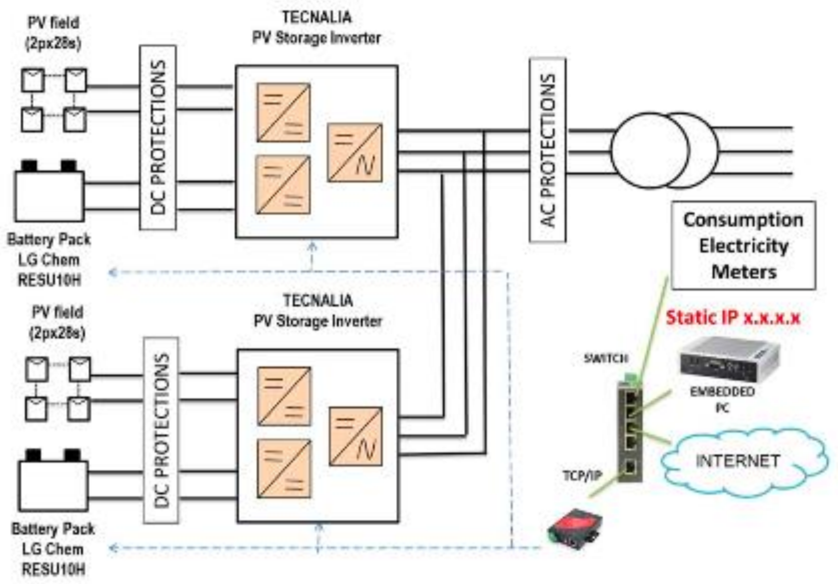
The electricity production from the BIPV modules will cover part of the electricity consumption for the common spaces of the building like staircase lights and ventilation. The aim is to self-consume the local production at its maximum. The excess electricity will be sold to an utility.

10.4 eFacade BIPV facade cladding - Electrical design

Inverter
The inverters used are the Tecnalia DC-coupled PV storage inverters. This is a high efficiency, low cost and flexible 10kW three-phase DC-coupled PV storage inverter. It can be easily extended in parallel to make larger systems up to hundreds of kW and offers a wide DC input range to cope with different BIPV generators and battery packs. It communicates with the Building Energy Managment System (BEMS) in order to provide monitoring data about the PV storage inverter performance and it receives the required commands to implement required energy management strategies. The Multilevel symmetrical topology is used for the DC-DC converter for battery and PV source management.

Both converters and the 3-phase DC-AC converter are coupled in a high-voltage DC link. The control unit is composed of a DSP controller (TMS320F28335) and FPGA for managing the power transfer inside the converter and provide external communication.

In the apartment building in Wattignies, two 10 kW inverters are used. The dimensions are 0.84 x 0.74 x 0.28 m.
Mounted vertically on the wall or on a solid surface with tilted backwards by max 15ºC. The location needs to be accessible and well ventilated. About 0.3 m around the inverter is needed to guarantee a good ventilation (see data sheets in chapter 11).



7.5 eFacade BIPV facade cladding - Software

Use of the PVSITES web tool

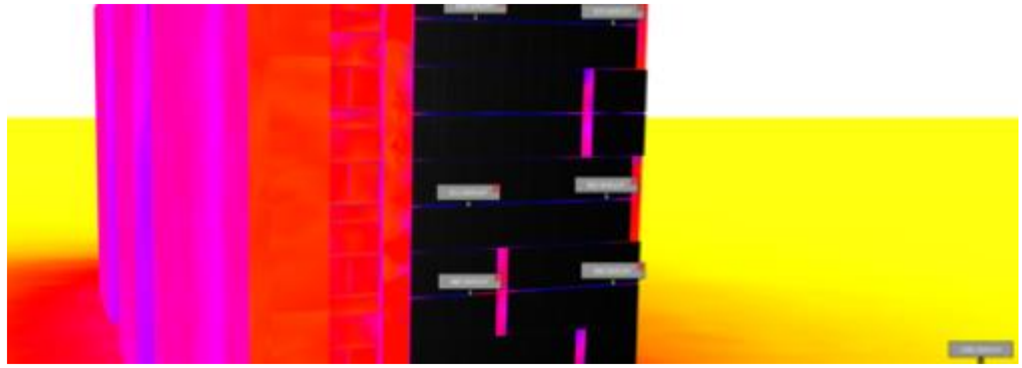
The software can be found on the pvsites.eu website.

Steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen

1

7



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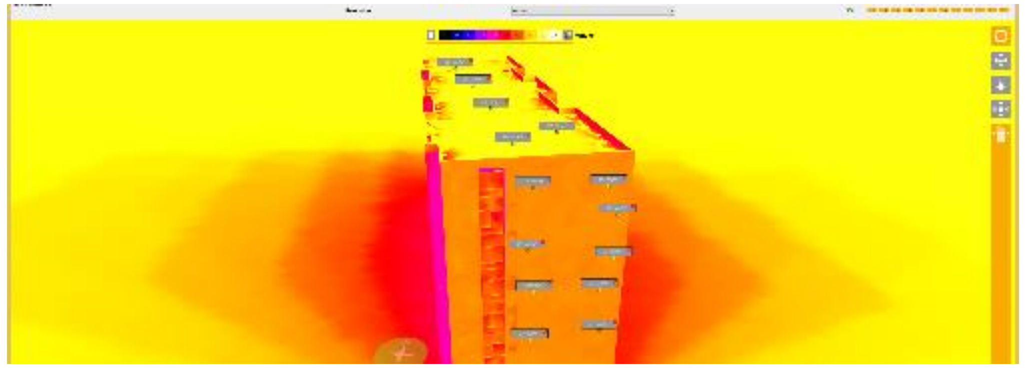

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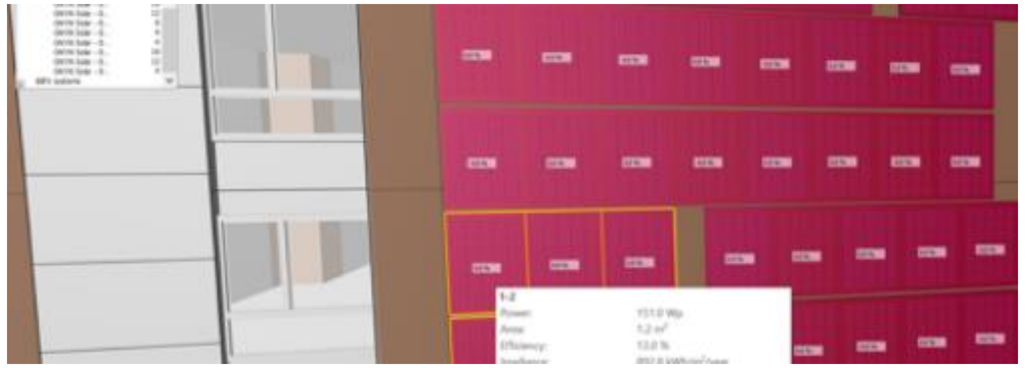

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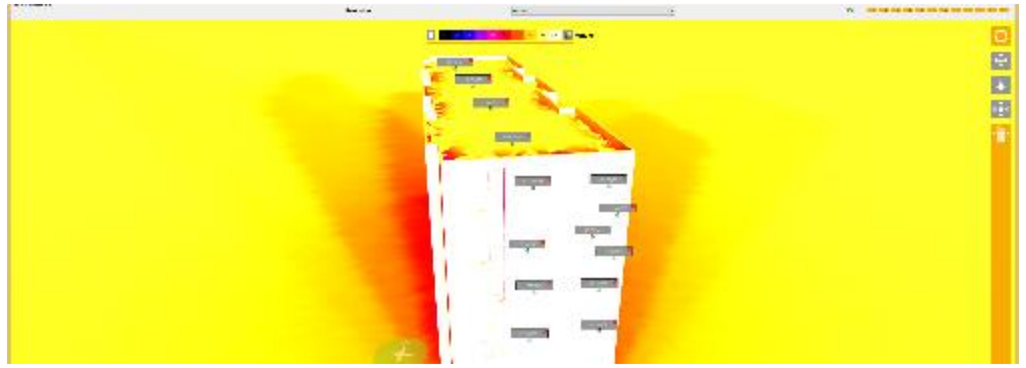

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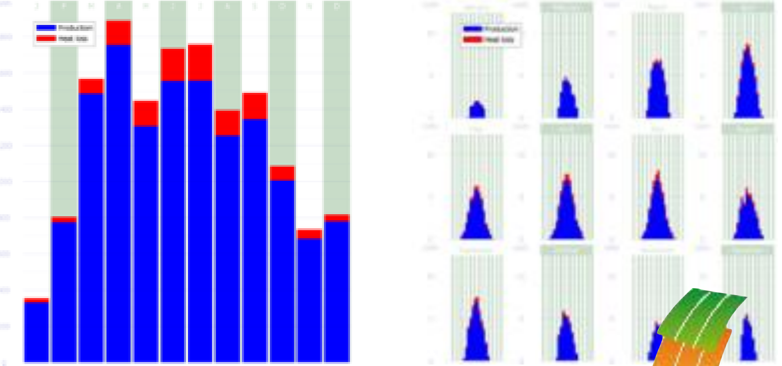


PVsites

7.6 eFacade BIPV facade cladding - Commissioning

For the commissioning process, a lot of milestones had to be considered. before the final agreement.

For this production site, a self-consumption contract with ENEDIS (grid manager) was established for the public areas of the building. In this contract, the distribution of electricity flows is as follows:

•The public areas will consume in priority the PV electricity production;

•If there is no PV electricity production, the consumption will be withdrawn from the batteries;

•If the batteries are not charged, the excess of production will be sent to an utility.

Next most important step is the certification of the electrical installation. Every installation in France must be officially certified by a technical body called CONSUEL (National Committee for the Safety of Electricity Users). They oversee the control of all electrical installation. Technicians will visit the site and deliver a report. Once the approval is given, the certification is delivered by CONSUEL.

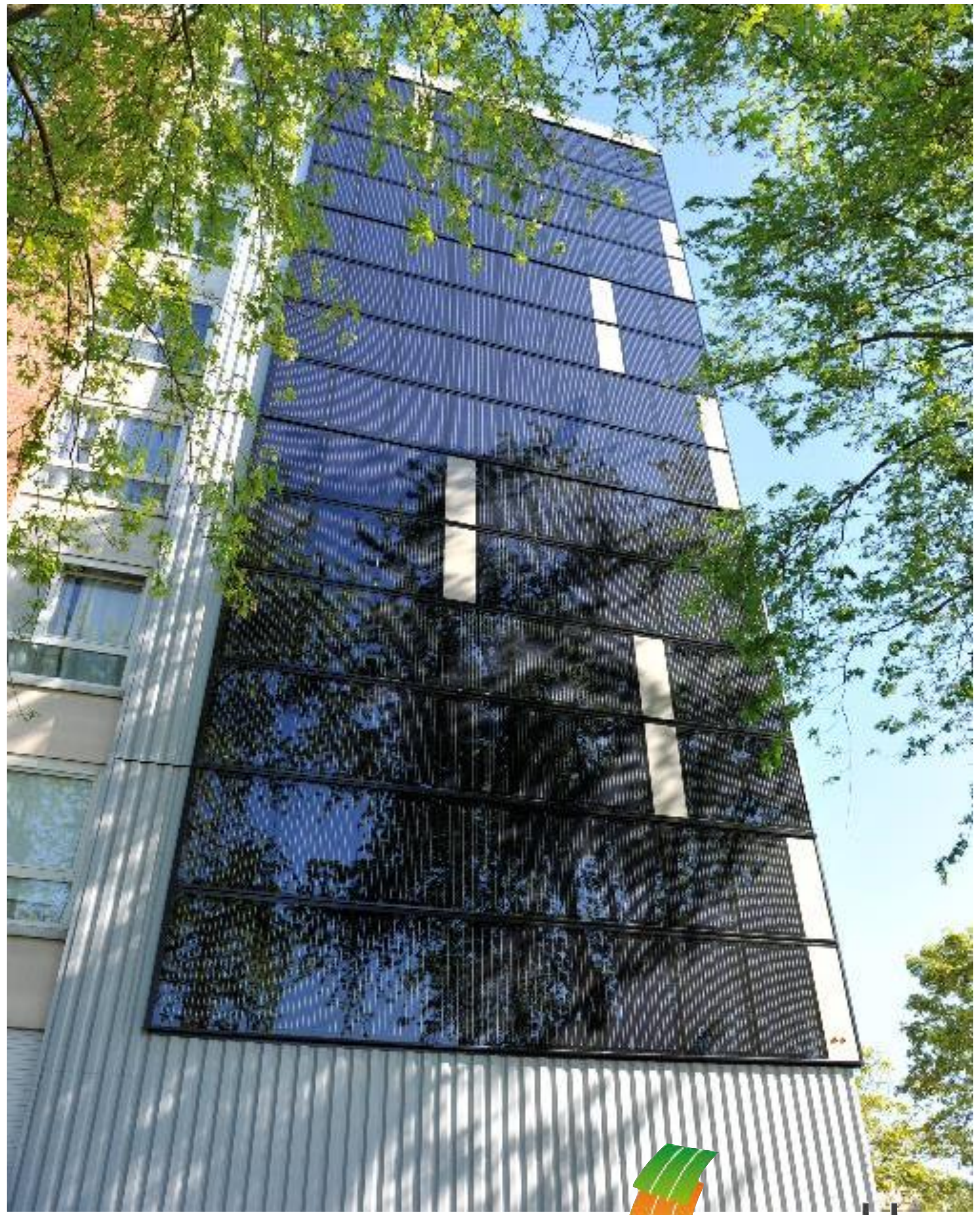
The final connection of the PV installation to the grid required the signature of the " Contrat d'Accès et d'Exploitation au Réseau Public de Distribution - Access and Exploitation Contract to the Public Distribution Network". Before the signature, some documents are required:

•Certification from CONSUEL;

•ARPE (Agreement of Attachment to the Balance Perimeter) signed between VILOGIA and HYDRONEXT;

•Agreement and Payment of the quotation for connection.

After all of these documents were sent to ENEDIS, the signature of the Contract and then the date for the connection was decided.



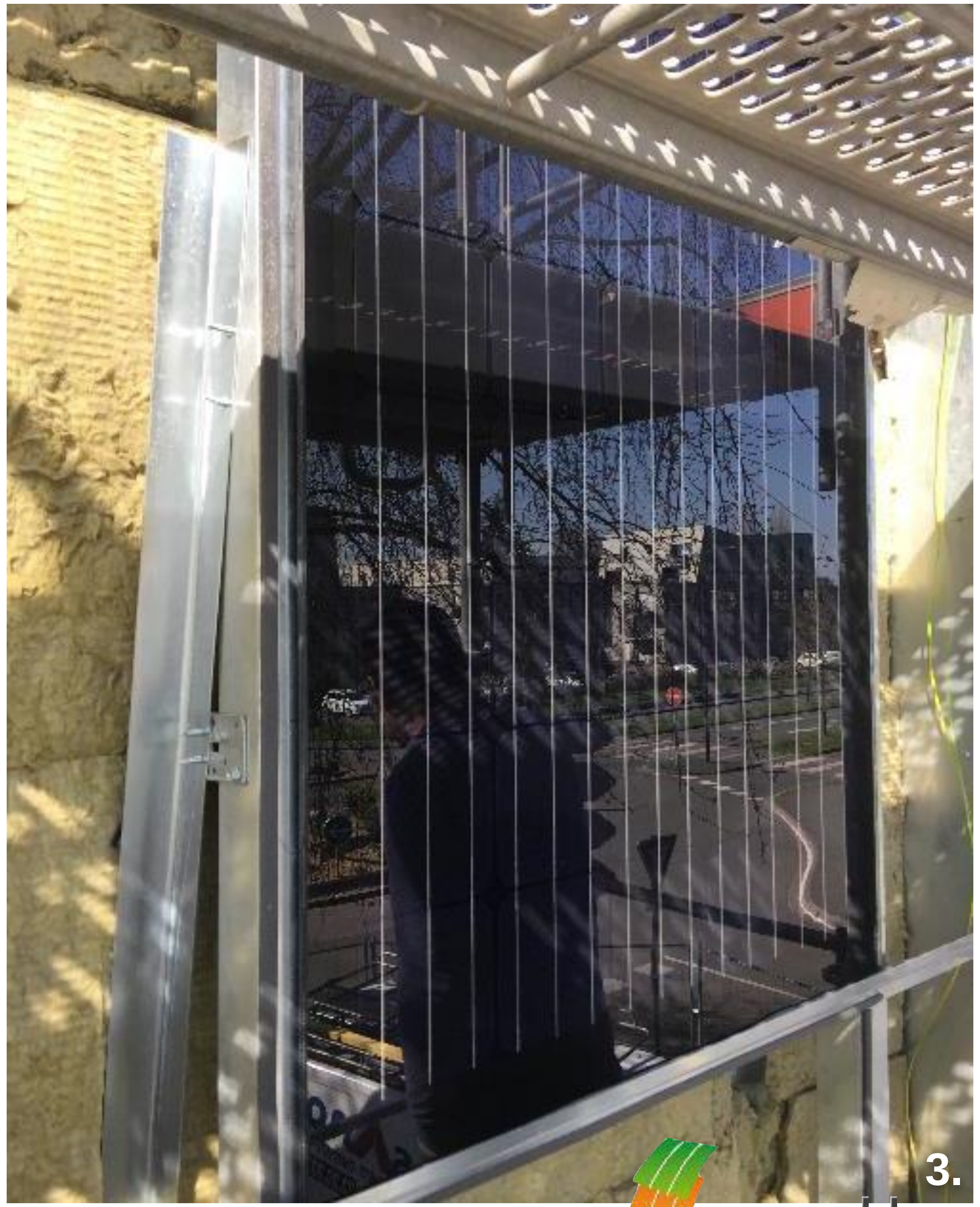
Installation

7.7 eFacade BIPV facade cladding - Installation

The apartment building will get a full thermal renovation and the whole skin (bricks) is taken away. Because the BIPV system is mounted before the other facades of the building, some spacing with existing windows is needed.
On the concrete structure, a watertight foil (rain screen) was applied and anchors and vertical profiles were mounted. Then the mineral wool insulation was placed.
Next is the placing of modules following the details in chapter 10.3.
After all modules and aluminium panels are mounted, the area around the system is temporarily covered with metal sheets until the final renovation of the building.

7.7 eFacade BIPV facade cladding - Installation

1. Corner detail near the window
2. Vertical profiles and anchors on the concrete wall with watertight foil
3. Adding the modules and fixating with the horizontal profile.



7.8 eFacade BIPV facade cladding - Maintenance

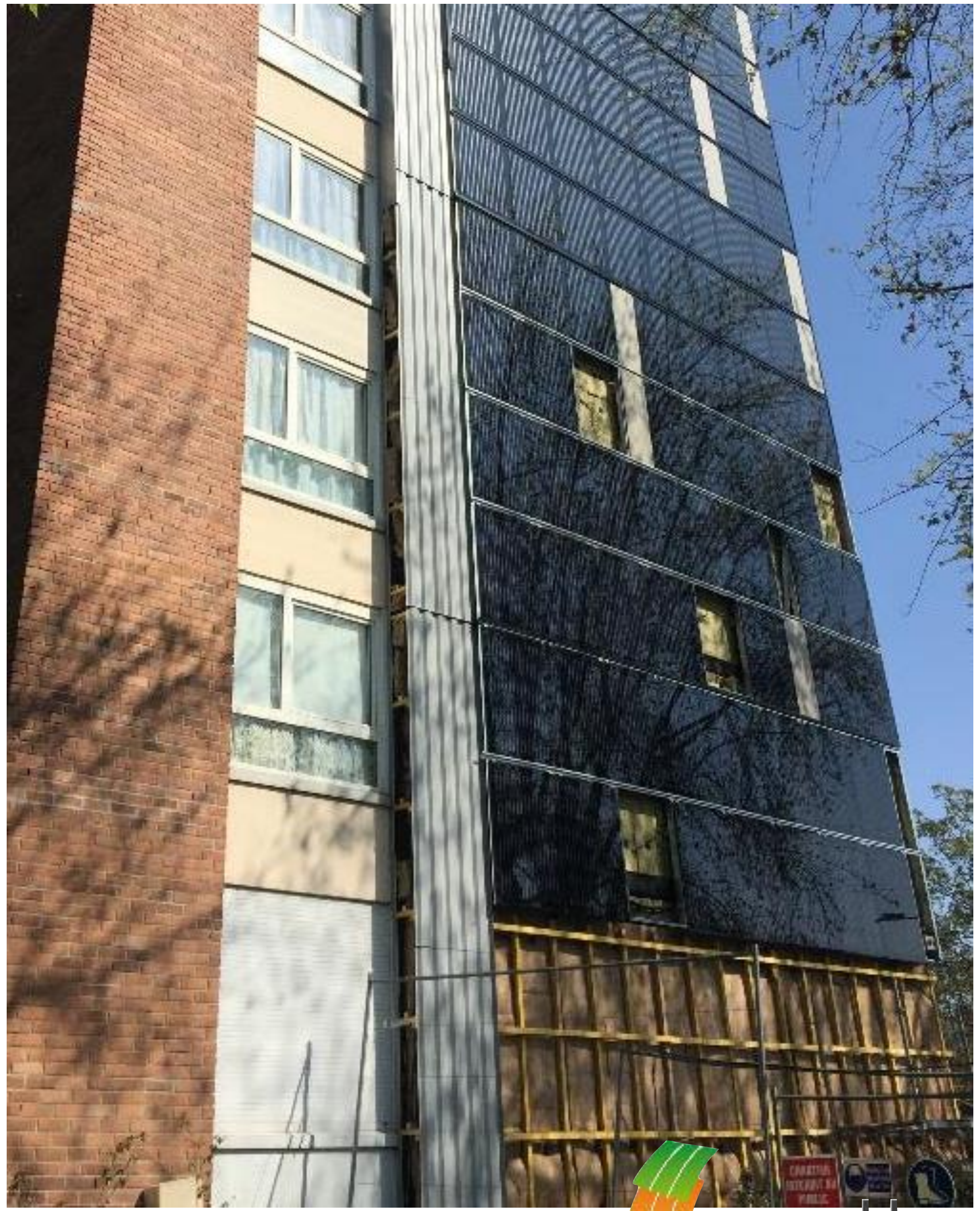
Preventive maintenance should take place at least twice a year. Key elements should be checked and verified. The minimum actions to be considered are:

- Checking system connections.
- Checking cable system especially if it has been in the sun or in bad weather conditions that can produce corrosion; cracks may appear on the covering which can produce energy loss.
- Checking the sealing of the j-boxes, even if there is a time lapse they should still be sealed and no corroded due to water.
- Checking all structural pieces in the structure that supports the photovoltaic modules to search for losses.
- Checking if any glass may be fractured. If so contact the supplier and change the module.
- Checking all segments of the BOS.
- Checking all earth connections

- Cleaning of the PV glazing is similar to equivalent glazing systems. Nevertheless, special care should be taken not to affect the PV sealants or connections.

Mainly rain eliminates the necessity to clean de panels. If needed, clean the surfaces with a mixture of neutral detergent and water. It is recommended using dissolution in water and neutral detergent with 3% of ammonia and a surfactant.

Typical cleaning tool for glass as rubber brush could be used in order to clean the PV module avoiding any scratch on the glass.



PVsites

11. eGlazing BIPV glazing - ONYX

Stand-alone/Self-consumption with battery storage of the generated energy

Data

11.1 eGlazing BIPV glazing - Data

Description

The semi-transparent BIPV module with hidden busbars is applied as a second skin in Tecnalia's office in San Sebastian, Spain.

The layers from back to front are:
6 mm extra clear tempered glass; 1.8 mm EVA,;c-Si solar cells; 1.8 mm EVA; 6 mm clear tempered glas

Dimensions

Rectangle 2250 x 760 x 21 mm (A) and
2212 x 765 x 21 mm (B)

Weight

51.3 / 50.8 kg/unit

Rigidity

Rigid

PV power

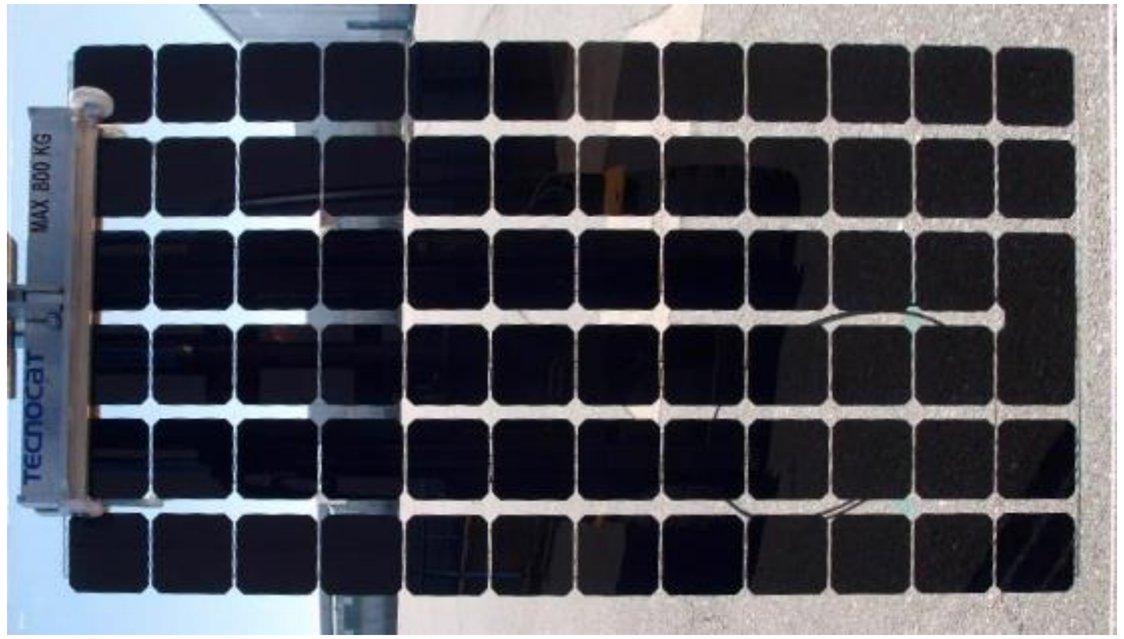
191,5 Wp/unit

Field of application

The BIPV module can be used in a 2nd skin facade, curtain wall or external shading.

Mounting system

A vertical profile system is mounted in front of the existing facade. The modules are fixated with a clip system.



PVSITES code

X6

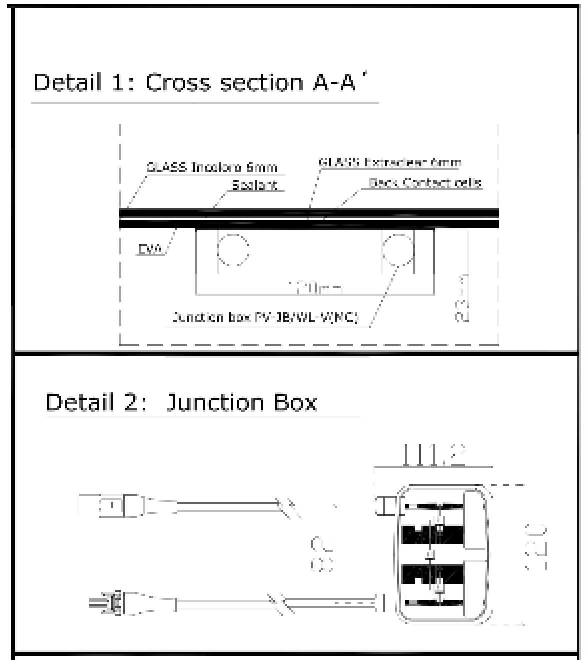
11.1 eGlazing BIPV glazing - Data

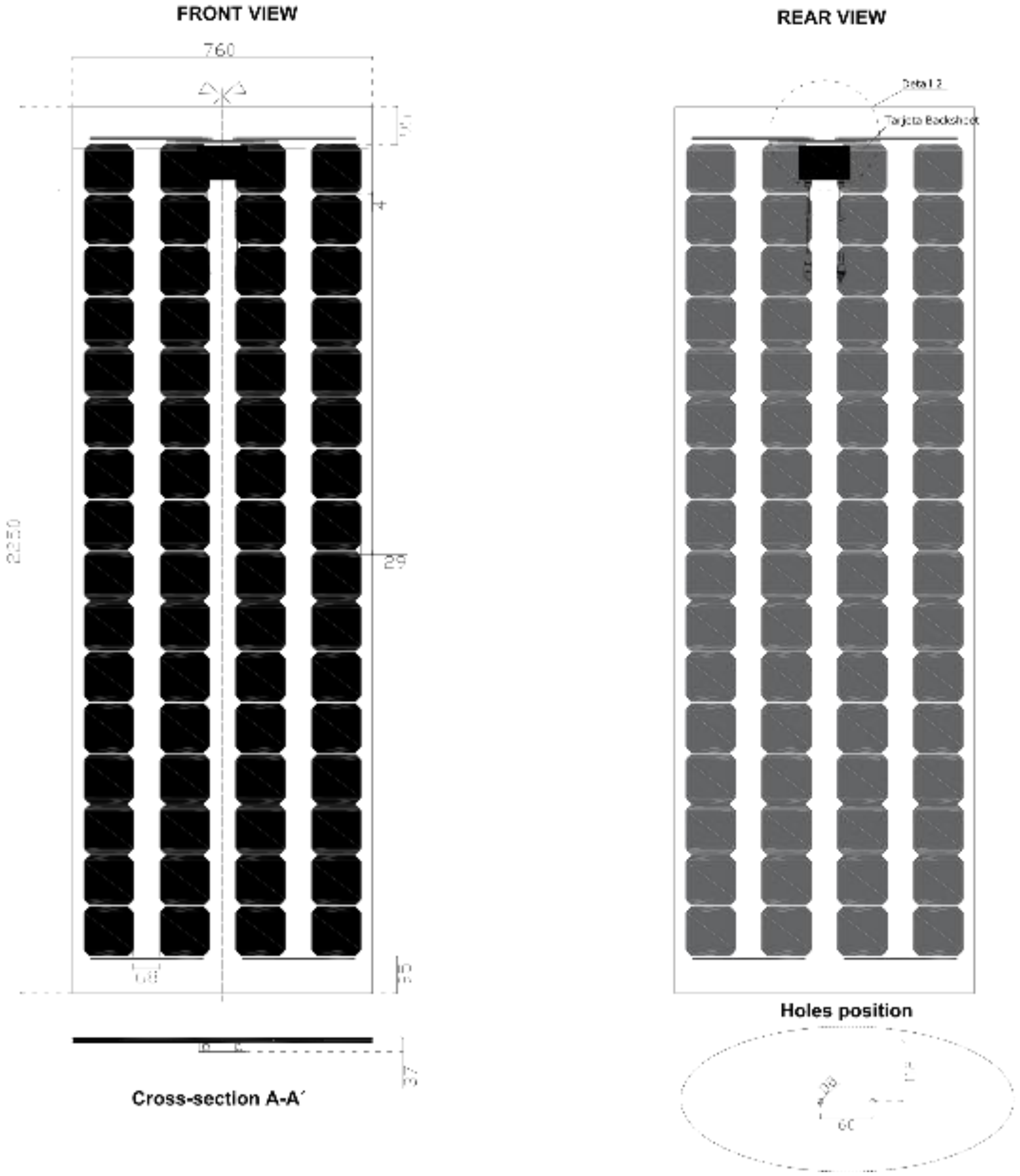
Electrical characteristics	
Vmpp: nom. power voltage	34.88 V
Impp: nom. power current	5.49 A
Voc: open circuit voltage	41.60 V
Isc: short circuit current	5.70 A
Isc (α) Temp. coefficient	0.01 %/°C
Voc (β) Temp. coefficient	-0.3 %/°C
P (γ) Temp. coefficient	-0.35 %/°C
Inverter	4 SMA 5000TL Dimensions

Operating range	
Temperature	- 40 - 85 °C
Maximum System Voltage	1000 V
Maximum Wind /Snow Load	2400 Pa

11.2 eGlazing BIPV glazing - Drawing

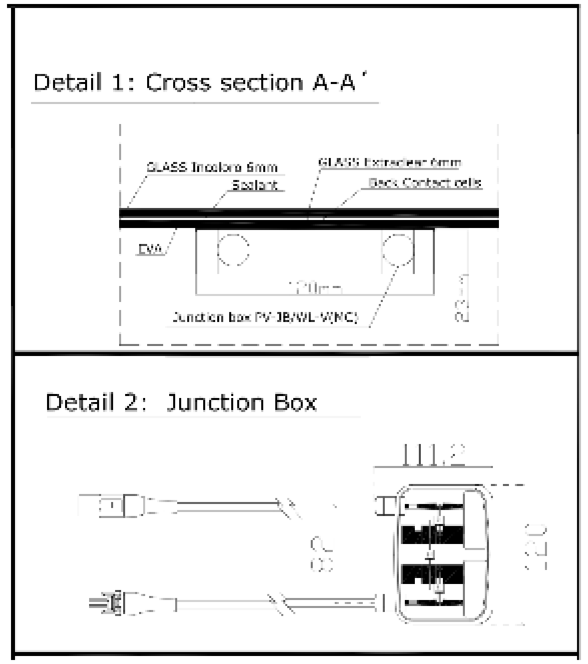
Drawing nr. 01 2250 x 760 mm

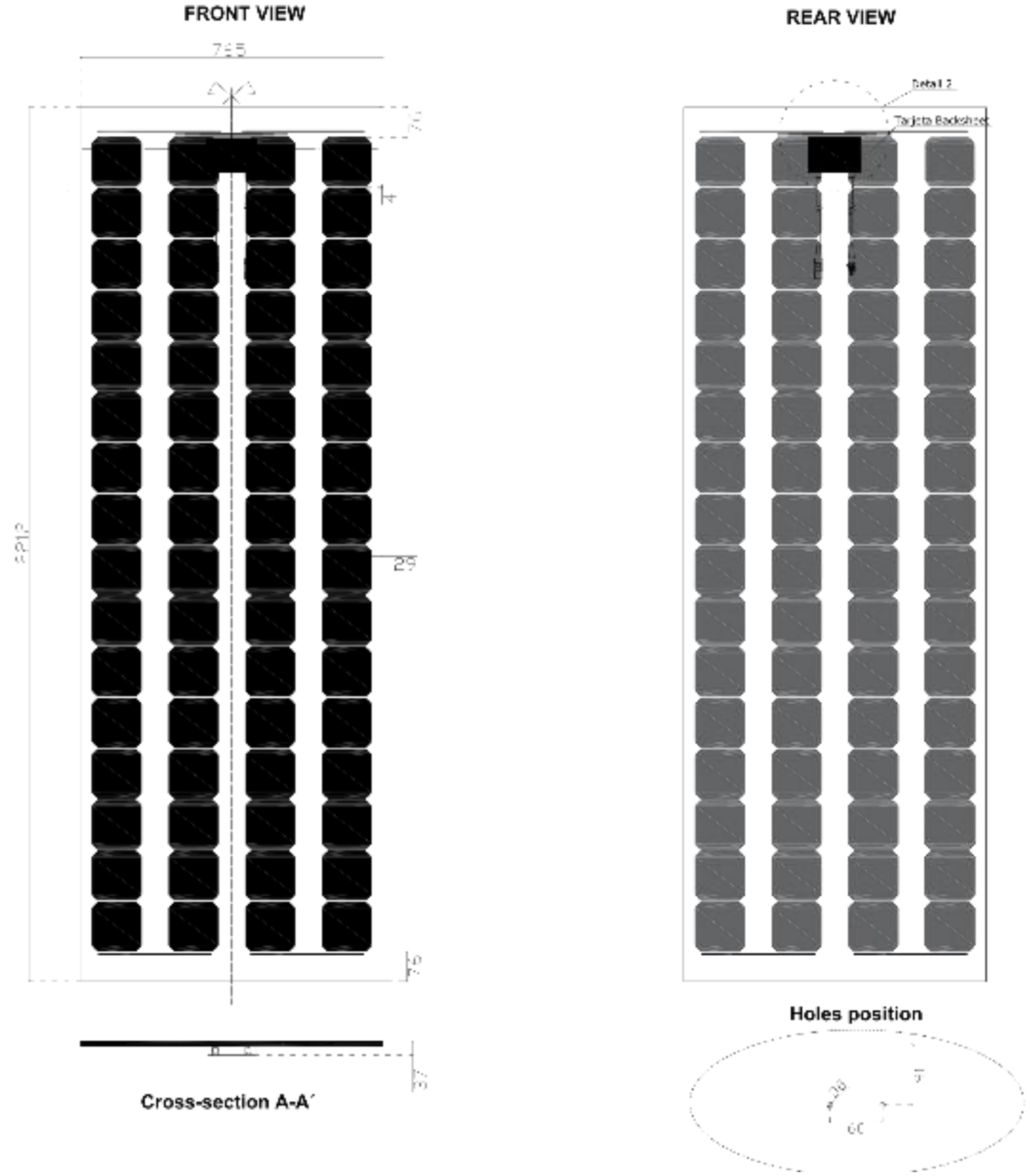




11.2 eGlazing BIPV glazing - Drawing

Drawing nr. 02 2212 x 765 mm

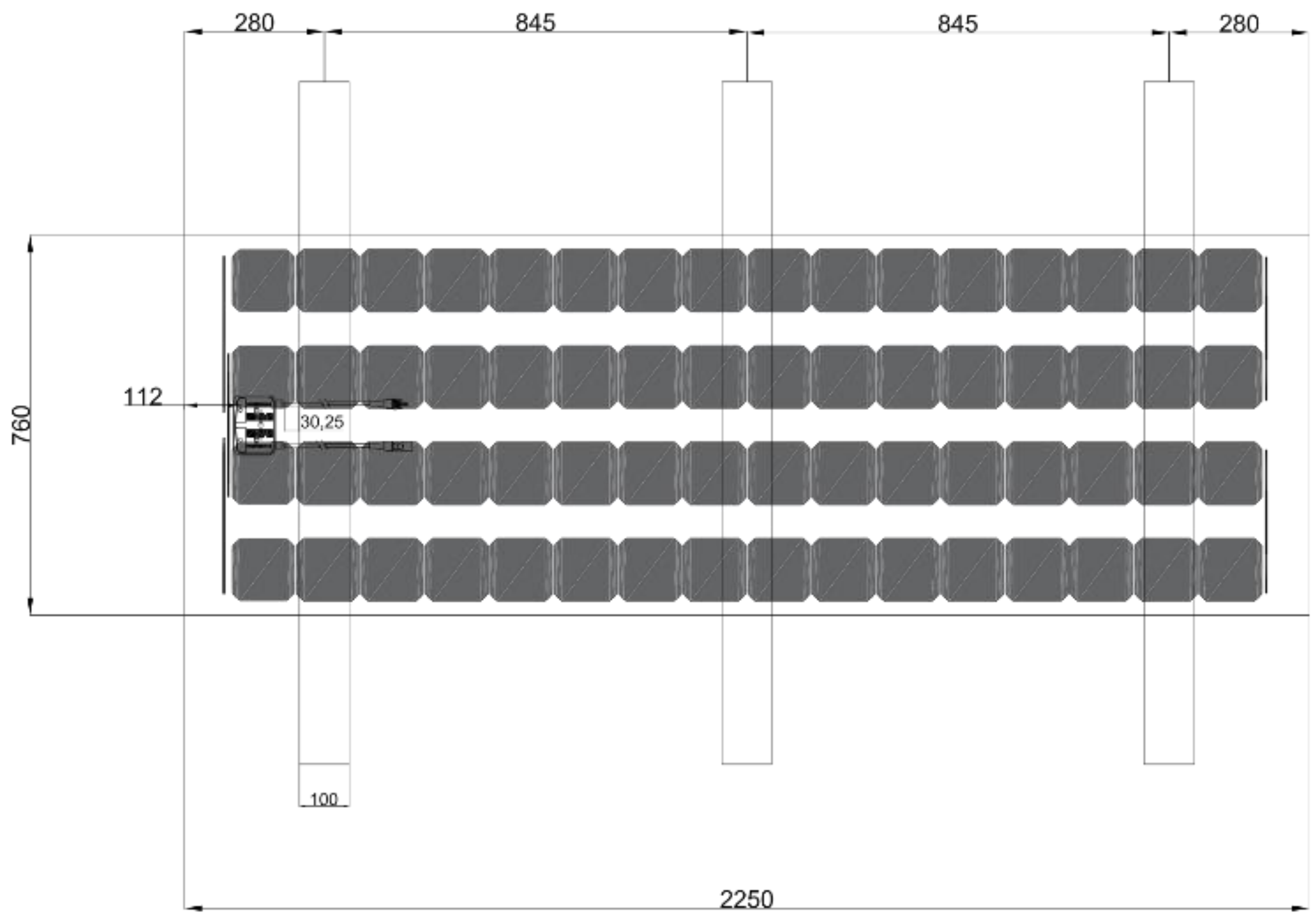




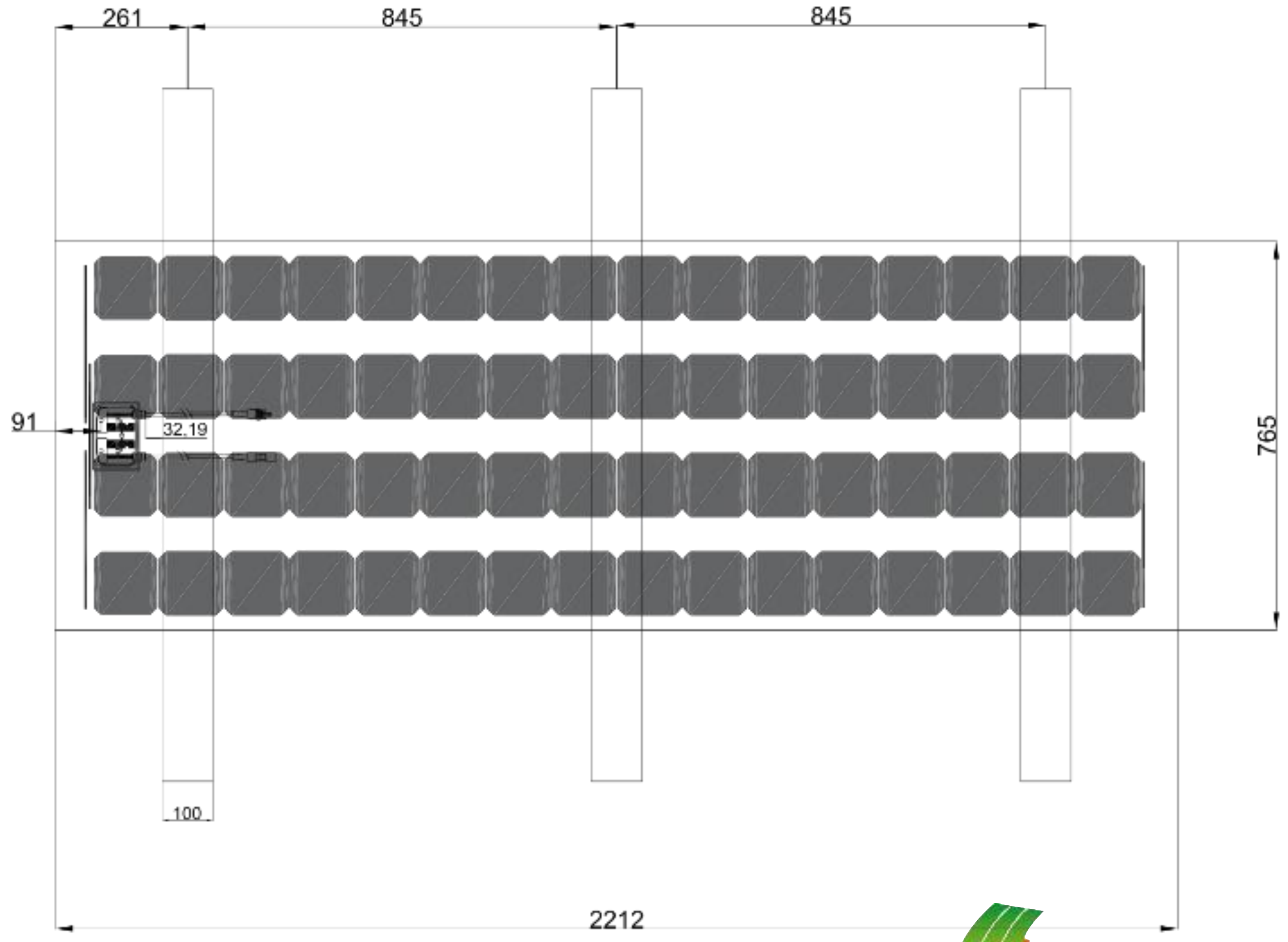
11.2 eGlazing BIPV glazing - Drawing

Drawing nr. 03

Façade A



Façade B

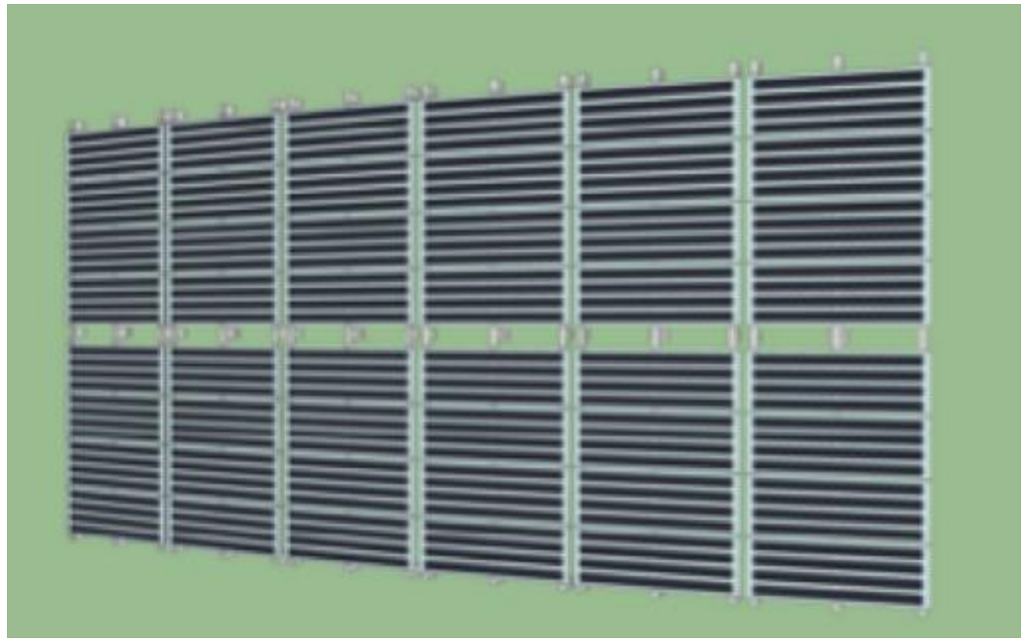


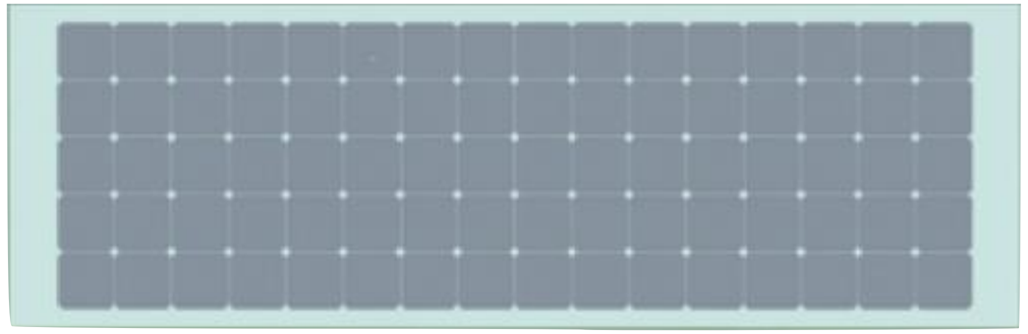
Design

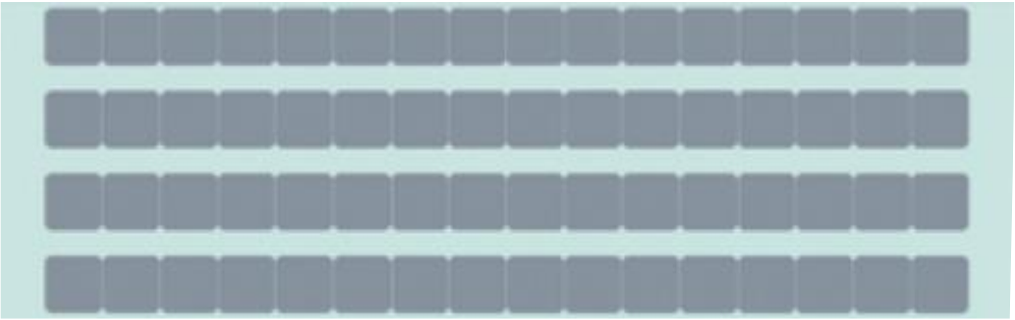
11.3 eGlazing BIPV glazing - Design

The BIPV system to be installed in the office façade of TECNALIA will consist of a double-skin in front of the existing curtain walls. The chosen façades, SSE & S, are large curtain walls; each one covers two floors. Both façades are bended in 6 sections. The entire aluminium curtain walls will be covered by the BIPV glazing.
Every floor has one row of horizontal openable windows.

To design a second skin for this existing facade, there are several options. The design has to balance between aspects as daylight, ventilation, view and installed power.
To reach the required capacity of 20 kWp we need around 96 modules with 64 cells each or 76 modules with 80 cells. Both are possible within the dimensions of the existing windows (2265 x 743 mm).
With higher density modules (80 cells) we can take out one row of modules at each floor for a clear outside view. With the less dense modules (64 cells) we need the full surface but there will be more equal daylight coming inside.







11.3 eGlazing BIPV glazing - Design

Besides the modules, we designed several options for the integration of the modules. Basically there are two directions:

1. Reynolds full profiles all around (see 3D drawings);
2. No profiles but a clip system (see 3D drawings with as reference the clips from SB fijaciones).

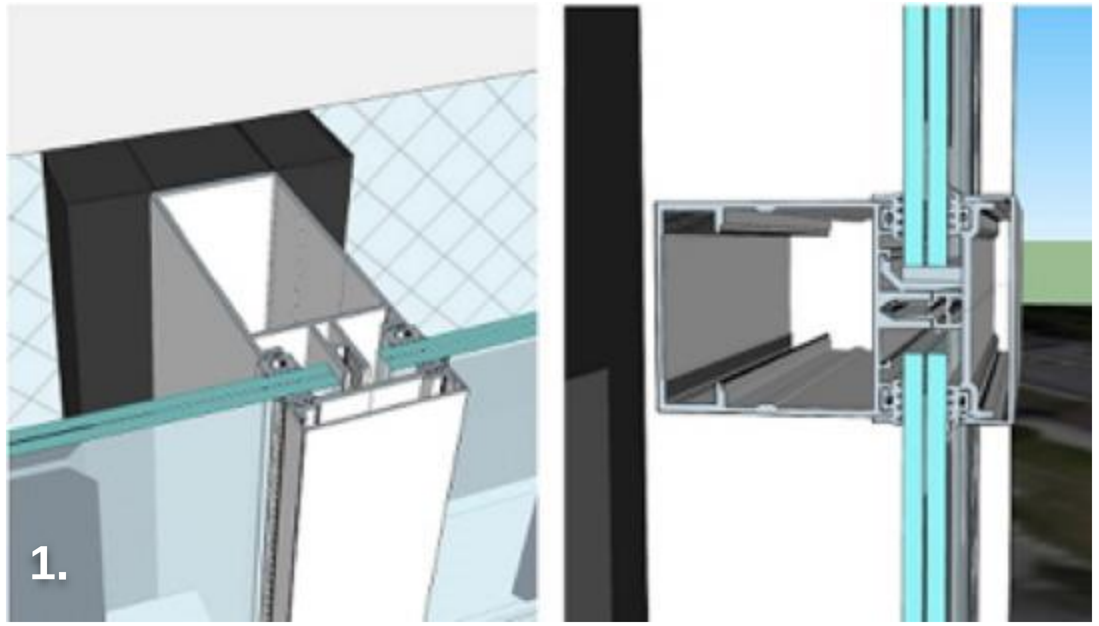
The second option looks more integrated and is chosen to go to the next step. Final installer and system is not decided.

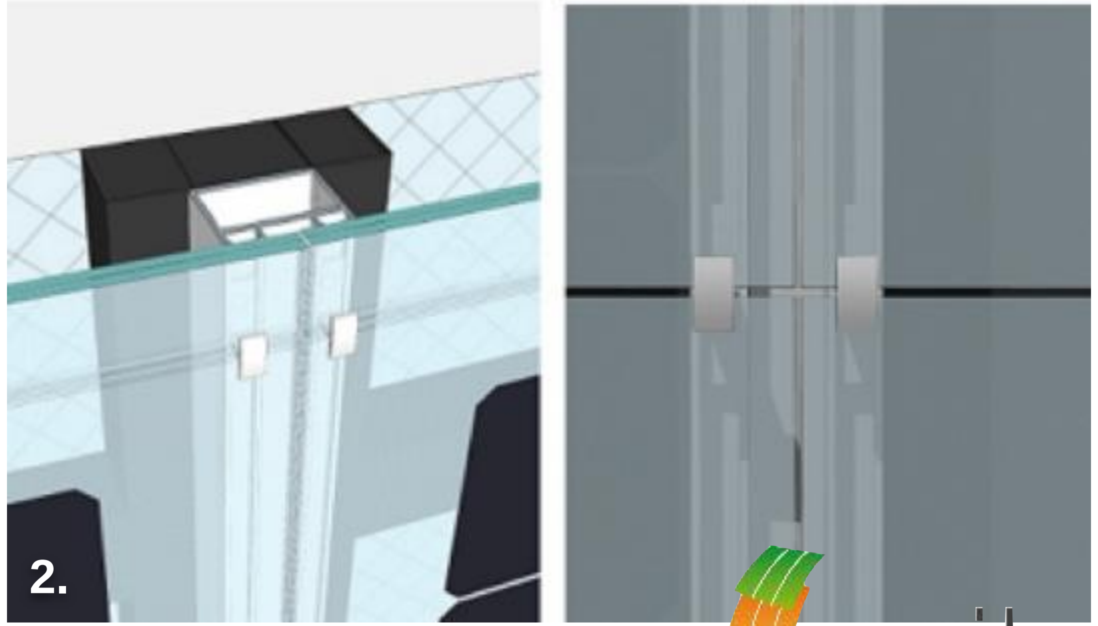
The use of the clips has one problem to solve. The modules need at least 6 supports (3 on top and 3 at the bottom). For opaque applications it is simple to add an extra vertical profile in the middle. Because of the existing windows and the outside view for the users, this is not preferred so another option has to be found. This result in two possibilities:

a. horizontal profile and another type of clips. or

b. vertical profiles like blocks that can be mounted on the existing window frames.

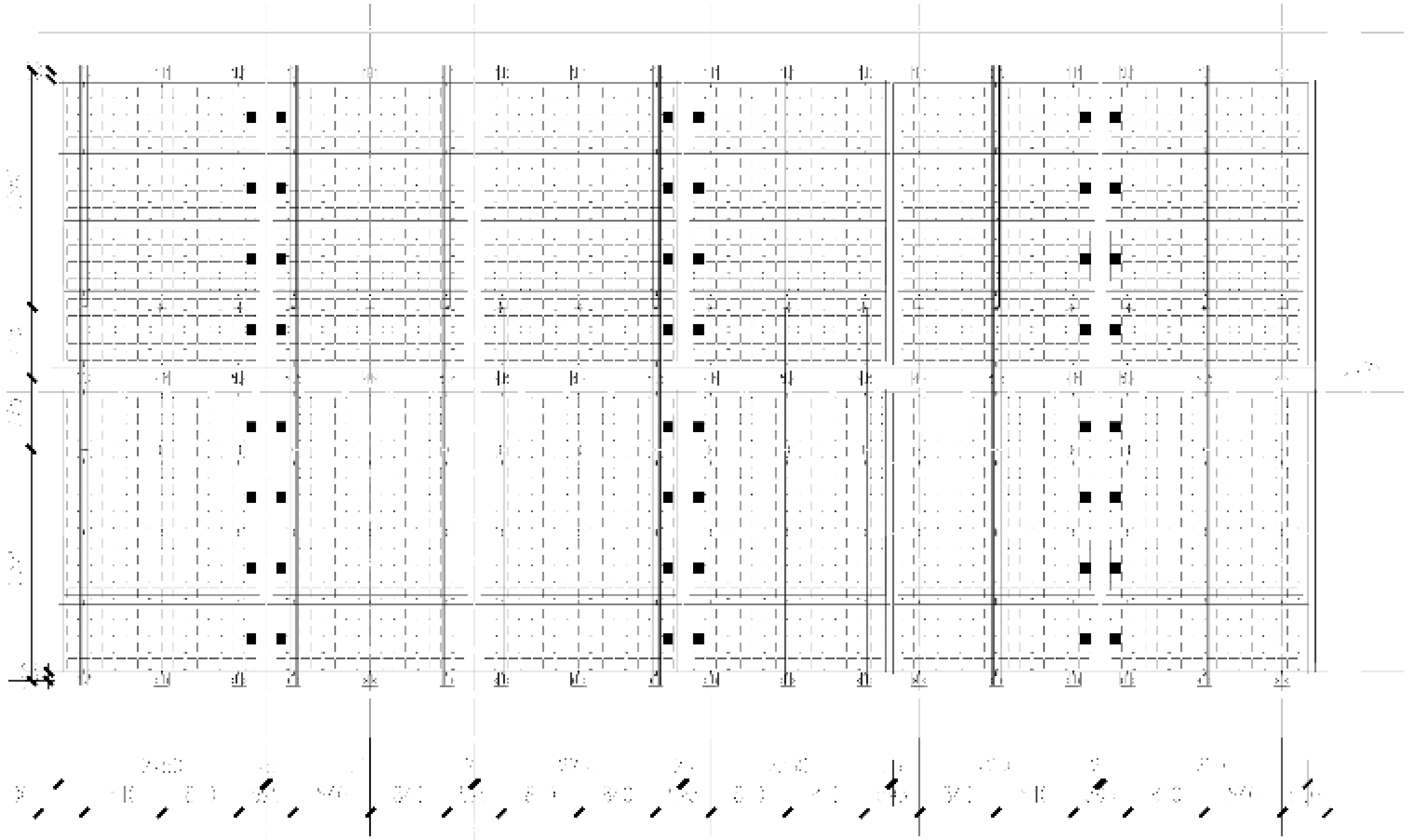
After internal discussion the extra vertical profile in front of the window is accepted.



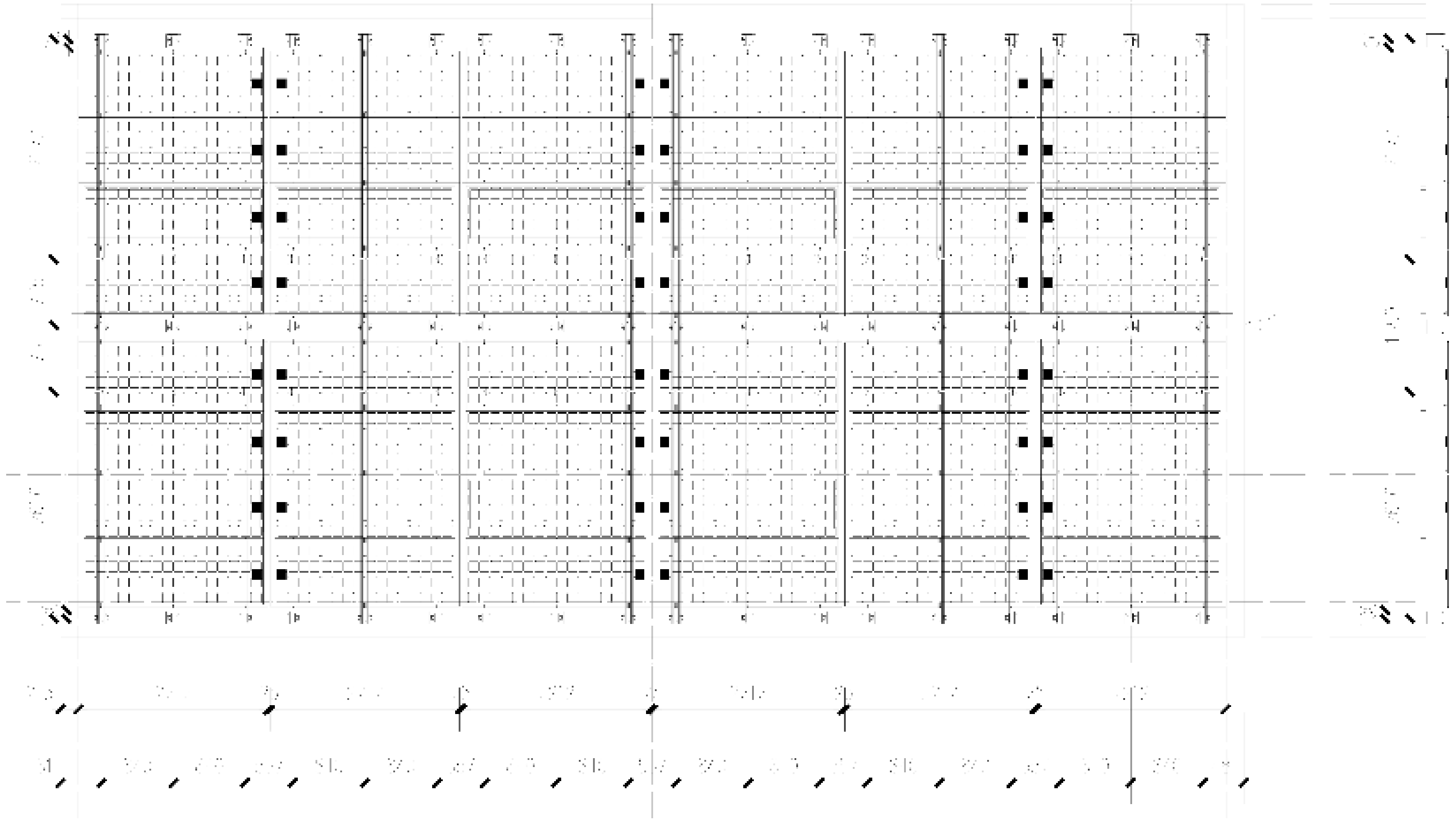


11.3 eGlazing BIPV glazing - Design

Facade layout



Façade A



Façade B

11.4 eGlazing BIPV glazing - Electrical design

Modules are classified at the production line depending on their power. They are already prepared to be connected in series or in parallel.

Series or parallel assembly

The configuration will depend on the voltage required. If a high voltage is required we will connect the modules in series because final voltage will be V = V1 + V2 + (...) Vn, and the intensity value I = I1 = I2 = (...) = In.

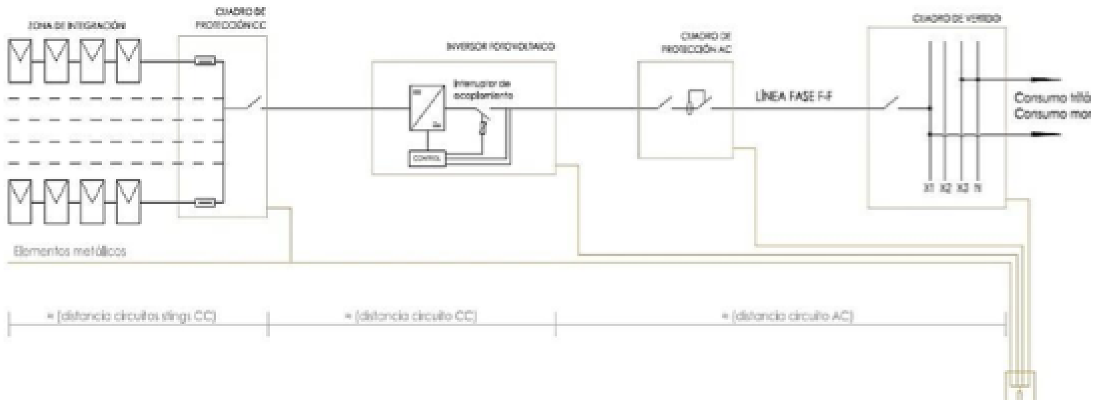
If on the other hand we are interested in obtaining high current intensities we will go for a connection in parallel: I = I1 + I2 + (...) + In, and final voltage V = V1 = V2 = (...) = Vn.

The maximum recommended configuration for modules connected in series is 1000V voltage (600V for USA). Isolation is guaranteed up to this voltage.

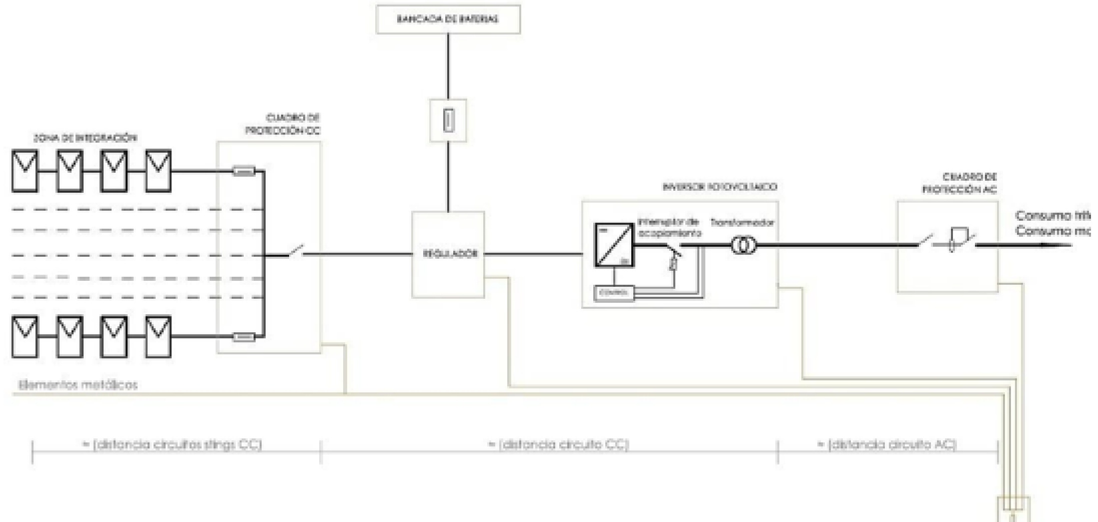
In a parallel connection you can connect as many modules as the gadget to which it is connected admits (i.e.: inverter, combiner box, regulator or other suitable equipment).

Always use suitable cables: high voltages or currents can produce short-circuit and degrade them by overheating. Please follow local/national electrical codes.

Protections: For certain BOS and applications (especially BOS for thin film technology) it would be necessary the integration of short- circuit current limiting fuses per a given number of strings to increase electrical safety and optimized maintenance.



Direct connection to building inner grid for self-consumption and without storage (strategy adopted).



Stand-alone/Self consumption with battery storage of the generated energy.

11.4 eGlazing BIPV glazing - Electrical design

BIPV units must be connected and interconnected by an electrical installer with proven experience in PV installations and low-voltage systems. The PV installation design must be certified by a registered professional electrical engineer. The PV BOS design and installation procedure must comply with local codes and requirements from all relevant authorities.

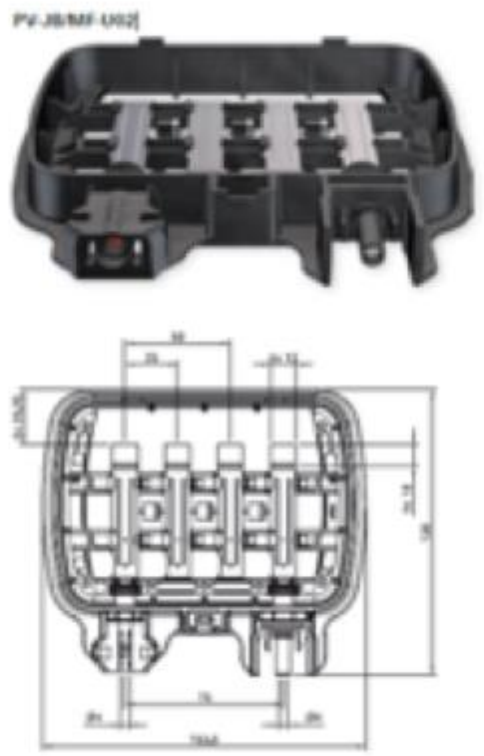
PV systems, as any electrical devices, require good ventilation ensuring proper thermal dispersion. Any solution preventing the aforementioned as: as silicone sealed of wiring, wrong cabling tubing de-ratio values, improper wiring tubing sections, etc. must be avoided.

Junction Box

Onyx Solar PV glasses are designed allowing different Junction Box (JB) implementation depending on each product type, standard or customized. JB can be placed at any point in the rear glass, can be welding or no-potting compatible, and can hold a variable number of by-pass diodes.

In the case of edge junction boxes, the Junction Boxes are designed to be run within a structure as aluminium/steel frames allowing both, good ventilation and absence of moisture. Direct exposure to external outdoors conditions should be avoided.

As general characteristics it should be pointed out that any JB system used by Onyx shows IP-65 protection grade.



11.5 eGlazing BIPV glazing - Software

Use of the PVSITES web tool

The software can be found on the pvsites.eu website.

Steps to be made are:

1. Create a 3D model (sketchup)
2. Import it in the software
3. Choose the location
4. Import the weather data
5. Next are Irradiance simulations and shadow influence.
6. Element set-up, choice of modules
7. Add the chosen modules to the roof
8. Copy it over the whole roof
9. Values for each module can be seen

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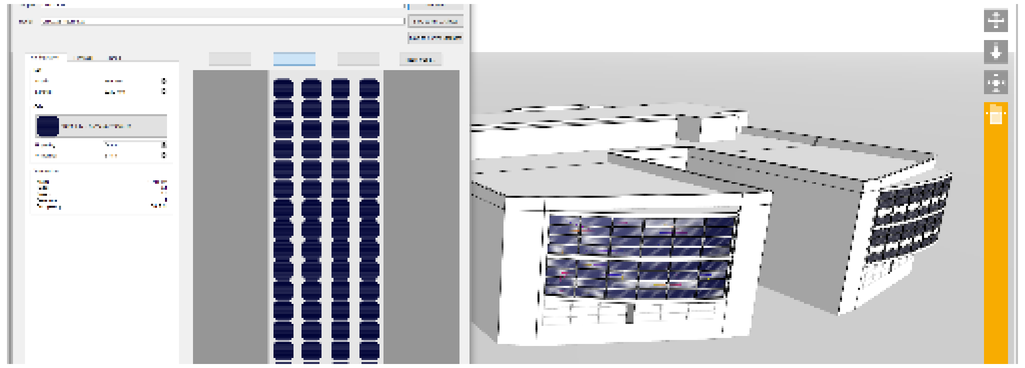

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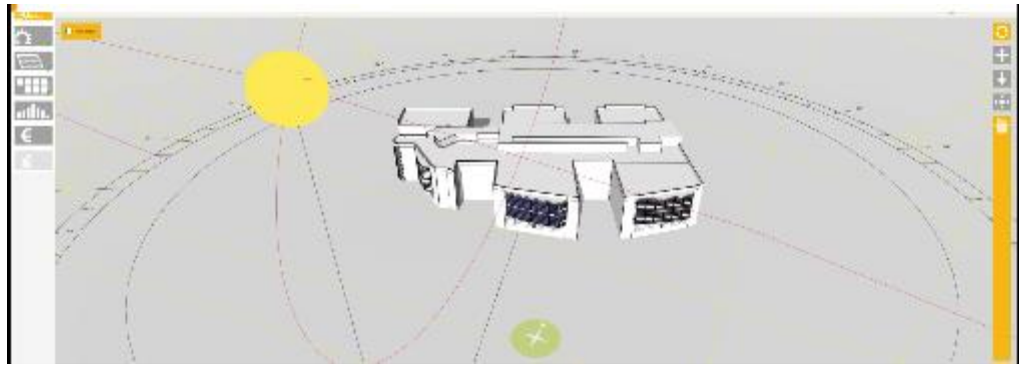

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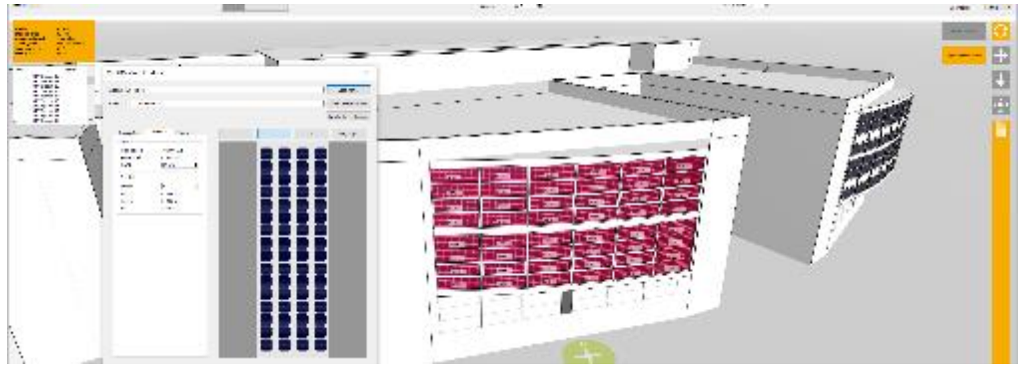

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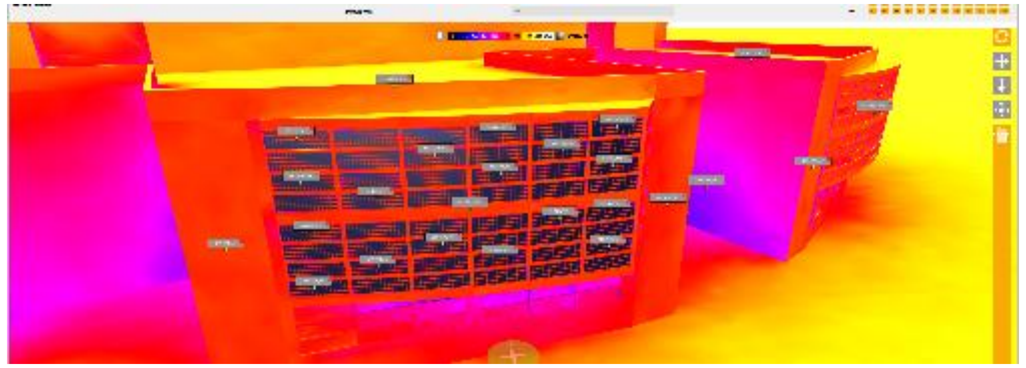

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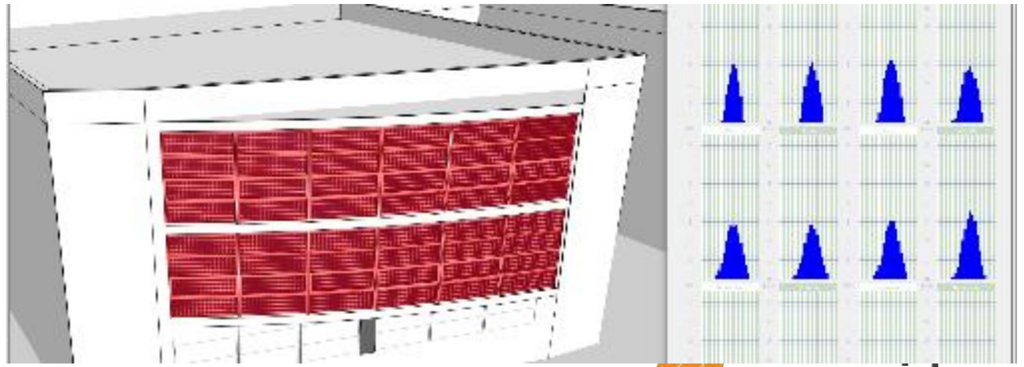


11.6 eGlazing BIPV glazing - Commissioning

Two permits were needed to perform the installation in compliance with the municipal and country legal framework. The construction license, which required presentation of a project endorsed by the architecture school, was approved by the municipality 2 months after the submission of the documentation. The permitting process for the legalization of the PV installation licence was led by the PV installer and required the approval of the local electricity distributor. An adaptation of the original technical solution was required due to the new self-consumption Spanish regulation.

The commissioning was relatively simple. After the outdoors and indoors works were finished (module installation, strings connection, cabling, meters, protections and inverters installation, etc.) the commissioning of the installation was addressed. In order to comply with the recently enacted RD 244/2019, a zero-injection kit was installed certifying that no excess energy will be injected into the grid. The inverters were then connected to the general distribution panel of one of the laboratory facilities of the building, where all the energy will be directly self-consumed.

Installation

11.7 eGlazing BIPV glazing - Installation

The BIPV installation was done relatively fast. The time consuming part was the construction of the substructure on the existing window frames because of the bended facade. This took five days.

Once the installation of the substructure was finished, the PV installer proceeded with the installation of the BIPV modules and string connection. Because of the dimensions and weight of the glass-glass modules (55 kg) 2-3 people were needed to safely handle and install each module. The installation was performed starting from the bottom part of the facade. The process is as follows:

- L-shaped clips are first fixed to the profiles at the lowest part of the facade.
- The first BIPV module is placed onto the clips.
- Next, intermediate T-clips are fixed, fixing the module, while leaving a free space of 2-3 mm between the glass and the clip to allow for the free vertical thermal dilatation of the module.
- The process is repeated for the first row of modules, keeping a 25 mm gap between each module.
- This is repeated until the upper part of the installation is reached in each column of modules, where L-shape clips are installed again. Electrical connections of modules are performed module by module during this step as modules are vertically installed.

The cabling is hidden and carefully organized behind the metal panels and taken to the inverters room inside.

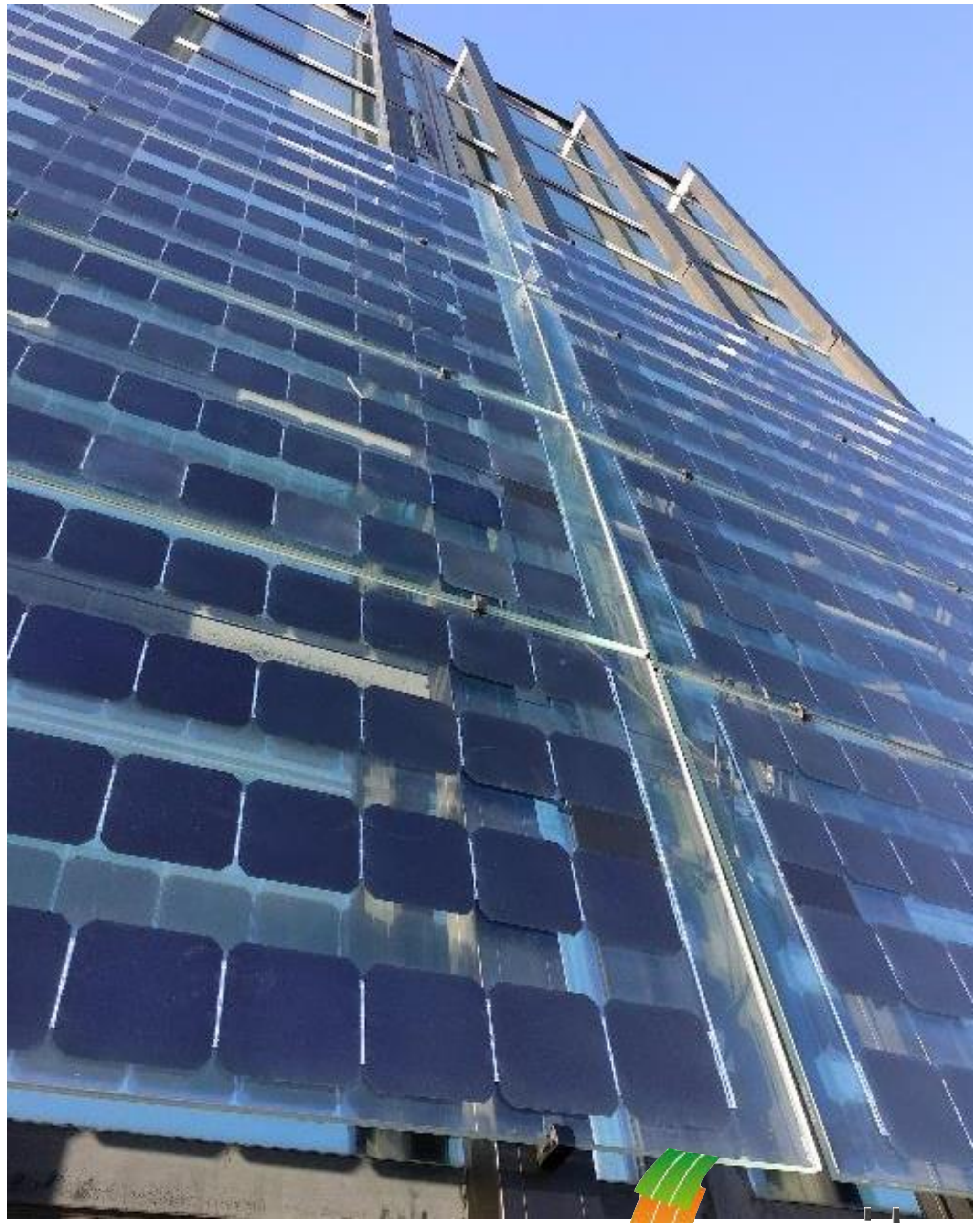
11.7 eGlazing BIPV glazing - Installation

11.8 eGlazing BIPV glazing - Maintenance

ONYX gives the following advise:
Preventive maintenance should take place at least twice a year. Key elements should be checked and verified. The minimum actions to be considered are:

- Checking system connections.
- Checking cable system especially if it has been in the sun or in bad weather conditions that can produce corrosion; cracks may appear on the covering which can produce energy loss.
- Checking the sealing of the j-boxes, even if there is a time lapse they should still be sealed and no corroded due to water.
- Checking all structural pieces in the structure that supports the photovoltaic modules to search for losses.
- Checking if any glass may be fractured. If so contact the supplier and change the module.
- Checking all segments of the BOS.
- Checking all earth connections
- Cleaning of the PV glazing is similar to equivalent glazing systems. Nevertheless, special care should be taken not to affect the PV sealants or connections.

Mainly rain eliminates the necessity to clean de panels. If needed, clean the surfaces with a mixture of neutral detergent and water. It is recommended using dissolution in water and neutral detergent with 3% of ammonia and a surfactant.
Typical cleaning tool for glass as rubber brush could be used in order to clean the PV module avoiding any scratch on the glass.



Thank you for your attention