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Results of installation and commissioning for every demo site

Project Report

ACCIONA, VILOGIA, CRICURSA, TECNALIA, FORMAT D2, FLISOM

www.pvsites.eu

Summary

Deliverable D8.6 is a report containing the complete results of the implementation of every demo-system in their respective demo-site.

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1 EXECUTIVE SUMMARY

Deliverable D8.6 is conceived as a brief report that includes the processes followed and their corresponding results achieved so far for the successful consecution of the demonstration installations in the frame of PVSITES project. The document basically includes a short description of the installation, permitting and commissioning actions undertaken to carry out the market replication of the products and systems developed in the project. On the other hand, real pictures of the installation works and the final result of the systems have been chosen to suitably illustrate the explanations.

1.1 Description of the deliverable content and purpose

Deliverable D8.6 distributes its content in several chapters, each one dedicated to each demo-system (products prototypes to be included in each demo). Since the carport system was implemented in two different demo-sites the correspondent chapter includes the installation and commissioning report of both systems.

As said in the summary, the demo-systems implementation results include a brief descriptions and real pictures of the installation, permitting and commissioning works.

The milestones achieved in Task "T8.3. Installation and commissioning of installation" come to be the beginning of the activities planned around the validation of the BIPV and BAPV products designed, developed and manufactured throughout the PVSITES project. In this way, every product has been installed and will be demonstrated in the chosen real buildings and urban elements included in this document, under real operating conditions during the monitoring period. Results obtained will be assessed after the monitoring phase, and guidelines and recommendations will be elaborated and suggested for the market replication of the products developed in the project in future reports.

1.2 Relation with other activities in the project

The activities carried out in the framework of T8.3, and the results documented in deliverable D8.6, are directly related to the tasks and reports listed in the table below, which are related to the design of the demo-systems and the manufacturing of the developed products:

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

Project activity	**Relation with current deliverable**
Task	**Deliverables**
Task 8.1. Design of demonstration installations	D8.3 Design pack for every demo site
Task 8.2. Manufacturing of prototypes	D8.4 Prototypes for demo sites - First batch
	D8.5 Prototypes for demo sites - Second batch
Task 8.6. Analysis of results	D8.16 Report on general architectural, photovoltaics, operational, economic, and environmental assessment of the demo-sites.
	D8.17 Guidelines and recommendations for replicability of PVSITES approach.

1.3 Reference material

This document does not content any reference external to the project.

1.4 Abbreviation list

BAPV: Building Attached Photovoltaics.

BIPV: Building Integrated Photovoltaics.

CLT: Cross-Laminated Timber.

DC: Direct current.

EHG: Ecole Hotelière de Genève

EKZ: Elektrizitätswerke des Kantons Zürich.

EMPA: Swiss federal laboratories for materials science and technology.

GSM: Global System for Mobile communications.

IP: Ingress Protection.

PV: Photovoltaics.

RD: Real Decreto (Royal Decree).

2 GENERAL OVERVIEW OF THE DEMO-SYSTEMS PROGRESS

The labours concerning the demonstration actions in general terms were undertaken from the beginning of the project. Several key aspects were addressed during the first months in order to guaranty the global success of the products development and their demonstration at real scenarios.

Among these issues, it can be highlighted the following ones: from the negotiation point of view, the achievement of the needed agreements with the demo-sites' owners for the demo-systems implementation at their respective buildings or facilities; considering the technical aspect, the assessment of the building and urban integration possibilities of the planed products in the chosen demo-sites, aimed to customize and optimize the design of the products and mounting structures; and from the legal perspective, the analysis and starting of the permitting processes needed to legalize the constructive interventions and the power generation systems.

Based on this approach, besides the project's general assemblies, a large number of periodic call conference meetings, specific sessions and particular communications have been carried out addressed to achieve these purposes. Simultaneously, a timetable containing the milestones and pending issues was continuously filled out and updated for each demo-system to have, all the time, a complete overview of the tasks evolution.

Table 2.1 Example of timetable of milestones and pending issues for the demo-systems follow-up

DEMO SYSTEMS FOLLOW-UP				TELCO 5- 7 February 2019	TELCO 6- 5 March 2019	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep
DEMO	ID	TASK	CONTENT			FD2												
1	FD2	8.2.	Manufacturing															
			PV	PV lamination challenging, late Feb for the tiles. Shipping end 1st week March. Installer can be selected by FD2.	Installer can be selected by FD2. PV tiles finished on 26th March and expected to be in Belgium 1st-2nd April. On 20th March. FLISOM will confirm.													
			Inverter	No conecting box avaiable before end of May. Protections have to be defined.	Conecting box expected to be delivered by end of june (24th-28th)													
			Batteries	New Baterries to be selected by Tecnalia	Batteries already selected. They have to be sent to TECNALIA for a previous test before sending them to FD2. Expected to be installed week 18 (29th April to 3rd May)													
			Local EMS															
		8.3.	Permitting, installing, commissioning	April	April													
DEMO	ID	TASK	CONTENT			FLISOM												
2	EHG	8.2.	Manufacturing	On hold till design and budget is finished.	On hold till design and budget is finished.													
			PV	April	April													
			Inverter	Commercial	Commercial													
			Batteries	No need	No need													
		8.3.	Permitting, installing, commissioning	Permission granted. Ownership to be contacted.	Permission granted. Ownership to be contacted.													

Demo-systems implementation have been possible thanks to the participation of the demo-sites owners and responsible, the products developers, the architects responsible of the building integration, the modules manufacturers, the partners responsible of the monitoring systems, etc.; some of them also in collaboration with external parts; such as local authorities, maintenance responsible and specialized installers.

The good coordination between the several parts involved in each demo-system implementation has allowed the great final result documented in this deliverable, even despite of the important problems and delays suffered in some cases for different reasons. D8.6 comes to confirm that every demo-system has been implemented with success at their respective demo-site. Products developed and integrating measures will be validated at the end of the project, once the whole monitoring data collected for a whole year from the commissioning of the systems will be assessed.

3 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEM 1: SINGLE HOUSE, BELGIUM

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-system 1, a single house in Stambruges (Belgium).

Figure 3.1: Final results of Demo-system 1, Single House in Belgium

3.1 Description of the installation works

The BIPV roof installation at the Single House located in Stambruges (Belgium) started with taking off the tiled roof end of April (2 days). The lathing and placing the tiles started at the beginning of May. 8 days in total with 3 workers were necessary to end the works.

After placing the scaffolding for security and taking off the ceramic tiles and the lathing, a new underroof 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 10 cm high), the placement of the underroof and the under lathing was very easy. This vertical lathing (every 60 cm) is a 38 x 45 mm section which makes possible ventilation in the higher air gap.

The greatest difficulty was to start correctly the horizontal lathing (32 x 38 mm every 44 cm and the intermediate support at 16 cm) because the tiles do not have the possibility to be adjusted. The upper corner part is fixed; so, only the positioning of the first line of tiles in the general gutter can be adapted in order to have an entire number of panels in height.

The calculation and the previous placement of all the elements needed to install the tiles took the most relevant duration. On the other hand, only 2 days were necessary to place the tiles.

Other works that took some time (2 days for 1 additional worker) was the opening of the upper fold of assembly of the panels with the help of a proper tool (profiled aluminium plate), the placing of the tiles and bands "compriband" on the various finishing elements, and the sorting (by power) of the PV panels in order to electrically balance the strings.

Previously to the installation of the panels, the grounding for every tile and support through metal strips and intermediate ventilated support were placed on the lathing.

According to the electrical connection scheme, 1 string is composed by 2 lines of 8 tiles (16 tiles in total). There are 18 tiles in a row, so there are 9 strings delivering 2 A and 750 V. At the end (144 tiles), final current will be 18 A, by connecting all the strings in series. For the electrical connection, cabling of 6 mm^2 section with MC4 connectors were used to accomplish with allowed DC losses.

6 temperature sensors were placed: 3 at the bottom of the roof and 3 at the upper part, 1 on the membrane, 1 in the middle of the airgap and 1 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.

3.2 Permitting process of Demo-system 1: Single house in Stambruges, Belgium

No permit is generally needed for placing BAPV because the roof elements already exist and were implemented with a permit addressed to the installation of panels on existing roofs; however, for BIPV applications the roof is composed of new elements. This circumstance is not referenced in the permit or into the urbanistic prescriptions of the place.

In the case of this demo-system, a permit was requested with description of the new material of the roof, colour included. Plans and administrative documents were given to the authorities. 35 calendar days were needed to have the agreement (period of validity of 2 years for beginning works).

3.3 Commissioning process of Demo-system 1: Single house in Stambruges, Belgium

A special agreement with the grid manager was achieved to use a non-commercial inverter (TECNALIA's one), 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 – net-metering scheme) but currently, from the 1st of January 2020, a tax for the kW reinjected into the grid must be paid.

3.4 Pictures and schemes

Figure 3.2: Installation and commissioning of Demo-system 1, Single House in Belgium.

4 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEM 2: EDUCATIONAL BUILDING, SWITZERLAND

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-system 2, an educational building in Genève (Switzerland), the Ecole Hotelière de Genève (EHG).

Figure 4.1: Final results of Demo-system 2, Educational Building in Switzerland

4.1 Description of the installation works

Two BIPV systems based on CIGS PV aluminium façade elements by Flisom have been installed at EHG demo-site, an educational building located in Genève (Switzerland), with 8.0 kWp power covering 110.1 m^2 total area in the east and west façades of different buildings.

The façade tiles were produced from March to June 2019.

The installation starting was a challenge due to some additional issues, such the language barrier and not having a single point high level contact on EHG side. To smoothen the installation works and to create awareness a kick-off meeting was organized in June 2019.

Once the project was presented to the director of EHG, the timeline was agreed. Installation works were scheduled by the end of June 2019, but they were stopped because the trees located in front of one facade were too big, they obstructed the access to the facade and EHG did not allow to cut them. As EHG was closed for the summer holiday, no access was possible to try to find a solution. After the summer holidays a solution was found: trees might be bended back without being damaged. However, the exams sessions started and EHG did not allow to go on with the construction works due to noise emission. Finally, installation date was established, and works started on 21th October, 2019. Some details of the system installation are currently in process.

All façade elements were delivered with a protection foil to not being scratched at further processing or mounting stages. Installation works basically consisted of:

- Installation of vertical rails on the brick walls. Screws were fixed between the bricks in order to not damage the facade.
- 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.
- The solar inverters were placed on the roof in order to minimize its visual impact.
- The modules protection foil was removed as last step.

4.2 Permitting process of Demo-system 2: Educational building in Genève, Switzerland

Permitting process for achieving the construction allowance was really too long and difficult at this demo-site, which delayed the execution on time of the parallel and subsequent tasks more than initially expected. The permission process was led by CADCAMation. Three attempts were needed, and a 5-year limited construction allowance was finally achieved. The construction allowance was finally got on January 2019.

The intensive negotiation with the buildings' property allowed a final agreement regarding the demonstration nature and scope and the installation timings and conditions.

4.3 Commissioning process of Demo-system 2: Educational building in Genève, Switzerland

The complete system was finally monitored and commissioned.

4.4 Pictures and schemes

The facade with the little trees in 2017

Panels being packed after PV lamination
for shipment to Ernst Schweizer AG

Installation works

West facade system

East facade system

East facade system

Figure 4.2: Installation of Demo-system 2, Educational Building in Switzerland

5 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEMS 3: CARPORTS IN ZURICH, SWITZERLAND

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-systems 3, two solar carports implemented in different locations (EKS and EMPA facilities) close to Zurich (Switzerland).

Figure 5.1: Final results of Demo-system 3, EMPA's Carport in Switzerland

5.1 Description of the installation works

This section includes a brief description of the installation works in the two chosen demo-sites, EKS and EMPA facilities.

- **EKZ's carport in Zurich, Switzerland**

  EKZ is the electricity provider for the region and supports renewable energy development. EKZ agreed to host the carport and took care of foundation works and permission process.

  The construction was developed by Zumstein AG and Flisom, taking an existing carport design as basis and modifying it for Flisom's solar module compatibility. The foundation for the carport was set up in between December, 2017 and January, 2018, as planned. The carport in Seuzach was then set up in February, 2018 within 1 week by Zumstein AG. The PV panels were mounted later, between April and June, 2019, also by Zumstein AG. The EKZ's carport is combined with an electric vehicle charging station, just located below the carport.

- **EMPA's carport in Zurich, Switzerland**

  The installation was performed similar to EKZ, as the carport is nearly identical. First step was foundation and putting the tubes for cables. Then, the metal construction, and finally the installation of PV panels and cabling. PV power conditioning is solved by SolarEdge devices (DC-DC converters).

  The connection to the EMPA grid was challenging, as EMPA has a sophisticated energy management system and the carport needed to integrate also software wise into the EMPA EnergyHub. Access to the carport via Internet is not possible due to EMPA safety restrictions; thus, the Carport monitoring is done Via mobile GSM solution. The communication between SolarEdge server and carport is directly via mobile network.

5.2 Permitting process of Demo-system 3: carports in Zurich, Switzerland.

This section includes a brief report of the permitting process carried out in the two chosen demo-sites, EKS and EMPA facilities.

- **EKZ's carport in Zurich, Switzerland**

  The first permit requested was denied by the municipality with the argument that it was 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).

- **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.

5.3 Commissioning process of Demo-system 3: carports in Zurich, Switzerland.

This section includes a brief report of the commissioning process carried out in the two chosen demo-sites, EKS and EMPA facilities.

- **EKZ's carport in Zurich, Switzerland**

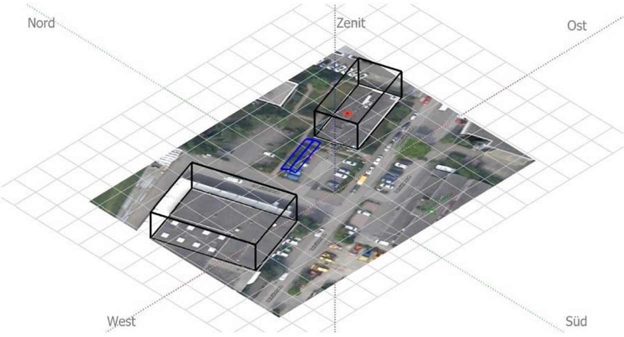
  3 companies were involved for both carports: Eberhard did the ground construction and foundation works, put the tubes for cables and restored the parking after setting foundation, Zumstein AG delivered and mounted the metal construction, and Flisom delivered the modules. Zumstein AG mounted and connected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

- **EMPA's carport in Zurich, Switzerland**

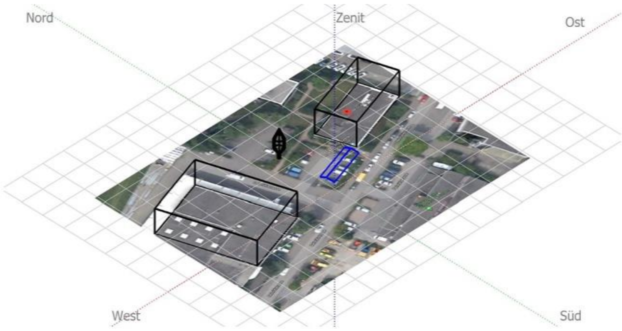
  Construction same as carport at EKZ. Commissioning was carried out as planned.

5.4 Pictures and schemes

Location proposed from the municipality, away from the street and with 6.7 MWh/year estimated generation



Location preferred by Flisom, close to the street with less shadowing and 7.3 MWh/year estimated production



Always 2 panels are always riveted together forming a nearly 200 W panel

The 5 m long panels are pulled from a wood support by 3 men and then fixes with rails

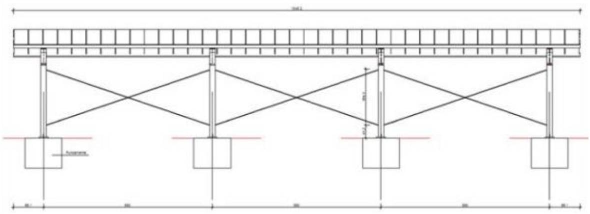
EKZ carport half covered with panels during the installation works

Final result of EKZ's carport

Figure 5.2: Installation and commissioning of Demo-system 3.1, EKZ's Carport in Switzerland

Carport foundations. The concrete foundation is needed to comply with Switzerland's regulation on snow load

Scheme of carport construction including the foundation



PV panel mounting works carried out at EMPA's demo-site

Rubber rail fixing the PV panels but still allowing thermal expansion to happen

Final result of EMPA's carport

Aerial view of EMPA's carport

Figure 5.3: Installation and commissioning of Demo-system 3.2, EMPA's Carport in Switzerland

6 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEM 4: INDUSTRIAL BUILDING, SPAIN

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-system 4, an industrial building in Barcelona (Spain).

Figure 6.1: Final results of Demo-system 4, Industrial Building in Spain

6.1 Description of the installation works

The installation of the Flisom's panels started on 6th June, 2019 and finished in July.

As the first step all, it was carried out the attachment of every BIPV module to the polyurethane sandwich-panels making up the roof. The FLISOM's industrial roofing tile was specifically designed to perfectly assembly with these panels, being positioned above the highest point of the roof sandwich-panels. The cavity left between the BIPV modules and the sandwich-panels works as an open-air chamber for ventilation. In general terms, the efforts dedicated to the architectural integration design brought good results on site, making easy the installation works and providing a functional and aesthetical integration.

After, a general cabinet was installed by CRICURSA housing most electrical components and devices. With an IP56, it was placed in the back yard (south face of building) and protected by a sandwich panels to better support the outdoors conditions. The cabinet houses 4 SMA solar inverters (waiting for the supply of the 2 inverters developed by CEA), a set of batteries provided by VICTRON, a “zero-injection” device to avoid energy surplus injection to the grid, DC and AC protections and EMS & monitoring equipment. Electrical connections between BOS components were done at the end of June, 2019.

On the other hand, sensors and meters were installed under the supervision of NOBATEK and configured to have all the installation remotely monitored (temperature at different parts of roofs, power consumption in specific points of the electrical installation, etc.).

The demo-system was finished in July 2019.

6.2 Permitting process of Demo-system 4: Industrial building in Barcelona, Spain

Regarding the permitting process, all the permissions required by the electrical company ENDESA were got from the summer of 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.

6.3 Commissioning process of Demo-system 4: Industrial building in Barcelona, Spain

The demo-system was commissioned in the second week of July, 2019, once finished the installation works.

Unfortunately, a general deterioration by oxidation was observed in the PV panels during the first months after their installation. Currently, a feasible solution is being tried to be found.

6.4 Pictures and schemes

Figure 6.2: Installation and commissioning of Demo-system 4, Industrial Building in Spain

7 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEM 5: APARTMENTS BUILDING, FRANCE

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-system 5, an apartments building in Lille (France).

Figure 7.1: Final results of Demo-system 5, Apartments Building in France

7.1 Description of the installation works

The demo-site chosen by VILOGIA is a social housing building from the 70s. The building, which includes 48 apartments, will run a full thermal renovation in the coming months. The BIPV facade works began in January 2019 by taking off the bricks cladding from the southern facade. On the concrete walls, a new rainscreen was deployed and then a new insulation in mineral wool was fixed. The rest of concerned facade is protected and waits to be linked with the future new envelope.

The 112 BIPV panels are disposed from the 1st floor to the top of the building (8th floor), on a right part of the south gable. The total length of the PV panels area is 7746 mm, for a height of around 18 m. The total area of PV Installation is 130 sqm. There are 14 ranges of 8 PV panels in total. Each panel is fixed on rails. For the part on which the PV panels are installed, a metallic disposal was deployed: on the walls, flat angle brackets were screwed, which support the rails where panels are fixed. It was important for VILOGIA to be able to maintain the panels easily. The structure provider was asked to design it in such way to be able to unfix the broken panel easily and replace it if needed.

Their positioning, the size and the structure were adapted to the specifications of the new future cladding to keep the coherence of the facade drawing and to assure architectural integration. The metallic structure on which the BIPV panels are fixed is aligned with the bottom parts of the lintels of each window and with a future cladding panel line. Every 2 ranges, an aluminium panel is fixed in a random position. The integration of those aluminium panels' "breaks" the black volume of the BIPV field and introduces future cladding, making the BIPV area integrated in the future facade design.

To set up the batteries, inverters and the monitoring devices, constructing of a new technical room was necessary. The building does not provide a lot of space and it was difficult to find enough volume to do it. The first choice was the cellar but because of technical reasons the technical room was transferred to the entrance no.14 corridor. All electrical installations were ready, and all devices programmed to be fully operational at the end of June 2019, although the system commissioning suffered several months delay because of the requirements set out by the technical body responsible for officially certificating the installation, and the bureaucracy associated to the access and exploitation contract.

The electricity production from the BIPV panels will be used to cover part of the electricity consumption for the common spaces of the building: staircases, lights & ventilation. The aim is to consume the local production at its maximum (self-consumption). The excess of production will be sold to an electricity provider.

7.2 Permitting process of Demo-system 5: Apartments building in Lille, France

The town permit for the construction works had been accorded since July 2018. Before beginning the installation, the support of panels, the batteries, inverters and the anti-islanding protection had to be approved by the supervising office in order to guarantee the whole installation. Due to the fact that the technical room couldn't be placed in the basement, the choice of batteries was determined according to the dimensions of the technical room. Also, the electricity meters from the common parts had to be changed. They were replaced with communicative meters so that self-consumption was possible. The monitoring of electricity production could then be easier and more accurate. After all these steps were crossed, installation works could be launched.

In order to obtain the grid permit for connecting the PV installation to the network, discussions with the owner of the network were anticipated in March 2018.

7.3 Commissioning process of Demo-system 5: Apartments building in Lille, France

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

First, it was required to fulfil details about the installation before the connection. The technical specifications were addressed to the grid manager (ENEDIS), and all the information was recorded into a web portal. For this production site, a self-consumption contract was established for the common parts of the building, which is only allowed from April 2017 on, in France. In this contract, the distribution of electricity flows is as follows:

- The common parts will consume in priority the PV production;
- If there is no PV production, the consumption will be withdrawn from the batteries;
- If the batteries are not charged, the excess of production will be sent to an electricity provider.

In this building, there are 4 electricity meters which supply the common parts of the building.

- Entrance 12: the meter supplies the elevator of this part of the building.
- Entrance 13: one meter for general services of the whole building (lights, etc.), one meter for the elevator and the HVAC of this part of the building.
- Entrance 14: the meter supplies the elevator of this part of the building.

The PV installation was connected to the meter in the entrance 14. In the self-consumption contract, this meter is defined as “producer”, and the other 3 meters are “consumers”. To each meter a power (in KVA) is assigned. Before installing PV panels, the power of the entrance 14 meter had to be risen from 9 kVA to 18 kVA, so the meter will accept the PV production and the energy supply will be constant.

On the portal, it is asked to indicate which electricity provider will buy the excess of production. The excess buyer (ENERCOOP) and the owner of PV installation must agree on the terms of the buying contract and declare it to ENEDIS. In the same time, a “responsible of balance” (HYDRONEXT) has to be appointed to protect the network of the variations induced by PV production. This responsible is linked to the excess buyer. After this step, ENEDIS established a quotation for the connection, which VILOGIA pays.

In parallel, the companies must finish their work on site. The most important step is the certification of the conformity of the electrical installation. In France, every installation must be officially certified by a technical organism called CONSUEL (Comité national pour la sécurité des usagers de l'électricité – National Committee for the Safety of Electricity Users). They oversee the check of all electrical installation in France, from the single-house system to PV installations. The technicians visit the demo site, and deliver on the quality of the electrical installation, and its compliance with standards and law texts. Once the approval is given, the certification is delivered by CONSUEL. To fix an appointment, a technical file must be completed by the electrician. The file was submitted mid-July to CONSUEL via their web platform. Usually, the visits take place 2 weeks after the sending, but due to bank holidays, the visit on the demo site was delayed on 4th September.

The visit lasted 2 hours (usually 30 minutes) and was followed by a lot of remarks. The electrician had to manage extra works for bringing the technical room up to standard. Among these remarks, it was asked:

- To add extra security breakers for batteries and PV cables (the ones already disposed on the inverters and batteries were not sufficient regarding the French standards).
- To change the breakers wired to the inverters for “Type B” breakers (the inverters include an electronic Type B protection, which is not sufficient regarding the French standards, this protection must be electro-mechanical).
- To add stickers for preventing technicians from electrical risks.

The works were done in one month and a counter-visit took place on the 24th of October 2019 for a new control. The CONSUEL had no further remark since the technical room now responded to standards, and the room was certified following the visit.

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 (Accord de Rattachement au Périmètre d’Equilibre – 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. The final connection happened on 26th November of 2019. A technician controlled the technical room and the electricity meter on which the PV installation is connected. He turned off the main circuit breaker to verify if the inverters would be in “security” mode and wouldn’t damage the grid.

Once the final connection was done, project partners needed to proceed with final tests, to make sure that EMS was working properly and the installation was properly controlled.

Finally, to ensure a proper operation of the installation for the next years, three tasks have yet to be completed:

- Create an as-built file gathering the description of all the main components of the system and their functioning, as well as the specifications in case they have to be replaced (after the end of PVSITES project);
- Describe the operation scenarios during the project and after the end of PVSITES project, so that the installation can be managed safely locally without the project partners;
- Write a maintenance contract and attribute it after a call for tender. To do so, all maintenance specifications are being gathered from suppliers (including project partners) and installers.

7.4 Pictures and schemes

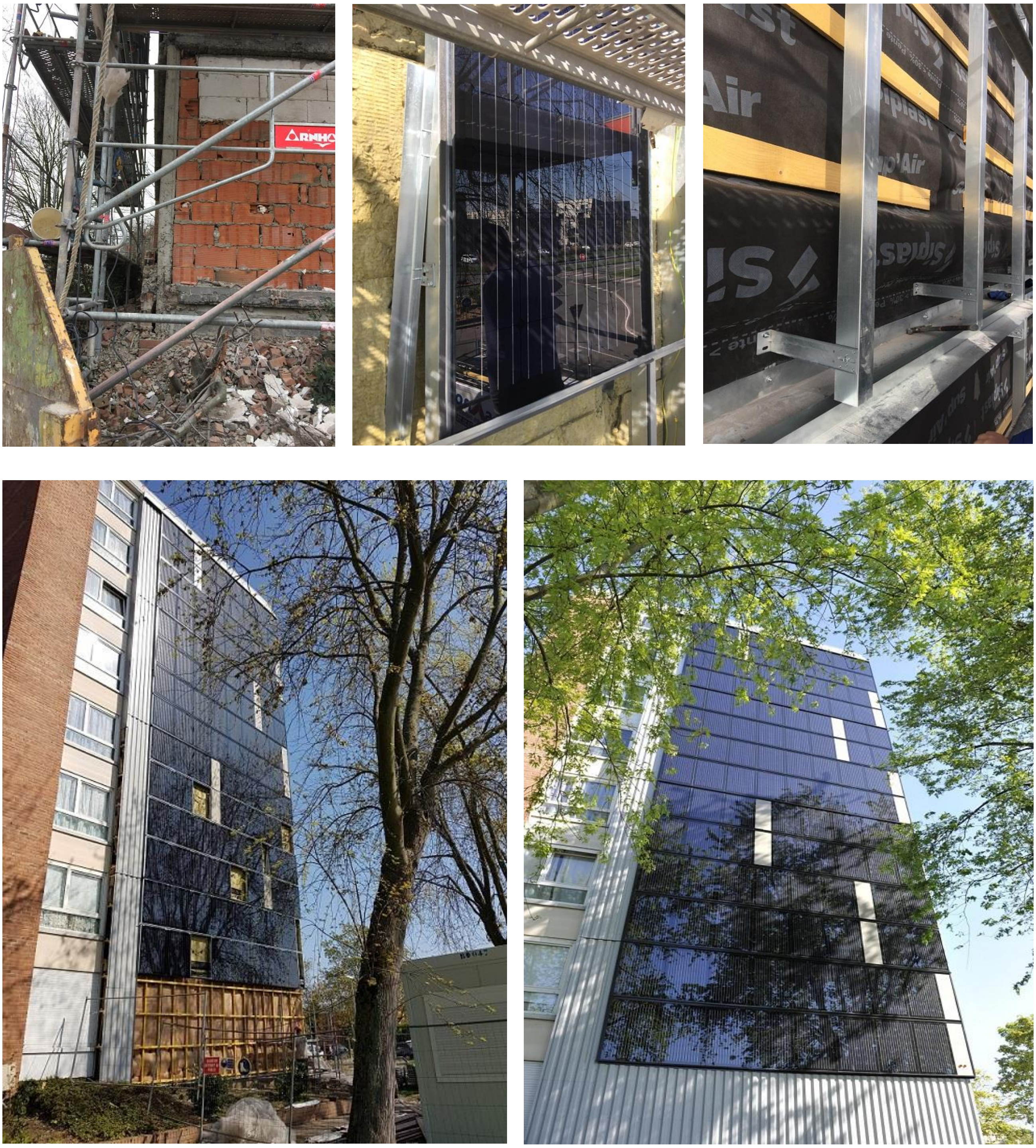


Figure 7.2: Installation and commissioning of Demo-system 5, Apartments Building in France

8 INSTALLATION AND COMMISSIONING OF DEMO-SYSTEM 6: OFFICE BUILDING IN SAN SEBASTIÁN, TECNALIA's HQ, SPAIN

This chapter contents a brief and illustrated report of the installation, permitting and commissioning works related to Demo-system 6, an office building in San Sebastian (Spain).

Figure 8.1: Final results of Demo-system 6, Office Building in Spain

8.1 Description of the installation works

The installation of the BIPV ventilated facade at TECNALIA's office building took place during March 2019. First, onsite measurements of the dimensions of the facade were taken by the installer to verify to what extent the drawings used during the design phase were consistent with the reality and, if needed, propose adjustments to correct possible deviations. After this preliminary verification, the metallic substructure was installed (HILTI, MFT-S2S). Five full working days were required to correctly install the brackets and vertical profiles needed in each facade, mainly due to the complexity introduced by the facet geometry of the facade.

Once the installation of the substructure was finished, the PV installer proceeded with the installation of the BIPV modules and string connection. The dimensions and weight of the glass-glass modules (2225 x 760 mm, 55 kg) made impossible the installation of the modules by a single person, and 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:

1. ‘L’ shaped clips are first fixed to the profiles at the lowest part of the facade.
2. The first BIPV module is placed onto the clips.
3. Next, intermediate ‘T’ clips are fixed, fully 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.
4. The process is repeated for the first row of modules, keeping a 25 mm gap between each module.
5. Step 3 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.

Although, in theory, once the first row of modules was installed verifying the horizontality of the rest of rows should not be required, in reality a module per module verification was finally needed in each row since, in certain modules, one of the glasses was slightly off-centre (one of the glasses protruded a little bit).

The cabling is hidden and carefully organized behind the metal embellishment panels and then taken to the inverters room inside of the building, where the electrical protections, meters, and zero-injection kit are installed. The connection from the inverters to the distribution panel of the building is performed next, allowing the direct self-consumption of the generated energy.

8.2 Permitting process of Demo-system 6: Office building in San Sebastian, TECNALIA’s HQ, Spain

Two permits were required to perform the installation in compliance with the municipal and country legal framework. For the authorisation of the construction works, a construction license appliance was required. The approval of the license was subjected to the presentation of a project endorsed by the architecture school, describing the building, the works to be carried out, drawings, and the justification of the compliance with the standardisation framework in force. A Safety Coordinator was selected to guarantee that the installation works were performed safely. The answer with the approval from the municipality was received 2 months after the submission of the documentation.

On the other hand, a license appliance was also required for the legalisation of the PV installation. The process 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 revision of the PV legal framework (RD 244/2019 for self-consumption) in Spain during the project design. The installation has been declared as ‘without excess energy’ and a ‘zero-injection’ kit was installed to guarantee the functioning of the installation under this modality.

8.3 Commissioning process of Demo-system 6: Office building in San Sebastian, TECNALIA's HQ, Spain

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.

8.4 Pictures and schemes

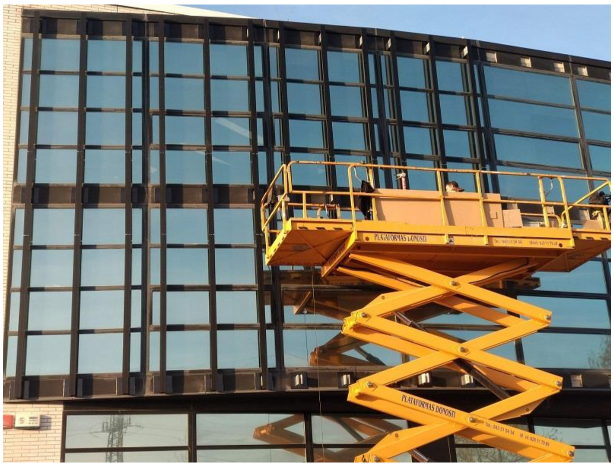


Figure 8.2: Installation and commissioning of Demo-system 6, Office Building in Spain

9 CONCLUSIONS

As a conclusion, the most relevant achievements, difficulties or comments related to every demo, regarding the installation, permitting and commissioning actions carried out in each case are summarized.

Installation

- Demo 1. Single House in Belgium: excellent planning and execution of installation works; thanks, among others, to the careful architectural integration design in a new building highly conducive to accept BIPV solutions. But it has required millimetric works.
- Demo 2. Educational Building in Switzerland: success of the methodic manufacturing process of the facade tiles. The system has been finished and commissioned.
- Demo 3. Solar carports in Switzerland: EKZ: successful carport design and installation maintaining the design stile of the previous carport. The new carport allows the electric vehicles charging. Works carried out in between December, 2017 and June, 2019. EMPA: in this case, the new product has demonstrated its capability to adopt an EMS to the existing in the demo-site's facilities.
- Demo 4. Industrial Building in Spain: the installation executed between June, 2019 and July, 2019. The efforts dedicated to the architectural integration design phase have brought good results on site, making easy the installation works.
- Demo 5. Apartments Building in France: the final integration design was quite conditioned to aesthetical criteria, related to the architectural design of the building retrofit in process; the effort dedicated to this aspect has provided not only a good functional result, but also a great aesthetic appearance.
- Demo 6. Office Building in Spain: installation works took place during March, 2019. The singular geometry of the existing facade has required specials efforts during the architectural integration design phase and the installation works. Despite of difficulties, final result was highly satisfactory.

Permitting

- Demo 1. Single House in Belgium: relatively easy permitting process with short deadlines. Special aesthetic characteristics were required to get the construction allowance of the municipality.
- Demo 2. Educational Building in Switzerland: long and difficult permitting process for achieving the construction allowance, which prolonged the undertaken of the parallel and subsequent tasks more than initially expected. Nevertheless, everything was finally solved and installation is currently being finished.
- Demo 3. Solar carports in Switzerland: EKZ: the first permission requested was denied by the municipality. It was necessary to justify the suitability of the location proposed by the partner responsible. EMPA: there was no problem to get the needed permission, because the carport is located in a private zone, far from public areas or private households.

- Demo 4. Industrial Building in Spain: relatively easy permitting process. Last changes in the Spanish self-consumption legislation raised some doubts, currently in the process of being resolved, about the way of connecting the system to the grid.
- Demo 5. Apartments Building in France: municipal allowance achieved on June 2018, after a long and difficult permitting process due to the public housing character of the demo-building. For this reason, parallel and subsequent tasks suffered important delays for this demo-site. Today, the demo-system is successfully installed and legalized.
- Demo 6. Office Building in Spain: Different permissions were required, related to the construction works and the self-consumption PV system. All of them were achieved with no significant problems.

Commissioning

- Demo 1. Single House in Belgium: commissioning executed as planned. The use of the non-commercial inverter was accepted by the grid manager, by means of a special agreement. Some economic aspects have changed in the Belgian legislation; so that, from 2020, the PV system owner will have to pay a tax for the power reinjected into the grid.
- Demo 2. Educational Building in Switzerland: commissioning process was successfully carried out just after the end of the installation works.
- Demo 3. Solar carports in Switzerland: commissioning of the two carports executed as planned. No problem detected.
- Demo 4. Industrial Building in Spain: commissioning was carried out in the second week of July 2019, once finished the installation works.
- Demo 5. Apartments Building in France: commissioning was carried out at the end of November 2019, after a long and tricky permitting process: it was necessary to meet several technical conditions, to sign an agreement with the electricity provider and to get a permission for the grid connection.
- Demo 6. Office Building in Spain: commissioning carried out according to the new Spanish self-consumption legislation.

Final conclusion

- In general terms, installation, permitting and commissioning works have been carried out satisfactorily, considering difficulties existing in some cases, mainly related to the permitting processes.
- All demo-systems will be monitored until the end of the project for the assessment of the power performance and the integration effectiveness in the chosen real scenarios, among which a wide range of constructive functionalities and energy uses are included.
- From this analysis, and from the experience gained by the implementation of the demo-systems, the most suitable guidelines and recommendations will be suggested for a successful market replication of the products developed in PVSITES project (D8.17 and D8.18).