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PVsites

E-catalogs of BIM objects for the PVSITES products

Project report

CADCAMATION

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www.pvsites.eu

Summary

This deliverable summarizes the current state for the digital catalog - eCatalog - of PVSITES BIM objects for the PVSITES products in its pre-commercial version to date (M23) and its related exploitable results. It characterizes the distinctive functionalities, connections, maturity levels and steps needed to maximize exploitation, market uptake and commercialization. It is part of WP7 (BIPV software tool) and specifically of T7.2 "BIM objects for PVSITES products".

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The present report was mainly prepared by PVSITES project partner CADCAMATION. The report was originally submitted to the European Commission as Project Deliverable D7.5 in December 2017.

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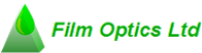

About the PVSITES project

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

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

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

The PVSITES consortium:

<p>Tecnia Research & Innovation</p> 	<p>CTCV</p> 	<p>FormatD2</p> 
<p>Onyx Solar</p> 	<p>Flisom</p> 	<p>Vilogia</p> 
<p>BEAR-ID</p> 	<p>Cricursa</p> 	<p>R2M Solution Research to Market</p> 
<p>Nobatek</p> 	<p>CEA</p> 	<p>CADCAMation</p> 
<p>Film Optics</p> 	<p>Acciona Infraestructuras</p> 	<p>WIP - Renewable Energies</p> 

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1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

This deliverable summarizes the current state for the digital catalog - eCatalog - of PVSITES BIM objects for the PVSITES products in its pre-commercial version to date (M23) and its related exploitable results. It characterizes the distinctive functionalities, connections, maturity levels and steps needed to maximize exploitation, market uptake and commercialization. It is part of WP7 (BIPV software tool) and specifically of T7.2 “BIM objects for PVSITES products”.

T7.2 activities will continue all along the project duration with the development of enhanced versions of the eCatalog, web services through the platform and the final commercial version of the BIPV tool. These activities are documented in this deliverable (D7.5). They constitute a research and development effort to create BIPV virtual objects (3D, parametric and BIM ready), challenged by testing activities (real projects, real objects) and real data comparison to ensure readiness towards market entry, and at the same time advising on the development routes to increase the strengths while limiting the weaknesses of the technical and economic models linked to digital simulation and prediction.

The deliverable content is all about virtualization of PVSITES products (called “BIM objects”), software and BIM specifications, users interfaces and development process (AGILE and SCRUM methodologies).

The description of the BIM objects themselves is made through screenshots of the user interface and mind mapping graphs.

1.2 Relation with other activities in the project

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

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

Project activity	Relation with current deliverable
T7.1	T7.1 provides a standalone simulation tool for BIPV services developed with a SaaS strategy (SOA). The PVSITES simulator is able to dialog with the PVSITES online platform to perform 3D display for the scene, main outcomes from simulation, in line with the users’ needs (watch, check, share) and the manufacturers’ innovations and objectives on the market
T1.1	Market and stakeholder analysis and needs
T1.4	Competence analysis, identification and management of exploitation results
T1.7	Commercialization, replication plan and market uptake
T1.8	Global risk analysis and mitigation
WP2	From market and legal requirements to system specifications (BEAR)
WP8 – D8.2	Large scale demonstration and assessment of BIPV systems in real buildings. Modelling of the demo buildings with BIPV systems

1.3 Abbreviation list

- AEC: Architecture, Engineering and Construction
- BIM: Building Information Modelling
- BIM Object: digital counterpart of a real PVSITES product
- BIPV: Building Integrated Photovoltaic
- CMS: Content Management System
- DoA: Description of Action
- ER: Exploitation Results
- eCatalog: Digital library of PVSITES products (BIM objects)
- GUI: Graphical User Interface
- nZEB: Nearly Zero Energy Buildings
- PV: Photovoltaic
- SaaS: Software as a Service
- SOA: Service Oriented Architecture
- SPEC: Technical specification
- UI: User Interface
- US: User Story
- WP: Work Package
- ZEB: Zero Energy Buildings

2 INTRODUCTION & METHODOLOGY

BIM objects as a means to integrate CAD software and BIM processes are today a new trend and a real opportunity for parametric modeling of various products, but still a challenge for energy modeling and simulation issues. Because of the lack of BIM objects for BIPV products, CADCAMation, as WP7 leader, is making use of its strong experience in BIM software development to innovate with BIPV components generator/configurator and virtual workspace integration to provide customizable services.

The aim is to create a specific PVSITES library, BIM ready, called “PVSITES eCatalog”, to deal with the PVSITES software for simulation issues and with the PVSITES platform for webServices. This eCatalog will focus on PVSITES products specifications and performance, connected, on one hand to the manufacturers datasheets (WP3, WP4) and on the other hand to the PVSITES simulation tool (standalone solution, see D7.2). This library will specify and showcase BIM objects for PVSITES products. This means that it will provide the market with not sophisticated but user friendly and realistic virtual objects (featuring innovation through assembled virtual components such as cells, modules, tiles, glazing systems, framing, mounting and fixing devices). These BIM objects should perform technical but also architectural benefit in the same interface to bridge the gap between BIPV products manufacturers, architects and owners.

The specific objectives for the PVSITES BIM objects and task T7.2 are the following:

- To develop the next generation of graphical user interfaces (GUIs) and configurators of BIM objects dealing with every upstream BIPV issues (WP2, from market and legal requirements to system specifications);
- To bridge the gap between BIPV products manufacturers and system designers (WP3, WP4, WP5, WP6) using integrated dynamic simulation provided by the PVSITES software;
- To provide users of leading BIM software in the market (Autodesk REVIT® as the first one) with BIM ready BIPV objects to integrate and improve the master digital workspace from the earliest phase of the project;
- To implement innovative services inspired by the Business Model analysis done in WP1 of PVSITES project (D1.13, M12).

2.1 Specifications

We use a slight and fast methodology to specify and develop BIM objects related to the PVSITES software in the same time: AGILE/SCRUM process:

1. First are the Users Stories (US): the experts express their wishes and the way they consider each functionality, each result and report;
2. The US are written or gathered by CADCAMation, and transmitted to the development manager, and then reviewed, discussed and validated;
3. The development team starts to design GUI and code in the same time as every US are turned into SPECIFICATIONS (Procedures>Documents>Recordings); these specifications are updated as often as needed following the PVSITES real products iterations;
4. As the PVSITES software is pushed forward through chronologic iterations, and versions, the BIM objects follow the same flow, sticking to the PVSITES Management Plan (and mainly to WP8 “Large scale demonstration and assessment of BIPV systems in real buildings”);

- Modelling and simulation of the demo buildings with PVSITES eCatalog. The development process is live and never ends until the end of the project.

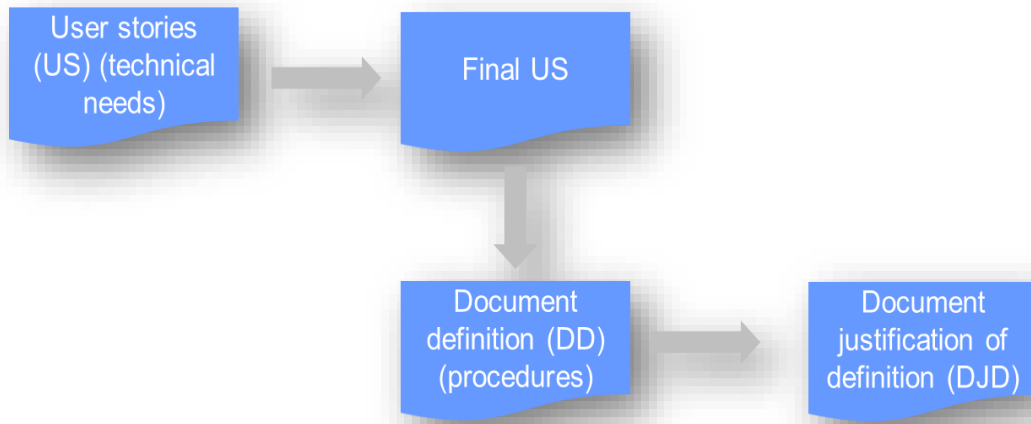


Figure 2.1: User Story process

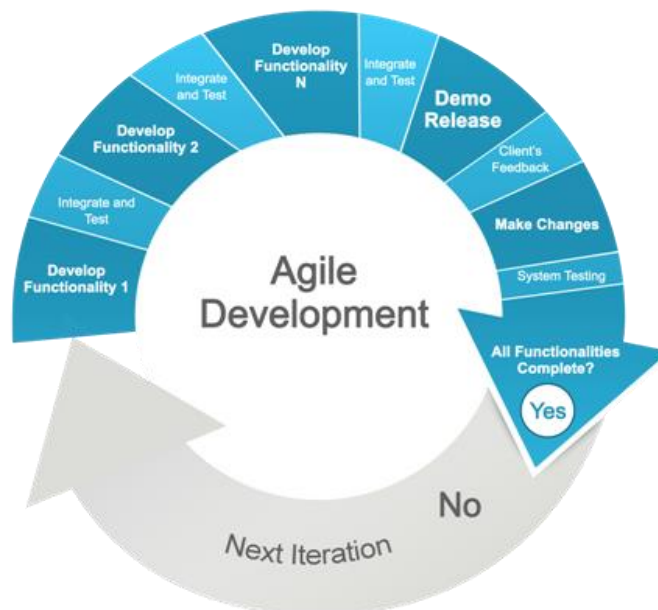


Figure 2.2: AGILE development

2.2 Software coding

The baseline for the design and the coding work comes from the requirements definition, software design and the models implemented in the software. CADCAMation translates the models and GUIs into C++ language, JavaScript, WebGL for dynamic 3D interfaces, json exporter, and optimizes the performance regarding the SaaS requirements.

BIM connection: Autodesk REVIT® connection is developed through dedicated plugin technology which is a specialty of CADCAMation team. This plugin should parameterize brand new REVIT families of PVSITES BIM objects in dynamic mode from the contextual simulation workspace.

Debugging and alpha testing (CADCAMation)

As a key stage of software development, a rigorous testing process is carried out for each version, in order to check the compliance with the established requirements and the rest of features that are essential for the quality of the final service. Bugs within the code are traced and corrected. Performance against requirements, as well as connection procedures, databases, and even support documentation, webinars, will be tested as soon as they will be implemented.

External Beta testing (every early adopter)

Early adopters coming from our dissemination process with an “end-user” profile will generate continuous feedback. They will be interviewed not only on results and technical features, but also on easiness-of-use, realistic uses cases and suggestions from improvement within commercial issues.

This data collection is aimed at feeding our improvement process and business modeling.

3 SPECIFICATIONS FOR THE BIM OBJECTS OF PVSITES PRODUCTS (BETA VERSION, PRE-COMMERCIAL VERSION)

The following US are a summary of the preliminary list of User Stories, specifications and issues that are currently being developed and constitute the vision of the partners. Each US is assigned to a manager who is responsible for providing information and updates on the writing, defining the steps needed to reach full commitment with the development team and testing it eventually with selected experts. This AGILE process is managed and supported by CADCAMation.

Table 3.1: List of Users Stories to specify the PVSITES eCatalog of BIM objects

#	TASK	User Story	US Manager
2.1	T7.2	General framework for the PVSITES BIM objects	CADCAMATION
2.2	T7.2	General framework for the PVSITES eCatalog	CADCAMATION
2.3	T7.2	X1-X4 Products: FLISOM BIM objects	CADCAMATION
2.4	T7.2	X5-X6 Products: ONYX Solar BIM objects	CADCAMATION
2.5	T7.2	X9-X11 Products: TECNALIA BIM objects	CADCAMATION
2.6	T7.2	WEBSERVICE #5: on line eCatalog	CADCAMATION

3.1 General framework for the PVSITES BIM objects

In their pre-commercial version, the PVSITES BIM objects are designed and embedded within the PVSITES simulation software (standalone). The full BIM potential will be developed as soon as the real products and the related physical models will be validated in real conditions.

The general framework next page describes how a BIM object is generated.

As a summary:

STEP#1 - CELL EDITOR: at cell level, all the parameters needed to display the aesthetical appearance and electrical production are set;

STEP#2 – GLASS/INTERLAYER EDITOR: defines the glazing system and calculates its optical and thermal performance according to the relevant European standards;

STEP#3 - GLAZING EDITOR: defines the glazing system including the cell distribution and calculates its optical and thermal properties according to the applicable European standards.

STEP#4 - MODULE/FRAMING EDITOR: at module level, every required parameter is set so as to display aesthetical appearance, building integration, electrical production, thermal, daylight and visual gains;

STEP#5 - MOUNTING/FIXING EDITOR: for BIM readiness issues, a specific mounting/fixing configurator must be developed to bridge the gap between PV layout and building structure.

BIM connection: once generated in the contextual workspace of PVSITES software, in Production Information Management mode, also validated in realistic integration on a building skin, the PVSITES objects should be translated into compatible parametric objects within CAD solutions, in central position in most of BIM processes. This is made possible only in native coding, i.e. through dedicated plugin. For instance, we started developing Autodesk REVIT® plugin as a commercial priority.

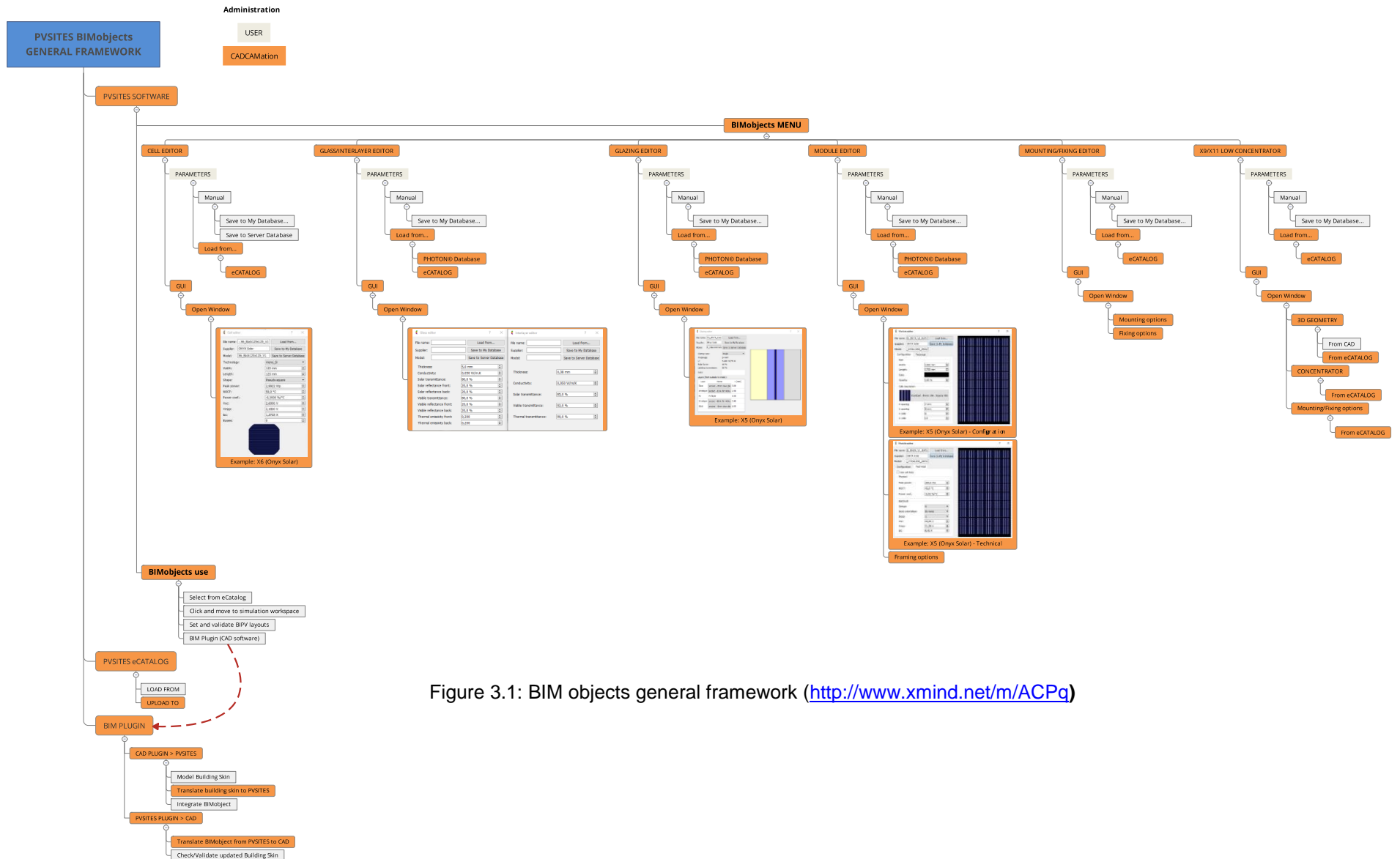


Figure 3.1: BIM objects general framework (<http://www.xmind.net/m/ACPq>)

E-catalogs of BIM objects for the PVSITES products

3.2 General framework for the PVSITES eCatalog of BIM objects

In its pre-commercial version, the PVSITES eCatalog is designed and embedded within the PVSITES simulation software (stand alone). The full potential will be performed through the Web platform of services (PUBLIC), and will be developed as soon as the real products and the related physical models will be validated in real conditions.

The general framework in next page describes how the eCatalog should be managed.

As a summary:

- eCatalog MENU inside PVSITES Software: a specific menu enables showcasing the PVSITES BIM objects and allows the user to sort them to perform various strategies for the project;
- eCatalog on the WEB: more effort is put to showcase virtual PVSITES products and their performance, innovation, attractiveness for ZEB/nZEB projects. This is a part of the PVSITES web platform of services coupled or embedded in the official PVSITES website;
- Every commercial message and materials from the partners should be linked to the contextual use of specific PVSITES BIM objects within the BIM processes of the largest community of users.

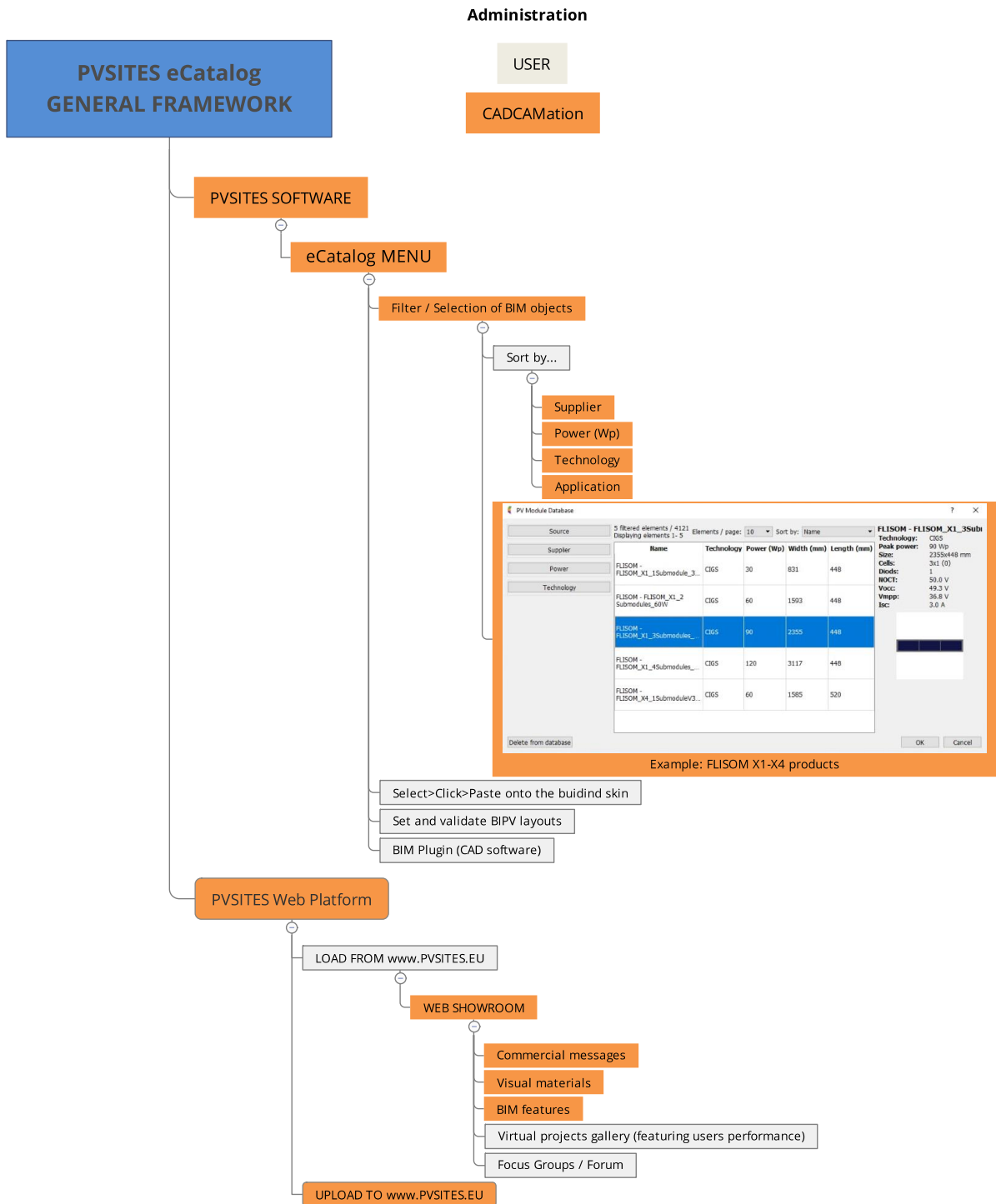


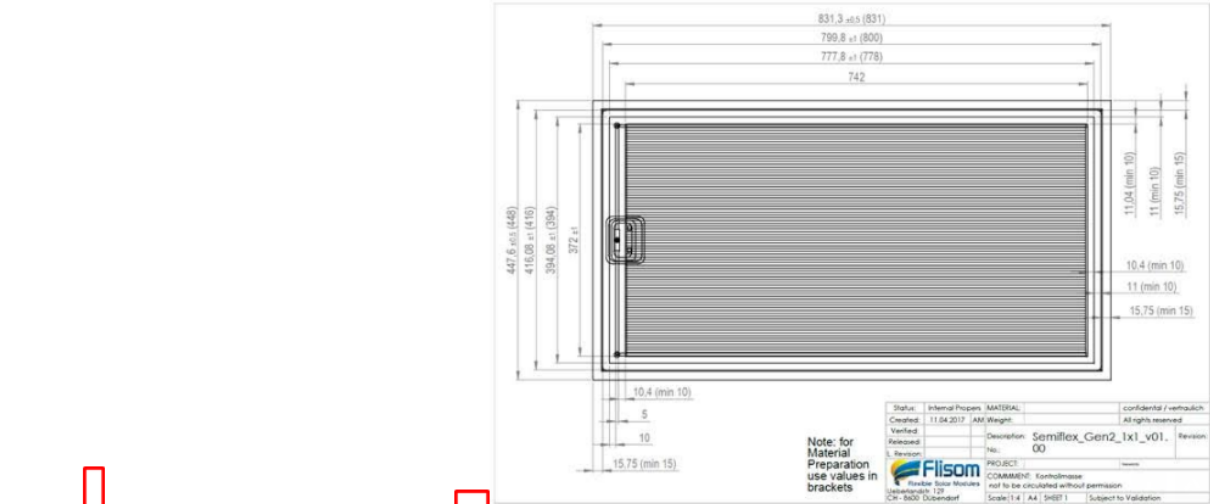
Figure 3.2: PVSITES eCatalog global framework

3.3 X1-X4 Products: FLISOM BIM objects

The virtual PVSITES objects for FLISOM products have been developed all along the specification of real ones regarding demo sites issues.

At the end of M23 the pre-commercial version of the FLISOM part of the PVSITES eCatalog is achieved. The portfolio of FLISOM BIM objects is based on a unique SUBMODULE specification, due to CIGS technology features.

Our submodules have the dimension 372mm x 742mm and consists of 80 cells.
The cells have a dimension of 4.5mm x 734mm. There is a 6 mm wide strip at both edges for the contact.



The electrical data's of one submodule:

output		
submodule Power [W]	30.00	W
total power	30.0	W
Efficiency	11.30	
Isc	1.00	A
Voc	49.25	V
FF	0.61	
Vmpp	36.83	V
Impp	0.81	A

Up to 4 submodules can be placed in a row. With 4 submodules you will reach a total power of 120 W.

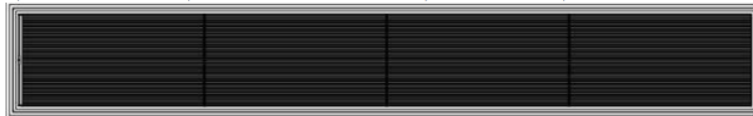


Figure 3.3: FLISOM CIGS submodule (specifications)

Within PVSITES software, this submodule equates to a cell. More feedback from real products is needed to adjust settings and at last to feature KPIs. Modules are generated from this unique submodule.

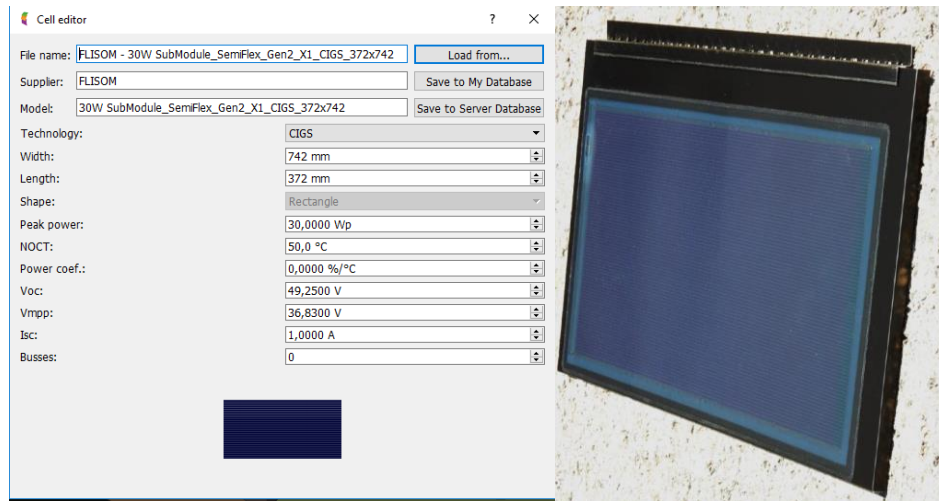


Figure 3.4: FLISOM CIGS submodule (eCatalog) and real appearance as a module

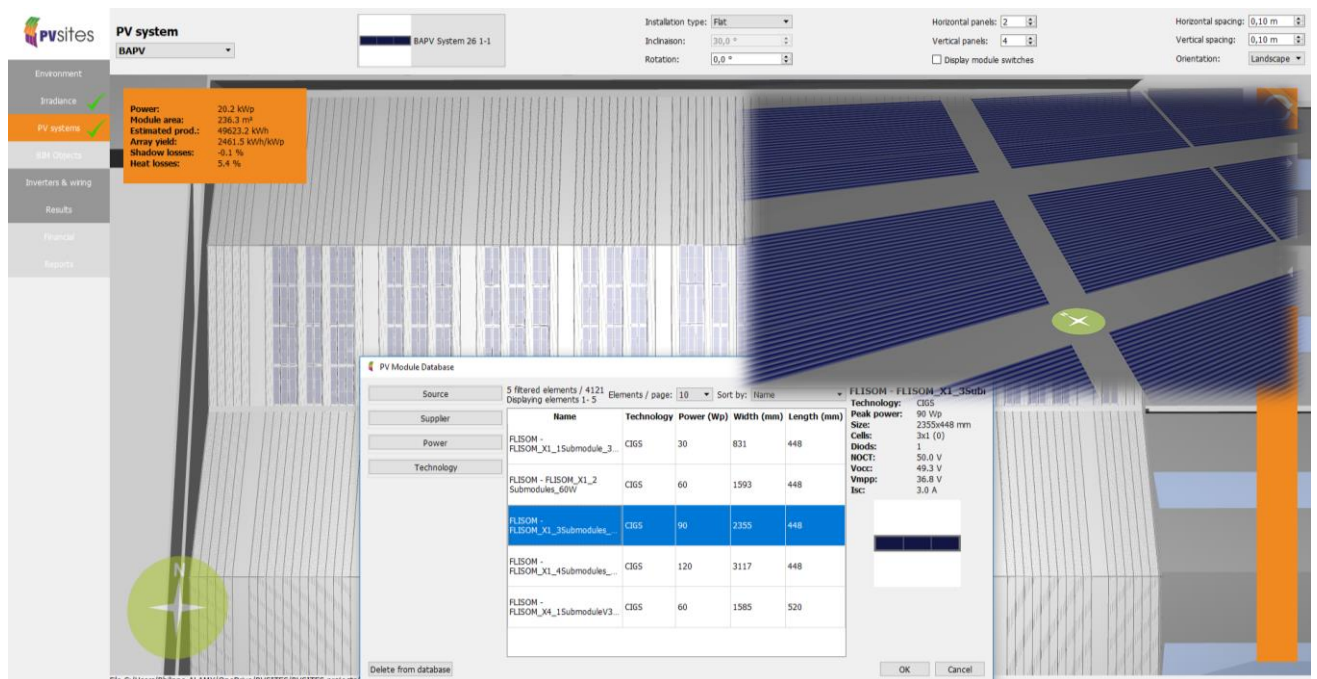


Figure 3.5: FLISOM CIGS modules (eCatalog opened for use in CRICURSA demo site)

3.4 X5-X6 Products: ONYX Solar BIM objects

The virtual PVSITES objects for ONYX Solar products have been developed all along the specification of real ones regarding demo sites issues.

At the end of M23 the pre-commercial version of the ONYX Solar part of the PVSITES eCatalog is achieved.

PHOTOVOLTAIC GLASS		1700 x 1000	
		6" Mono	Crystalline
Electrical data test conditions (STC)			
Nominal peak power	260	P_{mpp}	(Wp)
Open-circuit voltage	40,60	V_{oc}	(V)
Short-circuit current	8,45	I_{sc}	(A)
Voltage at nominal power	31,50	V_{mpp}	(V)
Current at nominal power	8,28	I_{mpp}	(A)
Power tolerance not to exceed	±10	%	
STC: 1000 w/m ² , AM 1.5 and a cell temperature of 25°C, stabilized module state.			
Mechanical description			
Length	1700	mm	
Width	1000	mm	
Thickness	13,8	mm	
Surface area	1,70	sqm	
Weight	51,00	Kgs	
Cell type	6" Mono	Crystalline	
No PV cells / Transparency degree	60	0%	(Opaque)
Front Glass	6 mm	Hidden connections	
Rear Glass	6 mm	Tempered Glass+Black fit	
Thickness encapsulation	1,80 mm	EVA Foils	
Category / Color code			
Junction Box			
Protection	IP65		
Wiring Section	2,5 mm ² or 4,0 mm ²		
Limits			
Maximum system voltage	1000	V_{sys}	(V)
Operating module temperature	-40...+85	°C	
Temperature Coefficients			
Temperature Coefficient of P_{mpp}	-0,451	%/°C	
Temperature Coefficient of V_{oc}	-0,361	%/°C	
Temperature Coefficient of I_{sc}	+0,08	%/°C	

* All technical specifications are subject to change without notice by Onyx Solar

PHOTOVOLTAIC GLASS		2250 x 750	
		5" Mono	Crystalline Back Contact
Electrical data test conditions (STC)			
Nominal peak power	191,5	P_{mpp}	(Wp)
Open-circuit voltage	41,60	V_{oc}	(V)
Short-circuit current	5,70	I_{sc}	(A)
Voltage at nominal power	34,88	V_{mpp}	(V)
Current at nominal power	5,49	I_{mpp}	(A)
Power tolerance not to exceed	±10	%	
STC: 1000 w/m ² , AM 1.5 and a cell temperature of 25°C, stabilized module state.			
Mechanical description			
Length	2250	mm	
Width	750	mm	
Thickness	13,8	mm	
Surface area	1,69	sqm	
Weight	50,63	Kgs	
Cell type	5" Mono	Crystalline Back Contact	
No PV cells / Transparency degree	64	39%	
Front Glass	6 mm	Tempered Glass Low-Iron	
Rear Glass	6 mm	Tempered Glass	
Thickness encapsulation	1,80 mm	EVA Foils	
Category / Color code			
Junction Box			
Protection	IP65		
Wiring Section	2,5 mm ² or 4,0 mm ²		
Limits			
Maximum system voltage	1000	V_{sys}	(V)
Operating module temperature	-40...+85	°C	
Temperature Coefficients			
Temperature Coefficient of P_{mpp}	-0,30	%/°C	
Temperature Coefficient of V_{oc}	-1,74	mV/°C	
Temperature Coefficient of I_{sc}	3,50	mA/°C	

* All technical specifications are subject to change without notice by Onyx Solar



Figure 3.6: ONYX Solar Modules Specifications and appearance (X5-X6 products)

Modules are generated from cells and glazing components within the BIM objects configurators.

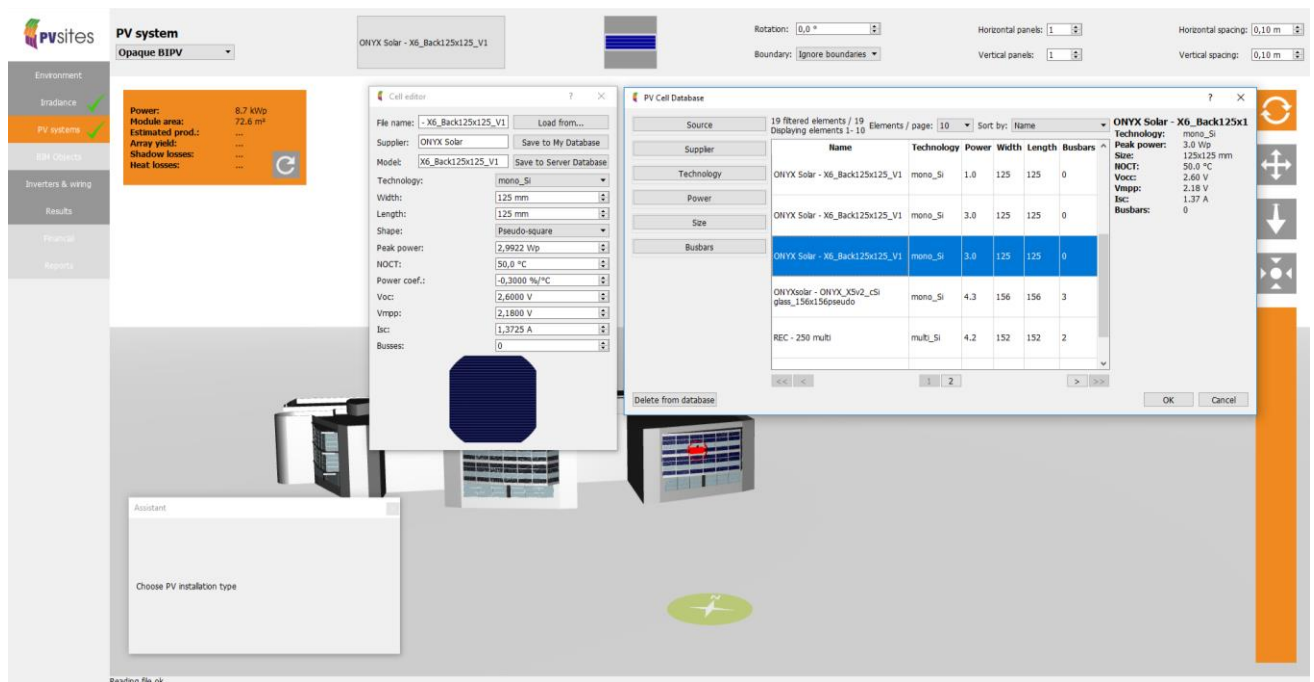


Figure 3.7: ONYX Solar back contact X6 modules (eCatalog opened for use in TECNALIA demo site)

3.5 X9-X11 Products: TECNALIA BIM objects (on-going)

The virtual PVSITES objects for low concentration c-Si Skylight products (innovation with TECNALIA) are still under development and we use 3D SketchUp® files and specific physical models from TECNALIA as sources for design and calculation.

At the end of M23 a pre-commercial version of BIM objects is not yet available. This product involves a very complex optical description whose translation into BIM is still under development.

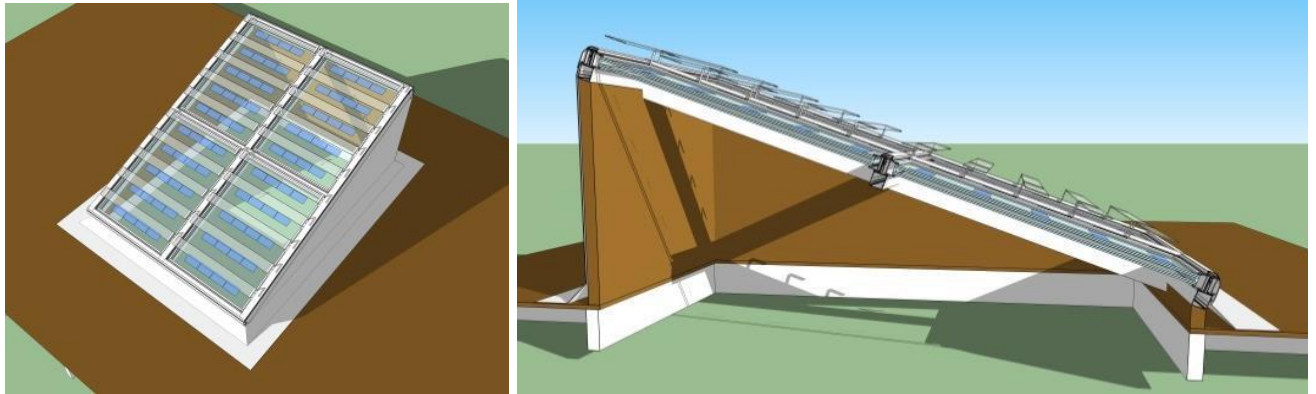


Figure 3.8: General view of low-c c-Si skylight system integrated with 20° inclination. (3D sketches from TECNALIA)

3.6 WEBSERVICE #5: on line eCatalog (on-going)

The main issue for the PVSITES eCatalog is to be a pillar of the business strategy. Because BIM came to be the central focus towards digitization of building industry.

The “eCatalog” should bridge the gap between BIM workspaces for designers and techno-marketing dimension for manufacturers.

In fact, we decided to address both technical and marketing issues using the web platform as the first dynamic link between every stakeholder to a project.

The Webservice #5 (under development) aims at providing our users, community members, with the best focus on innovation in products regarding their project needs.

The “eCatalog” menu and page in the platform should showcase product innovation and address project needs in the same time.

A contextual assistant will guide the visitor through successful uses of PVSITES projects, best stories on real building (demo sites) and even virtual ones.

A questionnaire should ask for issues regarding architectural integration, regulation, sustainability and thermal performance, electrical production.

The platform should deliver a set of proposals with BIM objects and more information from manufacturers. The visitors should eventually be able to drag and drop the BIM objects into the virtual workspace (PVSITES software) of build their own eCatalog into the software.

Manufacturers should be connected to prescribers through a “ask for support” button or virtual assistant.

The web service will automatically synchronize the preferred BIMObjects between web platform and PVSITES software, using the user profile and learning from each case study.

4 RESULTS – OVERVIEW OF THE PRE-COMMERCIAL VERSION

In the following table, for each US (User Story) introduced above, more details are presented to establish the statement of the development of the current version of the eCatalog and guarantee a better visibility to the PVSITES consortium. Specifically, for each US we describe the innovative features under development, or already completed.

4.1 US and development statement (pre-commercial version)

Table 4.1: Expanded view of the US registration list as “ER table” for the software use before next task

#	TASK	User Story	US Manager	Completed features (Pre-commercial version)	Under development or expected (commercial version)
2.1	T7.2	General framework for the PVSITES BIM objects	CADCAMATION	<ul style="list-style-type: none"> • Structure implemented into the software • BIM object editors/configurators completed 	<ul style="list-style-type: none"> • Product Information Manager (PIM) connected to the web platform • Parameters enhancement • BIM connection to CAD
2.2	T7.2	General framework for the PVSITES eCatalog	CADCAMATION	<ul style="list-style-type: none"> • Framework completed • Prototype #1 under beta test (public) 	<ul style="list-style-type: none"> • Integration into the web platform • Web development matching with business models towards final release
2.3	T7.2	X1-X4 Products: FLISOM BIM objects	CADCAMATION	<ul style="list-style-type: none"> • Prototypes #1 completed • Simulation on demos sites completed (D8.2) 	<ul style="list-style-type: none"> • Mounting/fixing editor • BIM translation to CAD software
2.4	T7.2	X5-X6 Products: ONYX Solar BIM objects	CADCAMATION	<ul style="list-style-type: none"> • Prototypes #1 completed • Simulation on demos sites completed (D8.2) 	<ul style="list-style-type: none"> • Mounting/fixing editor • BIM translation to CAD software
2.5	T7.2	X9-X11 Products: TECNALIA BIM objects	CADCAMATION	<ul style="list-style-type: none"> • Definition of prototype #1 completed • Optical, geometrical and electrical specifications 	<ul style="list-style-type: none"> • Prototype #1 completed • Simulation on demos sites completed
2.6	T7.2	WEBSERVICE #5: on line eCatalog	CADCAMATION	<ul style="list-style-type: none"> • User story validated • Prototypes of page using WordPress® templates 	<ul style="list-style-type: none"> • Virtual visit and showcasing • Contextual assistant

5 CONCLUSIONS

This deliverable reports the development framework of the PVSITES eCatalog of BIM objects, related to real PVSITES products from manufacturers and modeling issues at element and building level.

M23 statement for the early pre-commercial version focuses on graphical user interfaces (GUIs) and configurators of data within the PVSITES software to deliver crucial information to users.

Most of the User Stories have been identified, turned to specifications, and development is still ongoing. Main outcomes are:

- BIM object mode completed inside the PVSITES software, for X1 to X6 commercial products;
- First use cases completed on demo site using 3D modeling from architects; refer to D8.2 Result of modeling and BIPV strategies for every demo site;
- Pre-commercial version of PVSITES eCatalog is open to public use through web access.

The main objective now is to continue on improving the quality of the GUIs, standalone and into the web platform, specifying, developing and validating BIM objects compatibility between the PVSITES workspace (simulation) and the worldwide BIM community of CAD users, Autodesk REVIT® being the priority.

6 REFERENCES

- [1] BIM object definition: The National Building Specification (NBS, UK)
https://www.designingbuildings.co.uk/wiki/BIM_object
- [2] WebGL: Khronos Group
- [3] JSON: JavaScript Object notation
<https://www.json.org/>