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PLUG-AND-USE RENOVATION WITH ADAPTABLE LIGHTWEIGHT SYSTEMS



D5.3 BIM Library

Version: 1.0

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Table of contents


1.	Publishable summary	5
2.	Executive summary	5
3.	Introduction	6
3.1	Relation with other WPs	6
3.2	Objectives	6
3.3	Document structure	6
4.	Inventory library	7
4.1	Gathering and analysis of information	7
4.2	Database of the BIM Elements for the envelope systems.....	8
4.3	BIM Modelling	8
5.	BIM objects for the PnU kits	9
5.1	Gathering and analysis of information	9
5.2	Database of the PnU kits and components	10
5.3	BIM Modelling	11
6.	Parametric BIM models for six demo cases	13
6.1	Gathering and analysis of information	13
6.2	BIM Modelling	13
7.	File repository in the CDE	15
8.	Conclusion	16
9.	References.....	16
10.	Annexes	16

List of figures

Figure 1: Master files containing the building elements of the six demo sites building envelopes.	8
Figure 2: Set of defined properties and non-defined values for a window.	9
Figure 3: Separate files of the PnU components available in the 2_PnUkits folder.	11
Figure 4: View of the BIM elements as components for the PnU kits.	12
Figure 5: Selection of envelope sections of the demo sites (left) and resulting bim models (right).	15

List of tables

Table 1: List of documents provided for the definition of the Inventory Library of building envelopes.	7
Table 2: Classical and Extended functions performed by Plural envelope systems.	10

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Terms, definitions, and abbreviated terms

GA	Grant agreement
EU	European Union
EC	European Commission
FP7	Seventh Framework Programme
H2020	Horizon 2020 Project
PLURAL	Plug-and-Use Renovation with Adaptable Lightweight systems
CDE	Common Data Environment
CZ	Czech Republic
ES	Espana
GR	Greece
PnU	Plug and Use
MODEST	Multi-objective Decision Support Tool
AMScope	AMS Control Panel
WP	Work Package
D	Deliverable
DST	Decision Support Tool
3D	Three-Dimension
BIM	Building Information Modelling
LOG	Level of Geometry
LOI	Level of Information

1. Publishable summary

2. Executive summary

This document, D5.3 of the PLURAL project, presents the creation of BIM components and databases with integrated environmental information to perform the assessment of the PLURAL solutions. The delivery consists of the BIM library formed by building elements of existing and new envelopes, the PNU kits and a PLURAL prototype of every Demo for achieving T5.5, T4.4 and T6.4. The BIM Library has been developed considering the requirements stated in D5.1.

The present document is based on the outcome of WP1 (D1.4), WP2 (D2.1, D2.2 and D2.6), WP4 (D4.1, 4.2 and D4.3) and WP7 (D7.1 and corresponding Annexes) of the PLURAL Project.

3. Introduction

3.1 Relation with other WPs

The present document is based on the outcome of WP1 (D1.4), WP2 (D2.1, D2.2 and D2.6), WP4 (D4.1, 4.2 and D4.3) and WP7 (D7.1 and corresponding Annexes) of the PLURAL Project.

The delivery is the BIM library for T5.1 based on the requirements stated in D5.1. Besides the already created BIM elements, the BIM Library will enable to produce further PLURAL prototypes and digital PnU kits for T5.5, T4.4 and T6.4.

3.2 Objectives

The main purpose of the task was to create and offer BIM objects for digitalizing the PnU kits with information according to the requirements stated in D5.1. The BIM components should contain integrated environmental information to perform an assessment of the new buildings in the BIM based big data management platform (StreamHandler) and Decision Support Tool (DST) to select the optimal elements, integration, speed, low-cost manufacturing and installation for obtaining the most suitable PnU kit for different European climates and residential building typologies. The usability of the BIM objects should also allow parametric BIM modelling of new construction solutions.

The deliverable is the BIM library containing:

- Inventory of BIM objects from the existing building envelopes and renovation solutions
- BIM objects for the PnU kits
- Parametric BIM models of the new construction solutions for all demo cases (the PnU kits applied on the buildings).

This document presents the folders and files in the PLURAL Common Data Environment that contain the BIM library.

3.3 Document structure

The document is divided in the following parts: a brief (3) Introduction and objectives, (4) Presentation of the inventory list of BIM objects for the existing building envelopes and renovation solutions, (5) Presentation of the BIM objects for the PnU kits, (6) Presentation of the parametric models for all 6 Demo cases, (7) Explanation of the file repository, (8) General conclusions, (9) Reference documents and (10) D5.3 Annexes.

4. Inventory library

4.1 Gathering and analysis of information

The information about the building elements of the existing and renovation envelope solutions of the six demo cases was taken from the project plans and the BIM models provided by the Design teams. This task started in the early stages of the project and has been complemented along with every new provision of documents describing the projects. The documents used for the modelling activities are listed in the following table:

TABLE 1: LIST OF DOCUMENTS PROVIDED FOR THE DEFINITION OF THE INVENTORY LIBRARY OF BUILDING ENVELOPES.

Demo case	Information source	Explanationenriched
CZ_Kasava	211231_Oi90 PLURAL_ARQ_R19_actual.ifc	Description of the existing building elements
	KAS_OB_191_DEF.3ds	
	KAS_OB_191_DEF.dwg	
	KAS_OB_191_DEF.ifc	
	KAS_OB_191_DEF.skp	
	ARQ_PLURAL_3DMODEL.ifc	Description of the proposal
	ARQ_PLURAL_3DMODEL.rvt	
ES_Terrassa	PLURAL_D7_1_Spanish Demo Case_ Actual State_3D.ifc	Description of the existing building
	PLURAL_D7_1_Spanish Demo Case_ Actual State_3D.rvt	
	220120_Plural 2D.dwg	CAD proposal
CZ_Kasava	PLURAL_D2.1_V1.4_CZ_ANNEXCZ01.pdf	Deliverable D2.1
	PLURAL_D2.1_V1.4_CZ_ANNEXCZ01_red.pdf	
	PLURAL_D2.1_V1.4_CZ_ANNEXCZ02F.pdf	
	PLURAL_D2.1_V1.4_CZ_ANNEXCZ03.pdf	
ES_Terrassa	PLURAL_D2.1_V1.4_ES_ANNEXES01.pdf	
	PLURAL_D2.1_V1.4_ES_ANNEXES02.pdf	
GR_Voula	PLURAL_D2.1_V1.4_GR_ANNEXGR01_02_03_r1.pdf	
	PLURAL_D2.1_V1.4_GR_ANNEXGR01_02_03_red.pdf	
Czech, German, Greek, Spanish, Swedish, Swiss Demo cases	PLURAL_D7_1_ANNEXES	Deliverable D7.1

4.2 Database of the BIM Elements for the envelope systems

The building systems that form the existing and renovation envelope solutions of the Demo cases (mainly walls, windows, doors and roof) had to be listed, re-named as element types and BIM materials together with the declared values of the properties and stored in a Common Data Environment (CDE) according to the current BIM state-of-the art. The resulting list and Database of the BIM objects is available in:

- The only-read list *PLURAL_D5.3_Annex2.pdf* attached to the present document
- The editable spreadsheet *PLURAL_InventoryLibrary.xlsx* in the *Inventory Library* folder.

4.3 BIM Modelling

It was carried out according to the requirements stated in D5.1, as far as possible. The resulting BIM objects are included in two master files in the [1 InventoryLibrary¹](#) folder and can be overviewed in the following figures:

- Berlin, Väsby and Voula: Plural_InventoryLibrary_BER+VA+VO_RVT19.rvt/ifc
- Belgium, Kaçava and Terrassa: Plural_InventoryLibrary_BE+KA+TE_RVT20.rvt/ifc

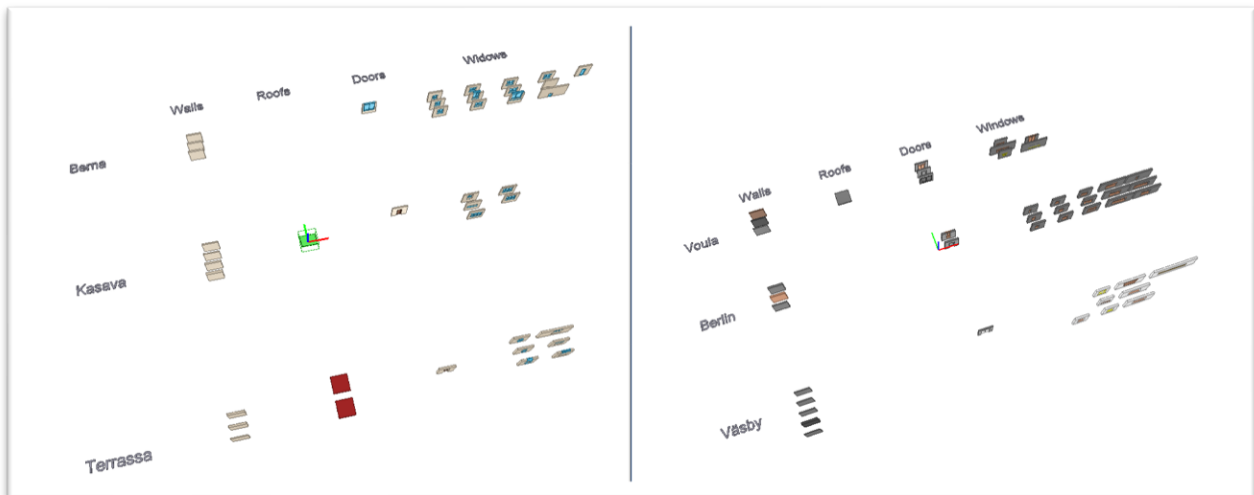


FIGURE 1: MASTER FILES CONTAINING THE BUILDING ELEMENTS OF THE SIX DEMO SITES BUILDING ENVELOPES.

¹ <https://plural.emdesk.com/#!/documents/direct/f7400>

5. BIM objects for the PnU kits

5.1 Gathering and analysis of information

The information about the PnU kits was taken from the following deliverables: D1.4, Annexes of D2.1, D2.2, D2.6, D4.1, D4.2 and Annexes of D 7.1. Since some aspects regarding the performance of the kit components are missing, certain values of the physical properties are still being defined, and they have been stated in the resulting BIM objects as such with a “Not defined” statement.

Given that the properties are already named and structured, once the tested/declared values will be obtained they could be added into the BIM objects in further stages of the project. See one of these situations in the following example.

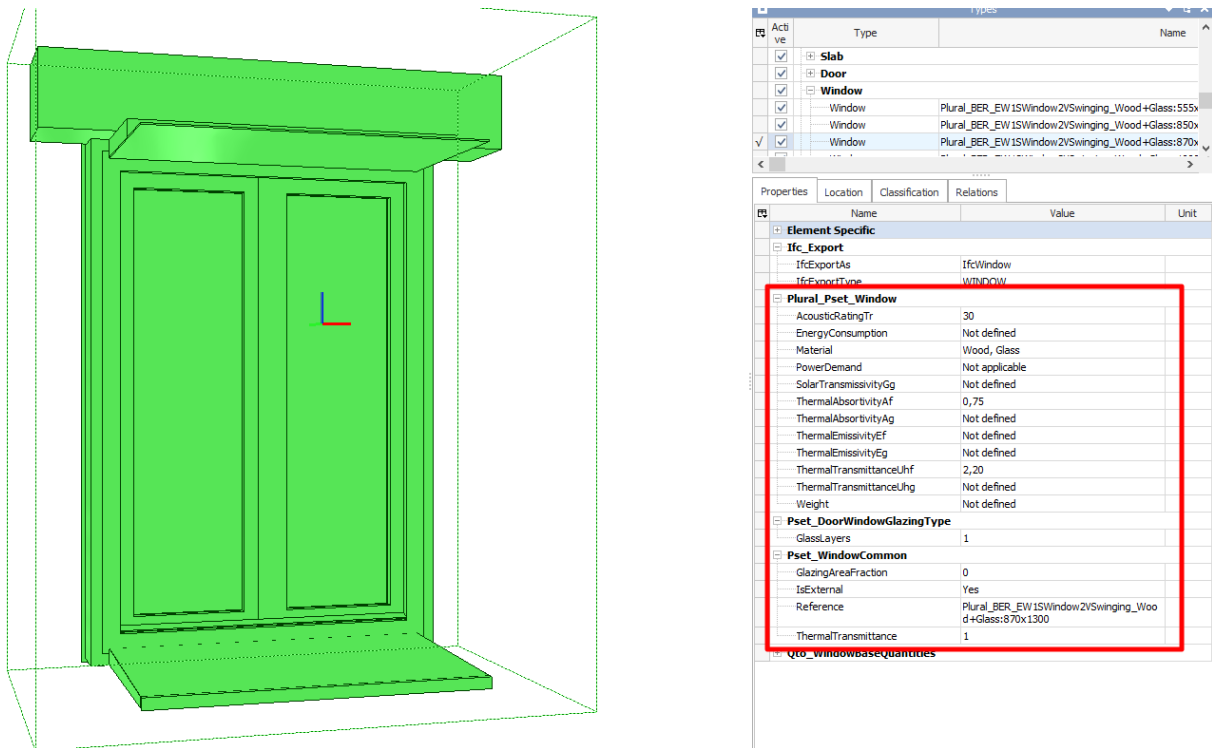


FIGURE 2: SET OF DEFINED PROPERTIES AND NON-DEFINED VALUES FOR A WINDOW.

5.2 Database of the PnU kits and components

The components that compose the three Plural kits were identified in D2.1 and D2.2. They were listed according to their description, functions, demo site, developer, manufacturer and whether they will be electricity dependents or not (see the list in PLURAL_D5.3_Annex3). They were also classified under the Ifc 4 Reference view² scheme and ended up being mapped into 29 Ifc classes: IfcAirTerminal, IfcAnchor, IfcCommunicationsAppliance, IfcController, IfcDoor, ... and IfcWindow (see the relation of components and BIM classes in Annex 3).

It must be taken into consideration that Plural PnU kits have resulted in very complex building systems with extended functions beyond the classical ones performed by building envelopes. Most of these functions belong to the Building Services domain and this has resulted in the addition of elements from the Electric, Hydraulic, Ventilation and Telecommunication specialties. The result is that PnU kits are formed by classical envelope BIM objects (walls, curtain walls, roofs, windows, doors, subframes, insulation layers and shading elements) complemented with BIM objects for Services such as ducts, pipes, fittings, ventilation units, batteries, inverters, smart toolboxes, grilles, tanks, heat pumps, coil units, valves, sensors, control panels, control boxes, grilles, solar panels and radiant heating systems.

TABLE 2: CLASSICAL AND EXTENDED FUNCTIONS PERFORMED BY PLURAL ENVELOPE SYSTEMS.

Classical Functions in Standard Envelope systems	Extended Functions in Plural Envelope systems
Airhandling, Fresh air supply Anchoring system Cladding Communication/interfacing/Control Connecting elements Cooling Envelope Heating Insulation system Panel frame/structure Panel system Panel system for roof Panel system for wall Sun shading Subframe structures Waterproofing Windows	Air distribution Airhandling, Cooling, Heating Power storage (batteries) Communication/interfacing Control Monitoring / Control Renewable energy source User interface

² Industry Foundation Classes 4.0.2.1 Reference View 1.2:

https://standards.buildingsmart.org/MVD/RELEASE/IFC4/ADD2_TC1/RV1_2/HTML/

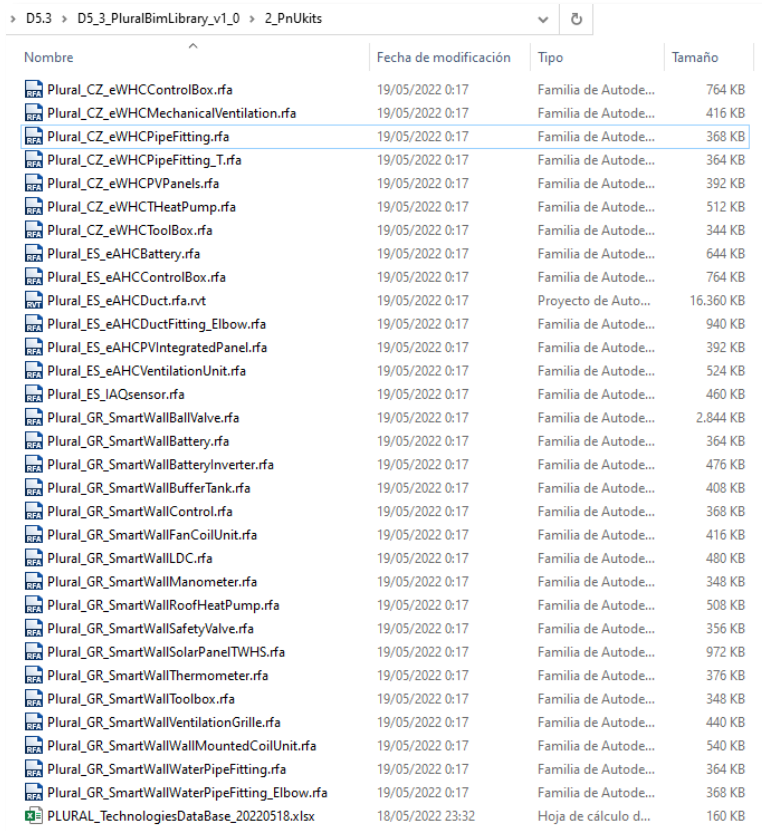
The Database of BIM objects which composes the PnU kits is available in:

- *PLURAL_D5.3_Annex3.pdf* attached to the present document
- The editable spreadsheet *PLURAL_TechnologiesDataBase.xlsx* in the *PnU kits* folder.

The BIM Object properties to specify the building components of the PnU kits had already been stated in D5.1 Annex. An updated list of properties with minor corrections (grey shaded) has been generated and attached at the end of the present deliverable as *PLURAL_D5.3_Annex1.pdf*.

5.3 BIM Modelling

The BIM modelling of the components for the PnU kits was carried out according to the requirements in D5.1. The resulting BIM objects are included in a library of separate files in [2_PnUkits³](#) folder for using them in a common native BIM modelling program.



Nombre	Fecha de modificación	Tipo	Tamaño
Plural_CZ_eWHCControlBox.rfa	19/05/2022 0:17	Familia de Autode...	764 KB
Plural_CZ_eWHCMechanicalVentilation.rfa	19/05/2022 0:17	Familia de Autode...	416 KB
Plural_CZ_eWHCPipeFitting.rfa	19/05/2022 0:17	Familia de Autode...	368 KB
Plural_CZ_eWHCPipeFitting_T.rfa	19/05/2022 0:17	Familia de Autode...	364 KB
Plural_CZ_eWHCPVPanels.rfa	19/05/2022 0:17	Familia de Autode...	392 KB
Plural_CZ_eWHCTHeatPump.rfa	19/05/2022 0:17	Familia de Autode...	512 KB
Plural_CZ_eWHCToolBox.rfa	19/05/2022 0:17	Familia de Autode...	344 KB
Plural_ES_eAHCBattery.rfa	19/05/2022 0:17	Familia de Autode...	644 KB
Plural_ES_eAHCCControlBox.rfa	19/05/2022 0:17	Familia de Autode...	764 KB
Plural_ES_eAHCDuct.rfa.rvt	19/05/2022 0:17	Proyecto de Auto...	16.360 KB
Plural_ES_eAHCDuctFitting_Elbow.rfa	19/05/2022 0:17	Familia de Autode...	940 KB
Plural_ES_eAHCPVIntegratedPanel.rfa	19/05/2022 0:17	Familia de Autode...	392 KB
Plural_ES_eAHCVentilationUnit.rfa	19/05/2022 0:17	Familia de Autode...	524 KB
Plural_ES_eAQsensor.rfa	19/05/2022 0:17	Familia de Autode...	460 KB
Plural_GR_SmartWallBallValve.rfa	19/05/2022 0:17	Familia de Autode...	2.844 KB
Plural_GR_SmartWallBattery.rfa	19/05/2022 0:17	Familia de Autode...	364 KB
Plural_GR_SmartWallBatteryInverter.rfa	19/05/2022 0:17	Familia de Autode...	476 KB
Plural_GR_SmartWallBufferTank.rfa	19/05/2022 0:17	Familia de Autode...	408 KB
Plural_GR_SmartWallControl.rfa	19/05/2022 0:17	Familia de Autode...	368 KB
Plural_GR_SmartWallFanCoilUnit.rfa	19/05/2022 0:17	Familia de Autode...	416 KB
Plural_GR_SmartWallLDC.rfa	19/05/2022 0:17	Familia de Autode...	480 KB
Plural_GR_SmartWallManometer.rfa	19/05/2022 0:17	Familia de Autode...	348 KB
Plural_GR_SmartWallRoofHeatPump.rfa	19/05/2022 0:17	Familia de Autode...	508 KB
Plural_GR_SmartWallSafetyValve.rfa	19/05/2022 0:17	Familia de Autode...	356 KB
Plural_GR_SmartWallSolarPanelTWS.rfa	19/05/2022 0:17	Familia de Autode...	972 KB
Plural_GR_SmartWallThermometer.rfa	19/05/2022 0:17	Familia de Autode...	376 KB
Plural_GR_SmartWallToolbox.rfa	19/05/2022 0:17	Familia de Autode...	348 KB
Plural_GR_SmartWallVentilationGrille.rfa	19/05/2022 0:17	Familia de Autode...	440 KB
Plural_GR_SmartWallWallMountedCoilUnit.rfa	19/05/2022 0:17	Familia de Autode...	540 KB
Plural_GR_SmartWallWaterPipeFitting.rfa	19/05/2022 0:17	Familia de Autode...	364 KB
Plural_GR_SmartWallWaterPipeFitting_Elbow.rfa	19/05/2022 0:17	Familia de Autode...	368 KB
PLURAL_TechnologiesDataBase_20220518.xlsx	18/05/2022 23:32	Hoja de cálculo d...	160 KB

FIGURE 3: SEPARATE FILES OF THE PNU COMPONENTS AVAILABLE IN THE [2_PnUkits](#) FOLDER.

³ <https://plural.emdesk.com/#!/documents/direct/f7401>

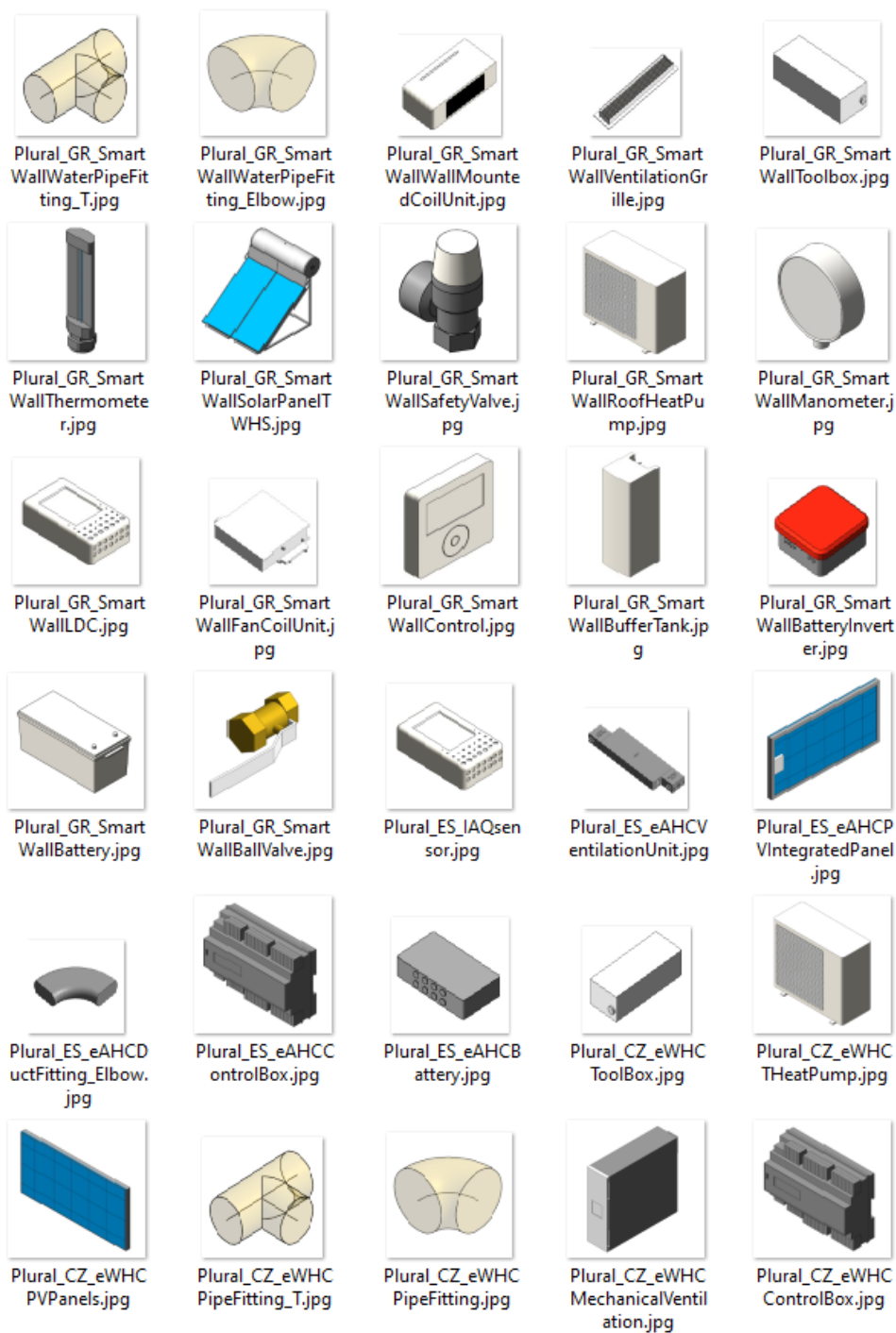


FIGURE 4: VIEW OF THE BIM ELEMENTS AS COMPONENTS FOR THE PNU KITS.

6. Parametric BIM models for six demo cases

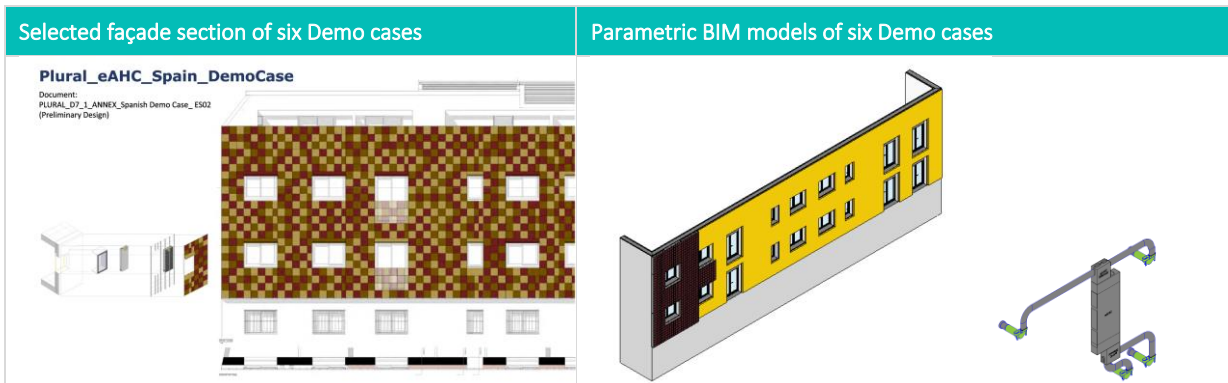
6.1 Gathering and analysis of information

The information for the parametric BIM models of the six Demo cases was taken and analysed from the D7.1 Annexes. A single stretch of façade was been selected for each Demo case to test the parametric BIM elements of the PnU kits. See the selected façades and their respective BIM models in section 6.2 BIM Modelling.

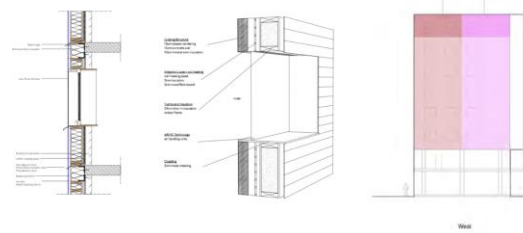
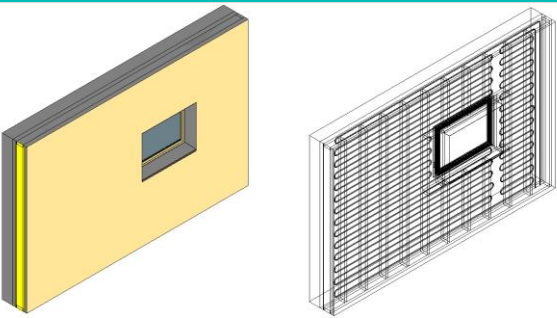
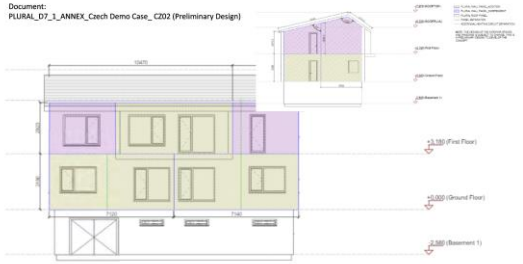
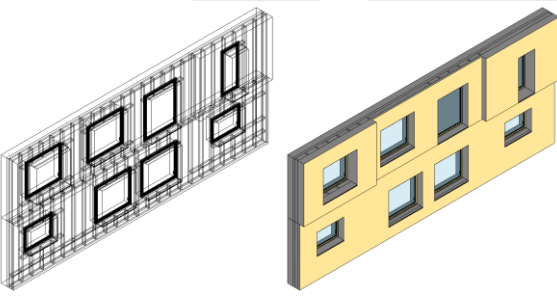
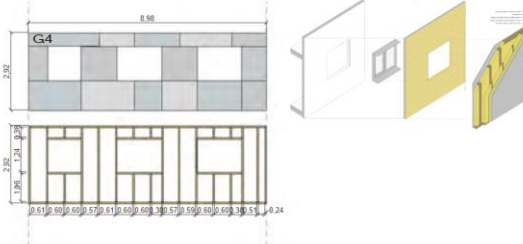
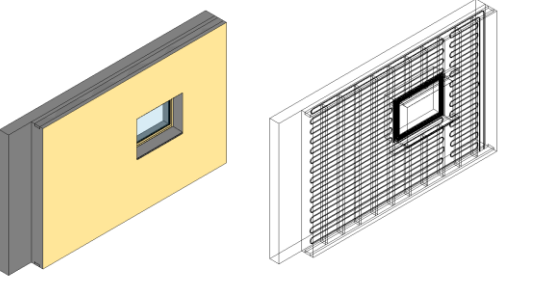
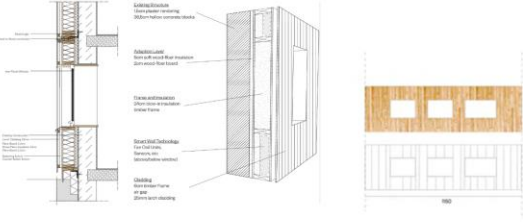
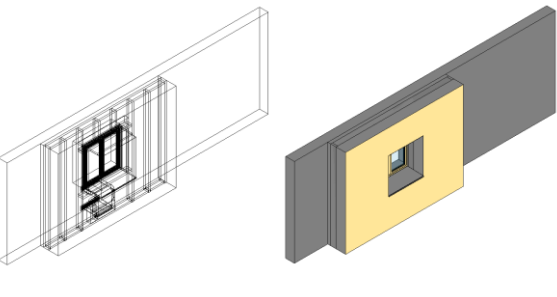
6.2 BIM Modelling

The BIM modelling of the parametric BIM Demo cases was carried out according to the requirements in D5.1. The resulting BIM models are included in a library of separate files in [3 ParametricBIMmodels](#)⁴ folder with these names and can be overviewed in the following figures:

- Plural_eAHC_Spain_DemoCase_1.rvt.rvt (Envelope systems)
- Plural_eAHC_Spain_DemoCase_2.rvt (MEP components)
- Plural_eWHC_Czech_DemoCase.rvt
- Plural_eWHC_Swedish_DemoCase.rvt
- Plural_eWHC_Swiss_DemoCase.rvt
- Plural_SmartWall_German_DemoCase.rvt
- Plural_SmartWall_Greek_DemoCase.rvt



⁴ <https://plural.emdesk.com/#!/documents/direct/f7402>

Selected façade section of six Demo cases	Parametric BIM models of six Demo cases
<p>Plural_eWHC_Swedish_DemoCase</p> <p>Document: PLURAL_D7_1_ANNEX_Swedish Demo Case_SE02 (Preliminary Design)</p> 	
<p>Plural_eWHC_Czech_DemoCase</p> <p>Document: PLURAL_D7_1_ANNEX_Czech Demo Case_C202 (Preliminary Design)</p> 	
<p>Plural_eWHC_Swiss_DemoCase</p> <p>Document: PLURAL_D7_1_ANNEX_Swiss Demo Case_CH02 (Preliminary Design)</p> 	
<p>Plural_SmartWall_German_DemoCase</p> <p>Document: PLURAL_D7_1_ANNEX_German Demo Case_GER02 (Preliminary Design)</p> 	

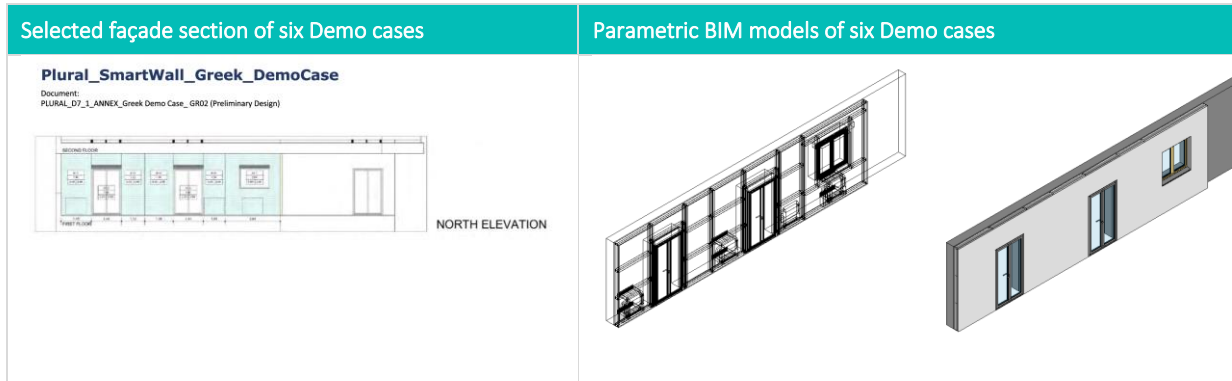


FIGURE 5: SELECTION OF ENVELOPE SECTIONS OF THE DEMO SITES (LEFT) AND RESULTING BIM MODELS (RIGHT).

7. File repository in the CDE

The PLURAL project is stored in this specific Common Data Environment: <https://plural.emdesk.com/>

The D5.3 BIM Library is stored in this access path: *Home -> 07 Deliverables -> WP5_IT_DST_INTRA -> D5.3 PluralBimLibrary_ITeC* with the following hyperlink:

https://plural.emdesk.com/#!/documents/all/07%20Deliverables/WP5_IT_DST_INTRA

The BIM Library contains a first version of the BIM objects and databases organized in three folders, one for each of T5.1 objectives:

D5_3_PluralBimLibrary

PluralBIMLibrary_v1_0

1_InventoryLibrary

2_PnUkits

3_ParametricBIMmodels

PluralBIMLibrary_v1_1

...

PluralBIMLibrary_v1_N

Further versions of the Plural BIM Library can be added along with the completion of the Demo Sites projects and the PnU kits.



8. Conclusion

The three sets of BIM objects and models in the D5.3 BIM Library have been created according to the available information up to the present stage of the PLURAL project. The modelled items may not have all the expected declared values for further calculations, but they already have the required structured properties to be completed as soon as they are declared and available by the developers and manufacturers.

This first version of the PLURAL BIM Library must be considered as a departure point for testing the Parametric BIM models with integrated environmental information to perform an assessment of the new buildings in the BIM based big data management platform (StreamHandler) and Decision Support Tool (DST) in order to complete tasks 5.3, 5.4 and 5.5 of PLURAL.

The first version of the PLURAL BIM Library will also allow to test the usability of the BIM objects in the parametric BIM modelling of new construction solutions and to be aware of the technological limitations that may occur with the digital modelling of complex building systems formed by products with very diverse functions and performances.

The BIM models of the 3 PnU kits combined with the six Demo Cases are a good basis to run the PLURAL Tools and to test the selection of optimal components and to define the most suitable PnU kit for the project conditions.

9. References

[Plural website](#)

[Plural CDE](#)

[Industry Foundation Classes 4.0.2.1 Reference View 1.2](#)

[OmniClass™ Construction Classification System](#)

[eCOB Standard for creating BIM objects](#)

10. Annexes

PLURAL D5.3 Annex 1: Update of BIM Objects Database of Plural Technologies for BIM Modelling and LCACC calculations

PLURAL D5.3 Annex 2: PLURAL Building Elements of the Inventory library

PLURAL D5.3 Annex 3: PLURAL Technologies, description, function, manufacturer and IfcClass