Change toolkit for digital building permit

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1. Executive Summary

Today, the current process of issuing building permits remains largely manual and reliant on the exchange of traditional 2D documents such as drawings, forms, and descriptive reports. This conventional, paper-based approach lacks automation and integration, resulting in limited precision, poor traceability, and overall inefficiency. Consequently, the process is vulnerable to human error, inconsistency in interpretation, and incomplete or outdated information.

CHEK (Change toolkit for digital building permit) project provides an innovative digital toolkit supporting the transition to a data-driven, model-based approach where digital building models can be automatically evaluated against predefined rules. This approach holds the potential to drastically improve accuracy, reduce processing time, and increase trust in regulatory outcomes.

Deliverable **6.3 Results of Demonstration of Scenario 2 -** provides an overview of the demonstration activities carried out in Task 6.3, a task within the CHEK project, focusing on digital validation of renovation building designs against urban planning regulations using BIM-based methodologies. The demonstrations took place in collaboration with 4 selected European municipalities or municipal authorities:

- Municipality of Lisbon (Camara Municipal de Lisboa), Portugal
- Gaiurb – Urban Planning and housing authority, Vila Nova de Gaia (Gaiurb, EM), Portugal
- The Prague Institute of Planning and Development (IPR Prague), Czech Republic and
- Municipality of Ascoli Piceno (Comune di Ascoli Piceno), Italy.

The central objective was to test the operational feasibility of the tools developed within the project, assess the level of interoperability and practical integration of the software applications that are comprising the CHEK's digital toolkit which is intended to help municipalities and other authorities to embrace the Digital Building Permits.

Each pilot test served both as a proof-of-concept and as a stress test, allowing the consortium to observe the tools under real-world constraints. The variation in building types, data quality, and local requirements helped to surface specific strengths and areas for improvement. The insights gathered here will inform future refinements and contribute to the long-term goal of enabling scalable, digital regulatory verification based on open standards.

Technical specifications of the software components are beyond the scope of this deliverable and are addressed in the corresponding outputs of Work Package 4. Instead, this document focuses on evaluating how the tools performed in operational contexts, and on drawing lessons about their usability, adaptability, and integration into existing design and permitting workflows.

2. Introduction

Deliverable *6.3 Results of Demonstration of Scenario 2* presents the results of Task *6.3 Demonstration Scenario 2 - DBP for building renovation* that took place in the period May – June 2025, even though the some preparatory and design activities started earlier to deliver draft models for software testing. The goal of Task 6.3 was to demonstrate the effectiveness of the CHEK digital toolkit for Scenario 2 – building renovation within the 4 pilot case plots identified within the CHEK strategic sample of municipalities: Lisbon, Vila Nova de Gaia, Prague and Ascoli Piceno.

Task 6.3 belongs to WP6 (*Work Package 6 – Pilot actions coordination and demonstration)* activities. WP6 aims to test, demonstrate, and evaluate the integrated CHEK system consisting of digital tools, workflows, and data exchange protocols in real permitting contexts across multiple European municipalities. It validates the practical usability, technical readiness, and institutional applicability of the CHEK approach for digitizing the building permitting process.

The deliverable 6.3 is closely connected with following WP6 deliverables:

- D6.1 Plan for demonstration of CHEK Digital Building Permit process on demo sites and
- D6.2 Results Demonstration Scenario 1- CHEK DBP for new building construction.
- D6.4 Report on the Pilots' assessment and stakeholders' feedback

D6.1 identified the pilot sites on which the demonstrations in T6.2 and T6.3 were performed. Also, presented a collection of relevant plot data, including applicable regulations, planning guidelines, and historical permitting procedures associated with each location etc. This was a critical preliminary step in shaping the scope of the CHEK project demonstrations. The selection of four distinct pilot sites was driven by the objective to ensure regulatory diversity and variety in building typologies, thus enabling a comprehensive and robust evaluation of the CHEK tools.

In alignment with early project agreements, the selected demo pilots represent different building use categories geographically distributed across three European countries locations and regulations, namely:

- A private residential house in Vila Nova de Gaia (Portugal)
- A mix-use residential building in Ascoli Piceno (Italy)
- A Multi-storey residential building in Lisbon (Portugal), and
- A Primary School in Prague (Czech Republic).

This strategic diversity in both building function and regulatory environment ensures that the CHEK digital building permit (DBP) tools are tested across a wide range of practical scenarios. As a result, the scalability and adaptability of the CHEK system can be effectively assessed, thereby strengthening the project's capacity to propose a replicable and extensible approach to digital permitting in Europe.

In T6.2 the demonstrations are performed on BIM models/project that simulate a new building scenario, while in T6.3, the same models are subject of renovation remodeling including vertical and horizontal extension and addition, changing that way various parameters such as building height, ratios and other building indices.

The demonstration pilots' assessment and stakeholders' feedback will be presented in Deliverable D6.4 Report on the Pilots' assessment and stakeholders' feedback. This document will serve as a comprehensive evaluation of the pilot demonstrations conducted across participating municipalities. It will analyze both the technical performance of the CHEK tools and the user experience of the various stakeholders (designers, municipal staff, software developers, etc.) involved in simulating the digital building permit (DBP) workflow.

During executing the activities of Task 6.3, Designers were using the results/deliverables of other work packages too, such as:

- D2.1 Regulations interpretation and needs identification for CHEK DBP
- D2.5 Exchange Information Requirements for DBP
- D3.1 Geo to BIM tool procedure
- D3.2 IFC georeferencing tool
- D4.5 IFC digital signature module
- D4.6 Tools for BIM based urbanism and accessibility
- D4.8 Checking tolls for the CHEK regulations
- D4.9 Software documentation and workshops.

Methodology for Renovation Demonstration and Feedback Collection

The demonstrations were carried out using a coordinated protocol based on the guidelines defined in D6.1. Designers and Municipalities were selected from CHEK consortium partner organizations ensuring diversity in backgrounds and contexts.

Renovation scenarios were executed in June 2025, as previously planned, right after New Construction scenario demonstrations that were completed in May 2025. The four plot sites were divided in two June timeslots:

- I week:
  - Lisbon Renovation scenario performed by SIA
  - Gaia Renovation scenario performed by ZWE
- II week:
  - Ascoli Piceno Renovation scenario performed by SIA
  - Prague Renovation scenario performed by ZWE

Each one-week timeslot was divided into two parts:

- Day 1 and 2: Designers part
- Day 3 and 4: Municipality part
- Day 5: Joint day

During the demonstration, Designers were documenting their workflow, while Municipalities gave feedback on their review and experience with the tools.

Each demonstration followed these steps:

1. **Preparation:** Setup of technical environments (IFC authoring tool, Nexus Twin, validation tools, etc.)
2. **Execution:** Designers followed test scenarios involving model creation, IFC export, rule checking, validation, and signature.
3. **Documentation:** Screenshots, logs, and intermediate results were captured.
4. **Feedback Collection:** Structured interviews and surveys were conducted to assess tool performance, usability, integration, and effectiveness.
5. **Analysis:** Evaluation based on qualitative impressions and quantitative KPIs.

As part of the preparatory phase preceding the start of the Renovation Scenario demonstrations, several foundational activities were carried out to ensure the effectiveness of the upcoming validation process. These included the development of early-stage design models by the design teams involved, iterative testing of the software tools during their development stages, and live demonstrations organized by the respective software providers. In addition, regular coordination meetings and technical discussions among consortium partners facilitated clarification of workflows, resolution of interoperability issues, and alignment of expectations between designers and municipalities. These preparatory actions laid the groundwork for a smooth and well-informed execution of the Renovation Scenario within the CHEK framework.

2.1 Workflow Description

The Building Renovation Demonstration workflow mimicked the complete lifecycle of a design process, beginning with the collection of input data (urban context, site information, existing conditions), followed by the creation and development of BIM models using standard authoring tools, up to validation of the design against the building regulations. The process ended with Municipal review of the submitted results from final validation of the BIM models.

Task 6.3 builds upon and extends the work initiated in Task 6.2, continuing the structured demonstration of the CHEK toolkit through a series of realistic and iterative design workflows. Both tasks were designed to replicate the actual sequence of activities that a designer would follow when preparing a building project for submission to municipal permitting authorities, with the overarching goal of validating the applicability of the CHEK system under real-world conditions.

The IFC models used in Task 6.2 - initially created to demonstrate new construction projects were reused and reconfigured to represent renovation projects, ensuring consistency in the input data and enabling comparative evaluation of new-build vs. renovation use cases. This also allowed for the testing of the toolkit's flexibility and its capacity to support diverse regulatory contexts and project typologies.

Throughout Task 6.3, designers made full use of the **CHEK digital toolkit**, which includes:

- **IFC export and validation tools** (e.g., IfcEngine, IDS-based schema checking),
- **Regulatory rule-checking environments** (e.g., CYPEURBAN, VCMap, Verifi3D),
- **City model extraction and integration tools** (e.g., VCMap, CityGML2IFC),
- **Digital signature services** (e.g., DiStellar),
- and the **Common Data Environment (**BIMserver.center**)** for structured data exchange and submission.

Each step in the demonstration was carefully documented, including the tools used, the types of input and output data generated, and the feedback from participating designers. Special attention was given to how the CHEK tools integrated into the typical design-authority communication cycle, particularly in the context of iterative model updates and pre-submission validations.

In summary, Task 6.3 served as an essential continuation and refinement of Task 6.2, expanding the scope of testing to include renovation scenarios and further validating the CHEK approach in realistic permitting workflows. It demonstrated the potential of the toolkit to support both new construction and existing building transformation projects within a unified digital permitting framework.

2.1.1 Workflow stages

The demonstration workflow in Task 6.3 was designed to replicate a typical renovation design project workflow and was comprised of following stages:

- Preparation / Pre-demonstration:
    - In this stage, Designers got familiar with the results of WP2 Regulation Interpretation and needs identification for CHEK DBP
    - Collection and review of existing site and building documentation and contextual data
    - Assessment of additional specific design relevant data depending on the pilot case
- Demonstration Execution:
    - Creating project in CHEK DBP platform based on BIMserver.center that serves as CDE
    - 3D site geometry collection using VCMap functionalities to obtain the surroundings models (in various file formats) including surrounding buildings, terrain, roads, vegetations etc.
    - CityGML to IFC Conversion with RDF converter tool.
    - Design of renovation scenario in BIM authoring tools
    - Exporting of native BIM model into IFC
    - Validation of proper georeferencing of the IFC model using IfcGref tool
    - Performing rule-based self-checks using validation applications such as CypeUrban, VCMap and Verifi3D, ensuring conformity with applicable planning and building codes.
    - Model correction in native BIM authoring tools if checks show failed checks
    - Upon successful validation, the models were digitally signed using the DiStellar plugin
- Documentation:
    - Documenting the steps taken to serve as narrative walkthroughs
    - Taking screenshots of each step using the digital toolkit
    - Highlighting any workflow deviations, tool-specific errors, or unexpected results during the demonstrations.
    - Preparation of D6.3 content
- Feedback Collection:
    - Collecting Municipal feedback questionnaire responses
    - Conducting meetings with Municipal officers
- Analysis:
    - Assessing the digital tools success
    - Analyzing the results of the demonstration pilots from designers' perspective

- Analyzing the responses from the municipal officers
- Performing quantitative and qualitative metrics
- Documenting the KPI's in D6.4

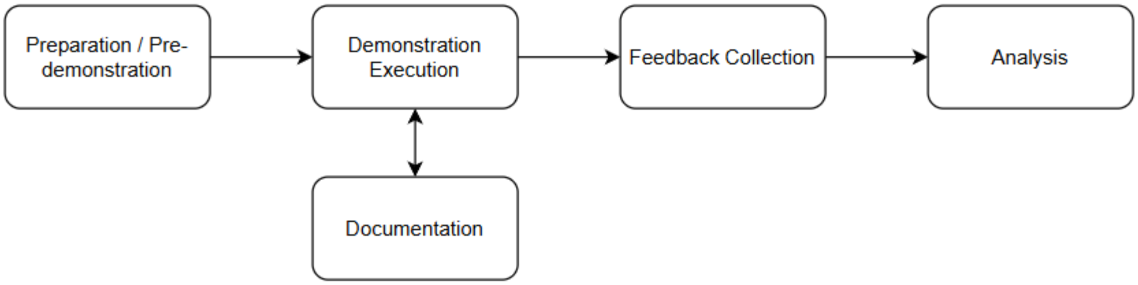


Figure 1 Pilot Demonstration Process Flow

2.1.2 Time allocation per stage

During executing the Renovation scenario demonstration, the time allocation per stages was divided as follows: Preparation (10%), Execution (75%), Documentation (5%), Feedback Collection (5%) and Analysis (5%). The pie chart titled "Tentative Time Allocation per Stage" illustrates the estimated distribution of time dedicated to each major phase of the CHEK demonstration activities. This breakdown provides a structured overview of how project partners, particularly designers and municipal participants, managed their efforts across the end-to-end workflow of the digital building permit (DBP) process.

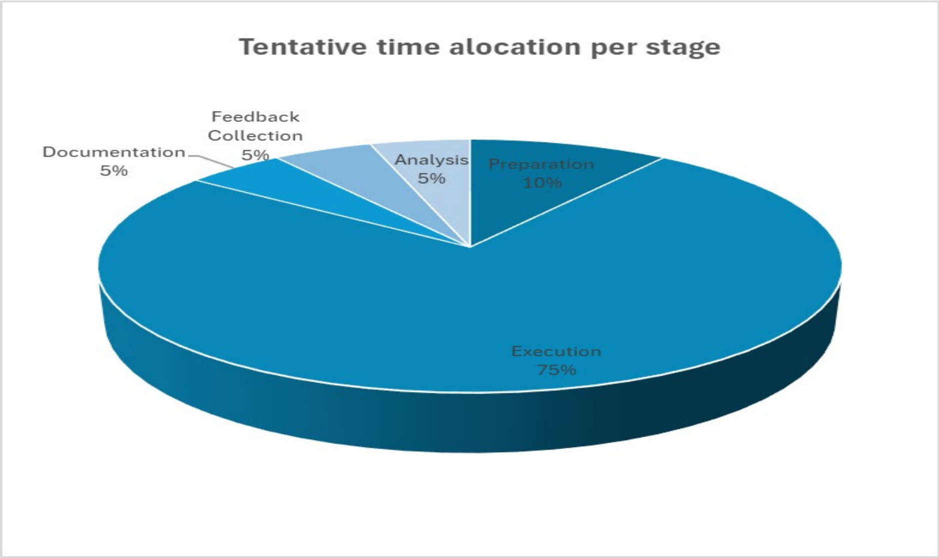


Figure 2 Tentative time allocation per stage

2.2 Workflow Approach

The workflow approach adopted in Task 6.3 was designed to simulate a realistic end-to-end process for preparing, validating, and submitting a building renovation project for digital permit approval. The intention was to closely replicate real-world professional workflows while ensuring alignment with the digital tools and methodologies developed within the CHEK project.

This task builds directly on the outcomes of Task 6.2, which focused on new construction scenarios. In Task 6.3, the same pilot projects were revisited and adapted to reflect renovation and transformation use cases, thus allowing a comparative evaluation between new-build and renovation workflows. This continuity ensured methodological consistency across the two tasks while also testing the flexibility of the CHEK tools in addressing the specific challenges posed by existing building conditions, such as partial compliance with current codes, limited data availability, and heritage constraints.

The approach was structured around several core principles:

- Interoperability – Ensuring that each step of the workflow could function with open formats (especially IFC4 Add2) and integrate across various tools in the CHEK digital toolkit.
- Scalability and Reusability – Demonstrating workflows that are modular and adaptable, so they can be replicated across different municipalities and project types.
- User-Centric Design – Involving real designers and technical staff to perform the demonstration, in order to assess the practical applicability and usability of the tools under realistic working conditions.
- Validation-by-Design – Embedding self-check and rule-checking stages early in the process to support early error detection and compliance assurance prior to formal submission.

Each demonstration began with the reuse of an existing BIM model from Task 6.2, which was remodeled to reflect a renovation scenario. This included modifications to geometry, functional layout, and performance characteristics. The updated models were then subjected to the CHEK toolchain, including IFC export, georeferencing validation, rule-based checking, digital signing, and submission via the Common Data Environment (CDE).

The workflow was designed not only as a technical exercise but as a process validation, confirming whether the proposed tools and methods could support real permitting procedures for renovation projects. By capturing user interactions, time requirements, and validation outputs, the approach enabled a structured evaluation of both tool performance and workflow logic.

In essence, Task 6.3's workflow approach served as both a proof-of-concept and a stress test, designed to verify the adaptability of the CHEK digital building permit system when applied to renovation contexts, which are often more variable and constrained than new construction projects.

3. Pilot Cases Demonstration - Renovation Scenario

This section provides a detailed overview of the activities conducted under Scenario 2 of the CHEK project, which focuses on the renovation of existing buildings. It outlines the methodologies applied and presents the results obtained from each demonstration carried out within this task.

Each pilot case was implemented within a real urban context and in communication with local authorities to verify the results of the demo. The demonstrations involved adapting existing BIM models originally developed in Task 6.2 for new constructions in order to represent renovation scenarios. The objective was to apply the CHEK workflow to verify compliance with relevant planning regulations and technical codes, using open-standard BIM models (IFC4 Add2) and the tools comprising the CHEK digital toolkit.

These demonstrations enabled the assessment of the toolkit's interoperability, adaptability, and operational feasibility when applied to renovation-specific challenges, such as pre-existing structural constraints, partial regulatory compliance, and integration with heritage or zoning considerations. The workflow also tested the ability of the tools to support iterative design processes, where updates and modifications are a frequent requirement.

The following subsections present the individual pilot cases undertaken within this scenario, outlining the renovation-specific aspects, tools employed, and any technical or procedural conditions that shaped their development and evaluation.

3.1 Vila Nova de Gaia

This section provides a detailed overview of the demonstration activities carried out in the Vila Nova de Gaia pilot within the scope of Task 6.3, focusing on the application of the CHEK digital workflow to a building renovation scenario. The aim was to test the adaptability of the CHEK tools when applied to existing buildings and to assess their performance in supporting a model-based, standards-driven building permit process.

DEMO PILOT CASE INFO CARD		
1	Demo plot location	Vila Nova de Gaia, Portugal
2	Building Type	Private House
3	Address	Rua Boavista | Rua Nuno Augusto de Oliveira Ramos
4	Designer of Scenario 1	SIA
5	Designer of Scenario 2	ZWE
6	Renovation Description	Horizontal extension
7	Demonstration period	02/06/2025 - 06/06/2025
8	Reviewer	GaiUrb, EM

Project Background and Designer Involvement

The demonstration was based on a renovation of a single-family residential house, originally developed by SIA as a new construction scenario in Task 6.2. The updated scenario was designed and modeled by ZWE, who adapted the existing BIM model to reflect typical renovation interventions—such as reconfiguration of internal spaces, partial modification of the façade, and adjustments to window and door openings.

A full description of the original project context, urban conditions, and baseline geometry can be found in Section 3.1.3 of Deliverable D6.1, which outlines the Gaia pilot in its initial Task 6.2 configuration.

Workflow and Tools Used

The renovation workflow followed the typical progression of a real design-to-permit process, beginning with the collection of existing building information and followed by model adaptation, validation, and submission. The model was developed in a standard BIM authoring environment and exported in IFC 4 Add2 format.

The following tools from the CHEK digital toolkit were used to execute the workflow:

- CYPEURBAN and VCMap: to perform rule-based spatial and regulatory checks against local planning conditions;
- IfcEngine (RDF): to validate IFC structure and schema compliance;
- IfcGref (TU Delft): to confirm georeferencing consistency of the IFC model;
- DiStellar plugin: to apply a digital signature to the validated model;
- BIMserver.center (CDE): as the shared platform for storing and managing model files, metadata, and validation outputs.

Scenario Objectives and Observations

This scenario tested the ability of the tools to accommodate the unique challenges of renovation workflows, including working with non-standardized existing building data and addressing partial compliance with current regulations. It also assessed how easily designers can reuse and adapt existing models within the CHEK environment, and whether the rule-checking mechanisms can distinguish between legacy conditions and newly introduced design elements.

The demonstration was conducted in collaboration with the Vila Nova de Gaia municipality, who provided regulatory context and validation feedback. The results confirmed that the workflow is applicable in renovation settings, though some limitations were noted—particularly with respect to rule interpretation for partially preserved elements and legacy construction standards.

Context

The Gaia renovation pilot contributed valuable insights into the flexibility and interoperability of the CHEK toolkit. It confirmed the viability of extending the digital permitting approach to renovation projects and underscored the importance of tool configurability when dealing with existing conditions. The experience also highlighted areas for future development, such as improved handling of renovation-specific rule logic and intuitive user guidance for designers working with mixed-condition models.

The following subsection details the technical steps followed in this pilot and presents the outputs of the demonstration.

3.1.1 Project Creation in BIMserver.center

Demonstration of the CHEK digital toolkit, started with BIMserver.center that serves as CHEK DBP platform where Designers created new project as central project repositorium for all project contributions and collaboration.

Inputs:

- No particular inputs

Outputs:

- Created New Project repositorium

Process description:

1. Designers' logged in into BIMserver.center with CHEK Designers account

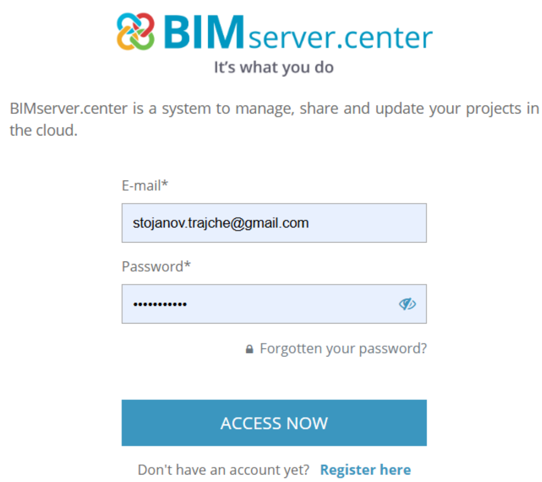


Figure 3 Login in BIMserver.center

2. New Project was created under name “GAIA FinalDemo Renovation”

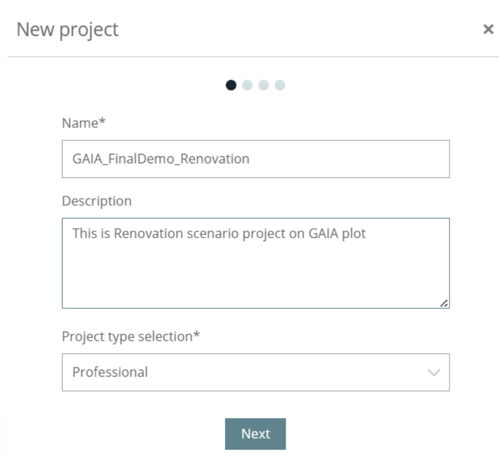


Figure 4 Creation of new project

3. Proper Tag (Gaia) was assigned to the project. The tag itself defines the proper site location and Municipality in-charge

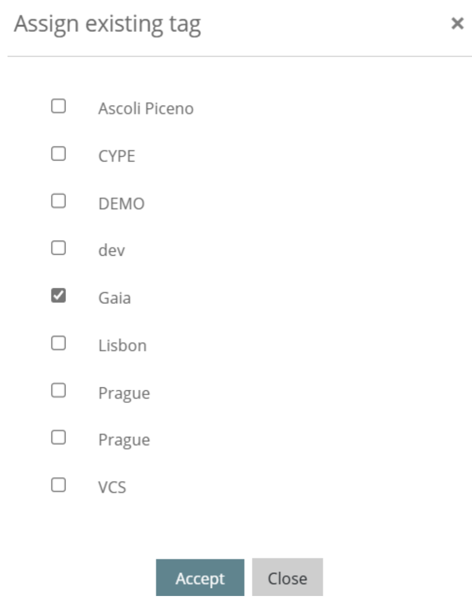


Figure 5 Assigning project tag

3.1.2 Gathering initial data, using VCMap

After the project was created in BIMserver.center the demonstration continued with collecting the site data as 3d geometry for future use in BIM authoring tool.

Inputs:

- No particular inputs

Outputs:

- 3D models of the Surroundings created in various file formats

Process description:

1. Designers logged in into VC Map platform with BIM.server.center CHEK Designers account

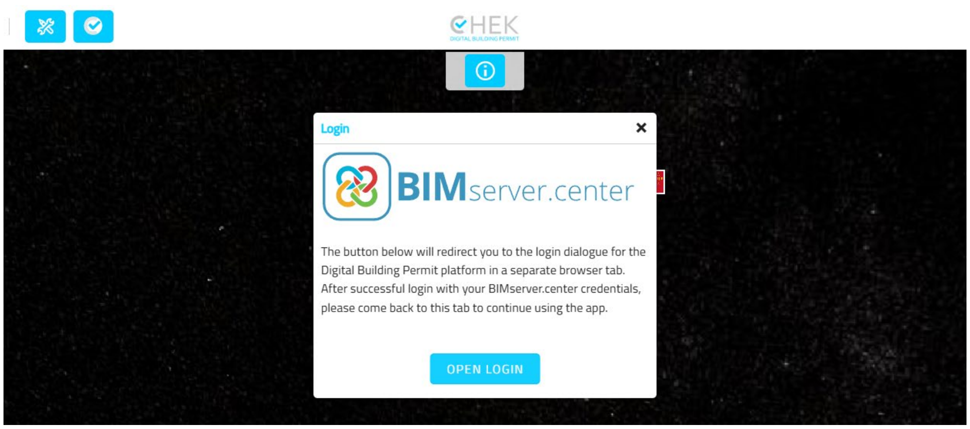


Figure 6 Login into VCMap with BIMserver.center

2. After allowing VCMap to connect to BIMserver.center VCMap was allowed to access the CHEK Designer's account and saved projects

Figure 7 Access to Designers Account

3. The newly created project was connected to VC Map

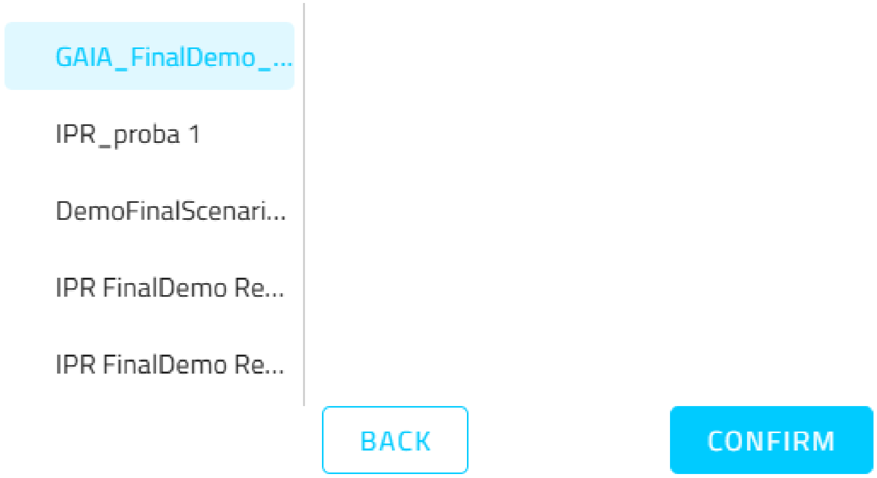


Figure 8 Opening of the relevant project

4. The plot location was properly displayed in VC Map

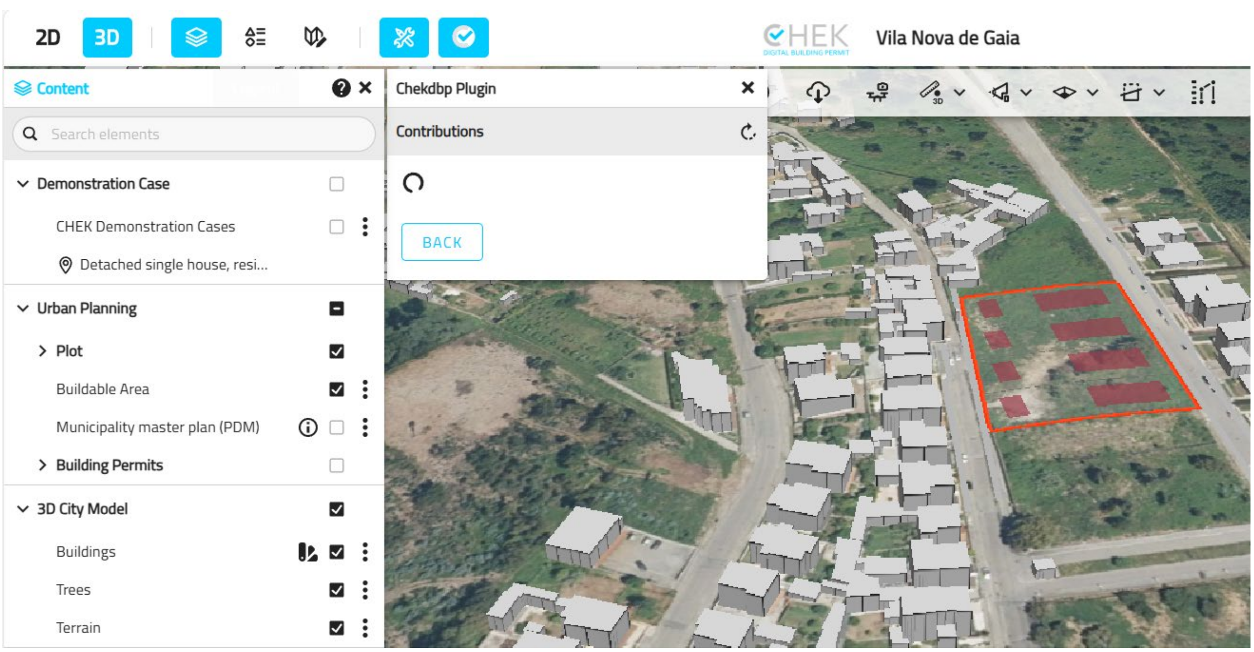


Figure 9 Opening on location

5. Export Tool in VC Map was used for exporting the surrounding data. Area selection tool was used to define the extent of the 3d surrounding that was meant to be exported.

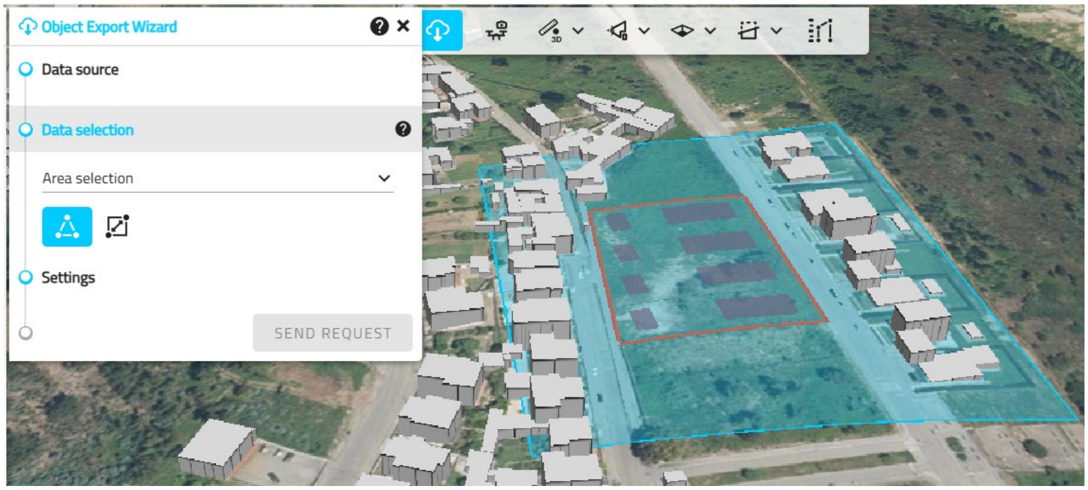


Figure 10 Exporting surrounding data

6. Various Surroundings file formats were selected for later usage in BIM Authoring tool

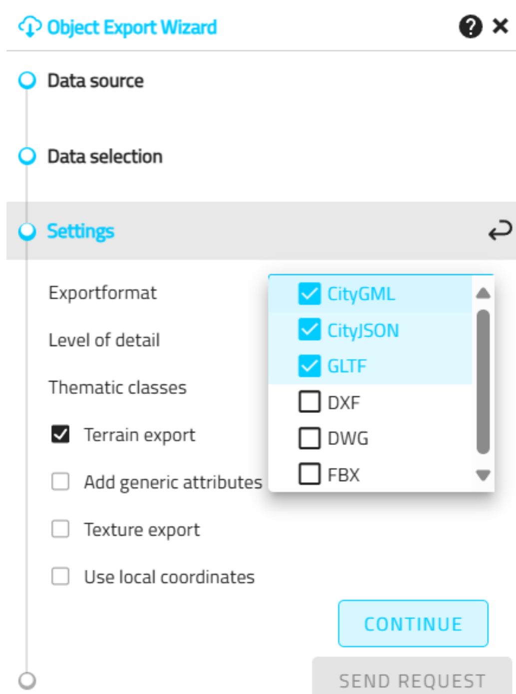


Figure 11 Selection of file format options

7. After finalization, a confirmation was received that the export operation was successful
8. The exported models of the surroundings were automatically exported directly to the project folder in BIMserver.center as a new contribution

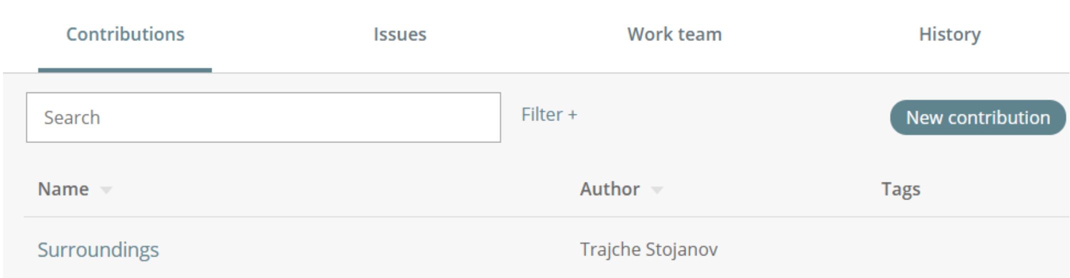


Figure 12 Surroundings exported directly in BIMserver.center

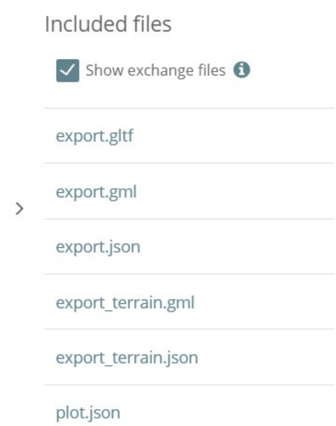


Figure 13 Exported data available in BIMserver.center

9. Exported CityGML files were further converted into IFC for use in BIM authoring tool

3.1.3 GIS to BIM conversion

Exported GIS (surrounding buildings and terrain) models from VCMap were further converted into IFC files via RDF's CityGML2IFC tool. This tool was run locally on Designers' computers and in essence transfers GIS data into BIM.

Inputs:

- CityGML files

Outputs:

- New IFC files converted from CityGML files

Process description:

1. Run CityGML2IFC locally with buildings gml file loaded

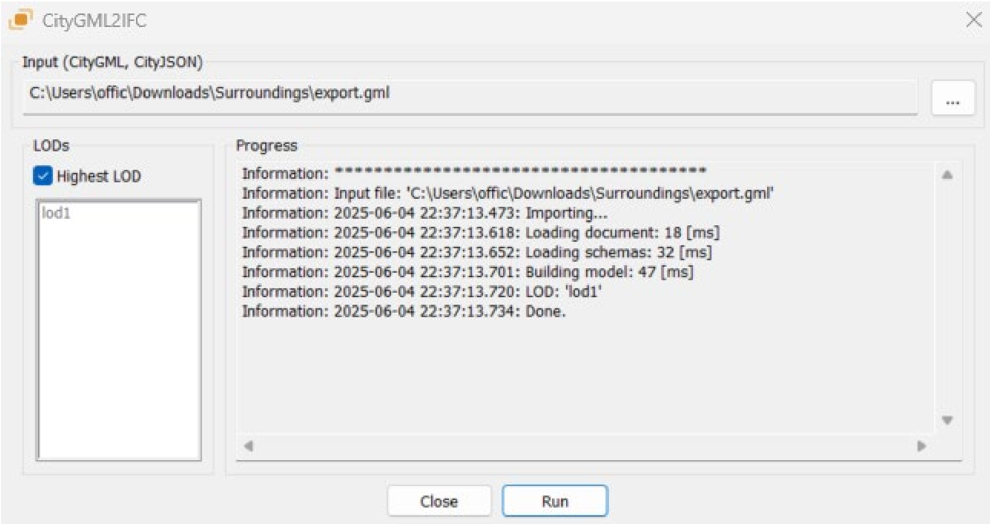


Figure 14 Conversion from CityGML to IFC

2. Run CityGML2IFC locally with terrain gml file loaded
3. The exported IFC files were located in the same folder where the gml files were uploaded from in CityGML2IFC converter.

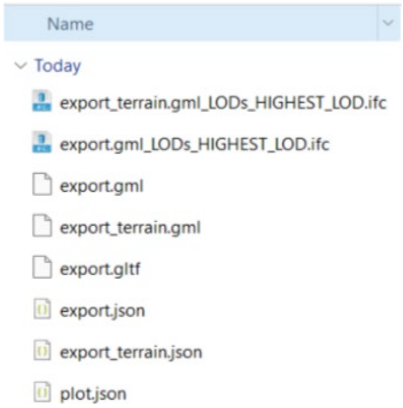


Figure 15 Converted IFC appears in the same folder as exported site data

4. The workflow continued in BIM authoring tool where the IFC models of the surrounding buildings and terrain were used.

3.1.4 Design using Autodesk Revit

Exported GIS (surrounding buildings and terrain) models from VCMap were previously converted into IFC files via RDF's CityGML2IFC tool. Having the site surroundings in IFC file format meant that these files can be used in Revit as BIM authoring tool of choice.

Inputs:

- Newly converted IFC files

Outputs:

- Fully georeferenced Revit file with surroundings

Process description:

1. A new file was opened in Autodesk Revit 2025, a BIM authoring tool used for this demo site.
2. Newly converted IFC models representing the surrounding buildings and terrain were linked using Link IFC tool. The links were bound into the Revit file and that file was saved to serve as surroundings file.

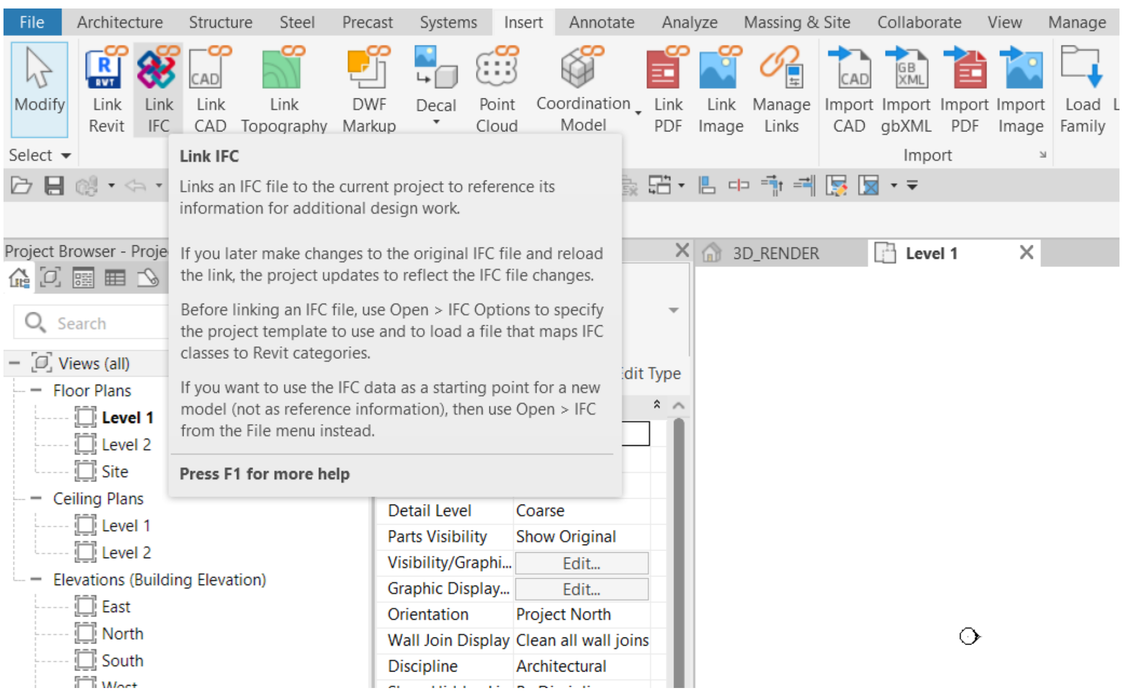


Figure 16 Using Link IFC option in Revit

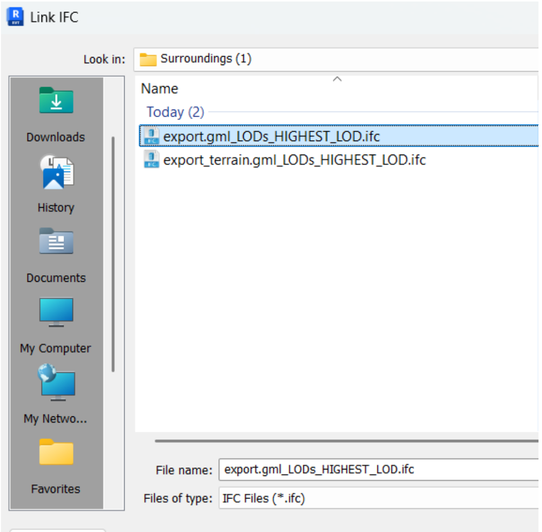


Figure 17 IFC Linking surrounding buildings in Revit

3. Georeferencing of the Revit file was done in order to reflect the realistic spatial context
4. The surroundings Revit file was linked into the Revit Building model

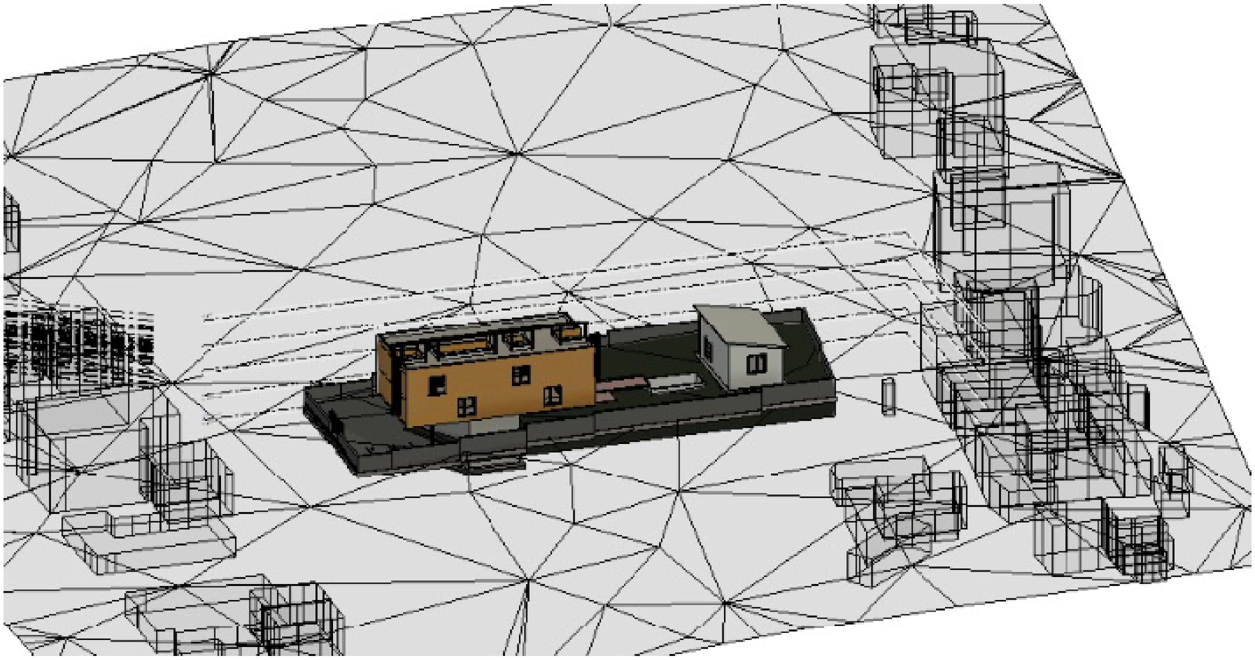


Figure 18 IFC federated linked files in Revit

5. At this moment, the model was exported in IFC with Revit's built-in IFC exporter in order to validate the georeferencing of the model, prior to any additional design development. The part with georeference check in IfcGref tool is presented further in this deliverable. Additionally, the created custom IFC export

contained proper georeferencing setup like EPSG code and was saved as custom MVD (Model View Definition).

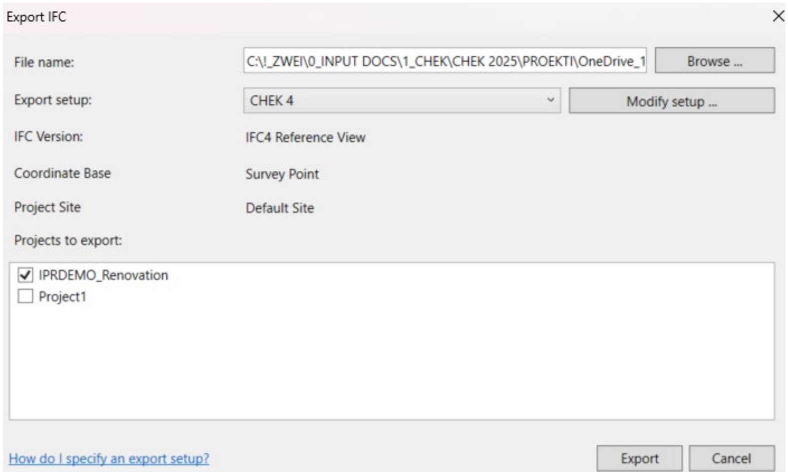


Figure 19 Export to IFC

6. After a georeferencing check was validated, the design development continues with remodeling the existing model of the building, particularly the building footprint was extended to accommodate additional glass sunroom.

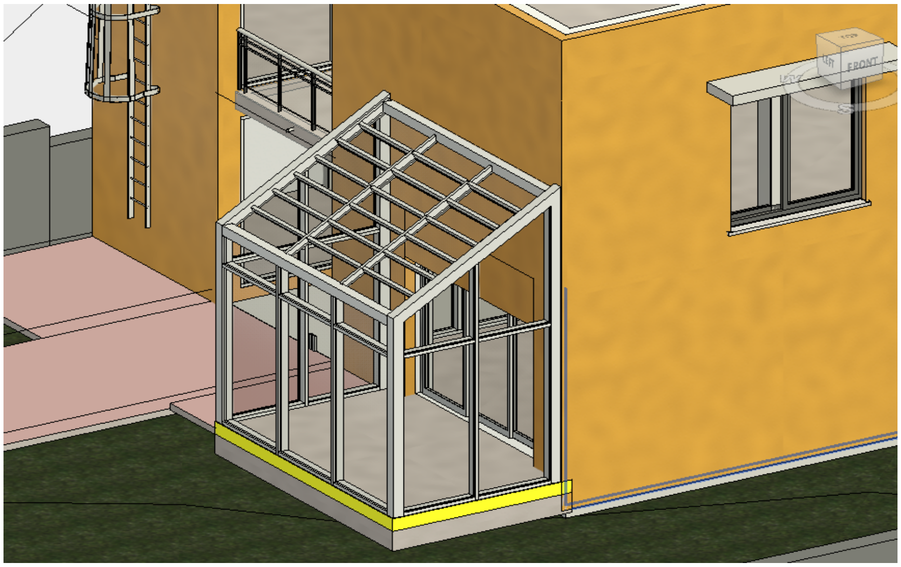


Figure 20 IFC Modeling the sun garden addition in Revit

7. After renovation model was done and relevant attributes were added to the Revit model, the model was exported in IFC with DiRoots IFC Exporter, presented further in this deliverable.

3.1.5 Exporting the project, using tool DiRoots IFC Exporter

When modeling in Revit as BIM authoring tool finished, export to IFC was done using the DiRoots plugin IFC Exporter. The DiRoots IFC exporter reads the existing custom IFC setup (IFC4 MVD) in Revit but also requires correct attribute mapping so the required attributes will be transfered to IFC file

Inputs:

- Finalized Revit model

Outputs:

- IFC file

Process description:

1. DiRoots IfcExporter was previously installed inside Revit 2025
2. In IFC Exporter, proper IDS was selected, along with IFC Export MVD. In the table, each required IFC property was mapped with corresponding Revit parameters

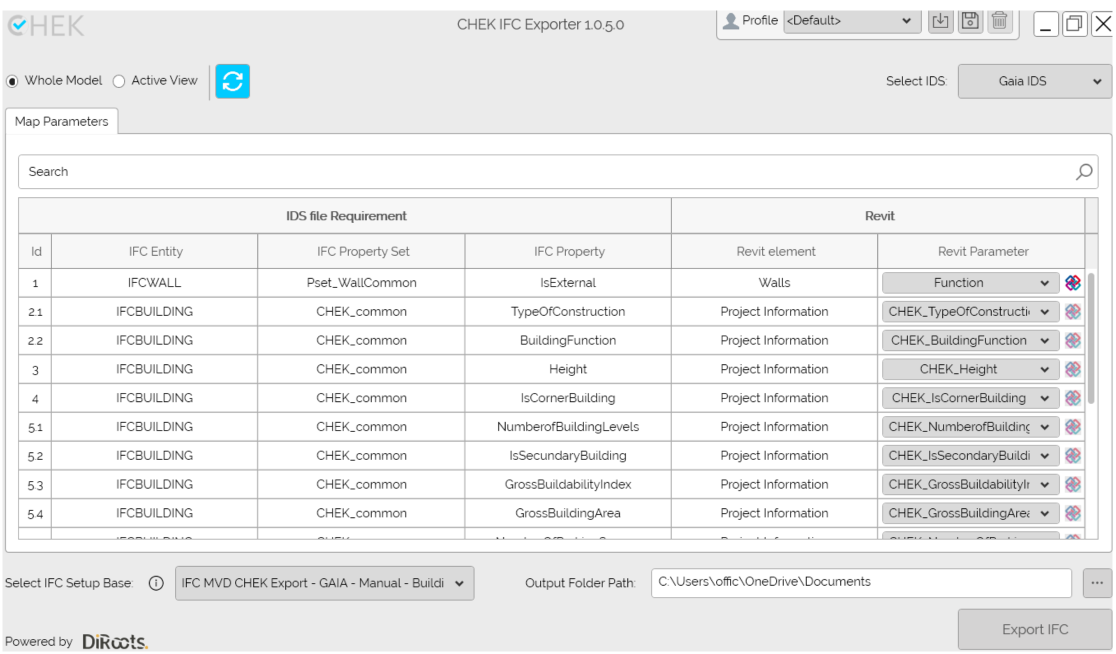


Figure 21 Exporting to IFC using IFCExporter

3. The DiRoots IFC Exporter created the project IFC model of the building that will be used further in the demonstration.

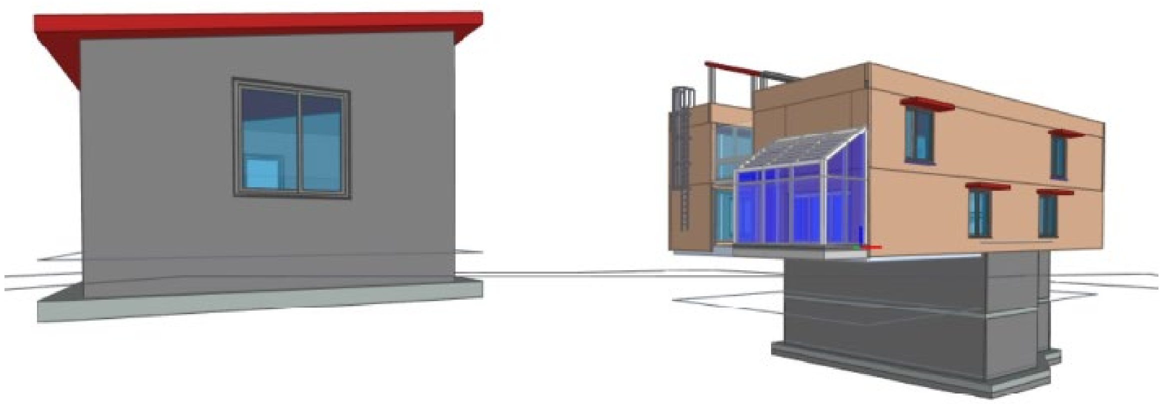


Figure 22 Exported IFC file

3.1.6 Georeference assessment, using tool IfcGref

After initial site surroundings were merged with the existing building model in Revit, the project was exported to IFC for further georeferencing check in IfcGref tool. IfcGref tool developed by TUDelft, is a web service that validates the proper georeferencing of the IFC file and offers additional tools such as visual inspection of the model on basemap.

Inputs:

- Georeferenced IFC model

Outputs:

- Validated IFC model

Process description:

1. The IFC model of the building was uploaded to IfcGref

IFC version: IFC4
IFC file is georeferenced.

IFCProjectedCRS Data

	property	value
0	id	28
1	type	IfcProjectedCRS
2	Name	EPSG:3763
3	Description	None

Figure 23Georeferencing check

2. IfcGref tool returned that the model is properly georeferenced
3. The model was properly positioned on the map giving the designers confidence to continue with the demo.

Figure 24 Visual check in IfcGref

3.1.7 IFC validation, using tool IfcViewer

To ensure validity of the IFC model data for further regulations compliance checks, the IFC model was checked against IDS requirements. This check was performed using the RDF's tool IfcViewer, a portable desktop application.

Inputs:

- IFC model

Outputs:

- Validated IFC model against IDS

Process description:

1. The IFC model of the building was opened with IfcViewer

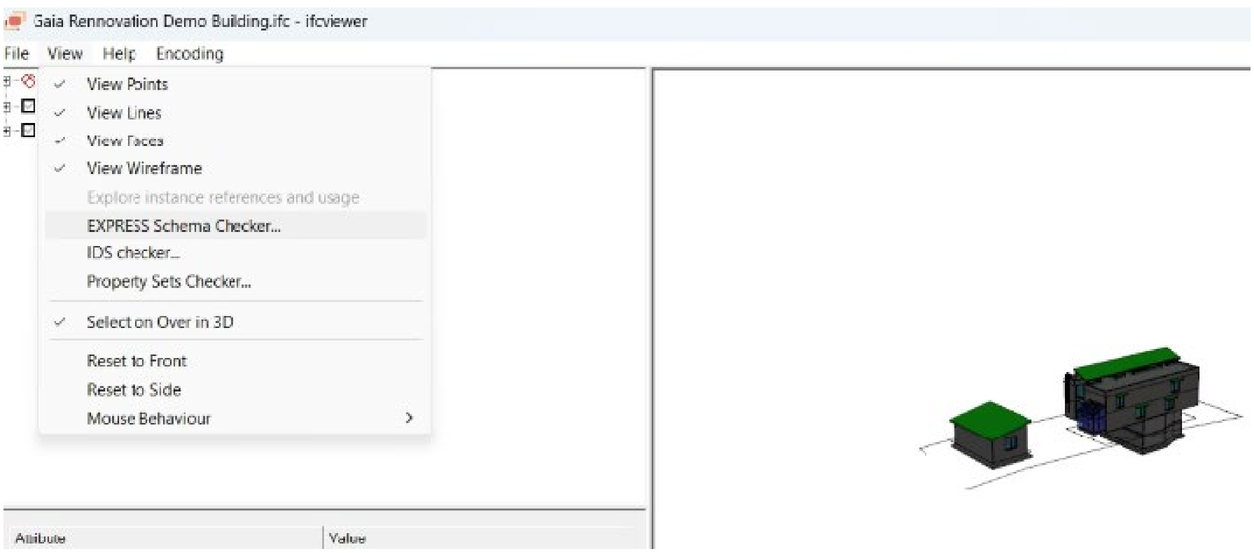


Figure 25 Model opened in IfcViewer

2. The EXPRESS Schema Checker returned the results

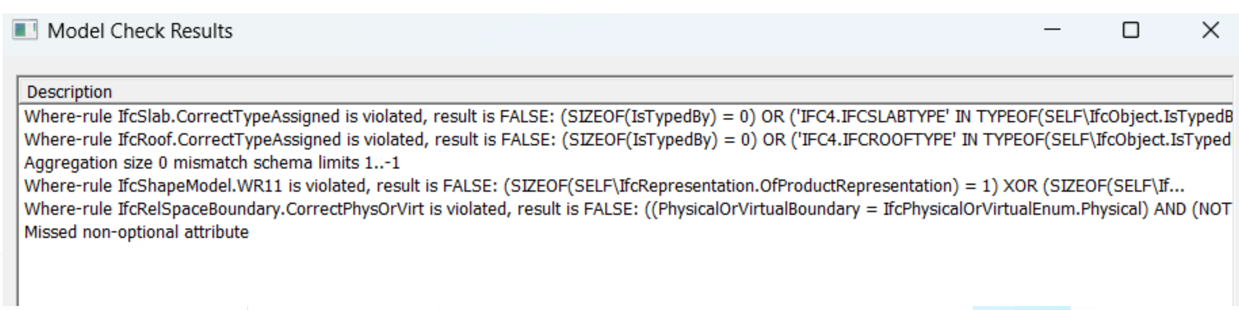


Figure 26 EXPRESS Schema check

3. The IDS checker requested import of Gaia pilot specific IDS file and after it was imported returned the following results:

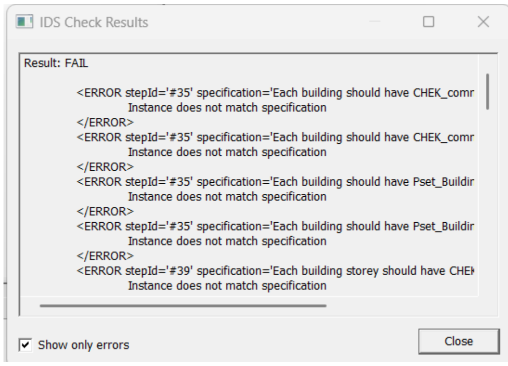


Figure 27 IDS check

4. Both checkers returned some failed results. The errors in the EXPRESS schema were identified prior to the demonstration phase and were attributed to the software vendor issues. These errors were not imposing issues in the next steps.

3.1.8 Uploading the model to the CHEK platform using tool BIMserver.center

After IFC model went through the validation against georeferencing, EXPRESS schema, and IDS requirements. Next step was to be upload as Contribution to the project folder on the CHEK DBP platform based on BIMserver.center. This contribution was later connected to CypeUrban and VC Map for performing self-check against predefined rules.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. New contribution was initiated in the project folder in BIMserver.center

Figure 28 Creating the contribution in BSC to include the project in validated IFC format

2. After uploading the IFC model in the contribution, the IFC model was converted to GLTF file format suitable for further visualization in web applications like BIMserver.center, VCMap and Verifi3D.

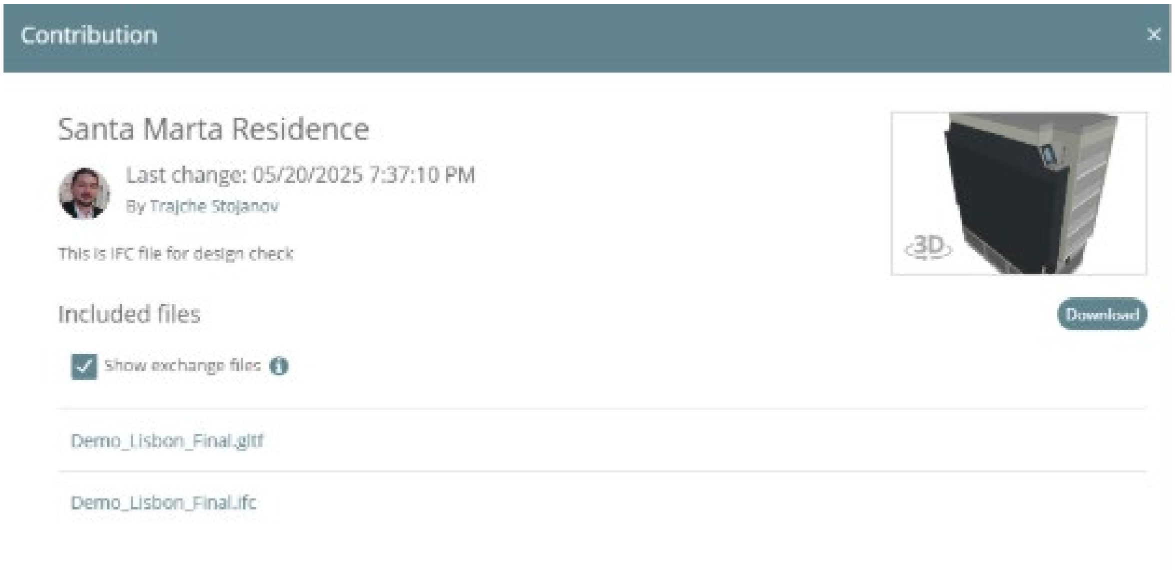


Figure 29GLTF automatic conversion in BSC to let visualize the project

3.1.9 CHEK pre-validation, using tool VC Map

Prior to performing final checks in checking application, Designers did selfcheck of the IFC model in this stage. The self-check returned some failed checks. This pre-validation is very beneficial in self-assessment of the model prior to submitting it for Review by the Municipalities.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. After Designers logon the VCMap platform and connected the BIMserver.center account, the IFC model was converted to Visualization Model in order to be visualize

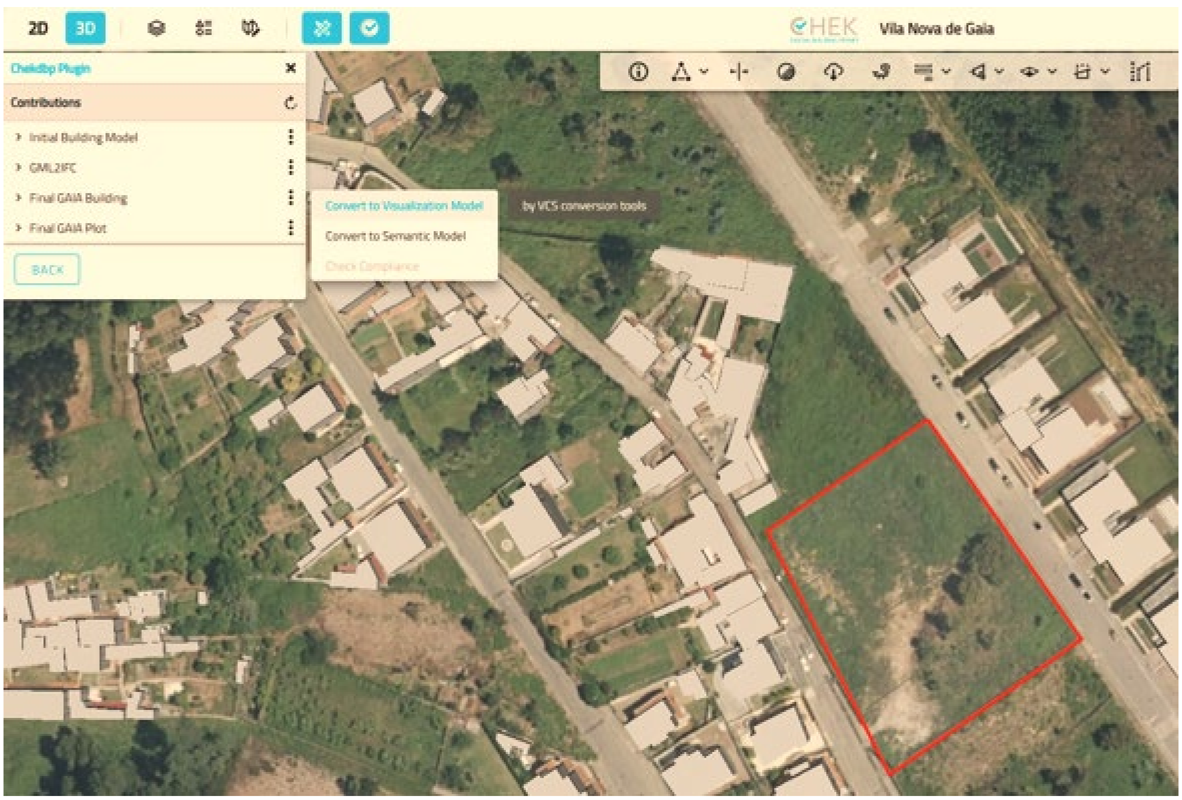


Figure 30 Visualization model conversion ongoing in VCMap

2. After converting the model into Visualization Model, conversion to Semantic Model was performed

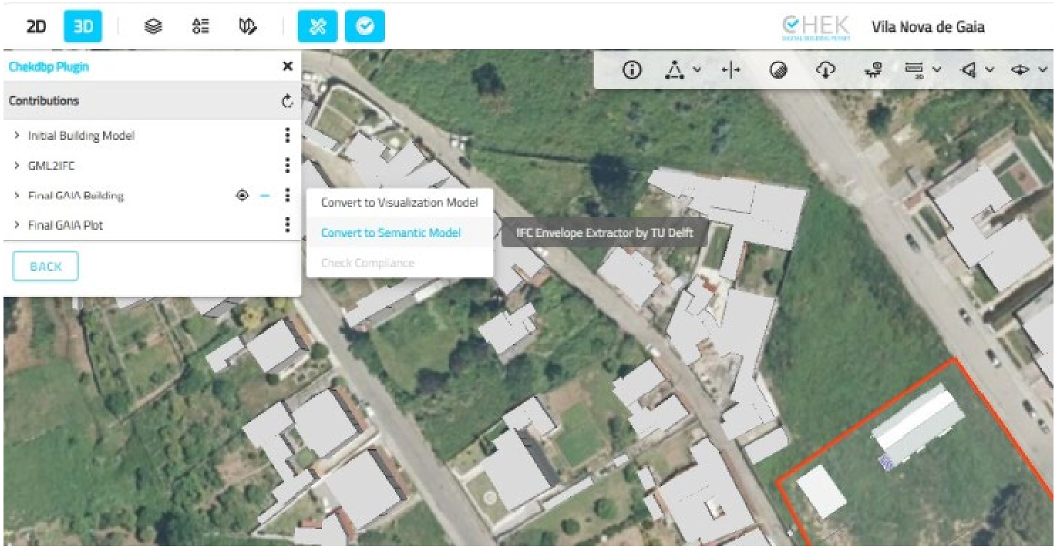


Figure 31 Conversion to semantic model

3. With both conversions completed, the check compliance was performed

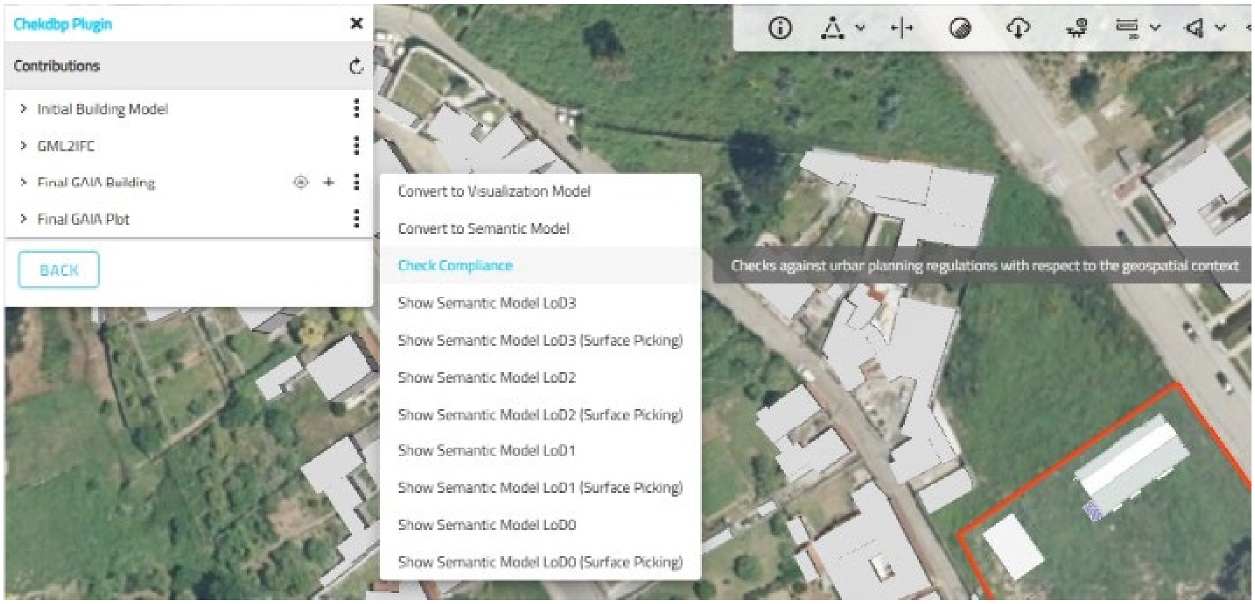


Figure 32Running check compliance in VCMap

4. The compliance check returned some failed checks, which was intentionally done in order to test the checking feature of the VCMap

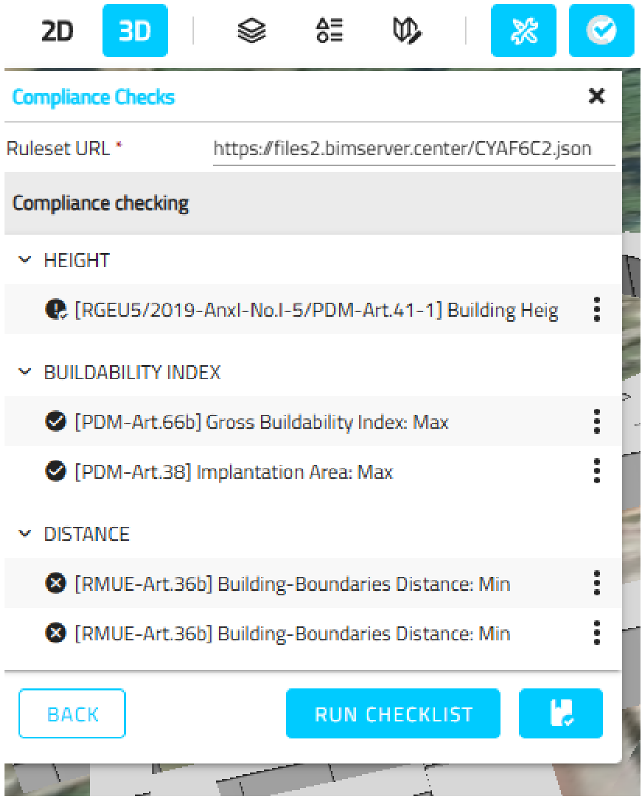


Figure 33 online report after running automatic the checklist

3.1.10 CHEK pre-validation, using tool CypeUrban

After the first set of compliance pre-check done in VC Map, Designers did self-check with CypeUrban tool too. The self-check returned some failed checks.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. Designers created a new project in CypeUrban and connected the BIMserver.center account in order to have seamless flow of data

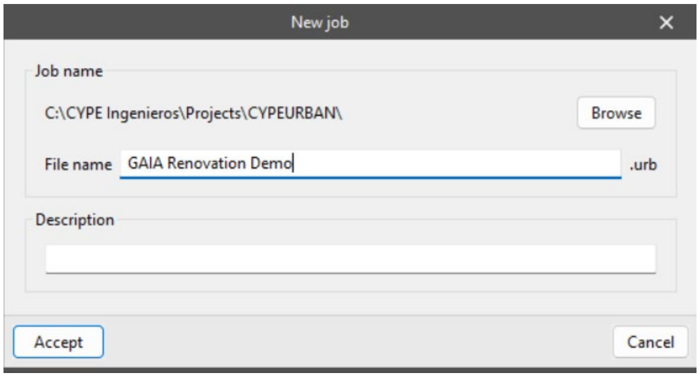


Figure 344 Creation a new project in CypeUrban

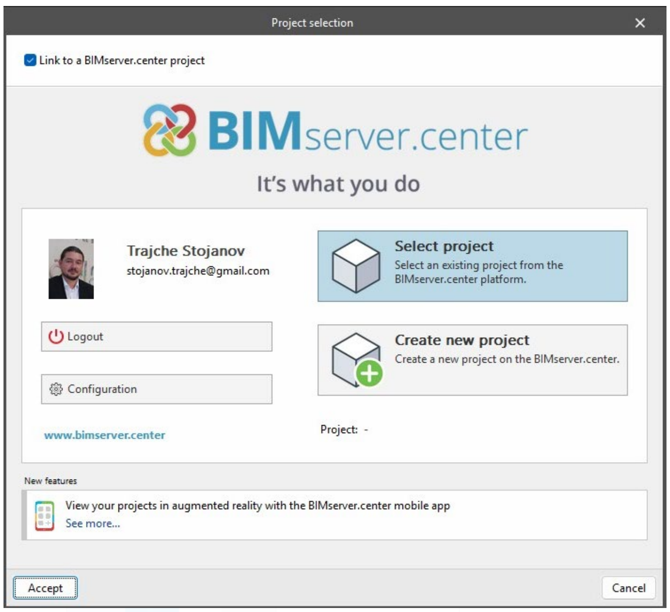
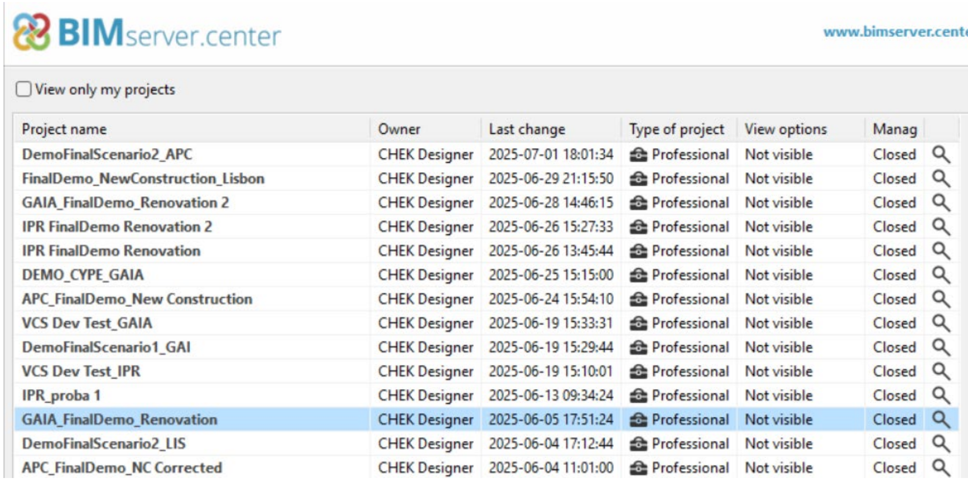


Figure 35 Logging into BSC, to enable project selection

2. The project files were opened



Project name	Owner	Last change	Type of project	View options	Manag
DemoFinalScenario2_APC	CHEK Designer	2025-07-01 18:01:34	Professional	Not visible	Closed
FinalDemo_NewConstruction_Lisbon	CHEK Designer	2025-06-29 21:15:50	Professional	Not visible	Closed
GAIA_FinalDemo_Renovation 2	CHEK Designer	2025-06-28 14:46:15	Professional	Not visible	Closed
IPR FinalDemo Renovation 2	CHEK Designer	2025-06-26 15:27:33	Professional	Not visible	Closed
IPR FinalDemo Renovation	CHEK Designer	2025-06-26 13:45:44	Professional	Not visible	Closed
DEMO_CYPE_GAIA	CHEK Designer	2025-06-25 15:15:00	Professional	Not visible	Closed
APC_FinalDemo_New Construction	CHEK Designer	2025-06-24 15:54:10	Professional	Not visible	Closed
VCS Dev Test_GAIA	CHEK Designer	2025-06-19 15:33:31	Professional	Not visible	Closed
DemoFinalScenario1_GAI	CHEK Designer	2025-06-19 15:29:44	Professional	Not visible	Closed
VCS Dev Test_IPR	CHEK Designer	2025-06-19 15:10:01	Professional	Not visible	Closed
IPR_proba 1	CHEK Designer	2025-06-13 09:34:24	Professional	Not visible	Closed
GAIA_FinalDemo_Renovation	CHEK Designer	2025-06-05 17:51:24	Professional	Not visible	Closed
DemoFinalScenario2_LIS	CHEK Designer	2025-06-04 17:12:44	Professional	Not visible	Closed
APC_FinalDemo_NC Corrected	CHEK Designer	2025-06-04 11:01:00	Professional	Not visible	Closed

Figure 36 List of available projects in BSC, as CYPEURBAN shows it

3. Vila Nova de Gaia regulations checks were chosen

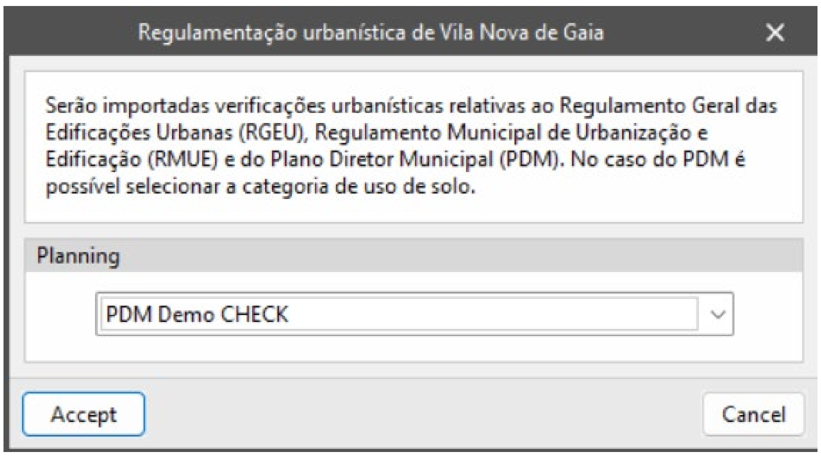


Figure 37 Selecting the municipality will show the list of regulations implemented

4. Certain model elements were properly defined, like rooms, building levels, setbacks etc.

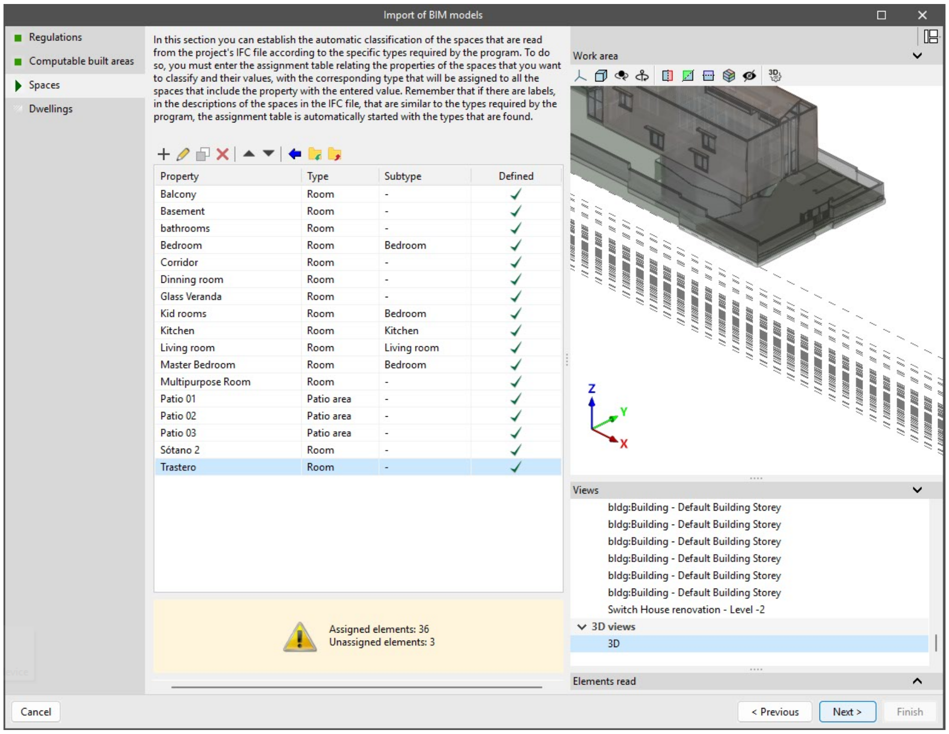


Figure 38IfcSpaces mapping to let CYPEURBAN perform some checks

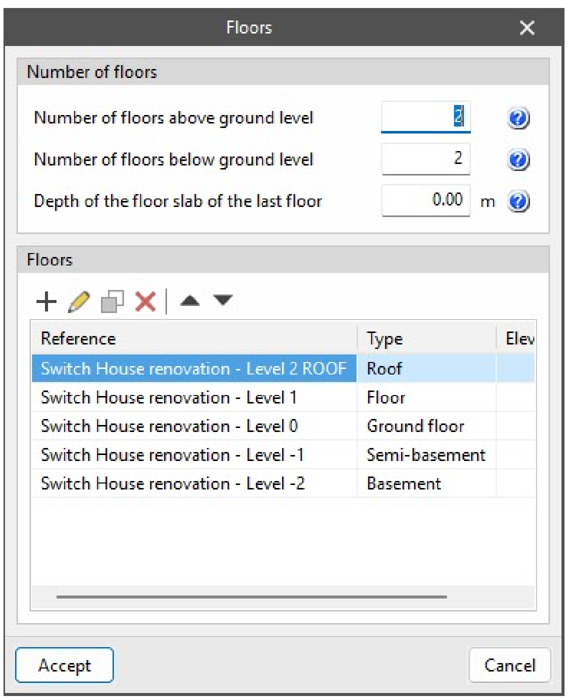


Figure 39 Setting the floor info

5. After setting up the project, the automatic code compliance check was initiated returning some failed checks
6. The results of performed self-check in CypeUrban were used to correct the model in Revit

3.1.11 Design correction using tool Autodesk Revit 2025

After a self-check was performed in VC Map and CypeUrban, Designers did correction of the BIM model in Autodesk Revit 2025, a commercial BIM application of choice. The corrections were made mostly in the building height of the ground floor, according to the results of the selfcheck. Since activities under this step have been already elaborated, the process description contains only main points.

Inputs:

- Analog check results

Outputs:

- Corrected and updated BIM model

Process description:

1. Designers did changes to the model in reference to the failed checks
2. The Revit model was exported in IFC using Diroots IFC Exporter

3.1.12 Digital signature of the IFC model, using tool DiStellar

Updated IFC file was digitally signed in DiRoots DiStellar with Signature functionality that runs on a personal account connected to Designer's personal mobile phone. The digital signature tool added additional information in the IFC file that can be assessed only by DiStellar app.

Inputs:

- IFC model

Outputs:

- Digitally signed IFC file

Process description:

1. The DiStellar app was opened and Designers logged in

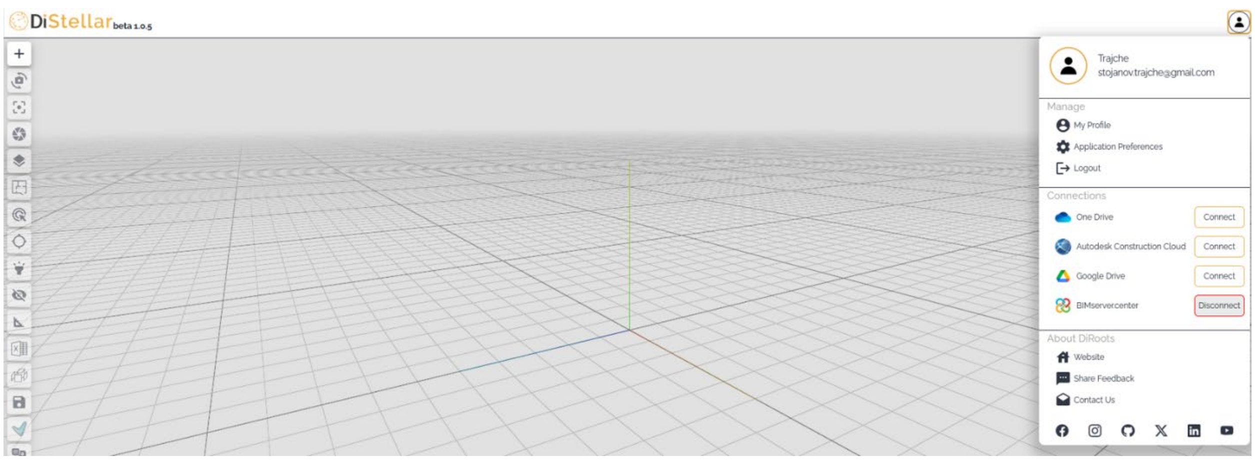


Figure 40 Starting the signing gadget in DiStellar

2. BIMserver.center was connected

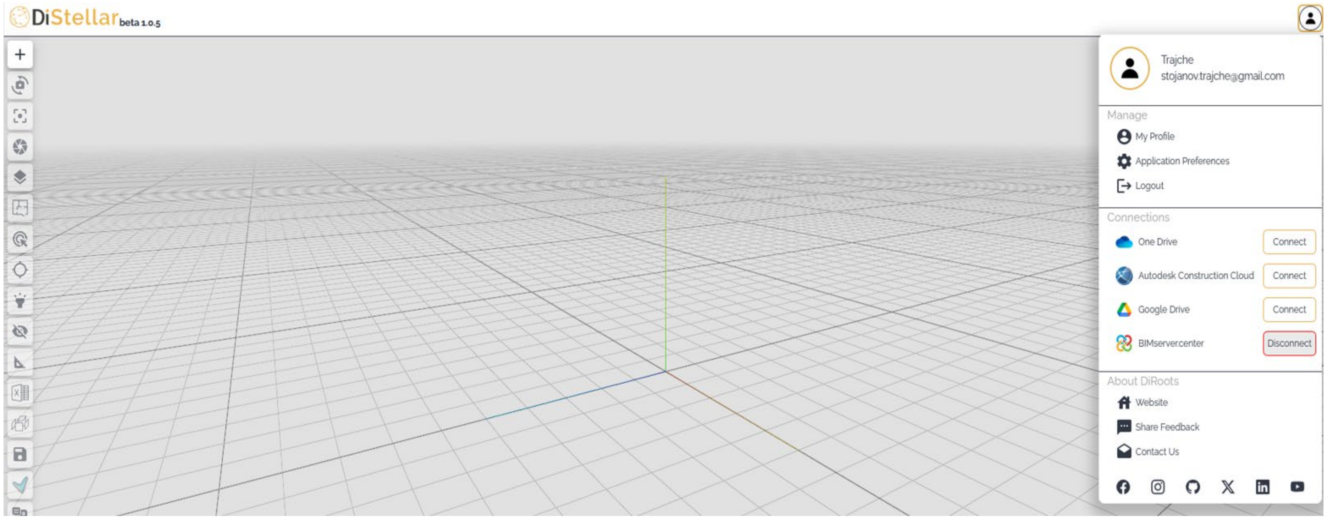


Figure 41 Cloud services available from the tool, among them BSC

3. The updated IFC model was uploaded and digitally signed

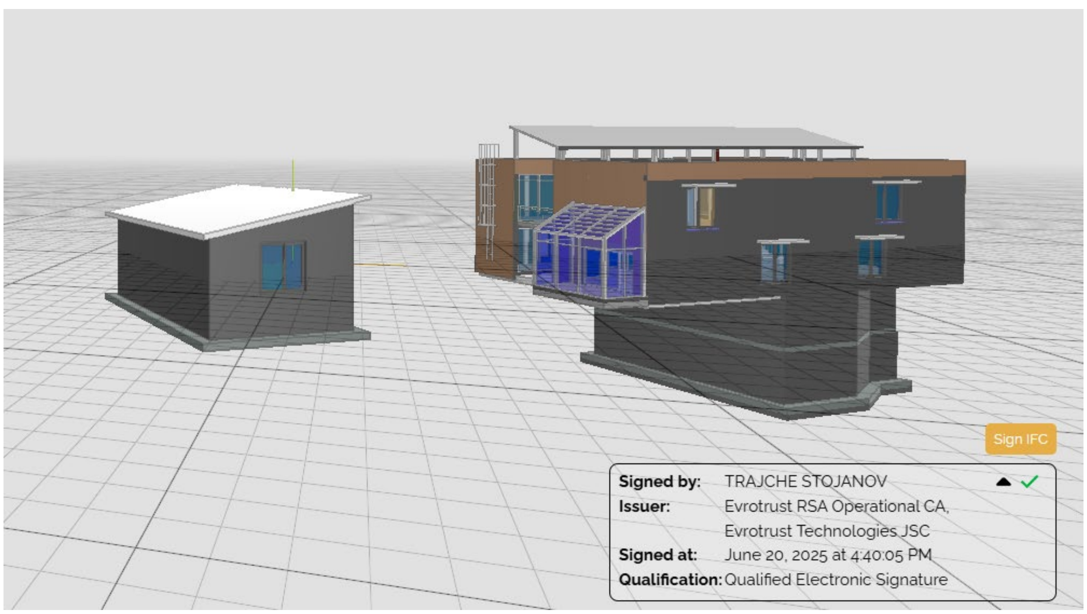


Figure 42 Uploaded and signed IFC file

4. Signed IFC model was uploaded to BIMserver.center in project folder

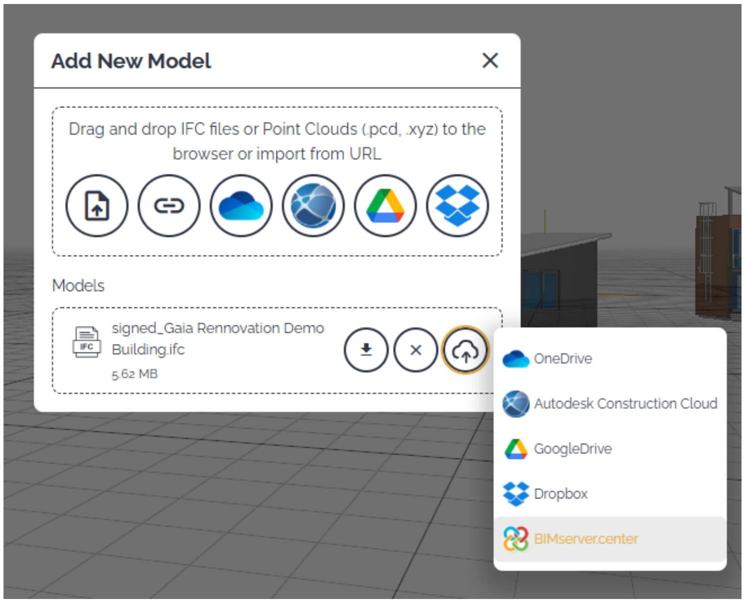


Figure 43 performing the upload of signed file into BIMserver.center

3.1.13 CHEK final-validation and report to municipalities, using tool VC Map and CypeUrban

The final step in Designers workflow was performing final validation (compliance check) of the IFC model and sharing the check report to Municipality of Vila Nova de Gaia via BIMserver.center. The final validation was performed in VC Map and CypeUrban, repeating the steps described in items 9 and 10 of this case study. Not to repeat the same steps, in this stage we are describing the steps after the check is performed.

Inputs:

- Digitally signed IFC model

Outputs:

- Shared json files as a check results file

Process description:

1. In VCMap platform, the updated IFC model was converted to Visualization Model and later to Semantic Model. The Compliance checks were performed. The results were shared
2. The newly uploaded updated digitally signed IFC model was opened in CypeUrban and Vila Nova de Gaia regulation checks were performed
3. The check results showed successful checks.

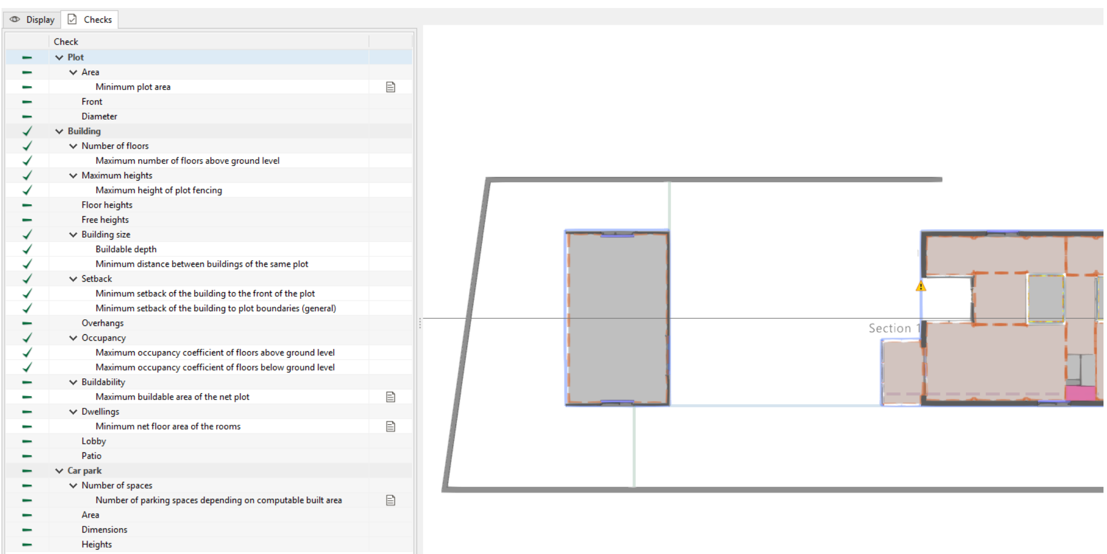


Figure 44 Results showing successful checks

4. The results and report of performed checks were shared via BIMserver.center to the Municipality of Vila Nova de Gaia for final review.

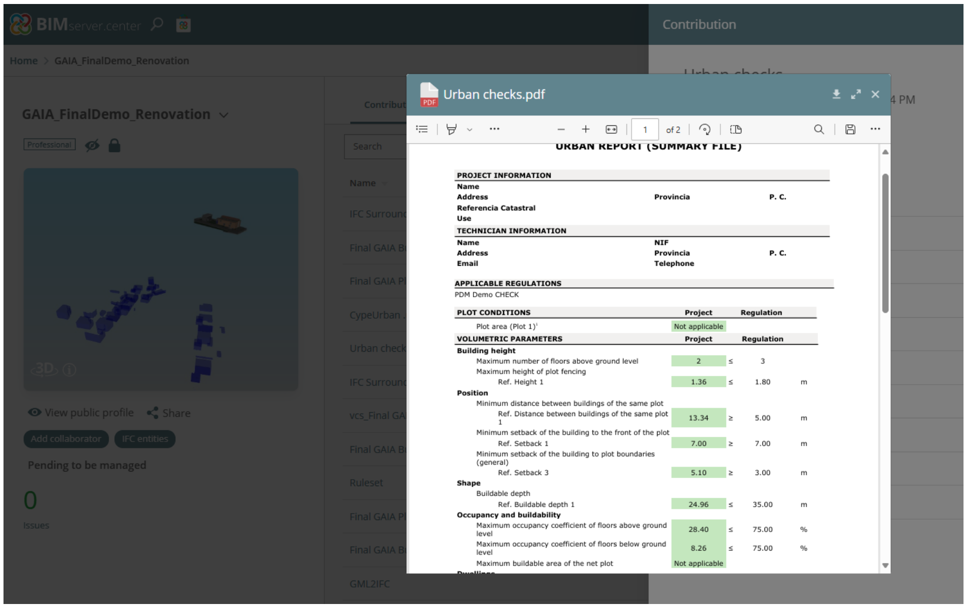


Figure 45 Sharing the report with municipalities via BSC

3.1.14 CHEK permitting tools. Municipality side, using tool BIMserver.center

After completion of the designer's workflow, the Municipality of Vila nova de Gaia received automatically a Request for Review of the submitted results check.

Inputs:

- Digitally signed IFC model
- Validation report / check results from VCMap
- Validation report / check results from CypeUrban
- Contribution files in BIMserver.center

Outputs:

- Request for Review result by Municipality of Vila nova de Gaia

Process description:

- As designers completed the checks and shared the results, the Gaia team:
  - .1. started evaluating the validation reports / check results along with
  - .2. Performing checks by themselves using the CypeUrban and
  - .3. Performing checks in VCMap application

URBAN REPORT (SUMMARY FILE)

PROJECT INFORMATION		
Name		
Address	Provincia	P. C.
Referencia Catastral		
Use		

TECHNICIAN INFORMATION		
Name	NIF	
Address	Provincia	P. C.
Email	Telephone	

APPLICABLE REGULATIONS

PDM Demo CHECK

PLOT CONDITIONS	Project		Regulation	
Plot area	Not applicable			
VOLUMETRIC PARAMETERS	**Project**		**Regulation**	
Building height				
Maximum number of floors above ground level	1	≤	3	
Maximum height of plot fencing	Not applicable			
Position				
Minimum distance between buildings of the same plot				
Ref. Distance between buildings of the same plot 1	13.34	≥	5.00	m
Minimum setback of the building to the front of the plot	Not applicable			
Minimum setback of the building to plot boundaries (general)				
Ref. Setback 1	5.26	≥	3.00	m
Ref. Setback 2	10.25	≥	3.00	m
Shape				
Buildable depth				
Ref. Buildable depth 1	31.98	≤	35.00	m
Occupancy and buildability				
Maximum occupancy coefficient of floors above ground level	Not applicable			
Maximum occupancy coefficient of floors below ground level	Not applicable			
Maximum buildable area of the net plot	Not applicable			
Dwellings				
Minimum net floor area of the rooms[1]	Not applicable			
CAR PARK	**Project**		**Regulation**	
Number of parking spaces depending on computable built area	3	≥	3	Spaces

[1]The expansion has no implications for existing divisions.

Figure 46 CypeUrban report on checking results received via BSC

- During the validation/checking activities, Gaia team reported some issues using the checking applications that were communicated with software vendors. The results of the checks performed were documented in a standardized format.

Figure 47 verification of rule no.7 in CypeUrban

- In CypeUrban, from 12 available checks, 7 were not applicable for the Renovation scenario, the rest 5 were successful.

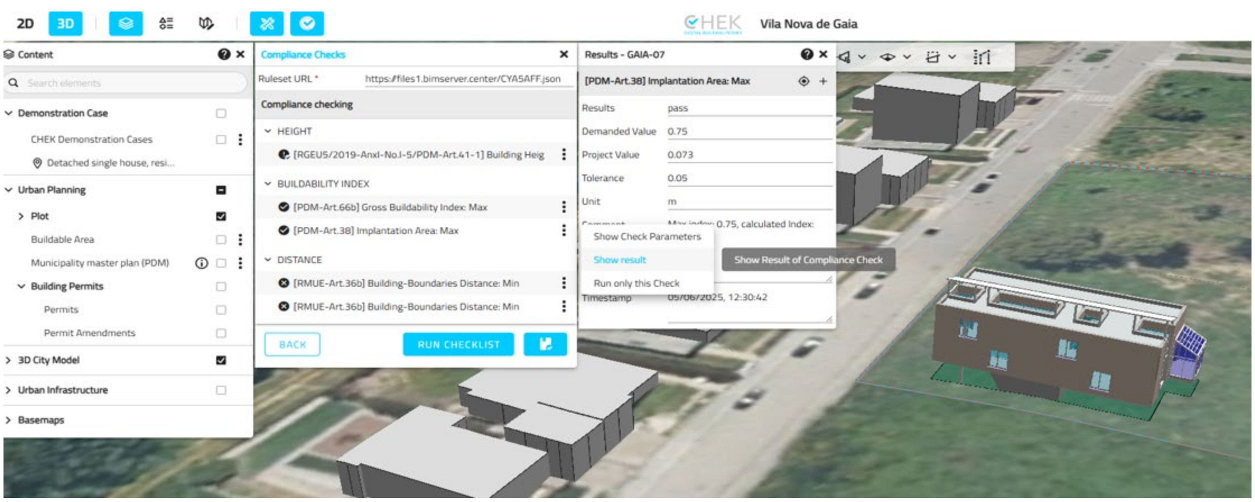


Figure 48 verification of rules in VCMap

- In VCMap, from 5 available checks, 1 was not applicable for Renovation scenario, 1 was confirmed to be failed, 1 was successful and for two rules, Gaia team expressed some doubts.

Conclusion

The Gaia Renovation Scenario successfully demonstrated the practical application and usefulness of the CHEK digital toolkit in the digital permitting context. The scenario showed that the proposed CHEK DBP workflow is viable, collaboration between the shareholders was achieved, the model was checked against the regulations, and time allocation of the processes was reduced. The tools were user friendly, comprehensive and contributed greatly to the designers and the municipalities processes. During the demonstration, some errors or issues were noticed and communicated further. Some of them were successfully resolved or bypassed, some stayed, but none of them had an adverse impact on the demonstration. Overall, the Gaia Renovation Scenario provided strong evidence of the potential for digitally enabled, rule-based permit workflows to streamline renovation permitting processes across European cities.

3.2 Lisbon

This demonstration carried out in the municipality of Lisbon falls under Scenario 2 of the CHEK project, focused on the renovation or extension of an existing building within a consolidated urban environment. The pilot project involved the extension of a residential building to incorporate a new ground-floor commercial unit intended for food service, partially occupying the inner courtyard. The intervention also included outdoor spaces such as terraces at street and first-floor levels, as well as a rooftop garden.

The design was developed by SIA.Architects, in coordination with the municipality of Lisbon, which was responsible for the urban planning validation.

The workflow followed in this pilot mirrored the structure established in the previous Scenario 1 demonstrations, but was adapted to the specific challenges of intervening in an existing building. Particular attention was given to the correct integration of pre-existing elements with newly designed components, both in the modeling process and in the structuring of the resulting IFC file.

The BIM model was exported to IFC format using the official DiRoots plugin, selecting the IDS corresponding to the municipality of Lisbon. This tool facilitated the mapping of regulatory parameters, although it does not validate their content. That task was performed later using the tools CYPEURBAN and VCMap.

The models were integrated into the BIMserver.center platform as the Common Data Environment (CDE), along with additional contributions representing the existing geographic context: the parcel, the original building, and the surrounding buildings necessary for the planning compliance checks.

To obtain the urban and geospatial context, and to enable automated regulatory validation, the VCMap tool was used. For the graphical and rule-based validation, CYPEURBAN was also employed.

Several technical issues were identified throughout the process, mainly related to georeferencing, space detection, and proper model federation between files originating from different authoring environments. These issues were addressed through iterative adjustments to coordinate systems and tailored exports, resulting in a single, harmonized version of the model (V9) that was compatible with both VCMap and CYPEURBAN. The final file was digitally signed.

To avoid redundancy, this section will emphasize the distinctive aspects of this demonstration in comparison with those already covered in Deliverable D6.2. Workflow steps that have been addressed in previous scenarios will be briefly summarized, with detailed explanations reserved for new or scenario-specific elements.

DEMO PILOT CASE INFO CARD		
1	Demo plot location	Lisbon, Portugal
2	Building Type	Multi-storey Residential Building
3	Address	Rua de Santa Marta, nº 41-41B
4	Designer of Scenario 1	ZWE
5	Designer of Scenario 2	SIA
6	Renovation Description	Horizontal Extension / New functionalities
7	Demonstration period	02/06/2025 - 06/06/2025
8	Reviewer	Municipality of Lisbon

Figure 49 Final version for Lisbon Scenario 2, renovation

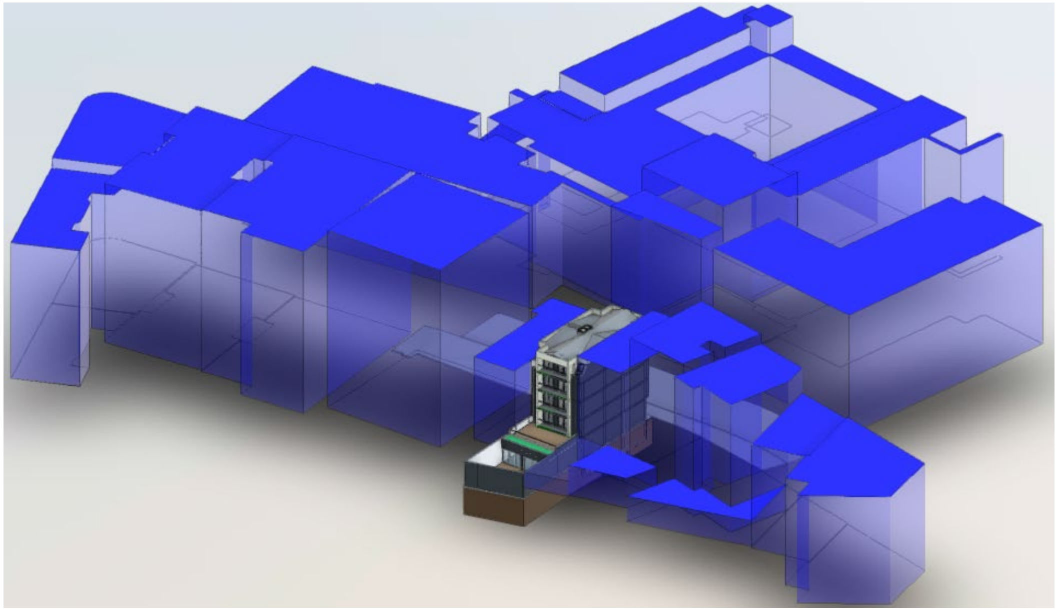


Figure 50 Integrated render Scenario 1 and scenario 2. Lisbon

3.2.1 Gathering initial data – VCMap

Settings:

- Project DemoFinalScenario2_LIS was created and tagged with the city of Lisbon to ensure proper visibility in VCMap

Inputs:

- IFC files inherited from Scenario 1, corresponding to the existing building and plot, to ensure its position en VCMap, although redundant.

Outputs:

- CityGML files for neighboring buildings and topography, although in this case they were not relevant for the urban planning checks in the renovation scenario

To improve:

- The IFC file of neighboring buildings from Scenario 1 had positioning issues relative to the Scenario 2 model. It was necessary to harmonize the model origins within the authoring software, aligning the coordinates of the renovated model with those of the original.
- The absence of a parcel boundary exported directly from VCMap required the use of data provided by the municipality in DXF.

Process description:

The process began with the creation of the project in BIMserver.center properly tagged for indexing by VCMap. Once the project became visible in the platform, the city model was accessed through the content tool, locating the area corresponding to the building undergoing renovation.

In this case, data previously generated during the Scenario 1 demo (LIS) was available, including the existing building model (Demo_Lisbon_Updated.ifc). However, upon verifying compatibility with CYPEURBAN, it was found that the model had been modified to meet tool-specific requirements, making it unsuitable for direct reuse. As a result, the renovated model had to be realigned to match the exact coordinates of the original.

Additionally, the IFC file containing the neighbouring buildings showed georeferencing issues and had to be discarded. As a workaround, a CityGML file of the surrounding context was downloaded from VCMap and converted to IFC using the RDF converter, ensuring spatial alignment with the parcel and the renovated building.

Finally, separate contributions were created in BIMserver.center for each component of the existing environment (plot, existing building, neighbours), enabling proper visual federation and a coherent validation setup.

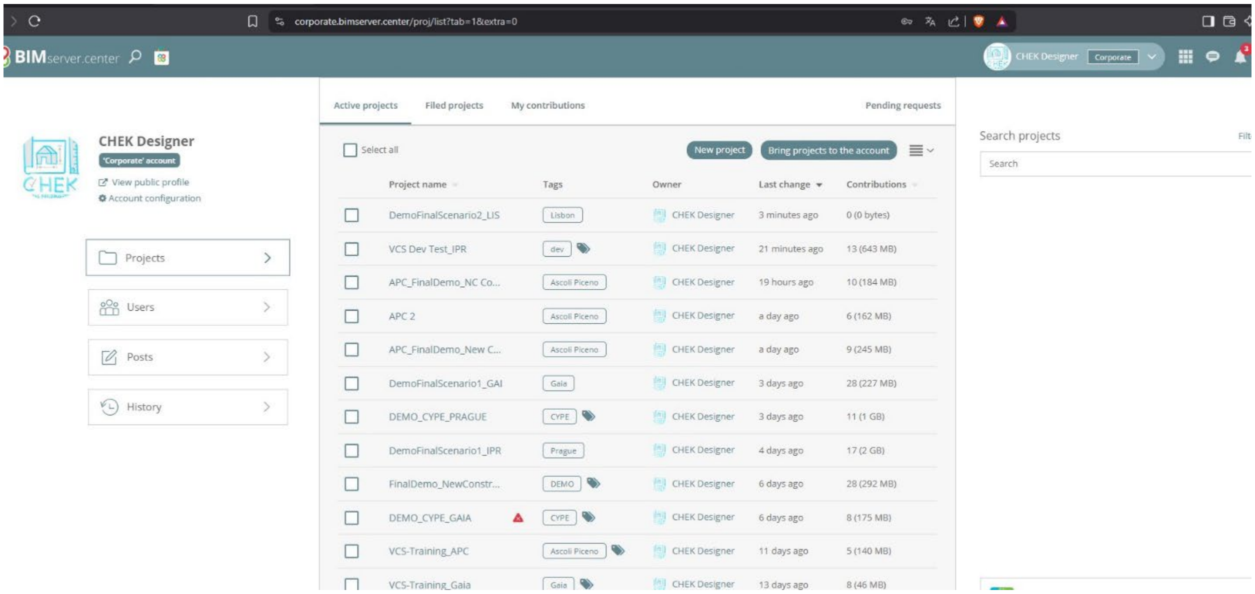


Figure 51 Project creation and tagging in the CDE

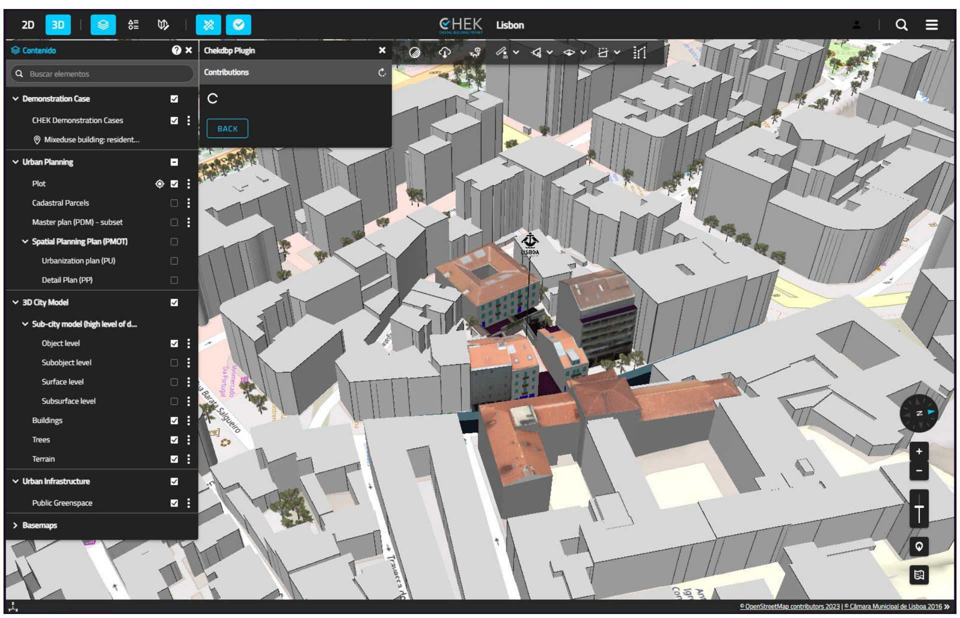


Figure 52 Plot shown in VCMap

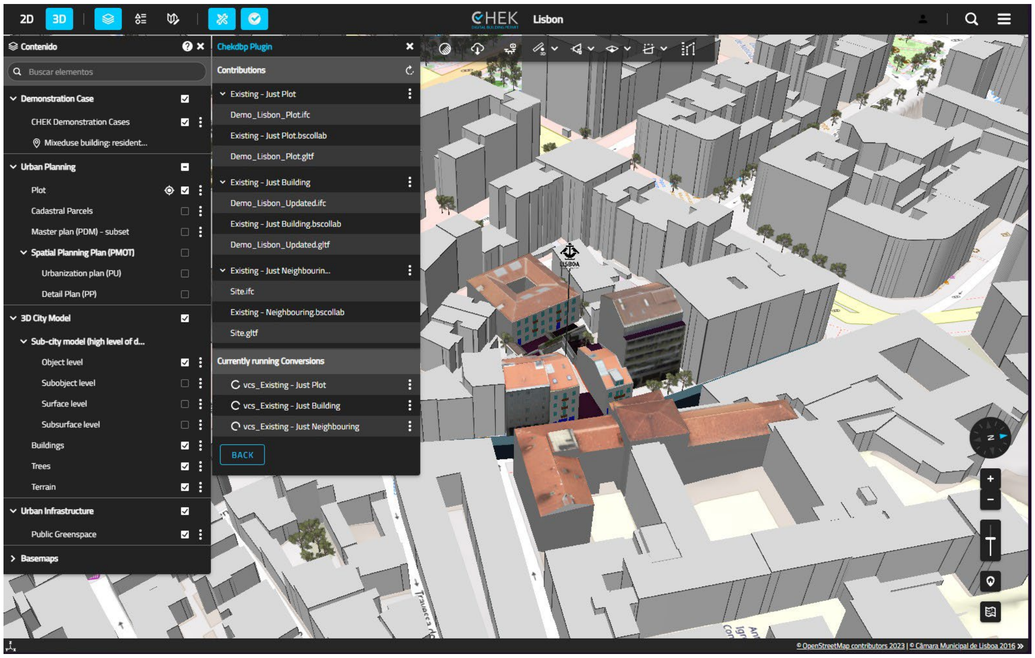


Figure 53 Converting provided IFC files from S1 into visualization model

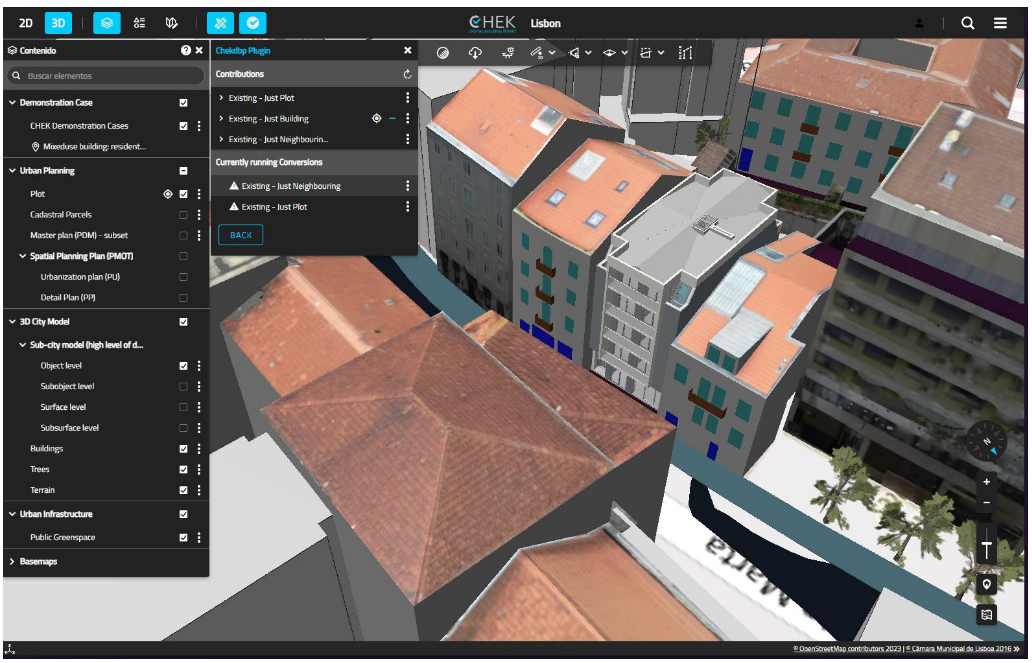


Figure 54 Issues with provided Visualization models converting

3.2.2 GIS validation

In this demonstration, as in the previous ones (including those documented in Deliverable D6.2), no formal GIS validation process was required on the designer's side. All necessary geospatial data (including the city model, terrain, and surrounding buildings) were obtained directly from VCMap, a platform already populated with structured, georeferenced data provided by the municipality or its GIS service providers.

Since the designer did not contribute new spatial datasets to the system (e.g., custom shapefiles, GMLs, or IFC-to-GIS conversions), no additional GIS validation was deemed necessary. Validation efforts were instead focused on the alignment and visual consistency of the models, confirmed through IfcGref and federation tests in VCMap and the RDF viewer.

A dedicated GIS validation workflow would only be relevant if new spatial data were created with the intention of integrating it back into the municipal GIS base. This was not the case in this demonstration.

3.2.3 GIS to BIM conversion – CityGML2IFC

Settings:

- The urban environment file was downloaded from VCMap in CityGML format.
- The standalone tool CityGML2IFC, developed by RDF and requiring installation, was used to convert GIS data into IFC format.

Inputs:

- Environment models exported from VCMap in CityGML format.

Outputs:

- Two georeferenced IFC files: one corresponding to the surrounding buildings and another to the terrain.

To Improve:

- In this case, IFC conversion was required as a workaround, since the IFC file provided in Scenario 1 could not be used directly due to georeferencing errors.
- It would be useful to have a preview viewer in the conversion tool to verify the correctness of the model before exporting.

Process Description:

The GIS to BIM conversion in this demo was driven by the need to incorporate adjacent buildings as context for urban planning checks. Initially, the team attempted to reuse an existing IFC file from Scenario 1, but it was incompatible due to spatial positioning issues.

As a solution, an updated model of the environment was downloaded from VCMap in CityGML format and processed using the CityGML2IFC tool. Two separate IFC files were generated: one for the adjacent buildings and another for the terrain (although the latter was ultimately not needed). Both files retained their original georeferencing and were visually verified alongside the renovation model to ensure correct alignment for later use in CYPEURBAN and VCMap.

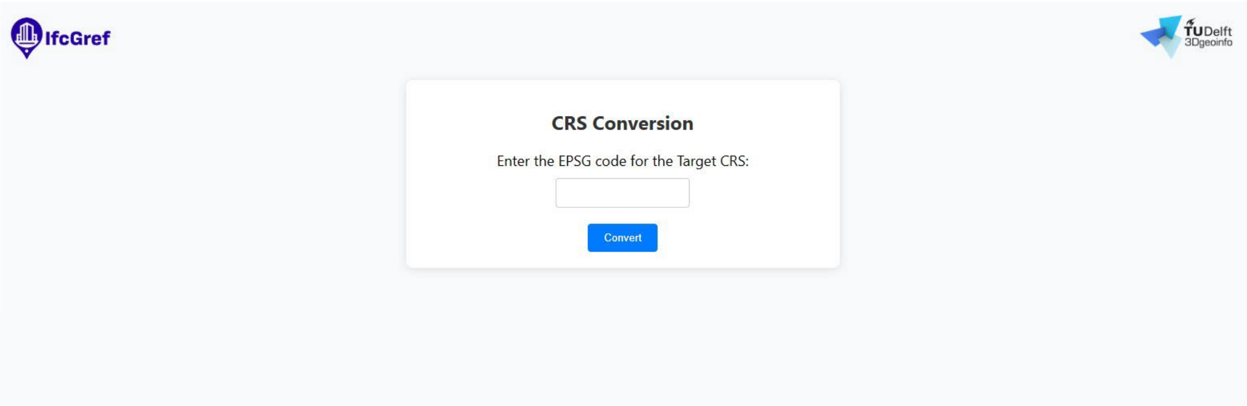


Figure 55 Surroundings initial information coming from scenario 1, error on positioning

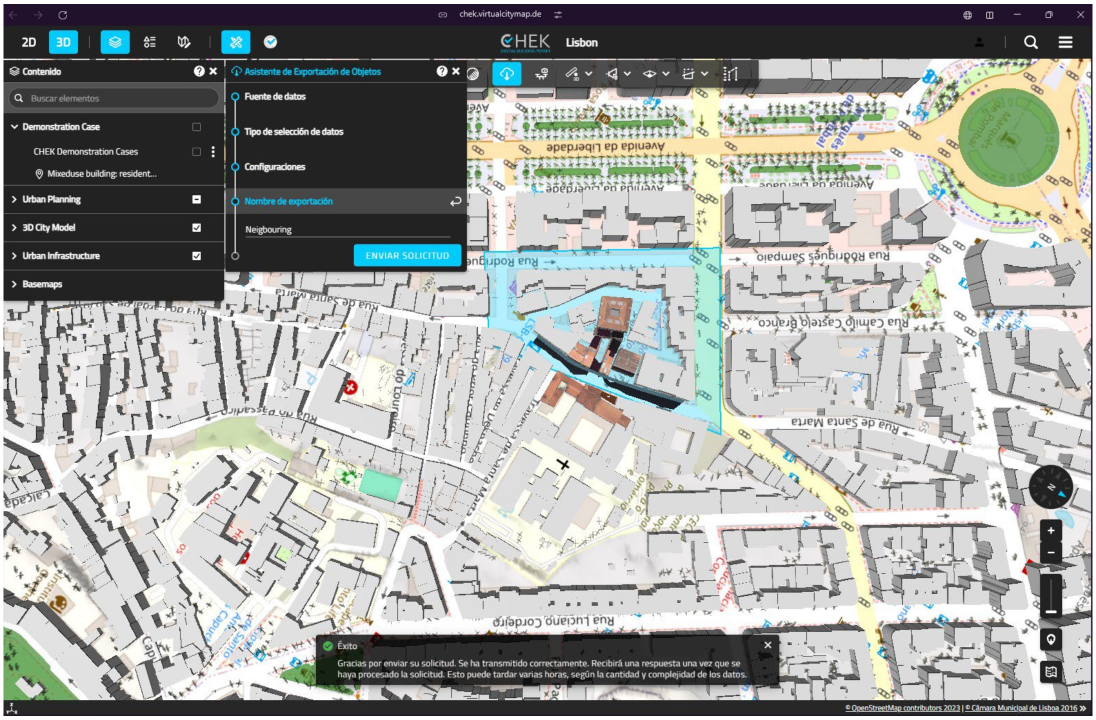


Figure 56Selecting the desired area for surrounds downloading

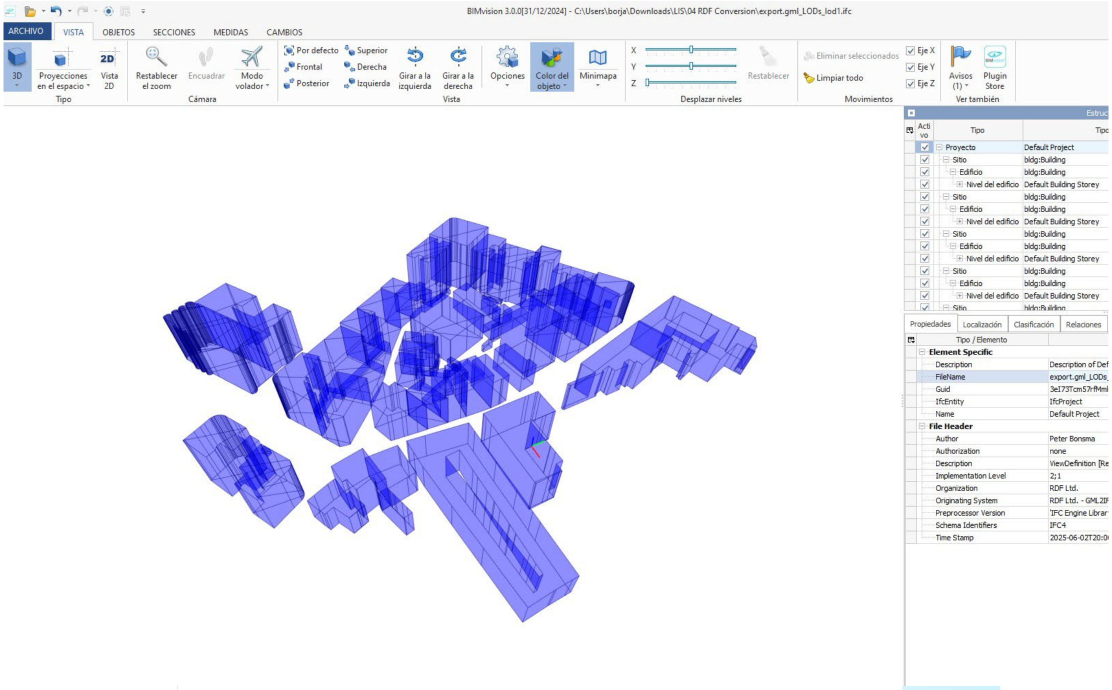


Figure 57 Converted surroundings into IFC

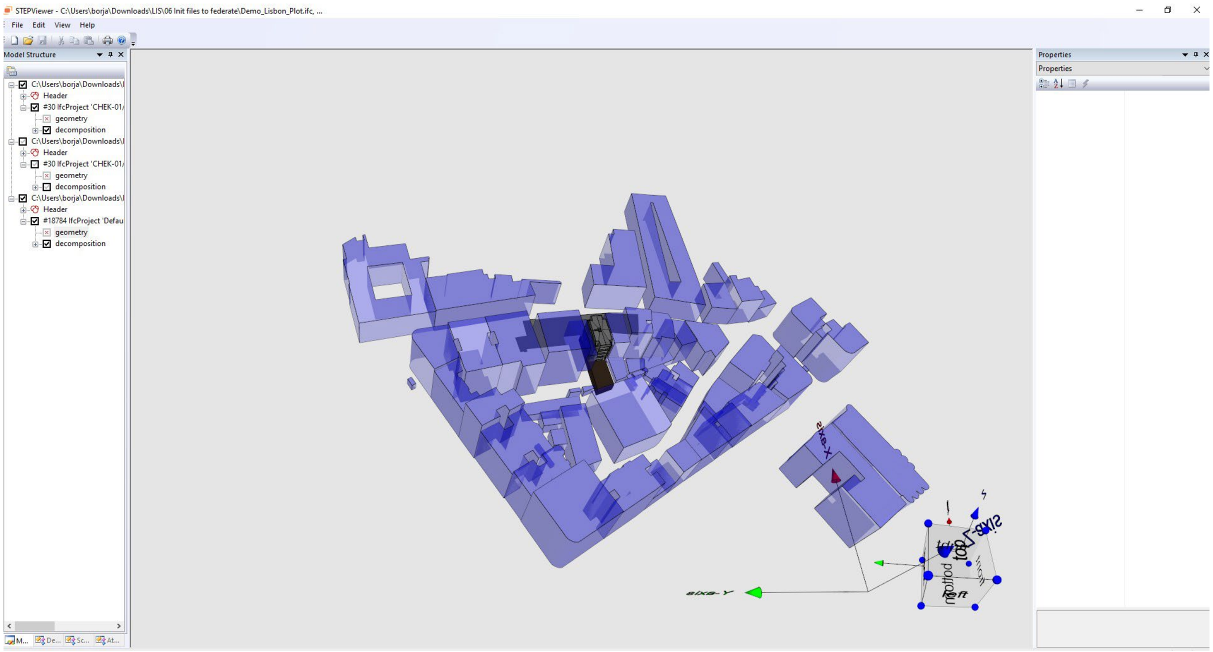


Figure 58Just converted surroundings perfectly aligned with existing building

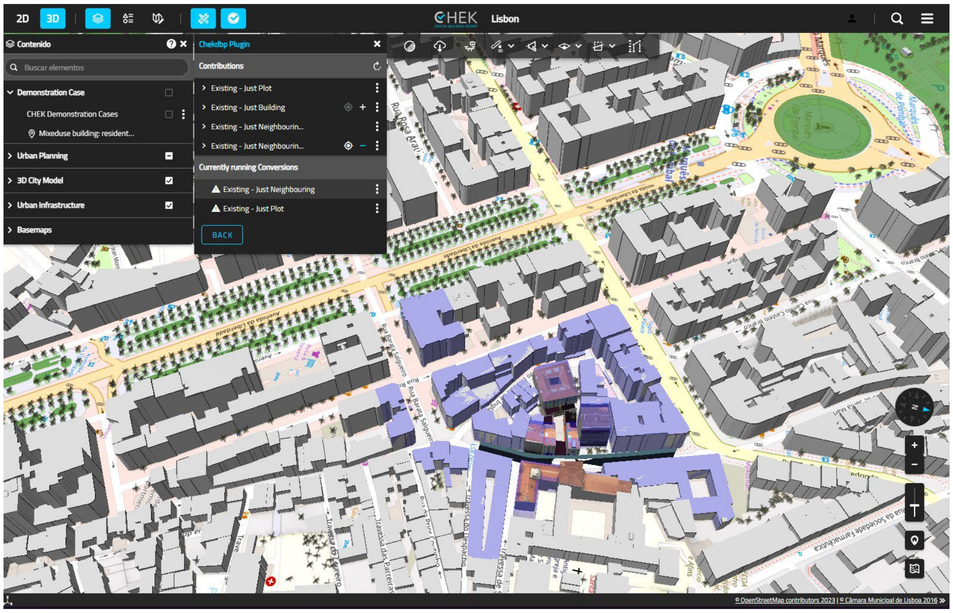


Figure 59 Neighboring georeference assessment with VCMap

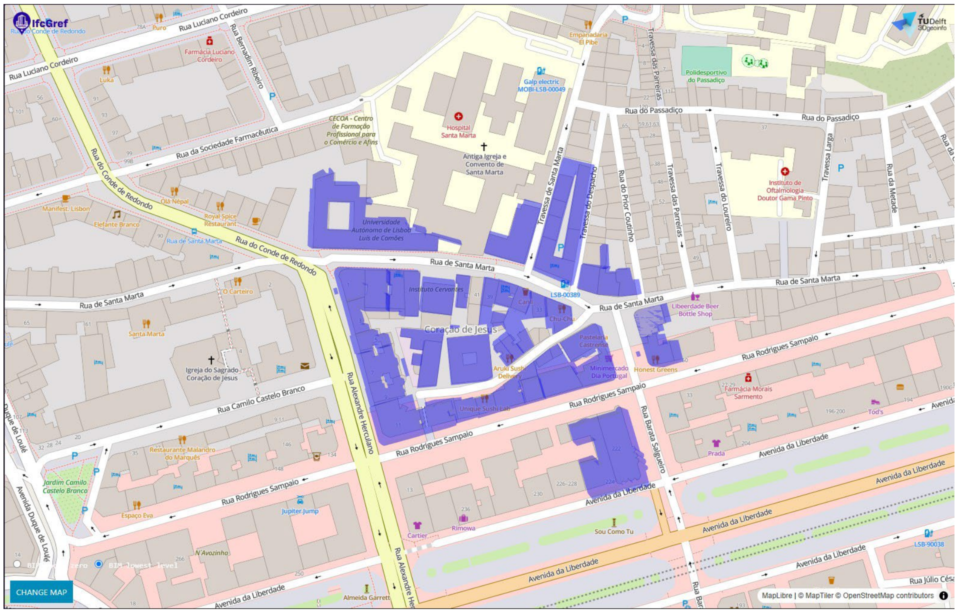


Figure 60 Neighboring georeference assessment with IfcGref

3.2.4 Design process overview

Settings:

The model design was developed entirely using Autodesk Revit, initially in version 2024 and version 2025 later. Unlike other scenarios, this project did not begin from a neutral base but from an existing building. Therefore, the workflow started by modeling the pre-intervention state, and then proceeded with the proposal for extension and renovation.

Since Revit does not natively interpret geolocation data embedded in IFC files, it was necessary to manually align the renovated model with the surrounding contributions (plot, adjacent buildings, etc.) using known reference points and coordinate-guided displacements.

During the modeling phase, a coherent structure of levels and spaces was created, with names following a convention compatible with the validation systems (e.g., Level 0 for the ground floor, Roof for the first floor, etc.). Functional spaces were defined for each area of the restaurant, including outdoor terraces and rooftop gardens. The rooms and levels of the existing building were excluded from the export to avoid duplications during federation with the new extension.

Parameters aligned with the Lisbon municipality's IDS were progressively introduced and prepared for later verification in the urban compliance tools.

Inputs:

- Existing building model (from Scenario 1) used as a spatial reference
- IFC files of the urban environment converted from CityGML

Outputs:

- Revit file containing the extension and renovation proposal, structured with levels and spaces, and parameters prepared for export and validation

Process Description:

The Revit-based design process stemmed from the need to extend an existing building. It began by replicating the current conditions and then developing the proposal for the restaurant and its outdoor areas. This approach made it possible to simulate a realistic intervention in a consolidated urban environment, as required by Scenario 2.

Special attention was given to geometric and spatial coherence to ensure the models could be properly validated by both CYPEURBAN and VCMap. Throughout the process, iterative corrections were applied to the coordinate system and space definitions until a consolidated version was ready for export. The final file was exported using the official DiRoots plugin, selecting the appropriate IDS for Lisbon, which then served as the shared base for both validation tools.

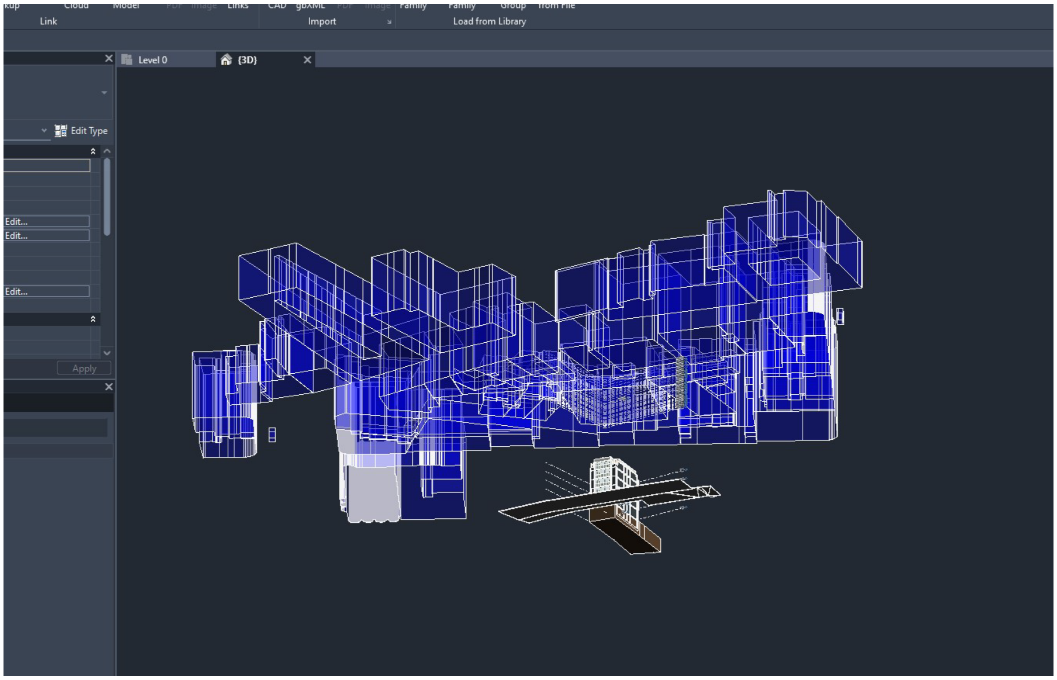


Figure 61 IFC Importing mess. IFC georeference not read in Revit

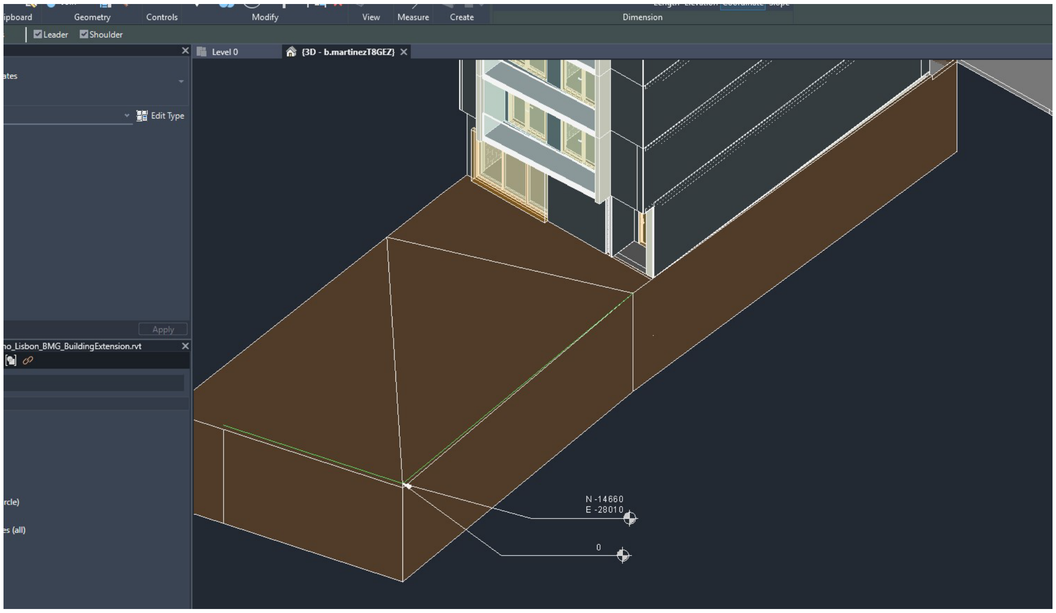


Figure 62 Measuring coordinates to geolocate the project in vendor software

3.2.5 Exporting the project – DiRoots plugin

Settings:

The model was successfully exported using the official CHEK Exporter developed by DiRoots, version 1.0.7. Unlike in some previous scenarios, the plugin worked properly from the beginning, allowing the selection of the IDS file corresponding to the municipality of Lisbon and the mapping of the required parameters.

The tool provides an intuitive graphical interface to associate Revit model parameters with the properties required by the IFC schema. This greatly facilitates the preparation of the model in terms of required parameters for validation, although in the case of CYPEURBAN and VCMap, which rely primarily on geometry, these parameters play a secondary role.

Inputs:

- Revit model including the proposed building extension
- Official IDS file for the municipality of Lisbon (.ids format)

Outputs:

- IFC file of the building extension, including all parameters mapped according to the IDS and structured geometry for federation and validation

Process Description:

Once modeling was completed, the export process was carried out using the DiRoots plugin. The IDS file specific to Lisbon was loaded, which defines which parameters must be present and how they should be structured. The system automatically detected the parameters already correctly defined in the model and flagged the missing ones with warnings.

The design team reviewed these warnings, added the required parameters directly in Revit, and relaunched the export. The plugin successfully generated a complete IFC file, including geometry, spaces, mapped properties, and the structure required for subsequent urban validation.

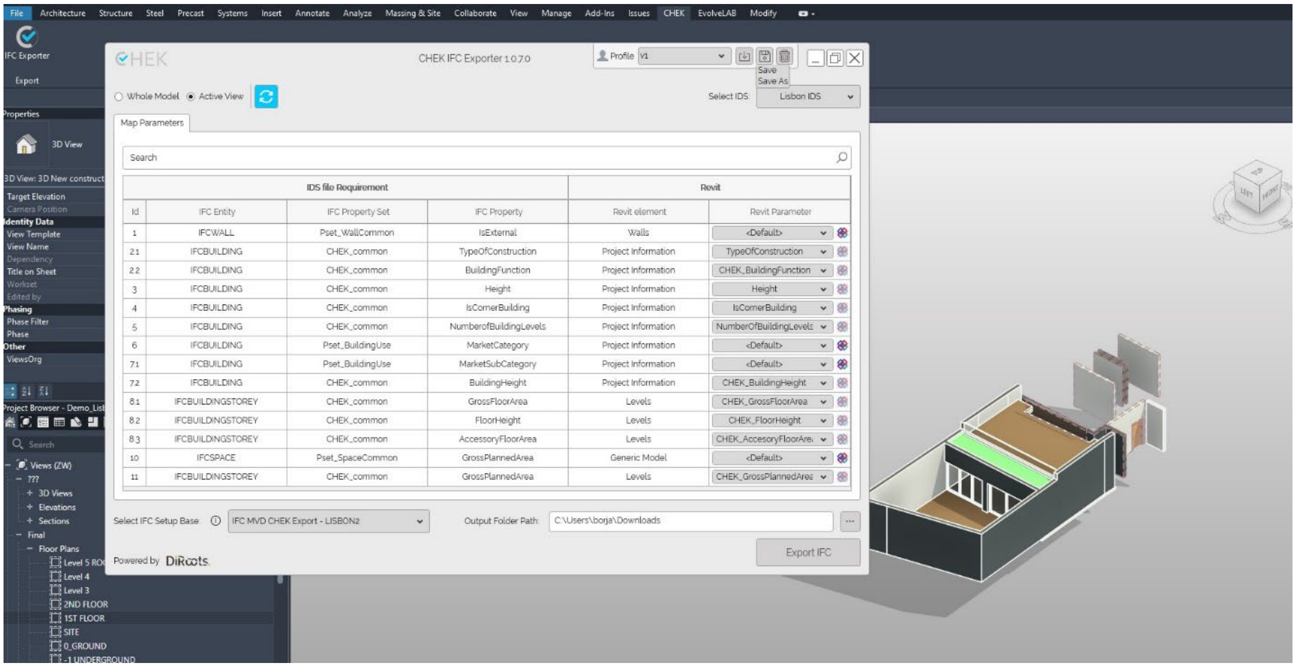


Figure 63 Mapping the parameters that should be in the exported IFC file

3.2.6 Georeference assessment – IfcGref/VCMap

Settings:

To validate the georeferencing of the exported model, the two known tools (IfcGref and VCMap) were used.

Unlike in previous scenarios, in this case it was particularly important to ensure spatial coherence between the renovated model and the pre-existing environment inherited from Scenario 1. Due to positioning issues in that earlier file, it was necessary to confirm that the updated version was correctly aligned within the Lisbon cadastral parcel.

Inputs:

- IFC file containing the renovated building model exported vendor software.
- IFC file of the surrounding environment (adjacent buildings + terrain), generated from CityGML using the RDF converter

Outputs:

- Confirmation of the correct geolocation of the model using both VCMap and IfcGref

Process Description:

Once the IFC file with the proposed renovation was exported, IfcGref was used to verify that the geolocation metadata was correctly defined. The file was then uploaded into VCMap and converted into a "Visualization Model", allowing visual confirmation that the building's placement matched the intended plot and aligned properly with the existing context.

This cross-validation confirmed the absence of overlaps or spatial discrepancies, establishing that the model was properly georeferenced for use in subsequent validation steps.

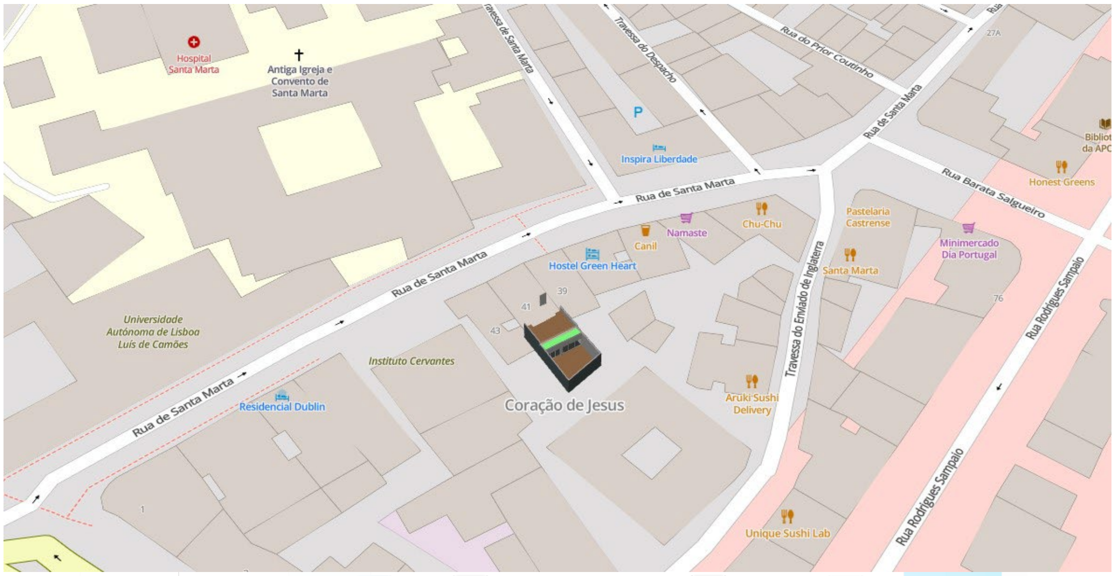


Figure 64 IfcGref visual geolocation assessment, successful

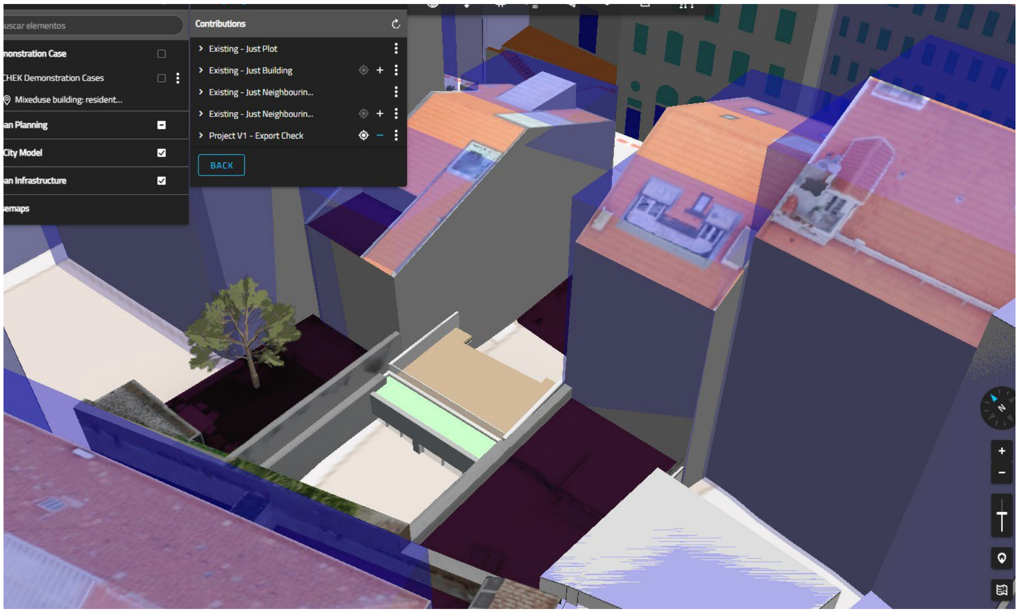


Figure 65 VCMap visual geolocation assessment, successful

3.2.7 IFC validation skipped

In this demonstration, no additional IFC validation step (such as EXPRESS or IDS checking) was carried out, since the procedure was identical to what was already been described in previous pilots in scenario 1. The structural validity of the file was ensured through the official exporter with integrated IDS support, and the urban compliance checks were successfully passed using CYPEURBAN and VCMap.

3.2.8 Uploading the model to BSC

The procedure for uploading the IFC model to the CHEK Platform (BIMserver.center) was identical to the one described in previous scenarios and is therefore not detailed again in this document.

3.2.9 CHEK pre-validation and submission of results – CYPEURBAN

Settings:

The first tool used for pre-validation of urban compliance on the designer's side was CYPEURBAN, integrated within the BIMserver.center ecosystem. It operates based, as already described in previous demos, on graphical rule checks executed over federated models.

Inputs:

- IFC file containing the refurbished building, exported with parameters mapped according to the Lisbon IDS.
- IFCs of the surrounding urban context (adjacent buildings and topography), converted from CityGML.
- BIMserver.center project correctly tagged as belonging to the city of LISBON, enabling automatic loading of the corresponding urban regulations.

Outputs:

- Graphical result on designer side of the compliance checks, possibly highlighting non-conformities or warnings.
- A PDF report and an IFC file containing visual validation elements, both generated by CYPEURBAN, for later review or integration into the CHEK platform validation account side.

Process Description:

After federating the refurbished building model with its urban context in CYPEURBAN, it was observed that the newly generated context IFCs did not align properly, despite being correctly exported, converted and previously validated. A known issue related to the handling of project centers in CYPEURBAN prevented correct federation in this configuration.

As a workaround, the team reused an older context model inherited from Scenario 1 (even though it had georeferencing issues described above) as it allowed the application to complete the federation process and proceed with compliance checks. This ad-hoc solution, also used in previous demos, points to a persistent bug in CYPEURBAN that should be addressed in future developments, but noncritical to the scope of workflow for this demo.

Once the federation was in place, the system applied Lisbon's urban regulations and used the user-defined geometric elements to perform automated checks (e.g., alignments, setbacks, plot occupation).

The results were displayed graphically within the application, and a structured report was generated summarizing all the checks performed. In this particular case, the model passed all applicable rules, and no further adjustments were required.

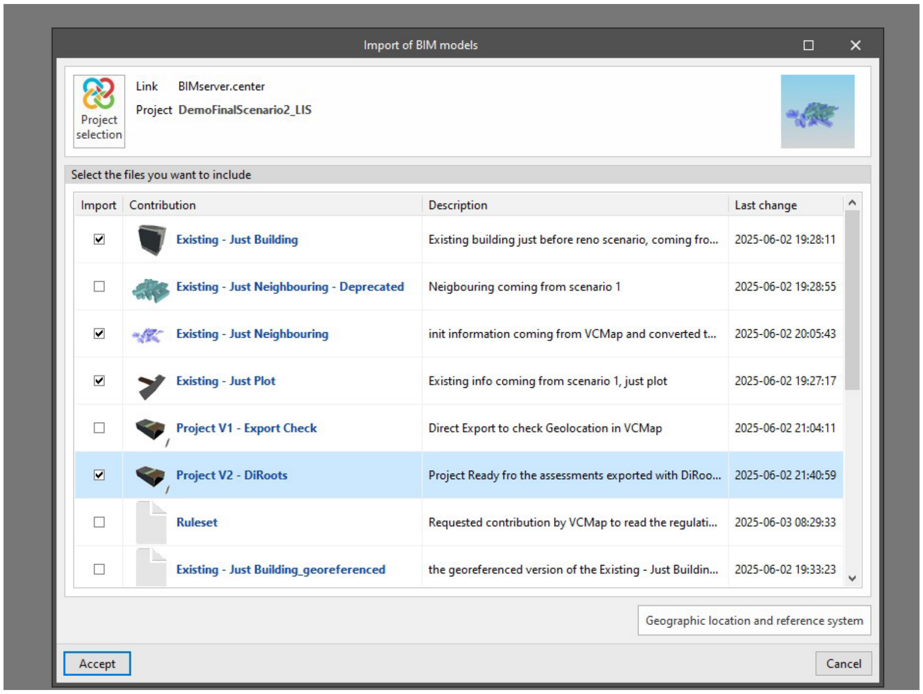


Figure 66 CYPEURBAN IFC sources from the CDE to federate

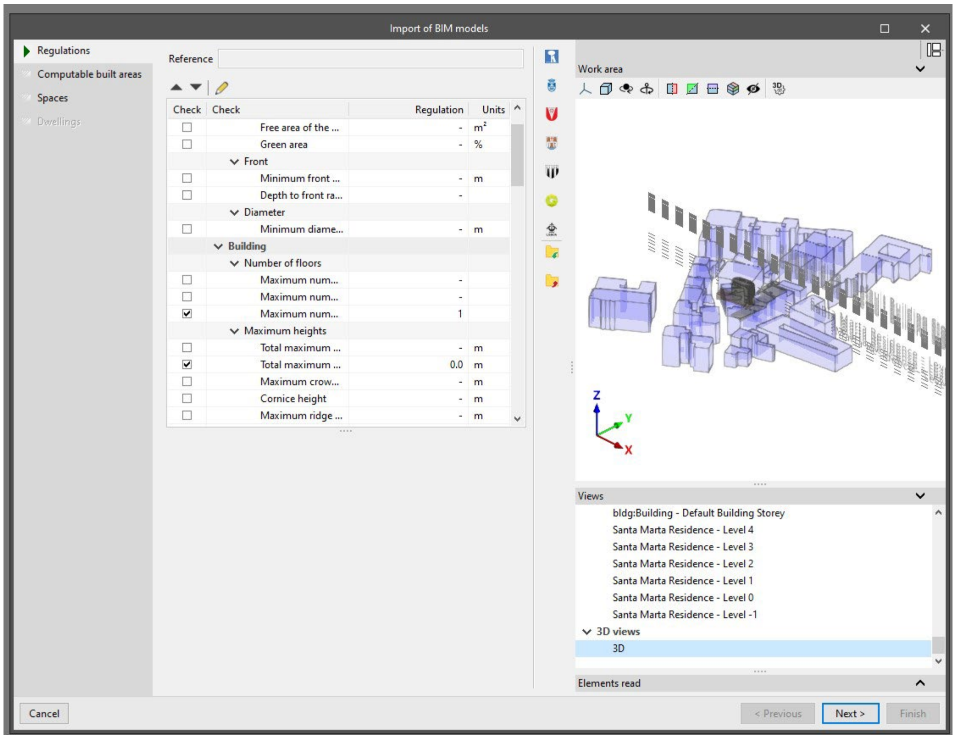


Figure 67 CYPEURBAN Urban plan ruleset selection

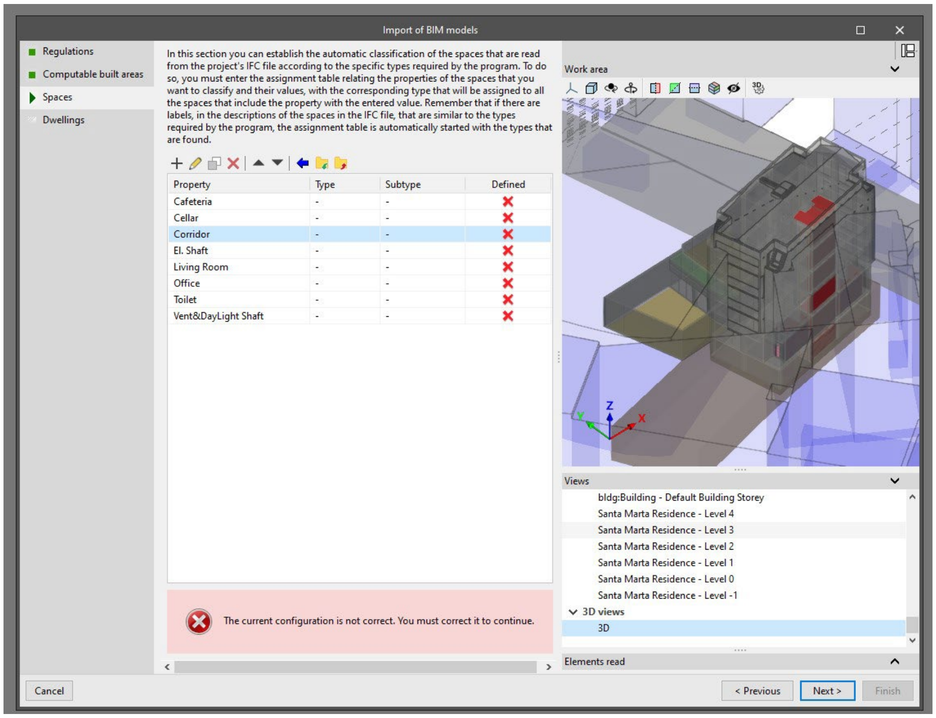


Figure 68 CYPEURBAN federation mismatch

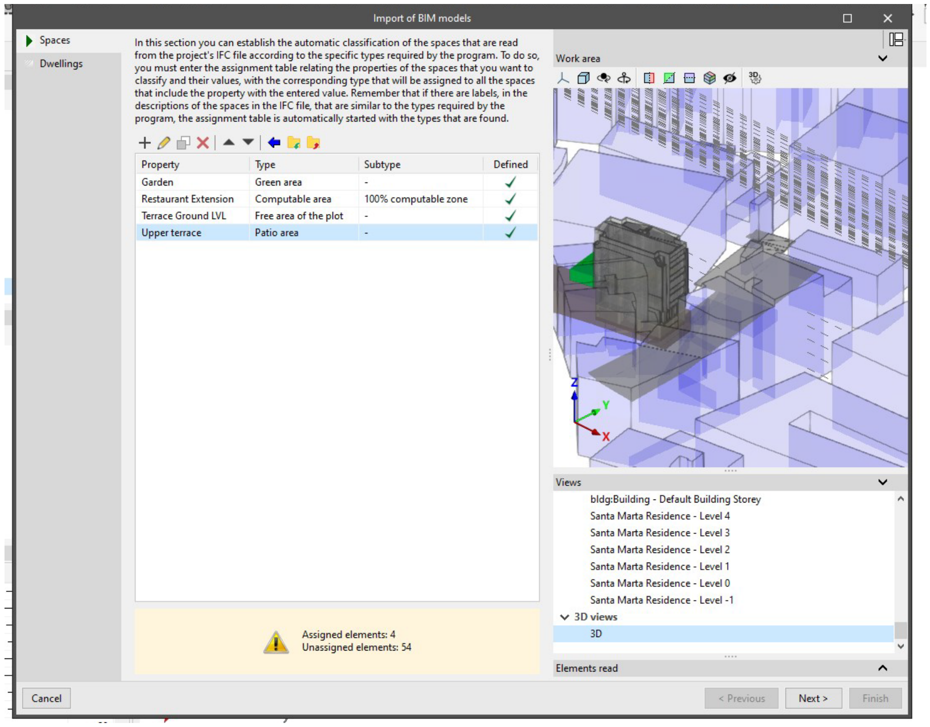


Figure 69 CYPEURBAN ifcSpaces information mapped

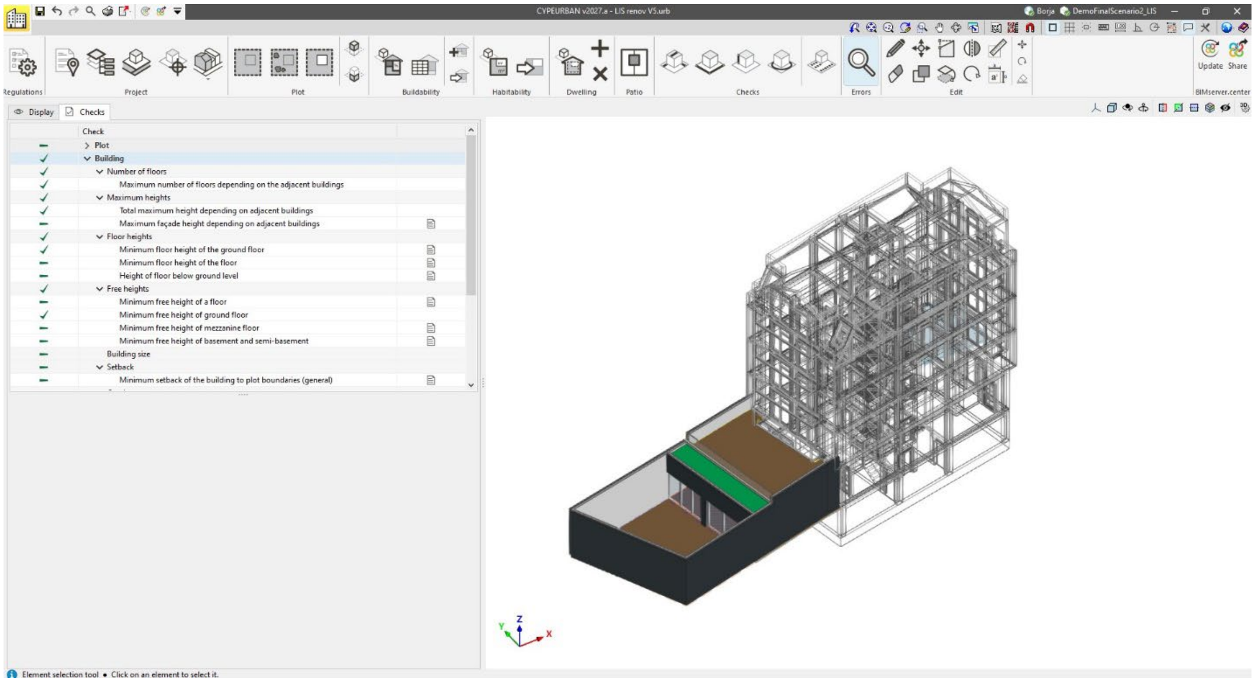


Figure 70 CYPEURBAN Final aspect of assessed model

3.2.10 CHEK pre-validation and submission of results – VCMap

Settings:

The second tool used to validate the urban compliance of the project from the designer's perspective was the already familiar VCMap. In this case, only the existing building was required for federation alignment purposes, while the renovated building was used to check compliance against the urban regulations after generating the semantic model.

Inputs:

- Contributions of the existing building and the extension, previously verified in earlier workflow steps.

Outputs:

- Graphical result of the urban compliance checks.
- Interactive report within the VCMap platform, indicating whether each implemented rule was satisfied.
- Exported report in JSON format submitted to the validation account.

To Improve:

Exporting of the IFC file must be done in meters for VCMap to correctly scale the visualization model, as so far is not capable of recognizing units, as it seems. If exported in mm the project appears huge in the map.

Process Description:

Once the IFC files were uploaded to the BIMserver.center project, VCMap was accessed from the designer's profile, and the Semantic Model conversion process was launched, which completed successfully.

After the semantic model was generated, the validation rules associated with the city of Lisbon were executed automatically. These rules had been previously configured by the validation team and included restrictions such as building coverage, distances to parcel boundaries, and other urban planning parameters.

VCMap's interface enabled a graphical visualization of compliant and non-compliant areas, along with detailed explanations for each check. In this case, all rules were satisfied without issues, confirming that the model was ready for submission to the municipality.

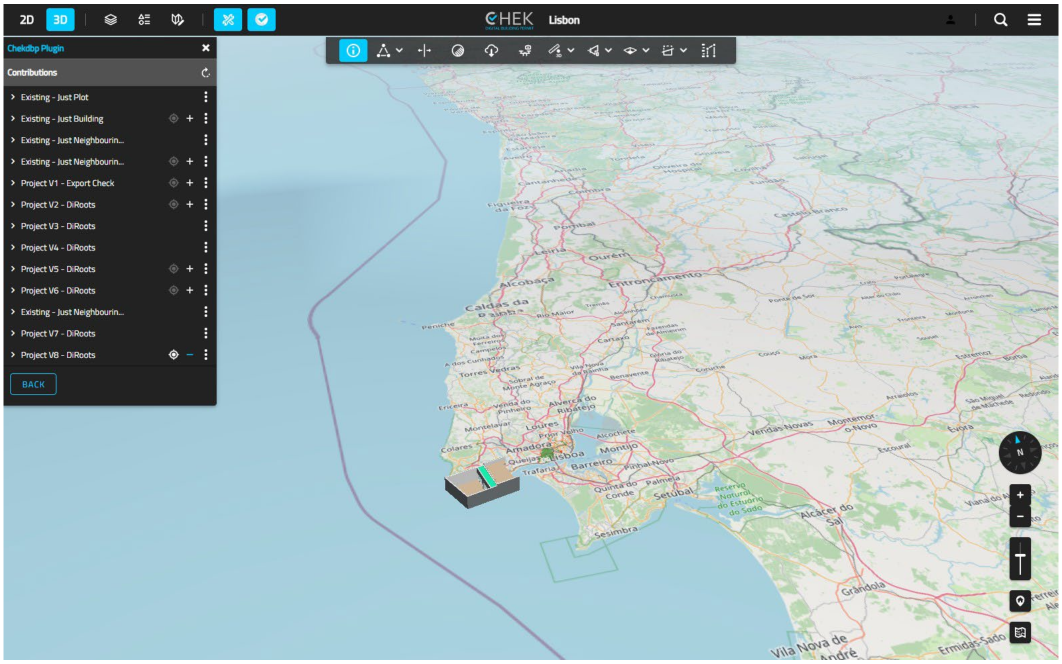


Figure 71 VCMap's visualization model if the IFC is exported in millimeters

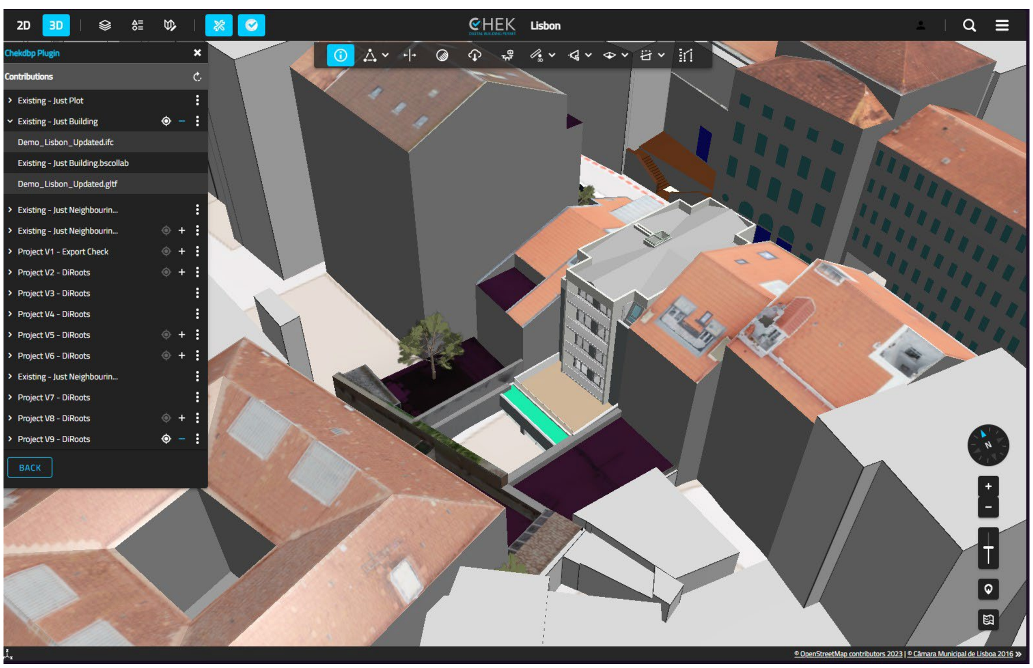


Figure 72 VCMap's visualization model if the IFC is exported in meters

3.2.11 Digital signature – DiStellar

Settings:

The IFC validated model both with CYPEURBAN and VCMap was digitally signed as already described using DiStellar.

Inputs:

IFC file of the renovated building, already validated and ready for submission.

Outputs:

Digitally signed IFC file with metadata indicating author, timestamp, and verification hash.

Process Description:

The signed IFC file was generated using the DiStellar interface, selecting the appropriate project, contribution, and user role (designer). The resulting file included a separate signature file stored in the project repository in BIMserver.center designer side.

To test the robustness and reliability of the digital signature mechanism, the signed IFC was intentionally edited using a plain text editor. Upon attempting to verify the file again with DiStellar, the system correctly detected that the file had been modified, and flagged the signature as invalid. This confirmed the integrity of the digital signature system and its effectiveness in detecting unauthorized changes to the model.

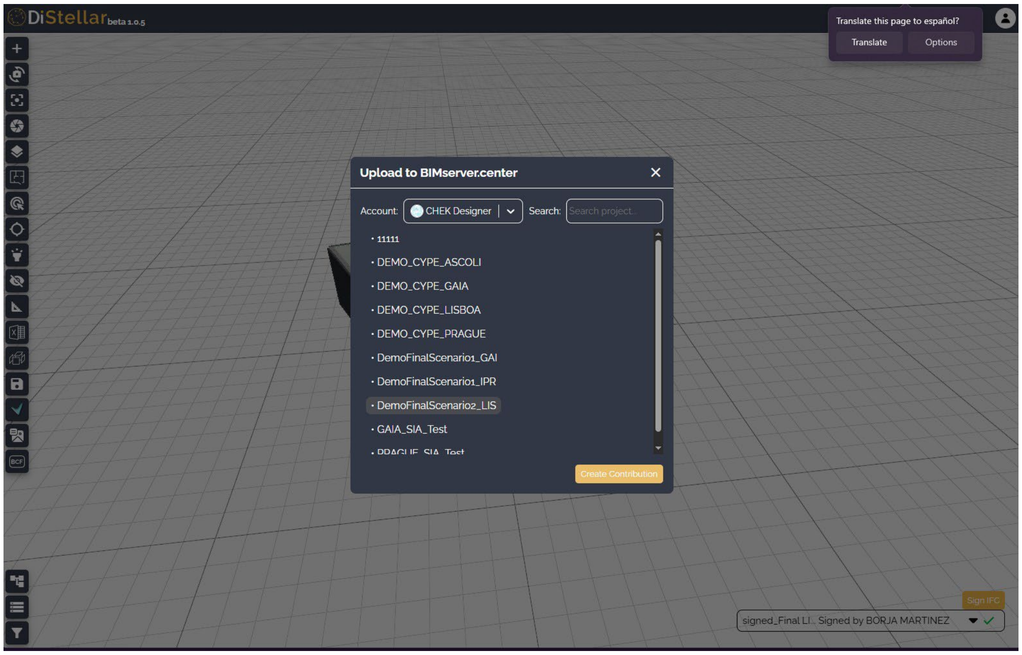


Figure 73 DiStellar signed file, and uploading to CDE

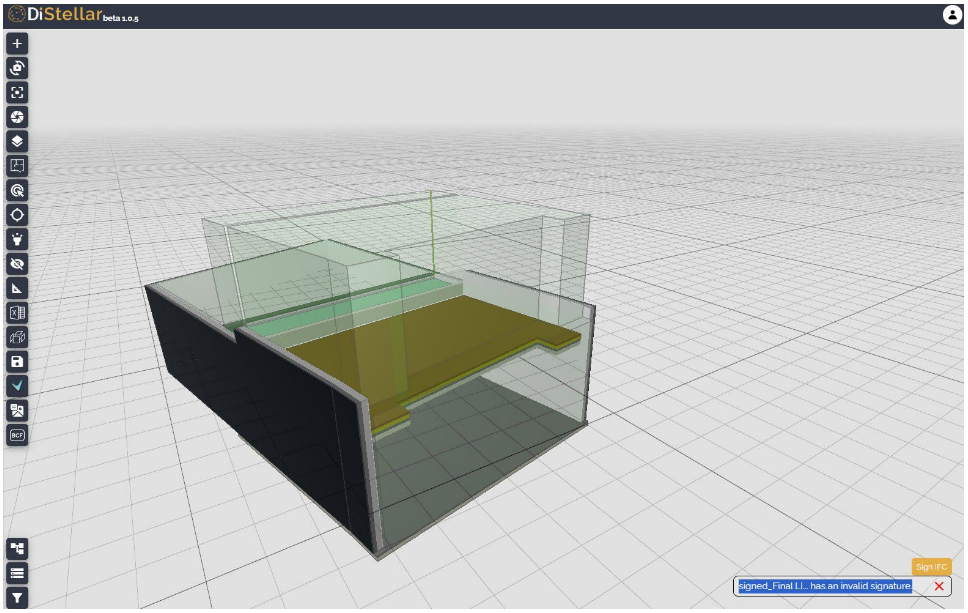


Figure 74 Edition of the IFC files is detected by the application

3.2.12 CHEK permitting tools. Municipality side workflow review

During Days 3 and 4 of the demonstration, the technical team from the Municipality of Lisbon evaluated the renovated model using the CYPEURBAN and VCMap tools, as part of the validation workflow defined in the CHEK project. However, the team reported that the technical limitations already identified in Scenario 1 remained unchanged in Scenario 2, and no new codified rules could be applied to the extension case under evaluation.

With regard to CYPEURBAN, issues were observed such as false positives in height verifications and the lack of automatic data extraction from the IFC model, which allows critical values such as building height to be manually edited—undermining the principles of traceability and reliability expected from BIM-based processes.

As for VCMap, the team confirmed that no new checks could be performed, due to the absence of codified rules suited to extension scenarios, which prevented a meaningful assessment of the proposed intervention.

In conclusion, the municipality stated that further analysis was not possible with the currently available resources, and emphasized the following needs:

- Expansion of the codified rule base to support cases such as extensions, partial demolitions, and changes of use.
- Increased flexibility of the tools to better adapt to diverse urban planning contexts.
- Closer collaboration with municipalities to ensure that the tools are aligned with real-world licensing procedures and legal requirements.

URBAN REPORT (SUMMARY FILE)

PROJECT INFORMATION				
Name				
Address	**Provincia**		**P. C.**	
Referencia Catastral				
Use				
TECHNICIAN INFORMATION				
Name	**NIF**			
Address	**Provincia**		**P. C.**	
Email	**Telephone**			
APPLICABLE REGULATIONS				
PLOT CONDITIONS	**Project**		**Regulation**	
VOLUMETRIC PARAMETERS	**Project**		**Regulation**	
Building height				
Maximum number of floors depending on the adjacent buildings	1	≤	8	
Total maximum height depending on adjacent buildings	3.4	≤	4.4	
Minimum floor height of the ground floor[1]	3.40	≥	3.40	m
Minimum floor height of the floor[2]	Not applicable			
Height of floor below ground level[3]	Not applicable			
Minimum free height of a floor[4]	Not applicable			
Minimum free height of ground floor	2.70	≥	2.40	m
Minimum free height of mezzanine floor[5]	Not applicable			
Minimum free height of basement and semi-basement[6]	Not applicable			
Position				
Minimum setback of the building to plot boundaries (general)	Not applicable			
Overhangs				
General maximum overhang[7]	Not applicable			
Maximum overhang of cornice and/or eave[8]	Not applicable			
Dwellings				
Minimum net floor area of the rooms[9]	Not applicable			
CAR PARK	**Project**		**Regulation**	

[1]Height conditioned by the first floor of existing building
[2]All development of renovation is in ground floor
[3]The renovation does not have any level below ground
[4]Renovation ocupies only ground floor
[5]The renovation does not include mezzanines
[6]The renovation does not include basement floors
[7]There are no overhangs

Figure 75 Validation report / Results from CypeUrban

Conclusion

The Lisbon Renovation Scenario successfully demonstrated the practical application and usefulness of the CHEK digital toolkit in the digital permitting context. The scenario showed that the proposed CHEK DBP workflow is viable, collaboration between the shareholders was achieved, the model was checked against the regulations, and time allocation of the processes was reduced. The tools were user friendly, comprehensive and contributed greatly to the designers and the municipalities processes. During the demonstration, some errors or issues were noticed and communicated further. Some of them were successfully resolved or bypassed, some stayed, but none of them had an adverse impact on the demonstration. Overall, the Lisbon Renovation Scenario provided strong evidence of the potential for digitally enabled, rule-based permit workflows to streamline renovation permitting processes across European cities.

3.3 Prague

This section provides a detailed overview of the demonstration activities carried out in the Prague pilot within the scope of Task 6.3, focusing on the application of the CHEK digital workflow to a building renovation scenario. The aim was to test the adaptability of the CHEK tools when applied to existing buildings and to assess their performance in supporting a model-based, standards-driven building permit process.

Project Background and Designer Involvement

The demonstration was based on a renovation of a primary school, originally developed as a new construction scenario in Task 6.2 by SIA. The updated scenario was designed and modeled by ZWE, who adapted the existing BIM model to reflect typical renovation interventions—such as adding additional space and functionalities to the roof level.

A full description of the original project context, urban conditions, and baseline geometry can be found in Section 3.1.4 of Deliverable D6.1, which outlines the Prague pilot in its initial Task 6.2 configuration.

Workflow and Tools Used

The renovation workflow followed the typical progression of a real design-to-permit process, beginning with the collection of existing building information and followed by model adaptation, validation, and submission. The model was developed in a standard BIM authoring environment and exported in IFC 4 Add2 format.

The following tools from the CHEK digital toolkit were used to execute the workflow:

- VCMap and Verifi3D: to perform rule-based spatial and regulatory checks against local planning conditions;
- IfcEngine (RDF): to validate IFC structure and schema compliance;
- IfcGref (TU Delft): to confirm georeferencing consistency of the IFC model;
- DiStellar plugin: to apply a digital signature to the validated model;
- BIMserver.center(CDE): as the shared platform for storing and managing model files, metadata, and validation outputs.

Scenario Objectives and Observations

This scenario tested the ability of the tools to accommodate the unique challenges of renovation workflows, including working with non-standardized existing building data and addressing partial compliance with current regulations. It also assessed how easily designers can reuse and adapt existing models within the CHEK environment, and whether the rule-checking mechanisms can distinguish between legacy conditions and newly introduced design elements.

The demonstration was conducted in collaboration with the Prague municipality, who provided regulatory context and validation feedback. The results confirmed that the workflow is applicable in renovation settings, though some limitations were noted—particularly with respect to rule interpretation for partially preserved elements and legacy construction standards.

Context

The Prague renovation pilot contributed valuable insights into the flexibility and interoperability of the CHEK toolkit. It confirmed the viability of extending the digital permitting approach to renovation projects and underscored the importance of tool configurability when dealing with existing conditions. The experience also highlighted areas for future development, such as improved handling of renovation-specific rule logic and intuitive user guidance for designers working with mixed-condition models.

The following subsection details the technical steps followed in this pilot and presents the outputs of the demonstration.

DEMO PILOT CASE INFO CARD		
1	Demo plot location	Prague, Czech Republic
2	Building Type	Educational Building
3	Address	Habrová
4	Designer of Scenario 1	SIA
5	Designer of Scenario 2	ZWE
6	Renovation Description	Vertical extension / New functionality
7	Demonstration period	09/06/2025 - 13/06/2025
8	Reviewer	IPR Prague

3.3.1 Project Creation in BIMserver.center

Demonstration of the CHEK digital toolkit starts with BIMserver.center that serves as CHEK DBP platform where Designers create new project as central project repositorium for all project contributions and collaboration.

Inputs:

- No particular inputs

Outputs:

- Created New Project repositorium

Process description:

1. Designers' logged in into BIMserver.center with CHEK Designers account

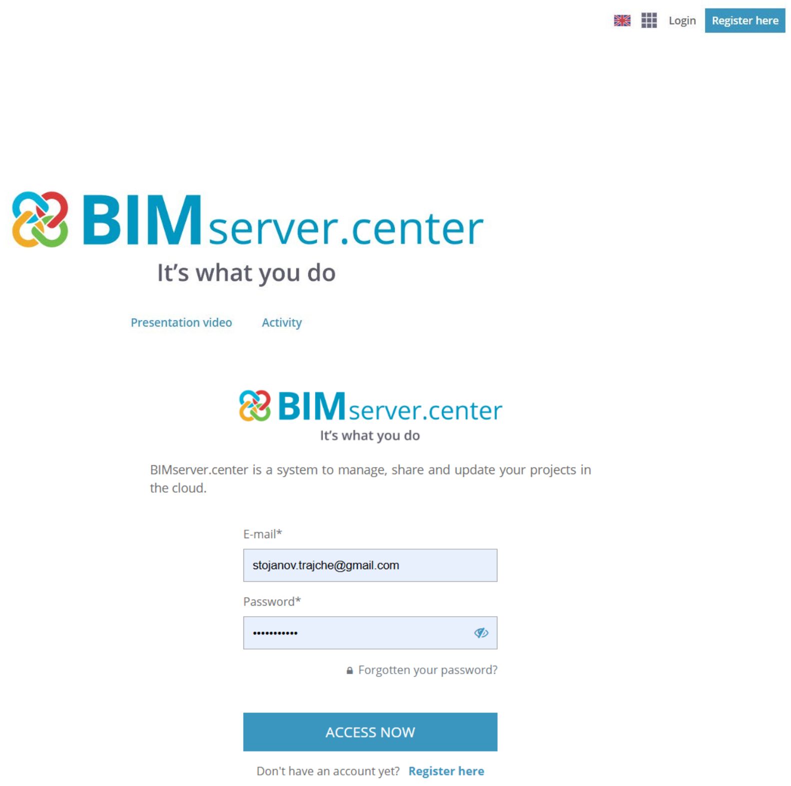


Figure 76 Loging to BIMserver.center

2. New Project was created

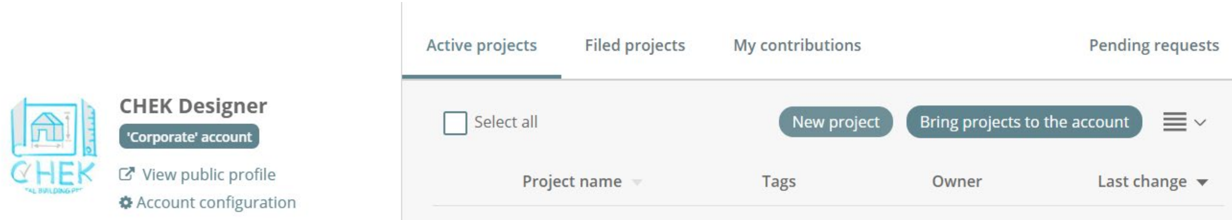


Figure 77 New project created

3. Tag was assigned

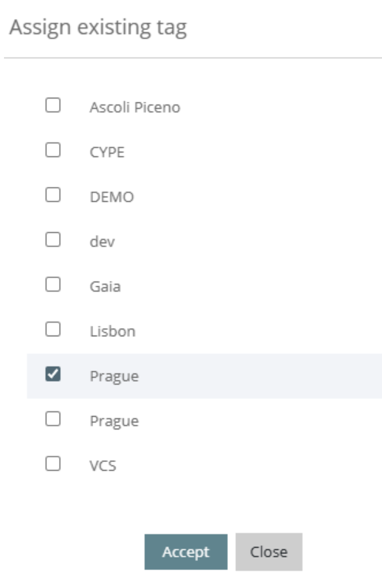


Figure 78 Assigning project tag

3.3.2 Gathering initial data, using VCMap

After the project is created in BIMserver.center the demonstration continues with collecting the site data as 3d geometry for future use in BIM authoring tool.

Inputs:

- No particular inputs

Outputs:

- Surrounding models created

Process description:

1. Designers logged in into VC Map platform with CHEK Designers account

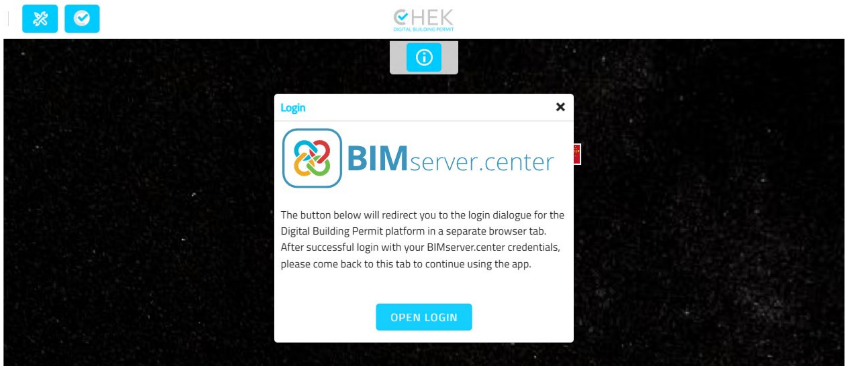


Figure 79 Login in VCMap through BIMserver.center account

2. After allowing VCMap to connect to BIMserver.center VCMap was allowed to access the CHEK Designer's account and saved projects

Figure 80 Opening a project from Designers account

3. The plot location was properly displayed in VC Map

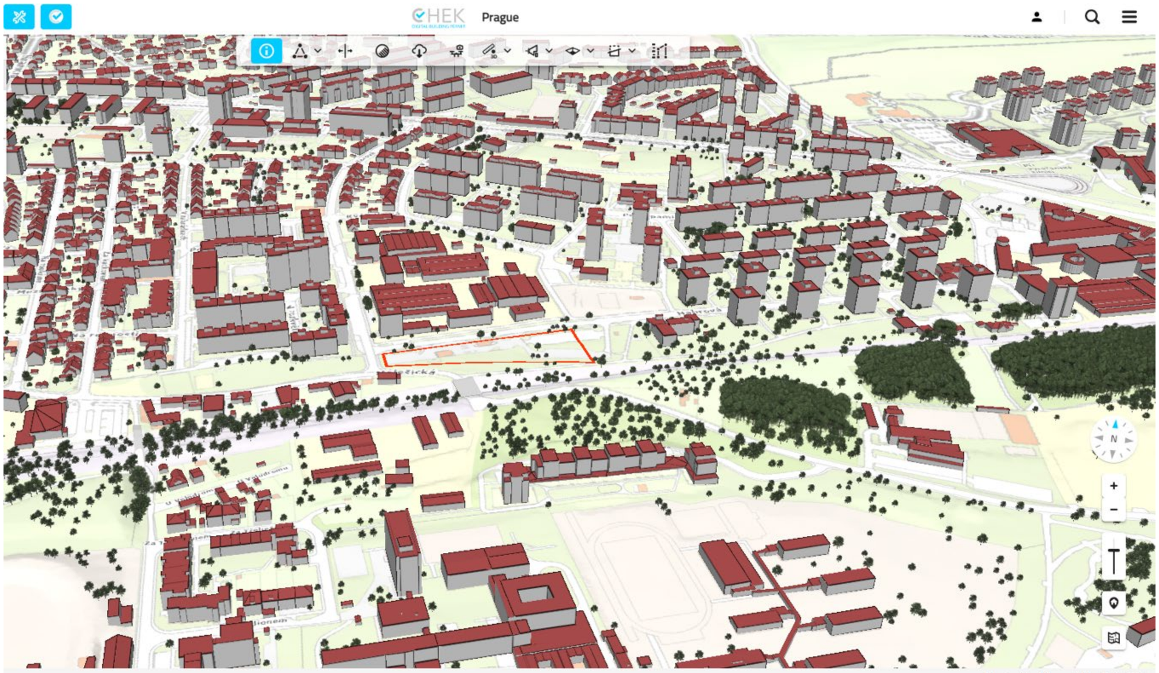


Figure 81 location shown in map

4. Export Tool in VC Map was used for exporting of the surrounding data

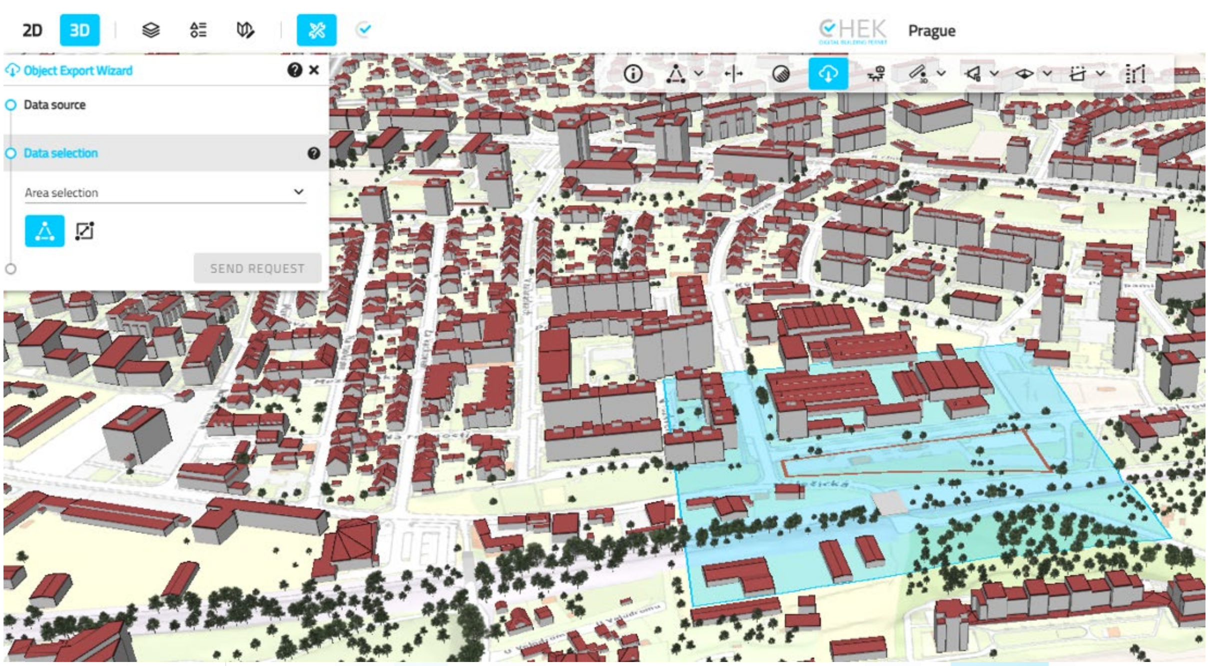


Figure 82 Export site surroundings

5. Surroundings file formats were selected for later usage in BIM Authoring tool

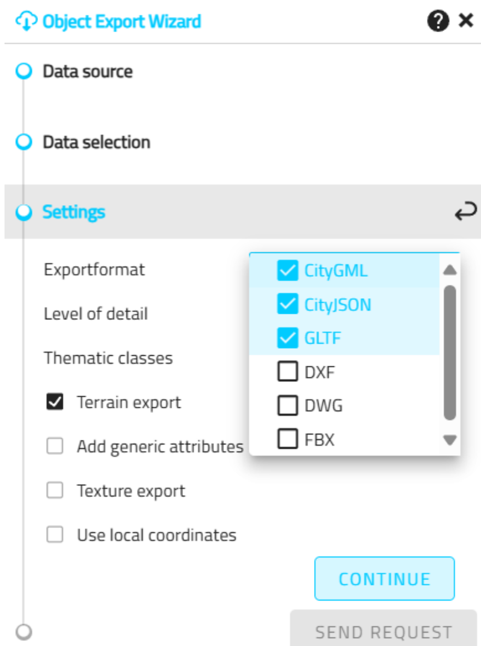


Figure 83 Export file formats selection

6. After finalization, a confirmation was received that the export operation was successful
7. The exported models of the surroundings were exported directly to the project folder in BIMserver.center as a new contribution

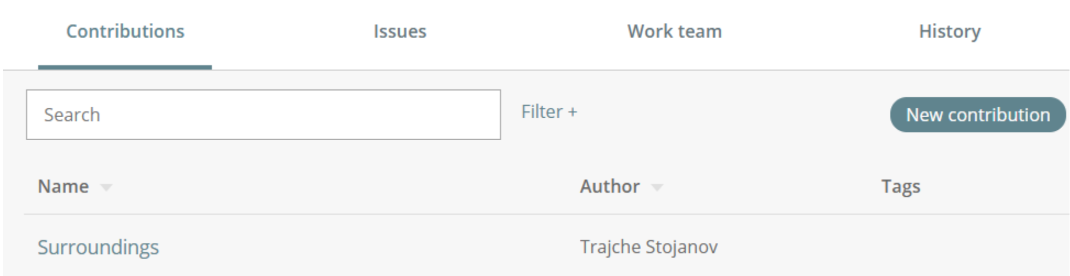


Figure 84 Exported files shows as new contribution in BIMserver.center

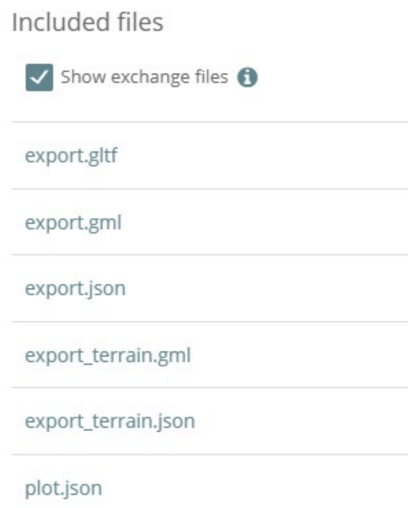


Figure 85 Downloading the site data

8. Exported CityGML files were further converted into IFC for use in BIM authoring tool

3.3.3 GIS to BIM conversion

Exported GIS (surrounding buildings and terrain) models from VCMap were further converted into IFC files via RDF's CityGML2IFC tool. This tool was run locally on Designers' computers and in essence transfers GIS data into BIM.

Inputs:

- CityGML files

Outputs:

- New IFC files from CityGML files

Process description:

1. Run CityGML2IFC locally with buildings gml file loaded

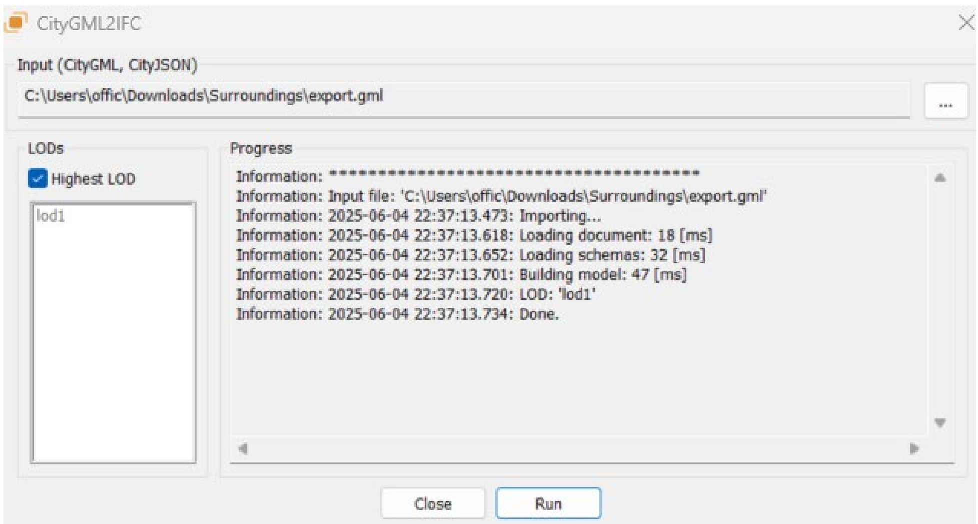


Figure 86Surrounding buildings exported to IFC

2. Run CityGML2IFC locally with terrain gml file loaded

3. The exported IFC files were located in the same folder where the gml files were uploaded from in CityGML2IFC converter.

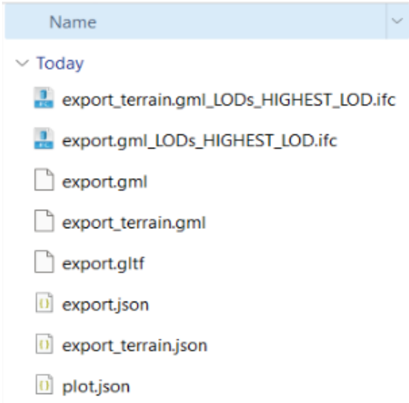


Figure 87 Converted IFC files appear in the same folder as exported site files

4. The workflow continued in BIM authoring tool where the IFC models of the surrounding buildings and terrain were used.

3.3.4 Design using Autodesk Revit

Exported GIS (surrounding buildings and terrain) models from VCMap were further converted into IFC files via RDF's CityGML2IFC tool. This tool was run locally on Designers' computers.

Inputs:

- Newly converted IFC files

Outputs:

- Fully georeferenced Revit file with surroundings

Process description:

1. A new file was opened in Autodesk Revit 2025, a BIM authoring tool used for this demo site.
2. Newly converted IFC models representing the surrounding buildings and terrain were linked using Link IFC tool. The links were bind into the Revit file and was saved to serve as surroundings file.

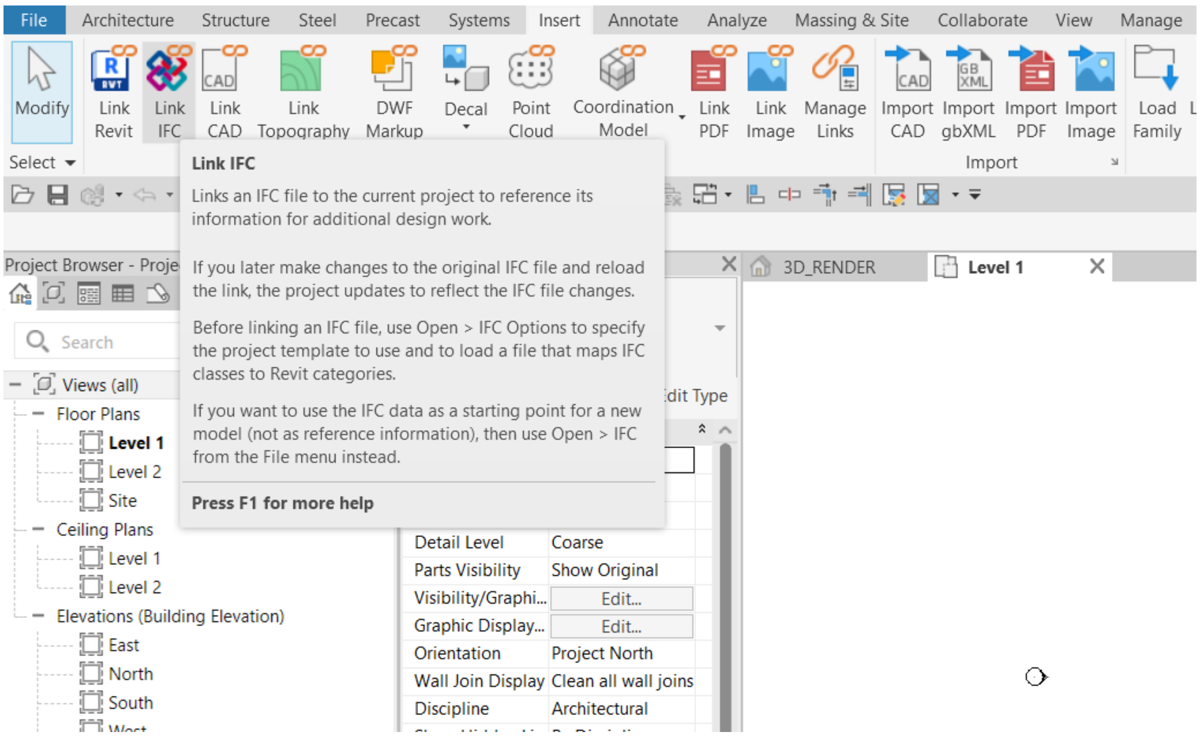


Figure 88 Using Link IFC option in Revit

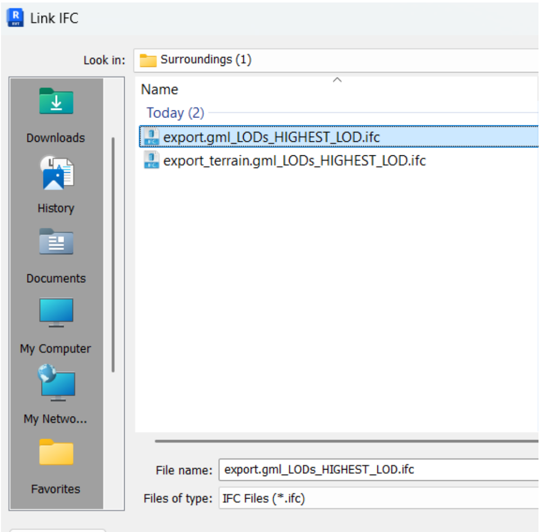


Figure 89 IFC Linking surrounding buildings in Revit

3. Georeferencing of the Revit file was done in order to reflect the realistic spatial context
4. The surroundings Revit file was linked into the Revit Building model

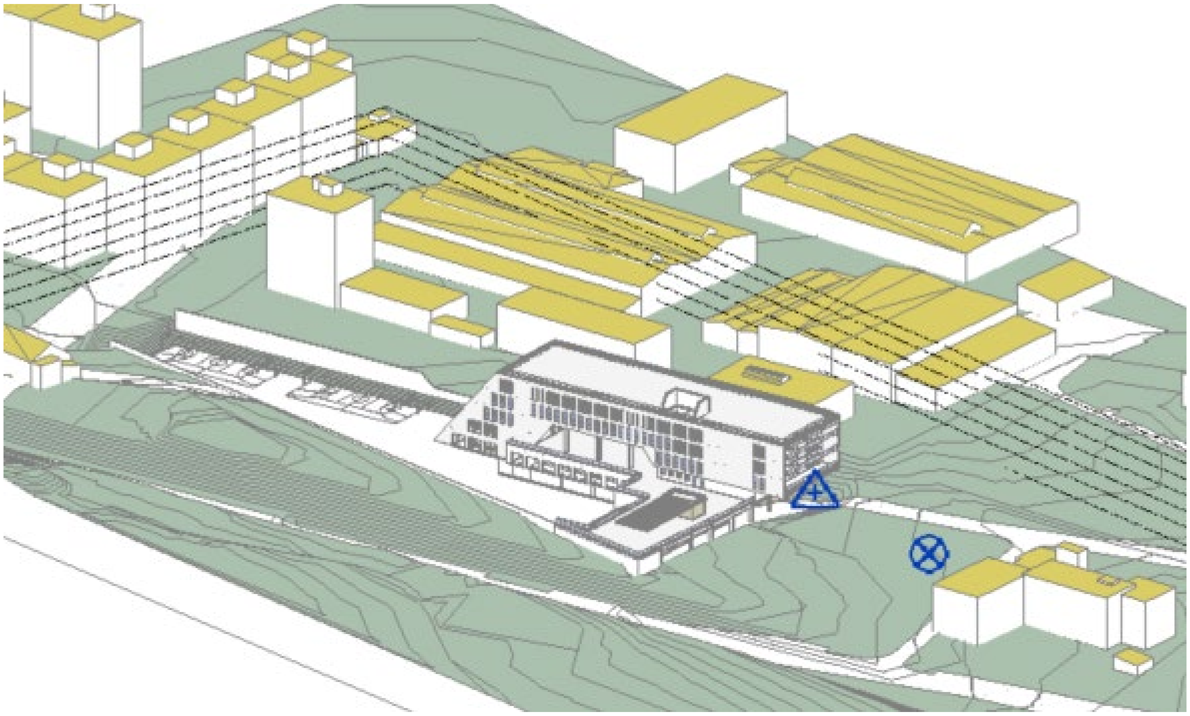


Figure 90 IFC federated linked files in Revit

5. At this moment, the model was exported in IFC with Revit's built-in IFC exporter in order to validate the georeferencing of the model, prior to any additional design development. The part with georeference check in IfcGref tool is presented further in this deliverable. Additionally, the created custom IFC export contained proper georeferencing setup like EPSG code and was saved as custom MVD (Model View Definition).

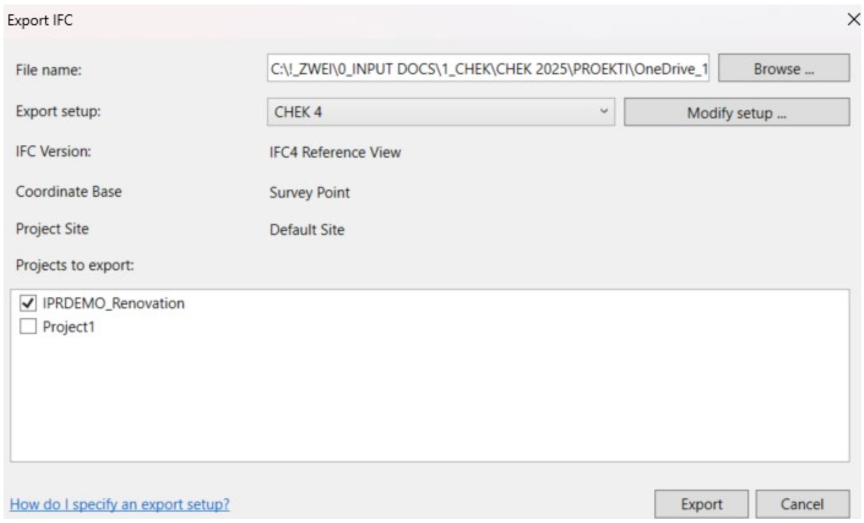


Figure 91 Export to IFC

6. After a georeferencing check was validated, the design development continues with remodeling the existing model of the building, particularly the building footprint was extended to accommodate additional glass sunroom.

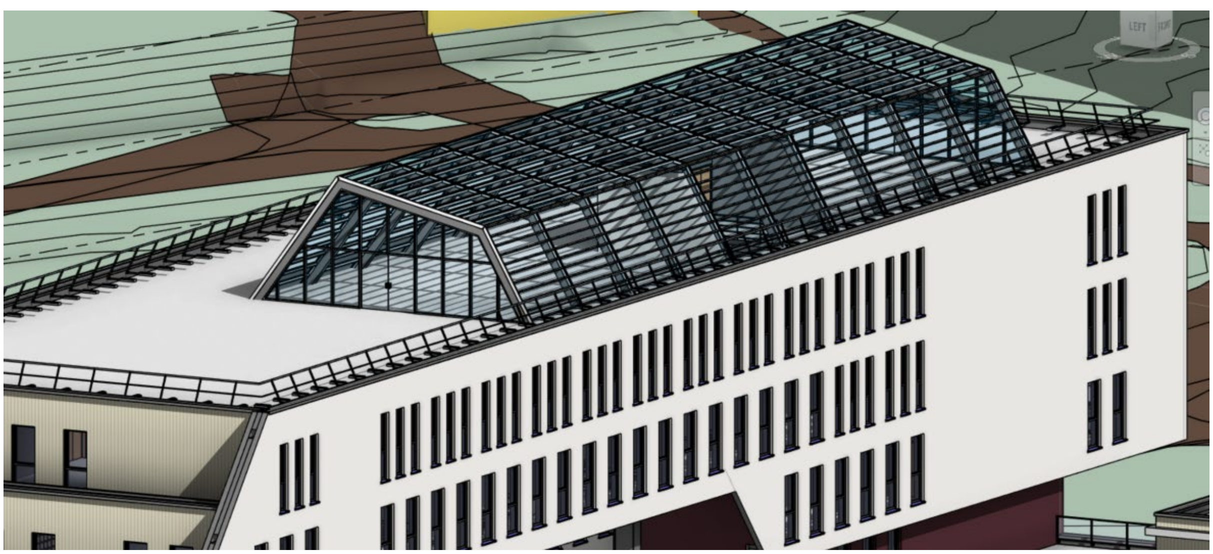


Figure 92 IFC Modeling the addition on the roof in Revit

7. After renovation model was done and relevant attributes were added to the Revit model, the model was exported in IFC with DiRoots IFC Exporter, presented further in this deliverable.

3.3.5 Exporting the project, using tool DiRoots IFC Exporter

When modeling in Revit as BIM authoring tool finished, export to IFC was done using the DiRoots plugin IFC Exporter. The DiRoots IFC exporter reads the existing custom IFC setup (IFC4 MVD) in Revit but also requires correct attribute mapping so the required attributes will be transfered to IFC file

Inputs:

- Finalized Revit model

Outputs:

- IFC file

Process description:

1. DiRoots IfcExporter was previously installed inside Revit 2025
2. In IFC Exporter, proper IDS was selected, along with IFC Export MVD. In the table, each required IFC property was mapped with corresponding Revit parameters

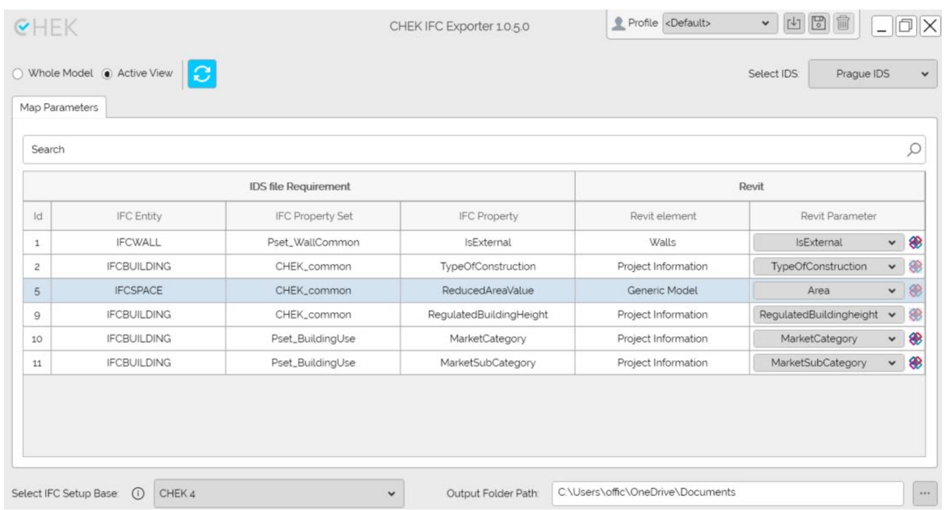


Figure 933 Exporting to IFC using IFCExporter

3. The DiRoots IFC Exporter created the project IFC model of the building that will be used further in the demonstration.

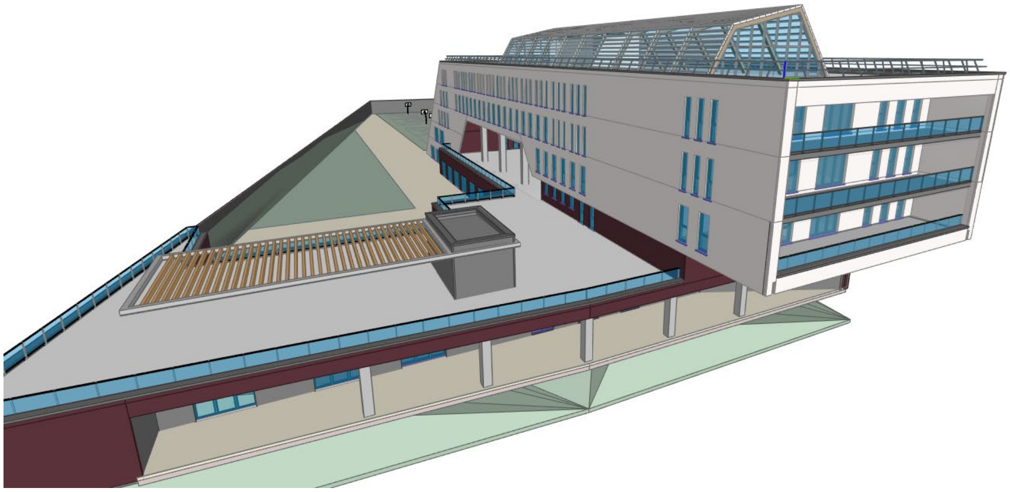


Figure 94 Exported IFC file

3.3.6 Georeference assessment, using tool IfcGref

After initial site surroundings were merged with the existing building model in Revit, the project was exported to IFC for further georeferencing check in IfcGref tool. IfcGref tool developed by TuDelft, is web service that validates the proper georeferencing of the IFC file and offers additional tools such as visual inspection of the model on basemap.

Inputs:

- Georeferenced IFC model

Outputs:

- Validated IFC model

Process description:

1. The IFC model of the building was uploaded to IfcGref

IFC version: IFC4
IFC file is georeferenced.

IFCProjectedCRS Data

	property	value
0	id	27
1	type	IfcProjectedCRS
2	Name	EPSG:5514
3	Description	None
4	GeodeticDatum	None
5	VerticalDatum	None
6	MapProjection	None
7	MapZone	None
8	MapUnit	None

IFCMapConversion Data

	property	value
0	id	28
1	type	IfcMapConversion
2	SourceCRS	[None, Model, 3, 1e-05, [[(0.0, 0.0, 0.0)], None, None], [(6.123233995736766e-17, 1.0)]]
3	TargetCRS	[EPSG:5514, None, None, None, None, None, None]
4	Eastings	-737733.275
5	Northings	-1043624.915
6	OrthogonalHeight	250.5
7	XAxisAbscissa	1.0

Figure 95 Georeferencing check

2. IfcGref tool returned that the model is properly georeferenced
3. The model was properly positioned on the map

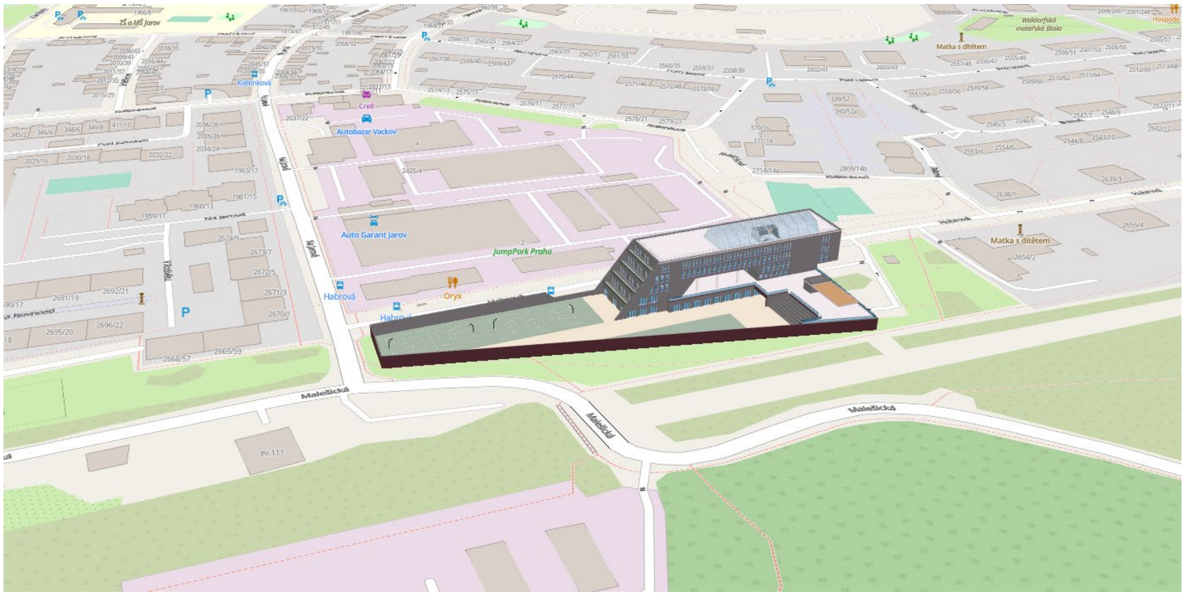


Figure 96Visual check in IfcGref

3.3.7 IFC validation, using tool IfcViewer

To ensure validity of the IFC model data for further regulations compliance checks, the IFC model was checked against IDS requirements. This check was performed using the RDF's tool IfcViewer, a portable desktop application.

Inputs:

- IFC model

Outputs:

- Validated IFC model against IDS

Process description:

1. The IFC model of the building was opened with IfcViewer

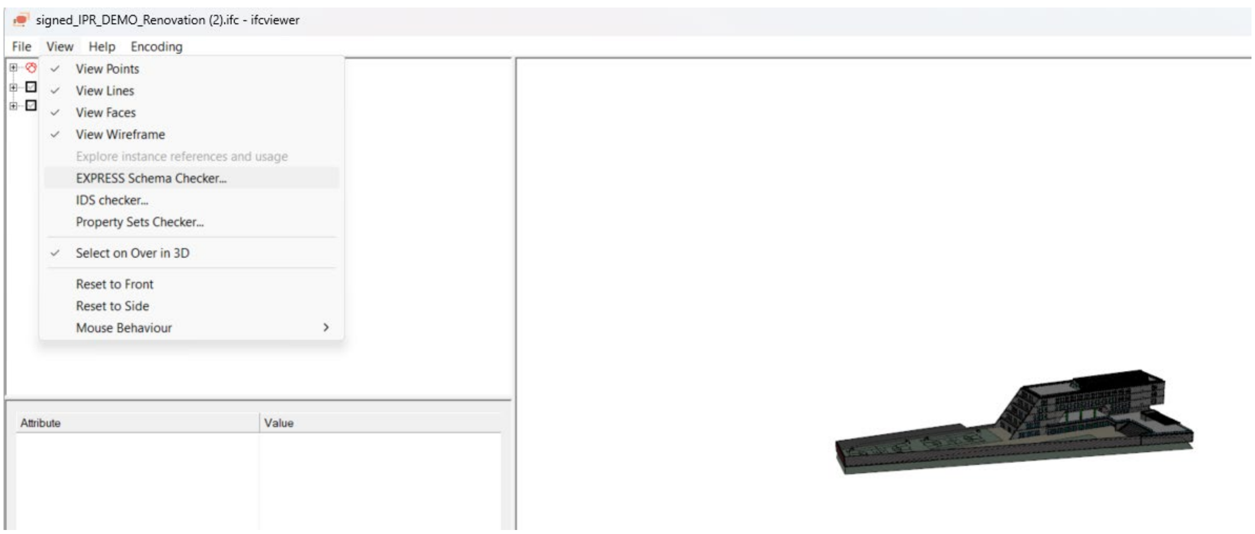


Figure 97 Model opened in IfcViewer

2. The EXPRESS Schema Checker returned the results

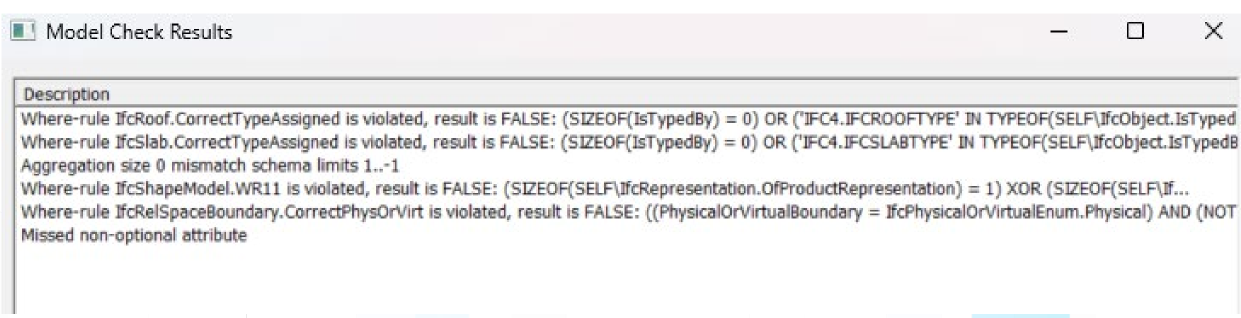


Figure 98 EXPRESS schema check

3. The IDS checker requested import of Gaia pilot specific IDS file and after it was imported returned the following results:

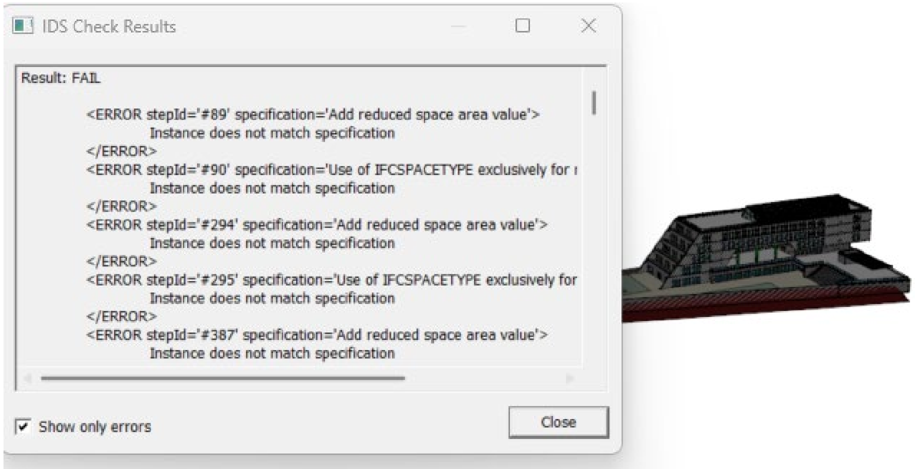


Figure 99 IDS check

4. Both checkers returned some failed results. The errors in the EXPRESS schema were identified prior to the demonstration phase and were attributed to the software vendor issues. These errors were not imposing issues in the next steps.

3.3.8 Uploading the model to the CHEK platform using tool BIMserver.center

IFC model was validated against georeferencing, EXPRESS schema and IDS requirements. Next step was to be uploaded as Contribution to the project folder on the CHEK DBP platform based on BIMserver.center. This contribution was later connected to CypeUrban and VC Map for performing self check against predefined rules.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. New contribution was initiated in the project folder in BIMserver.center

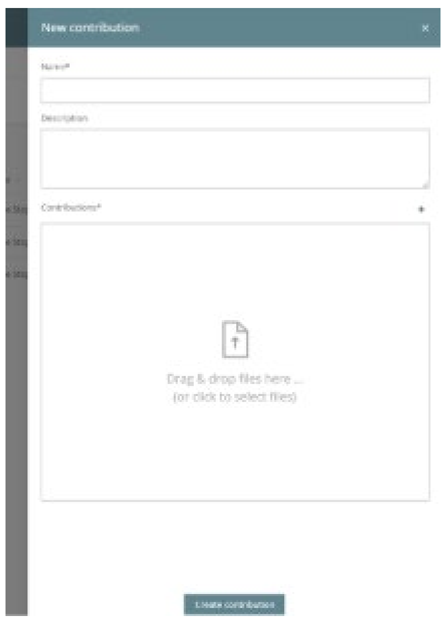


Figure 100 Creating new contribution

2. After uploading the IFC model in the contribution, the IFC model was converted to GLTF file format suitable for further visualization and checks

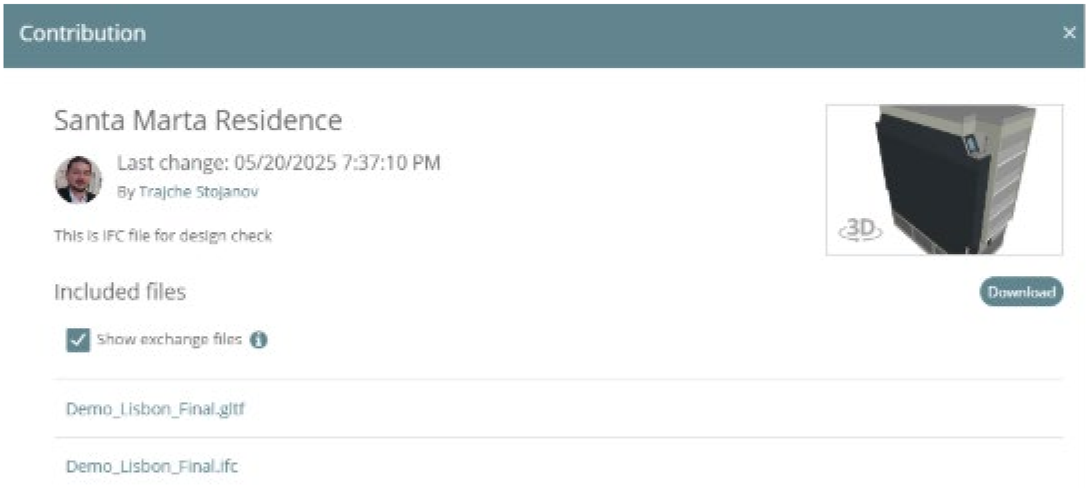


Figure 101 Contribution containing ifc and gltf files

3.3.9 CHEK pre-validation, using tool VC Map

Prior to performing final checks in checking application, Designers did selfcheck of the IFC model in this stage. The self-check returned some failed checks. This pre-validation is very beneficial in self-assessment of the model prior to submitting it for Review by the Municipalities.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. After Designers logon the VCMap platform and connected the BIMserver.center account, the IFC model was converted to Visualization Model in order to be visualize

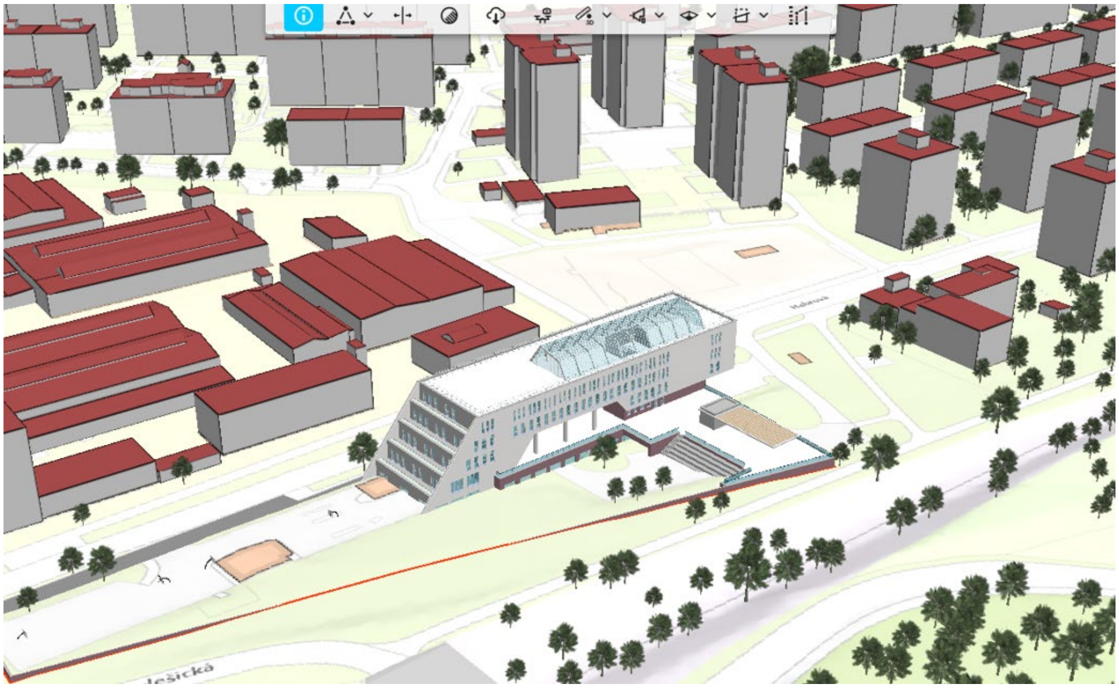


Figure 102 Visualization model conversion ongoing in VCMap

2. After converting the model into Visualization Model, conversion to Semantic Model was performed
3. With both conversions completed, the check compliance was performed

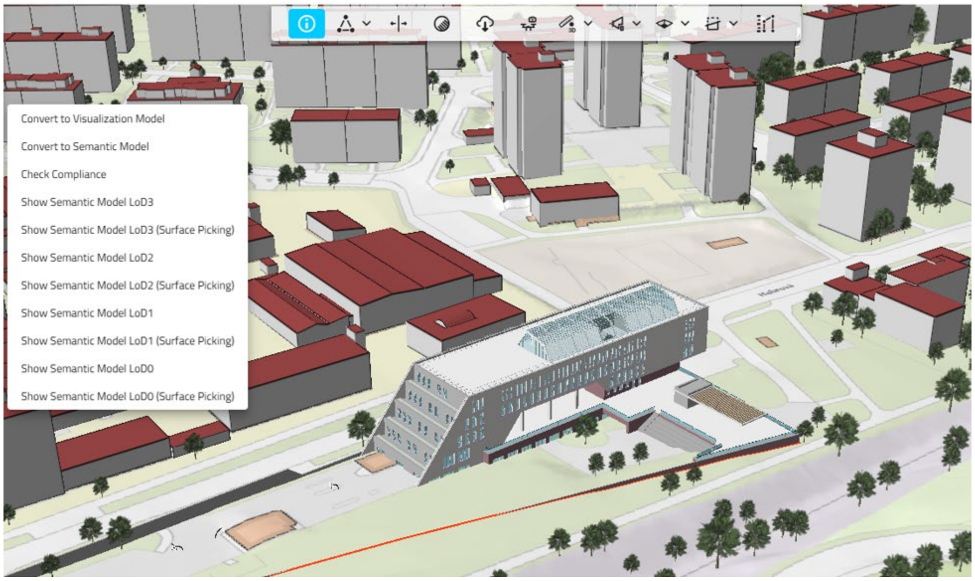


Figure 103 Starting compliance check

4. The compliance check returned some failed checks
5. To have a successful project, designers made changes to the model in Revit as BIM authoring tool of choice.

3.3.10 CHEK pre-validation, using tool Verifi3D

After the first set of compliance pre-check done in VC Map, Designers did self-check with Verifi3D tool too. The self-check returned some failed checks.

Inputs:

- IFC model

Outputs:

- Validated IFC model as contribution in BIMserver.center

Process description:

1. Designers connected the Verifi3d with BIMserver.center account

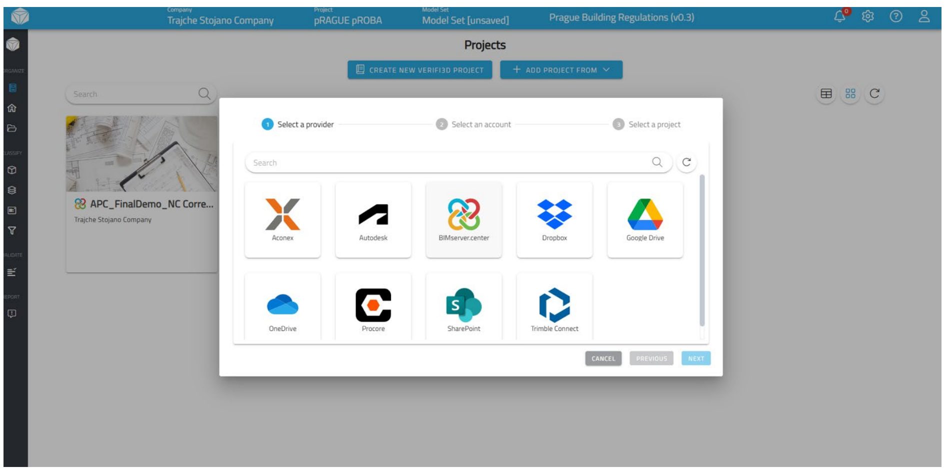


Figure 104 Connection of BimServerCenter account to Verifi3D

2. The project files were opened

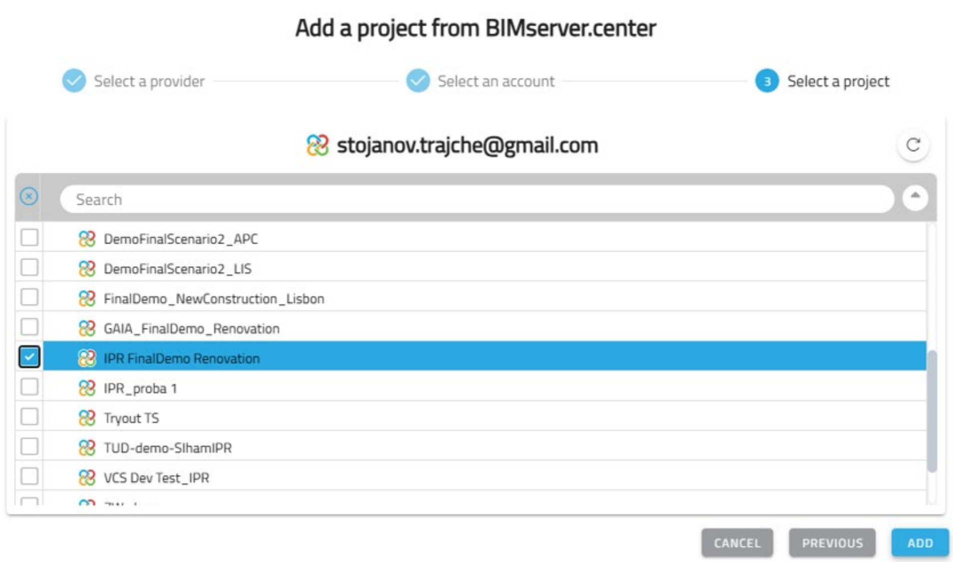


Figure 105 Selection of the project

3. Prague regulations checks were chosen

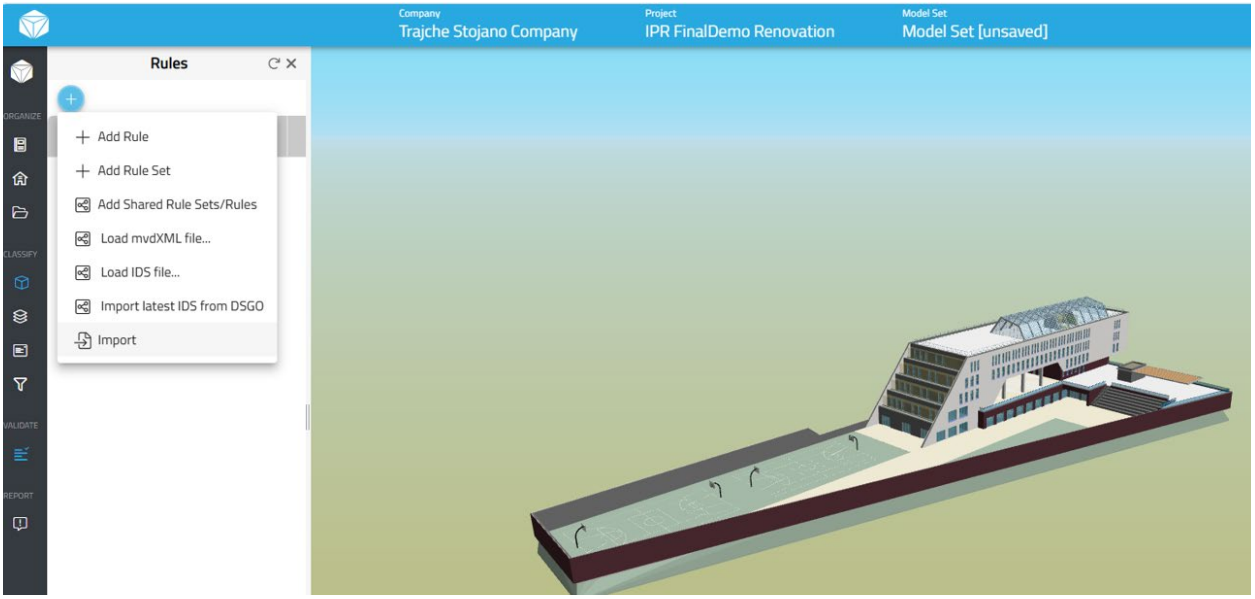


Figure 106 Importing rules for compliance check

4. Some checks returned failed checks

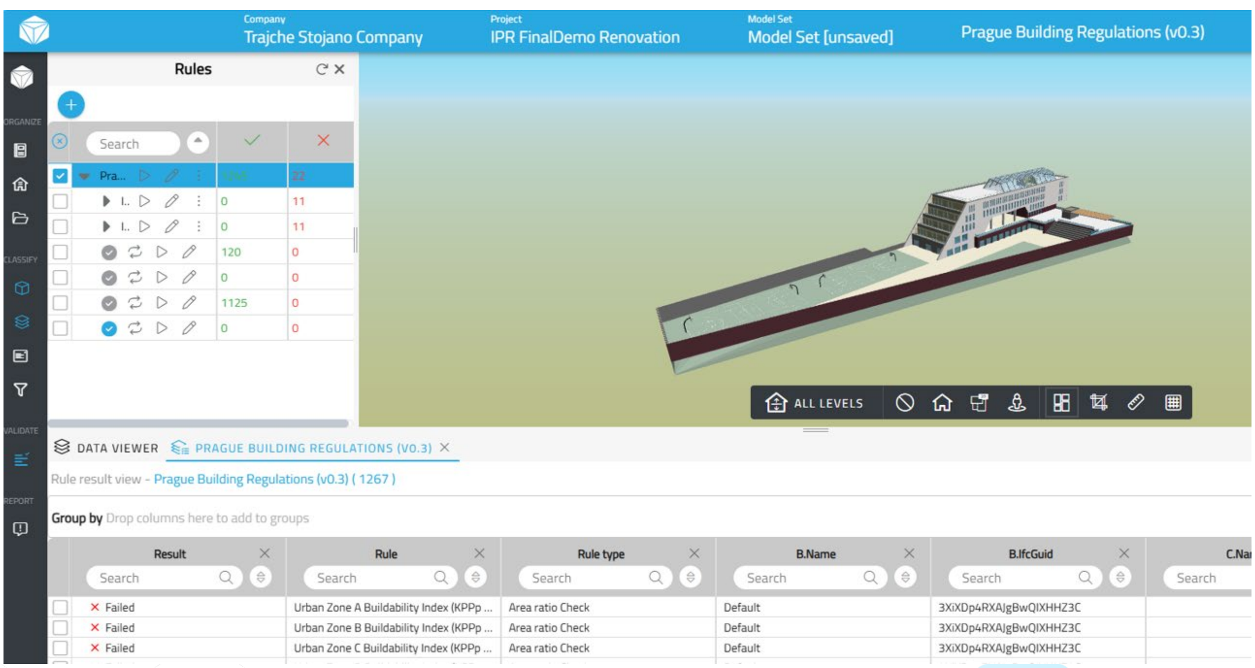


Figure 107 Rules were executed

5. The results of performed self-check in CypeUrban were used to correct the model in Revit

3.3.11 Design correction using tool Autodesk Revit 2025

After building code compliance, a self-check was performed in VC Map and Verifi3D, Designers did correction of the BIM model in Autodesk Revit 2025, a commercial BIM application of choice. The corrections were done mostly in the building height, height of the ground floor, etc.

Inputs:

- Analog check results

Outputs:

- Corrected and updated BIM model

Process description:

1. Designers did changes to the model in reference to the failed checks
2. The Revit model was exported in IFC using Diroots IFC Exporter

3.3.12 Digital signature of the IFC model, using tool DiStellar

Updated IFC file was digitally signed in DiRoots DiStellar with Signature functionality that run on personal account connected with personal account on Designer's phone. The digital signature tool added additional information in the IFC file that can be assesed only by DiStellar app.

Inputs:

- IFC model

Outputs:

- Digitally signed IFC file

Process description:

1. The DiStellar app was opened and Designers logged in

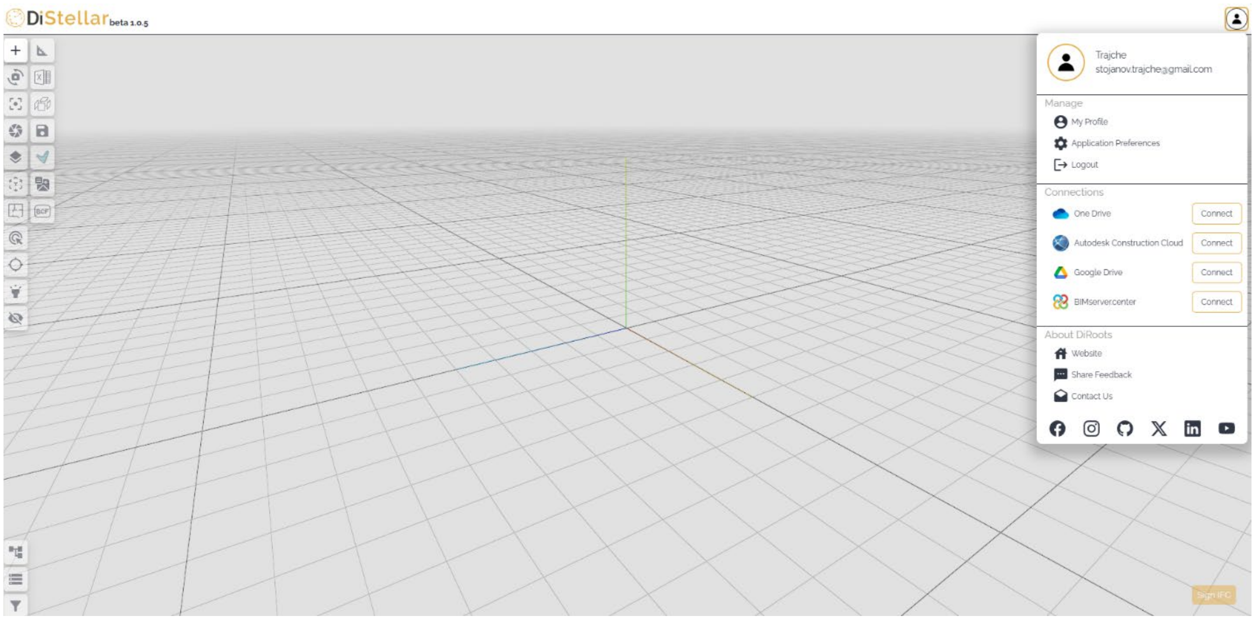


Figure 108 Login in DiStellar

2. BIMserver.center was connected

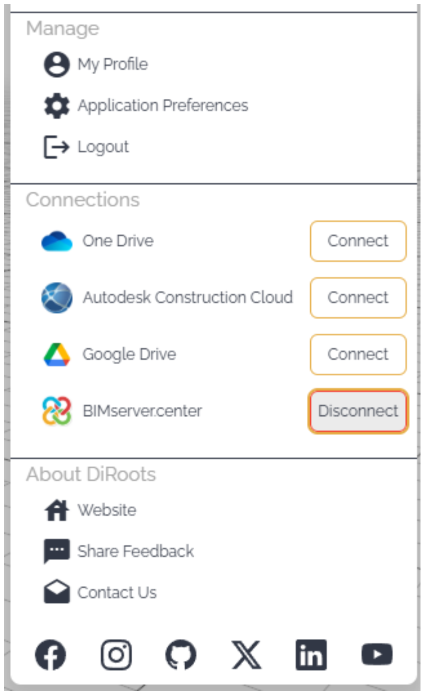


Figure 109 Connection of BIMServerCenter account

3. The updated IFC model was uploaded and digitally signed

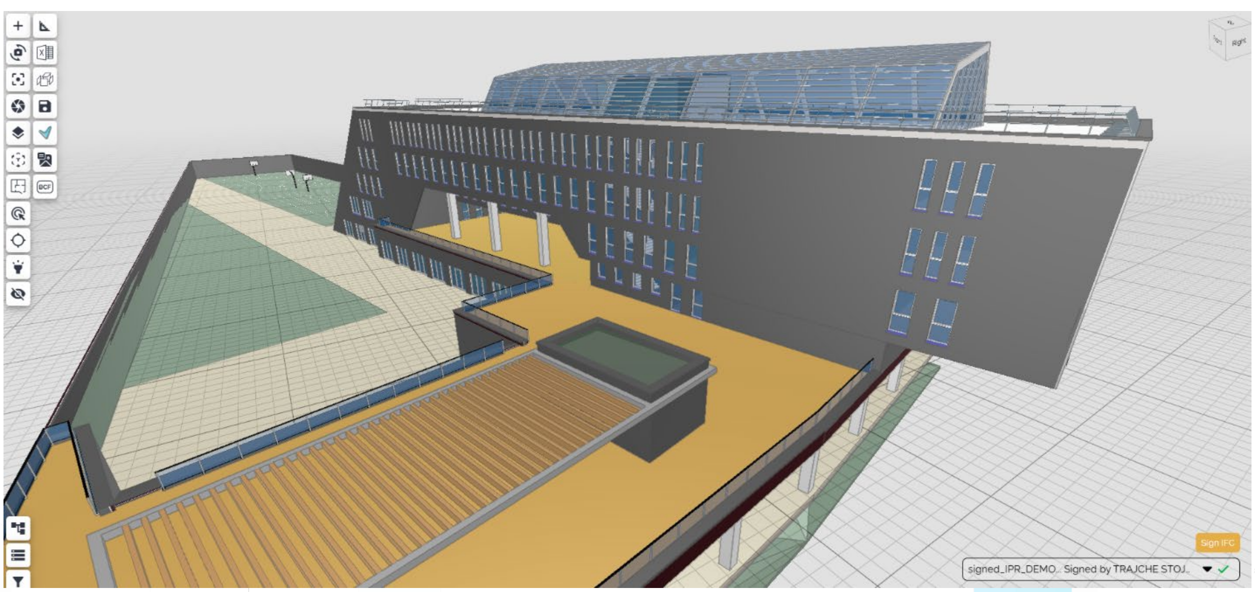


Figure 110 Uploading and signing the corrected IFC file

4. Signed IFC model was uploaded to BIMserver.center in project folder

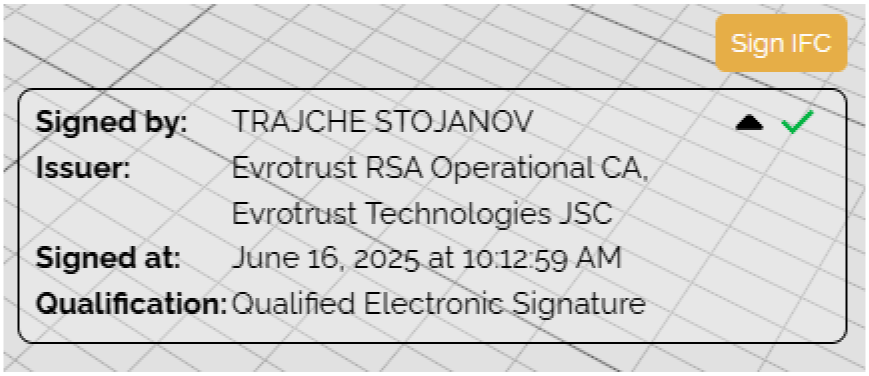


Figure 111 Digital Signature info

3.3.13 CHEK final-validation and report to municipalities, using tool VC Map and Verifi3D

The final step in Designers workflow was performing final validation (compliance check) of the IFC model and sharing the check report to IPR Prague via BIMserver.center. The final validation was performed in VC Map and Verifi3d, repeating the steps described in items 9 and 10 of this case study. Not to repeat the same steps, in this stage we are describing the steps after the check is performed.

Inputs:

- Digitally signed IFC model

Outputs:

- Shared json files as a check results file

Process description:

1. In VCMap platform, the updated IFC model was converted to Visualization Model and later to Semantic Model. The Compliance checks were performed. The results were shared
2. The newly uploaded updated digitally signed IFC model was opened in Verifi3D and Prague regulation checks were performed

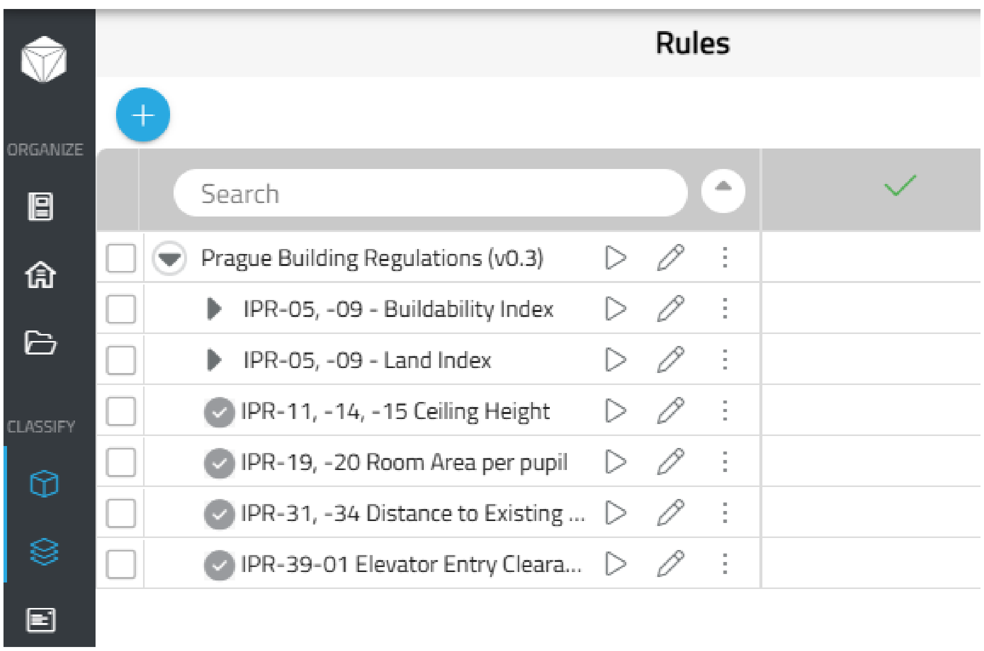


Figure 112 Performing compliance check in Verifi3D

3. The check results were presented in detail.

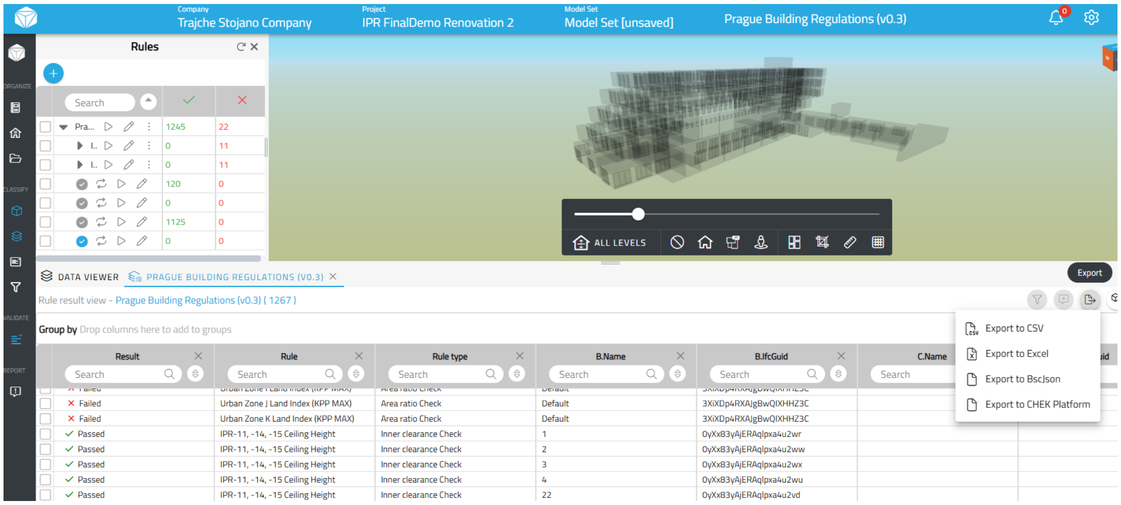


Figure 113 Results showing many successful checks

4. The results and report of performed checks were shared via BIMserver.center to the IPR Prague for final review.

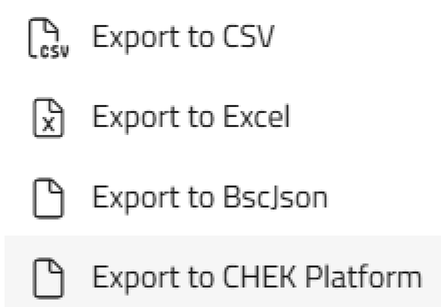
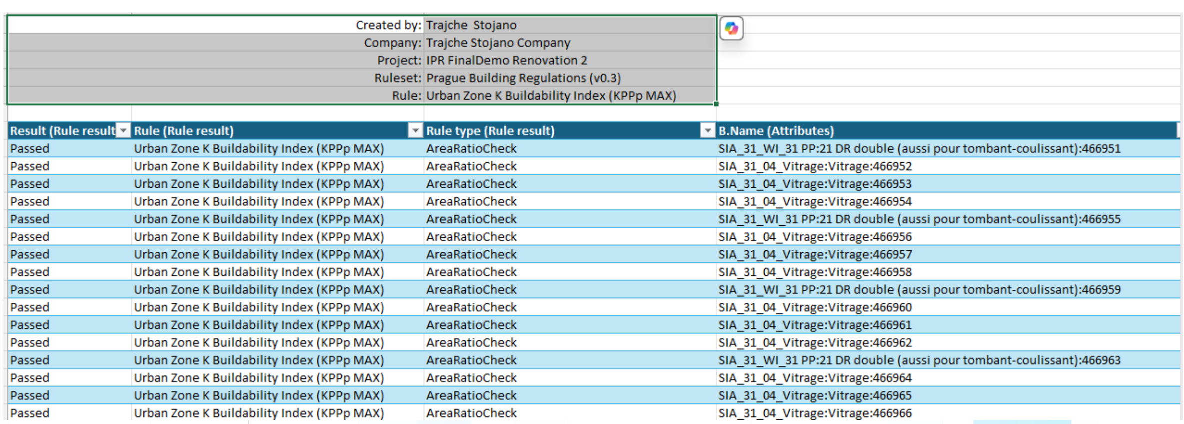


Figure 114 Sharing the report with municipalities via BSC



Created by:	Trajche Stojano
Company:	Trajche Stojano Company
Project:	IPR FinalDemo Renovation 2
Ruleset:	Prague Building Regulations (v0.3)
Rule:	Urban Zone K Buildability Index (KPPp MAX)

Result (Rule result)	Rule (Rule result)	Rule type (Rule result)	B.Name (Attributes)
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_WI_31 PP:21 DR double (aussi pour tombant-coulissant):466951
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466952
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466953
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466954
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_WI_31 PP:21 DR double (aussi pour tombant-coulissant):466955
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466956
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466957
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466958
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_WI_31 PP:21 DR double (aussi pour tombant-coulissant):466959
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466960
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466961
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466962
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_WI_31 PP:21 DR double (aussi pour tombant-coulissant):466963
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466964
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466965
Passed	Urban Zone K Buildability Index (KPPp MAX)	AreaRatioCheck	SIA_31_04_Vitrage:Vitrage:466966

Figure 115 How the xlsx report from Verifi3D shows

3.3.14 CHEK permitting tools. Municipality side, using tool BIMserver.center

After completion of the designer's workflow, the IPR Prague received automatically a Request for Review of the submitted results check.

Inputs:

- Digitally signed IFC model
- Validation report / check results from VCMap
- Validation report / check results from Verifi3D
- Contribution files in BIMserver.center

Outputs:

- Validation / Review result by IPR Prague

Process description:

- As designers completed the checks and shared the results, the IPR team:
  - started evaluating the validation reports / check results along with
  - Performing checks by themselves using the Verifi3D and
  - Performing checks in VCMap application
- During the validation/checking activities, IPR team reported some issues using the checking applications that were communicated with software vendors. The results of the checks performed were documented in a standardized format.

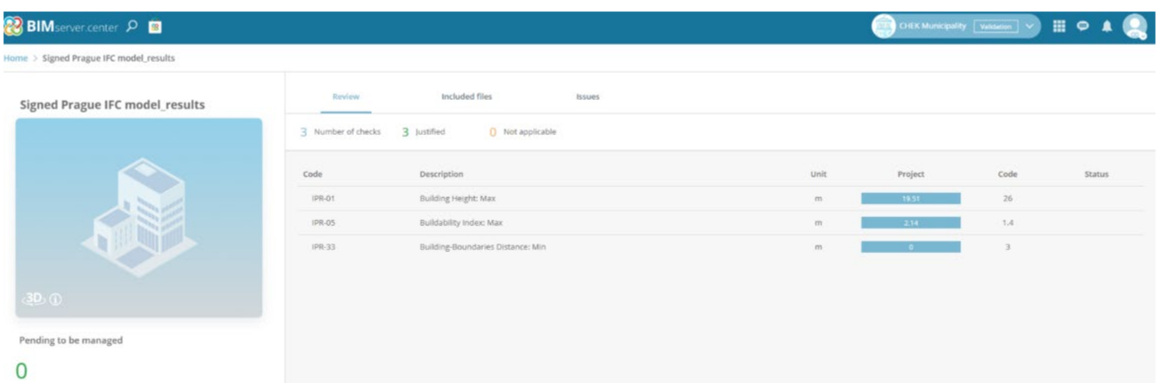


Figure 116 Municipality account in BSC

- In Verifi3D, from 6 available checks, 2 were not applicable for the Renovation scenario, the rest 4 were successful.

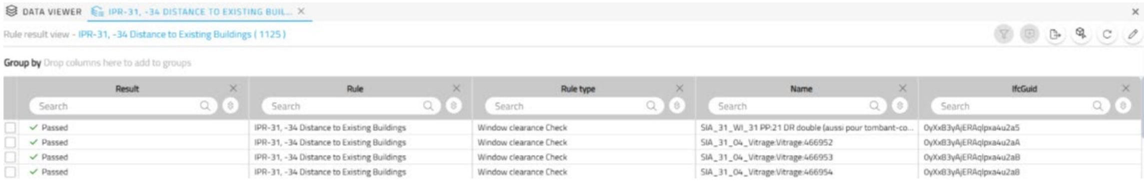


Figure 117 Verifi3D results check

- In VCMap, from 3 available checks, 2 were not applicable for the Renovation scenario, the rest 1 was successful.

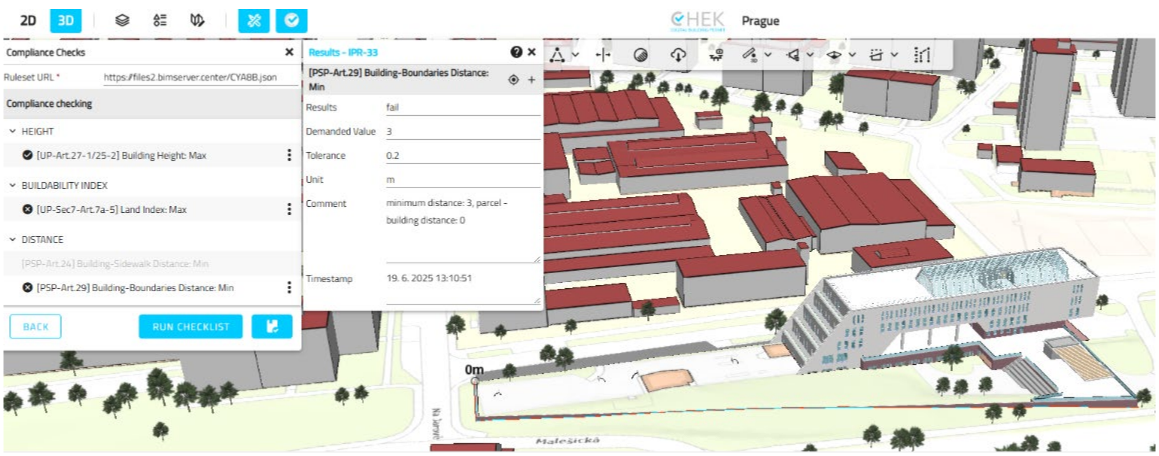


Figure 118 VCMap results check

Conclusion

The Prague Renovation Scenario successfully demonstrated the practical application and usefulness of the CHEK digital toolkit in the digital permitting context. The scenario showed that the proposed CHEK DBP workflow is viable, collaboration between the shareholders was achieved, the model was checked against the regulations, and time allocation of the processes was reduced. The tools were user friendly, comprehensive and contributed greatly to the designers and the municipalities processes. During the demonstration, some errors or issues were noticed and communicated further. Some of them were successfully resolved or bypassed, some stayed, but none of them had an adverse impact on the demonstration. Overall, the Prague Renovation Scenario provided strong evidence of the potential for digitally enabled, rule-based permit workflows to streamline renovation permitting processes across European cities.

3.4 Ascoli Piceno

This demonstration, carried out in the municipality of Ascoli Piceno, falls under Scenario 2 of the CHEK project, focused on the renovation or extension of an existing building within a consolidated urban environment. In this case, the project involved a partial extension of the original building by adding a new rooftop volume designed as a gym, functionally connected to the existing structure.

The design was developed by SIA.Architects, in coordination with the municipality of Ascoli Piceno, which was responsible for the urban planning validation.

The workflow followed in this pilot mirrored the structure already tested in previous scenarios, with particular attention paid to the proper differentiation between pre-existing and newly designed elements, both during the modeling process and in the IFC export.

The BIM model was exported to IFC format using the official DiRoots plugin, applying the parameters required by the corresponding IDS. The actual validation was carried out later using the tools VCMap and Verifi3D.

The BIMserver.center platform was used as the Common Data Environment (CDE), where the extended model was uploaded along with separate contributions representing the parcel, the existing building, and surrounding buildings. The latter were generated from geospatial data in GML format and converted to IFC using the RDF converter.

To establish the urban and georeferenced context and enable automated compliance checking, the VCMap tool was employed. Verifi3D was also used to test rule-based validation; however, in this case, no results were obtained due to the absence of key elements (such as elevators or suspended ceilings) in the initial model. After including a suspended ceiling in version 2, the rules still failed to execute properly, and no report was generated from this tool.

No significant issues were encountered regarding georeferencing or model federation.

The final file was digitally signed and uploaded to the platform, pending validation by the municipality.

DEMO PILOT CASE INFO CARD		
1	Demo plot location	Ascoli Piceno, Italy
2	Building Type	Mix-use building
3	Address	Via Genova, 4-6
4	Designer of Scenario 1	ZWE
5	Designer of Scenario 2	SIA
6	Renovation Description	Vertical extension / New functionality
7	Demonstration period	09/06/2025 - 13/06/2025
8	Reviewer	Municipality of Ascoli Piceno

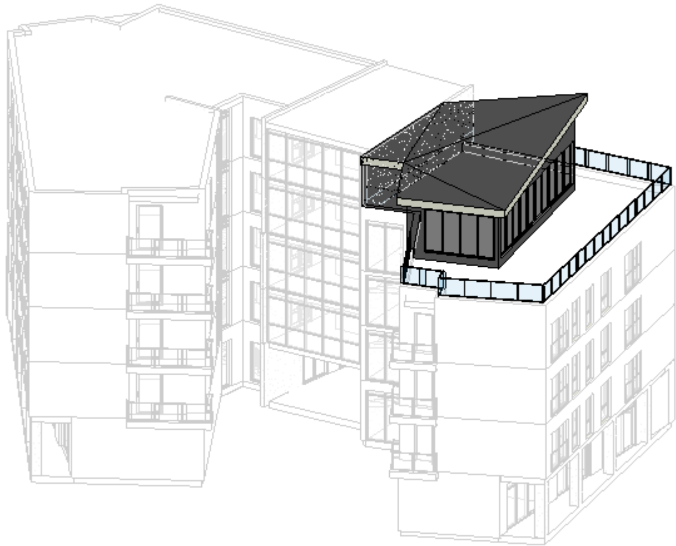


Figure 119 Final version for Ascoli Piceno Scenario 2, renovation

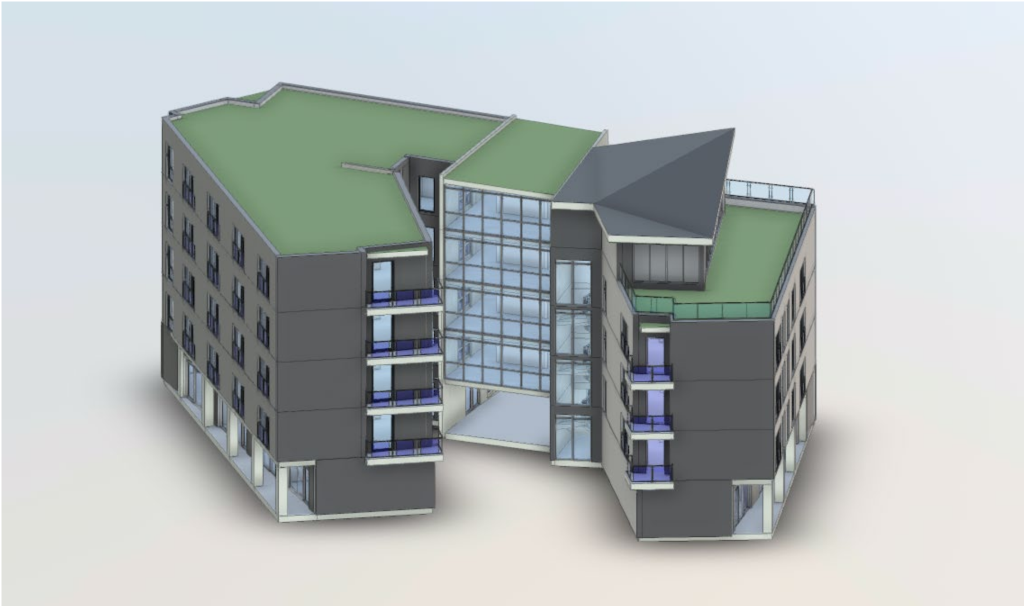


Figure 120 Integrated render Scenario 1 and scenario 2. Ascoli Piceno

3.4.1 Gathering initial data – VCMap

Settings:

The project DemoFinalScenario2_APC was created and tagged with the name of the municipality "Ascoli Piceno" to ensure proper indexing within the VCMap tool.

Inputs:

The IFC file of the existing building, previously generated during the Scenario 1 demonstration, was used as a reference to ensure continuity of the base model in terms of location and orientation.

Outputs:

IFC files corresponding to the plot, topography, and surrounding buildings were generated from CityGML files, following the already established procedure using VCMap.

To improve:

Minor discrepancies were detected during the visual review of some models converted from GML, particularly with the elevation of neighboring buildings. Although these issues did not compromise the validation workflow, they were reported to the VCMap technical team and promptly corrected.

Process description:

After the project was created and properly tagged in BIMserver.center the urban model in VCMap was accessed using the content tool. The area corresponding to the building under renovation was identified, and the CityGML files for the terrain and surrounding buildings were downloaded.

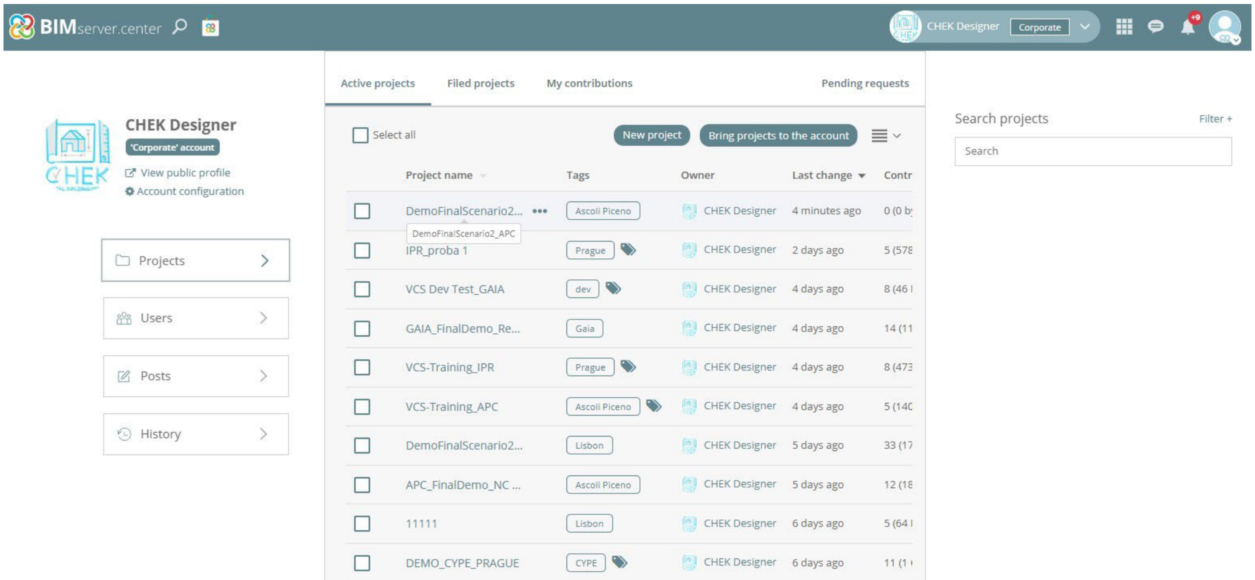


Figure 121 Project created and tagged in BSC

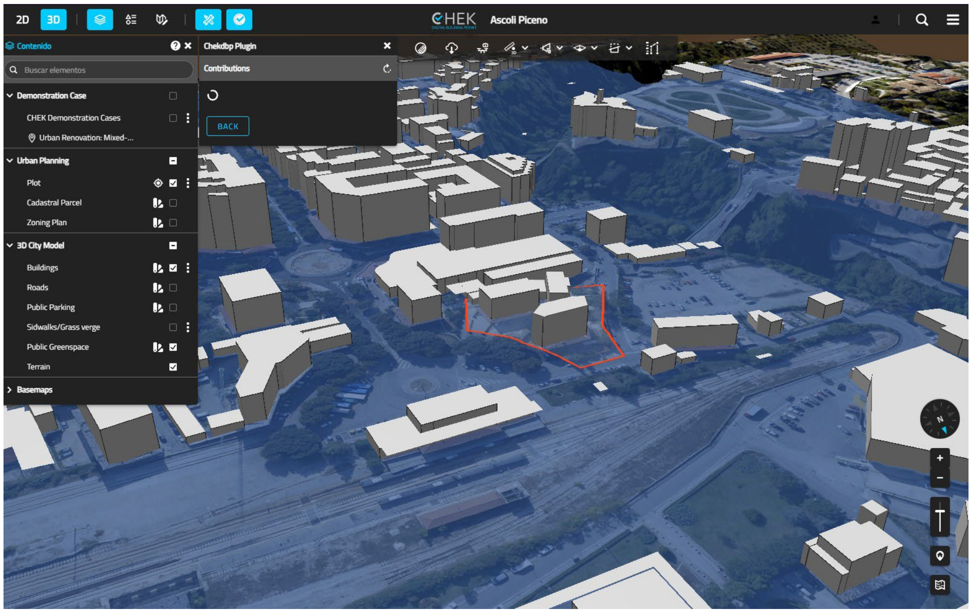


Figure 122 Plot correctly shown after correct tagging

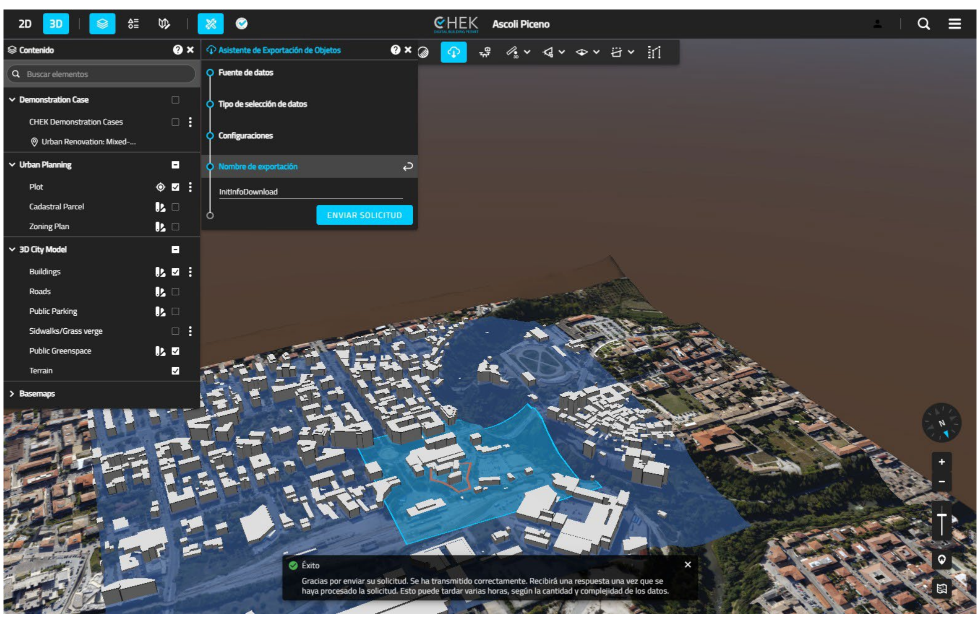


Figure 123Area selected to get the terrain and surroundings

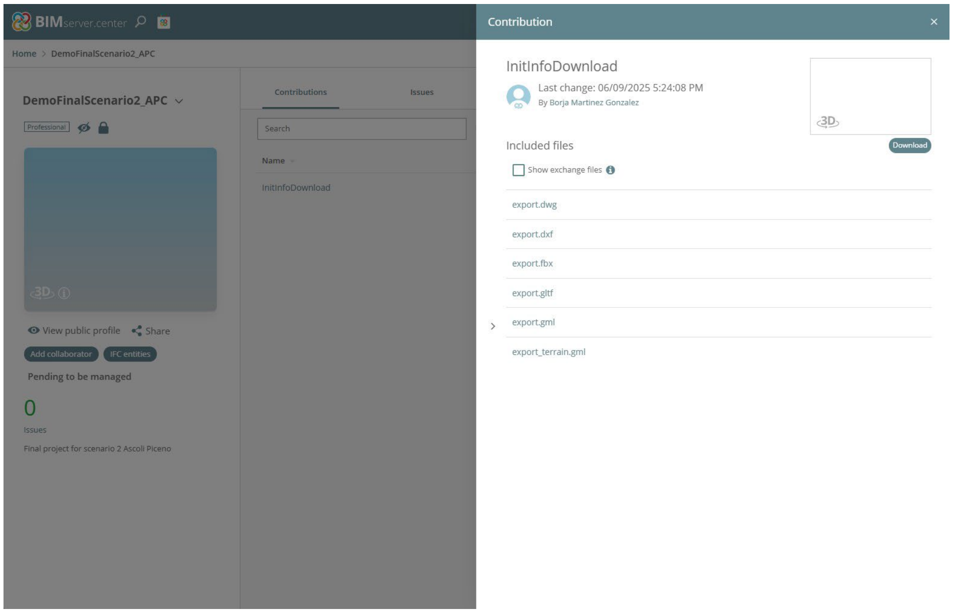


Figure 124 VCMap contributión including the initial information for design

3.4.2 GIS to BIM conversion – CityGML2IFC

Settings:

The urban environment from VCMap in CityGML format and converted to IFC using the standalone CityGML2IFC tool developed by RDF, as previously described in earlier pilot cases.

Inputs:

Environment models exported from VCMap in CityGML format.

Outputs:

Two georeferenced IFC files: one for the neighboring buildings and one for the terrain.

To Improve:

Minor discrepancies in the elevation of neighboring buildings were detected after conversion. These were reported to the technical team. No new issues were observed compared to previous scenarios.

Process Description:

Since the GIS to BIM conversion workflow in this scenario followed exactly the same procedure as the one described in the Lisbon pilot (Scenario 2 – LIS), please refer to that section for a more detailed explanation. In this case, the converted models were used to validate the positioning of the new volume and ensure proper federation in BIMserver.center.

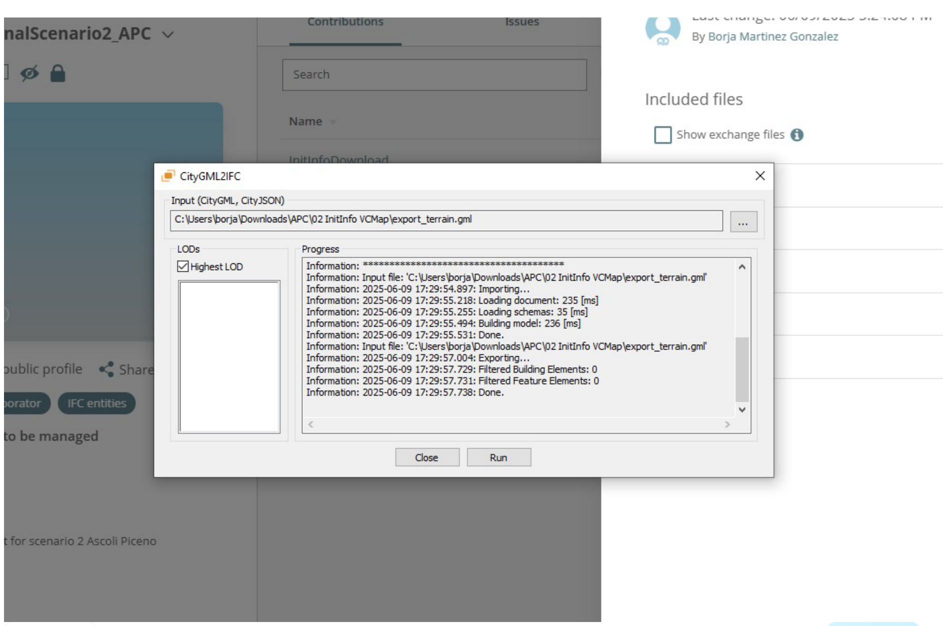


Figure 125Conversion from cityGML to IFC successful

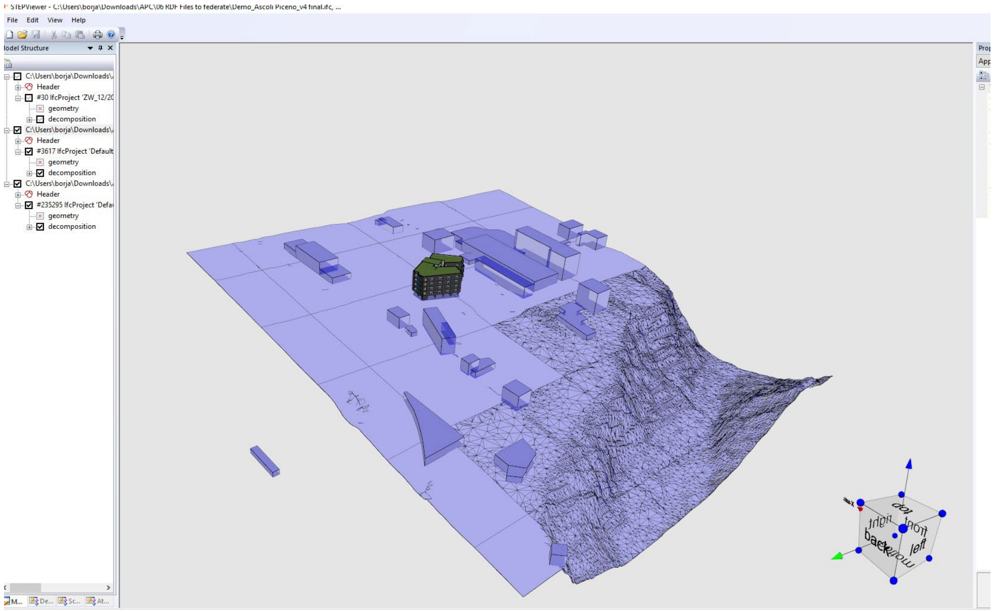


Figure 126Federating de existing building, and the converted files. Success!

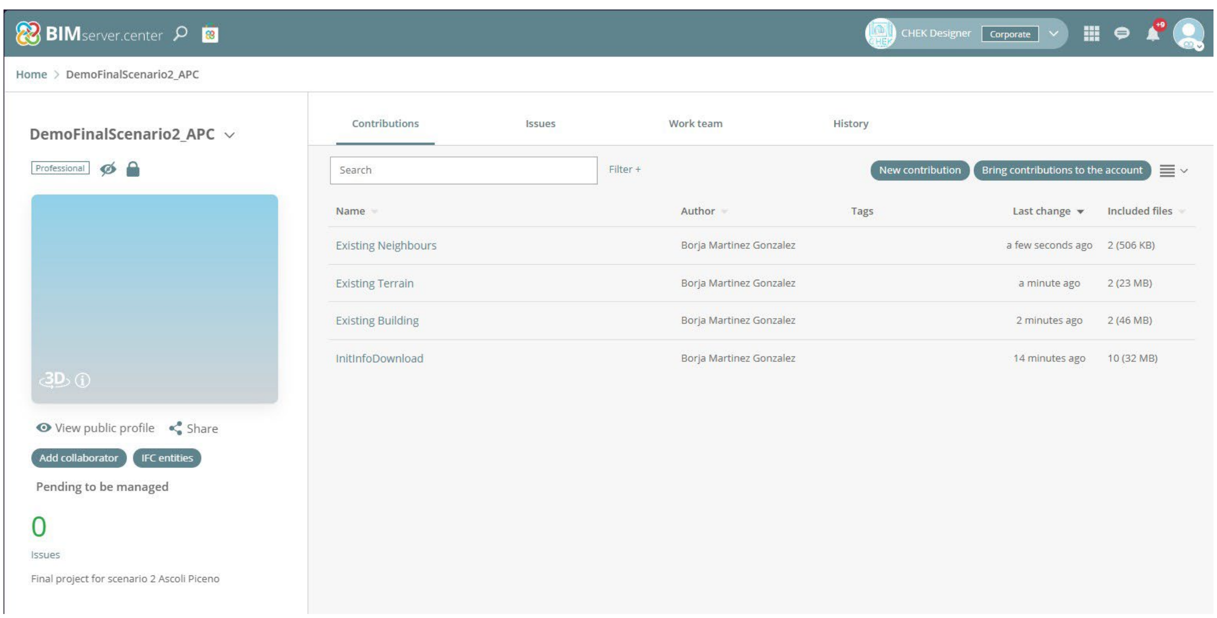


Figure 127 Separated contributions in BSC, for future federations/assessments

3.4.3 Designing, using Revit

The design was developed entirely in Revit, following the general modeling workflow already described in previous scenarios. In this case, the main specificity was the need to partially modify the existing curtain wall in order to integrate the new rooftop volume intended as a gym.

The required IDS parameters were manually added during the modeling process to facilitate subsequent regulatory validation. Additionally, a second version of the model was created, including a suspended ceiling, with the specific aim of triggering one of the predefined validation rules in Verifi3D (regarding minimum ceiling height). This change had no impact on the project's overall massing or functionality.

3.4.4 Exporting the project – DiRoots plugin

The model was exported to IFC format using the official DiRoots plugin, following the same procedure previously described in other CHEK project demonstrations.

During the export process, the corresponding IDS was selected, allowing for correct mapping of the parameters required by the urban regulations. As in previous cases, the plugin does not validate the content of these parameters, only their presence.

In this particular case, two versions of the IFC model were generated: an initial version without a suspended ceiling, and a second version including that element to attempt activation of validation rules in Verifi3D. Both versions were validated in VCMap, but only the second one was digitally signed and considered the final project version.

No technical issues were encountered during the export process.

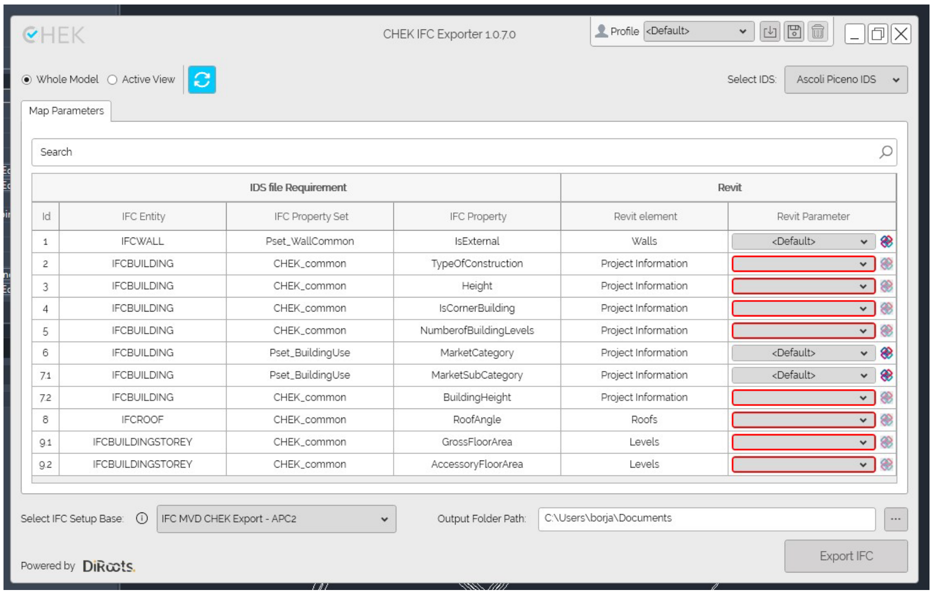


Figure 128 Mapping proccess before exporting. Red fields must be user guided

3.4.5 Georeference assessment – IfcGref/VCMap

The georeferencing of the model was assessed using the already known tools: IfcGref and VCMap, which provided a visual confirmation of the model's position within its urban context.

The extended building IFC file was correctly georeferenced from the first export, requiring no further adjustments. However, the IFC files generated from CityGML (terrain and neighboring buildings) presented minor elevation discrepancies, especially in the case of surrounding buildings. This issue was reported to the developers of VCMap, and did not interfere with the overall validation workflow.

Through both visual federation in BIMserver.center and position validation in VCMap, the model's placement was confirmed to be accurate for subsequent validation steps.

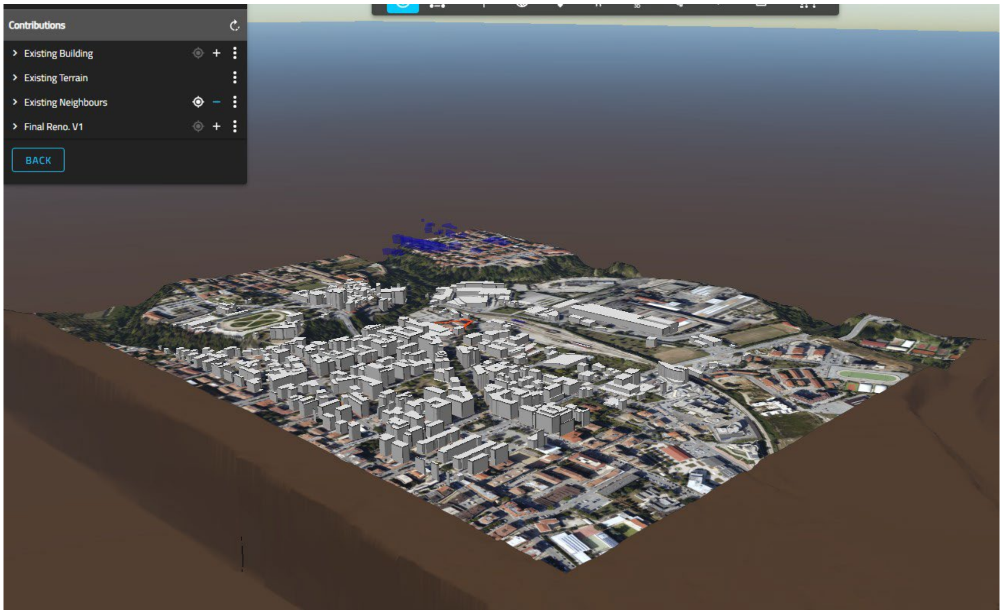


Figure 129 Minor issue regarding elevation, quickly solved

3.4.6 CHEK pre-validation and report – VCMap

The project pre-validation was carried out from the *Designer* role using the VCMap tool, with the aim of verifying regulatory compliance before municipal review.

The process began with the conversion of the IFC model into a *Semantic Model*, which was completed successfully on the first attempt. The automated urban compliance check was then executed, applying the regulations defined for the municipality of Ascoli Piceno. The result was fully positive, with no violations detected.

Following validation, the corresponding report was generated and submitted directly through the VCMap platform, completing the pre-validation process on behalf of the designer.

This workflow was completed without technical issues or the need for additional model adjustments, reflecting proper model preparation in earlier phases.

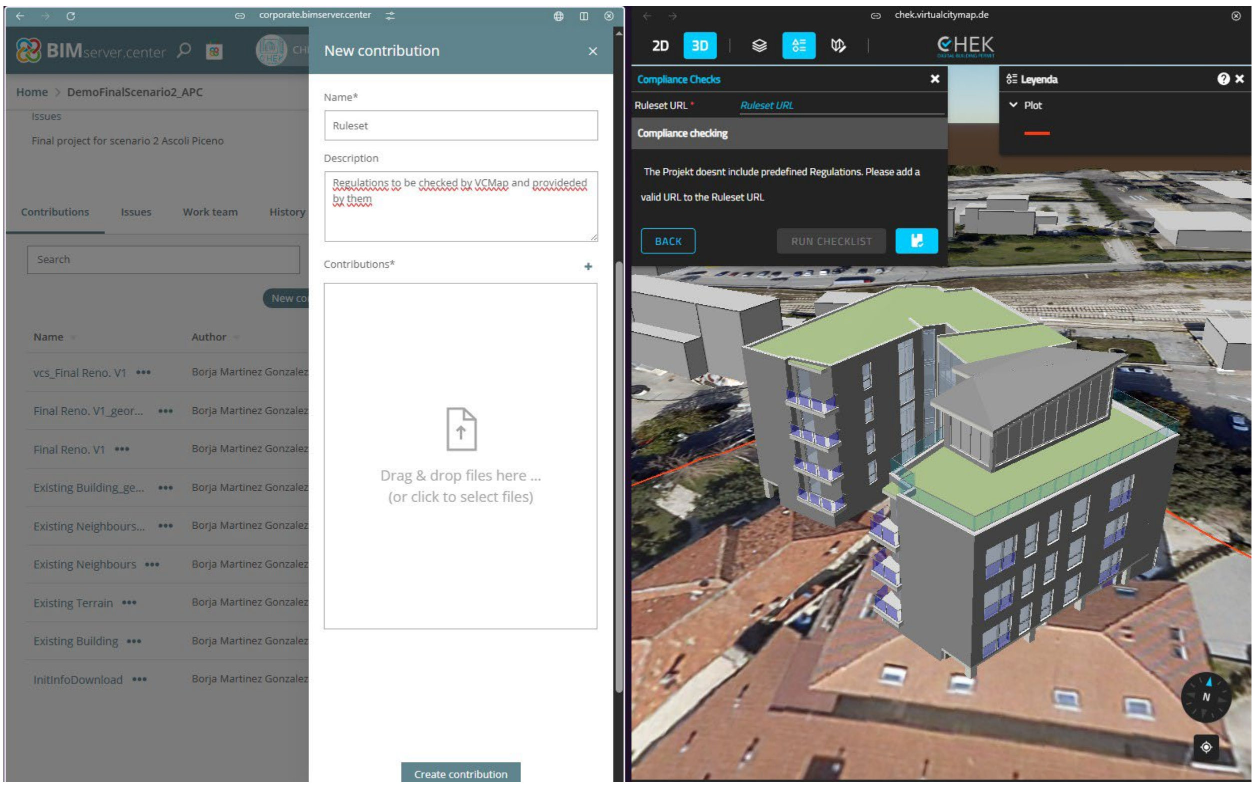


Figure 130Loading the Ruleset as a new contribution, following convention

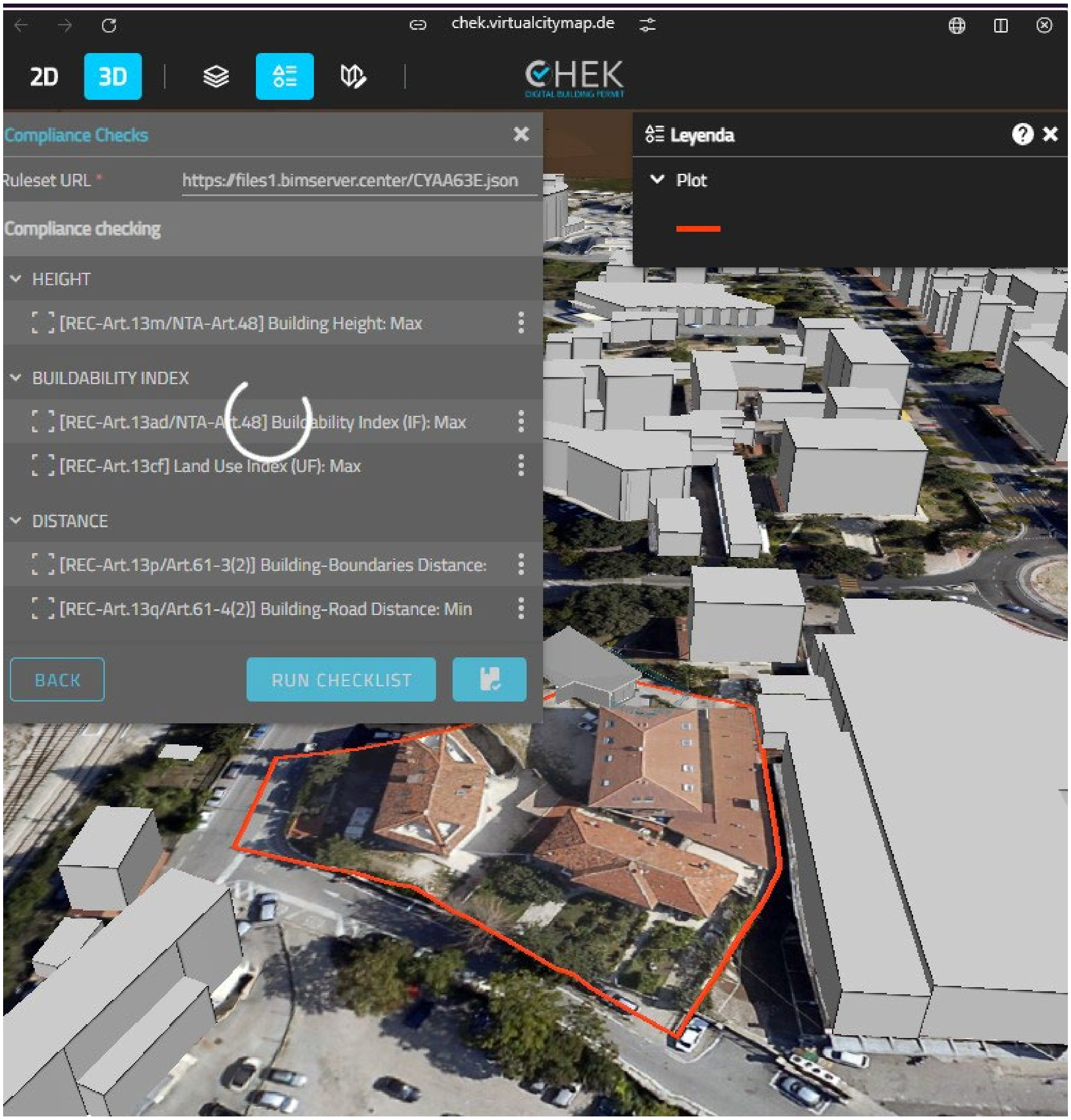


Figure 131 Running automatic assessments

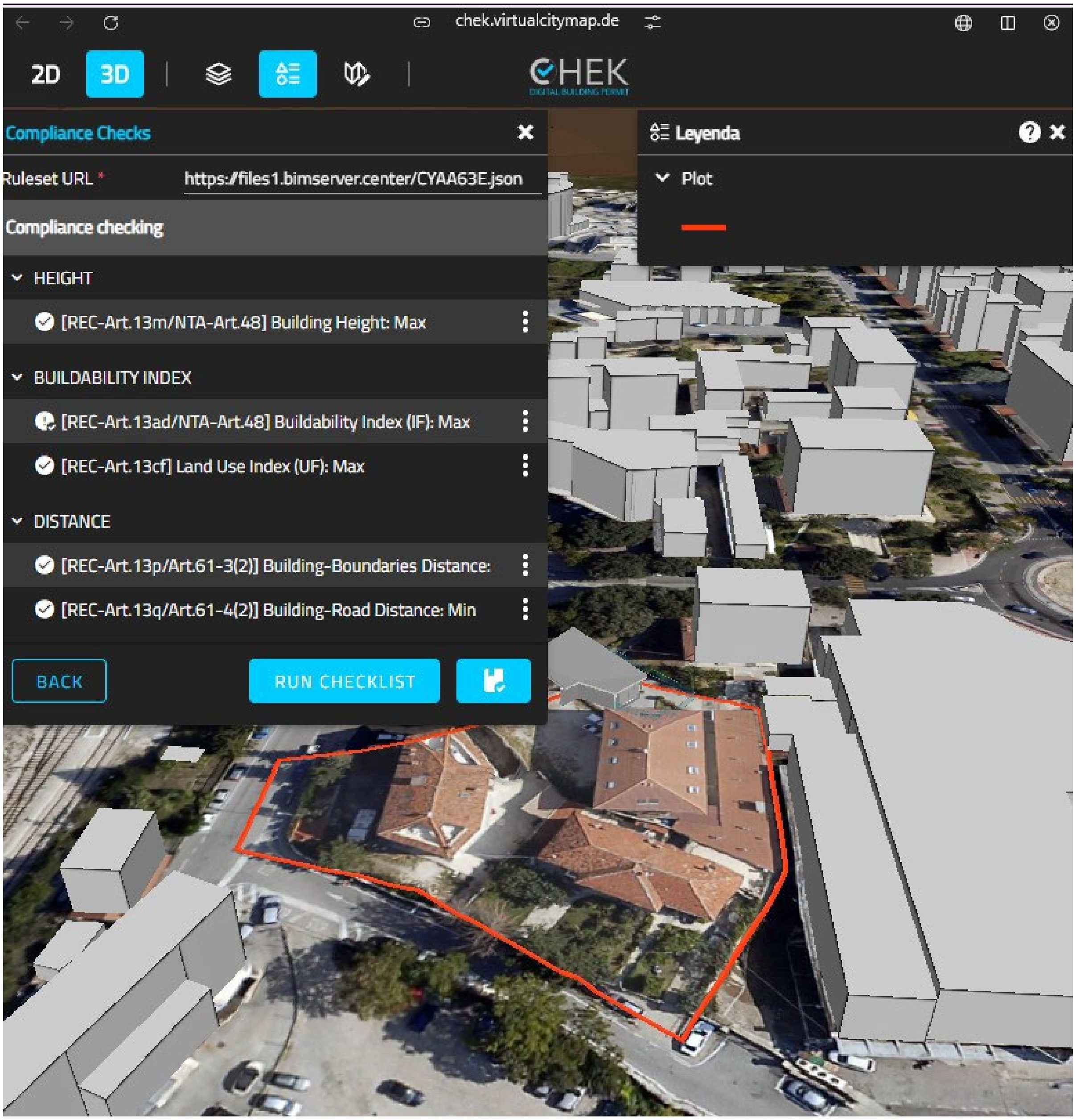


Figure 132 Regulatory test 100% passed, ready to report

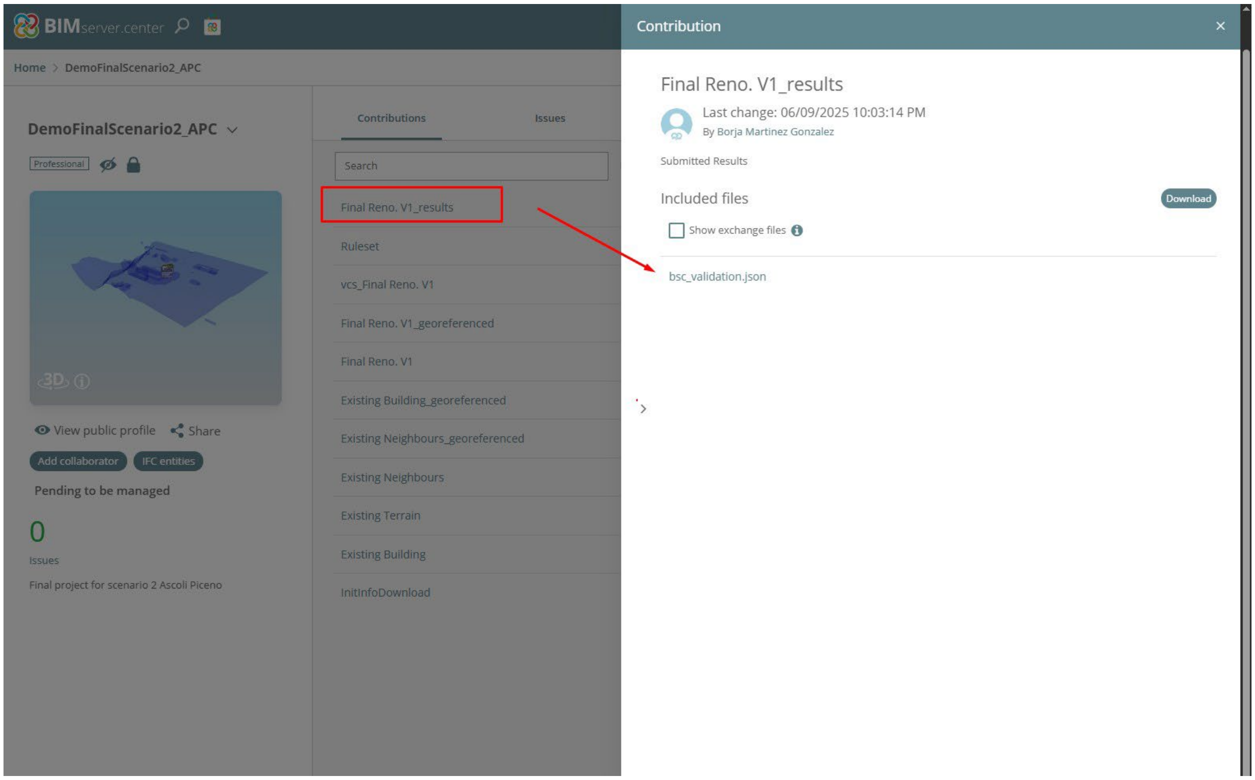


Figure 133 Contribution just created by VCMap automatic

3.4.7 CHEK pre-validation and report – Verifi3D

An attempt was made to perform model pre-validation using the Verifi3D tool from the Designer role, following the same procedure applied in previous CHEK project scenarios.

A new project was created in Verifi3D and linked to BIMserver.center to access the corresponding contributions. Two versions of the model were uploaded: an initial version and a second one with a suspended ceiling added, aiming to trigger the predefined rules related to minimum ceiling height.

However, in both cases, the rule execution produced no results. No errors, warnings, or reports were generated, which is attributed to the absence of the minimum conditions required in the model or limitations in the configuration of the rules within the tool.

As a result, no report was generated or submitted from Verifi3D for this demonstration. This outcome highlights the need to review the operational scope and sensitivity of the implemented rules when applied to real-world renovation cases.

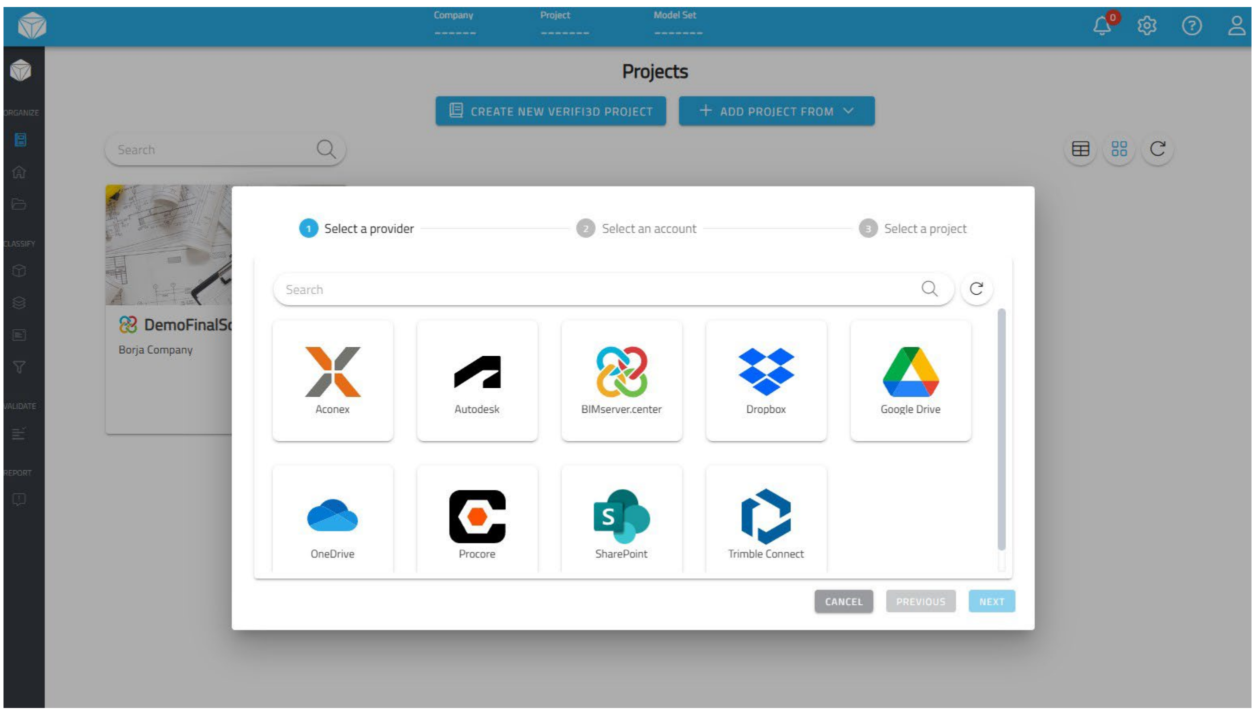


Figure 134 Connecting the just created project to the CDE

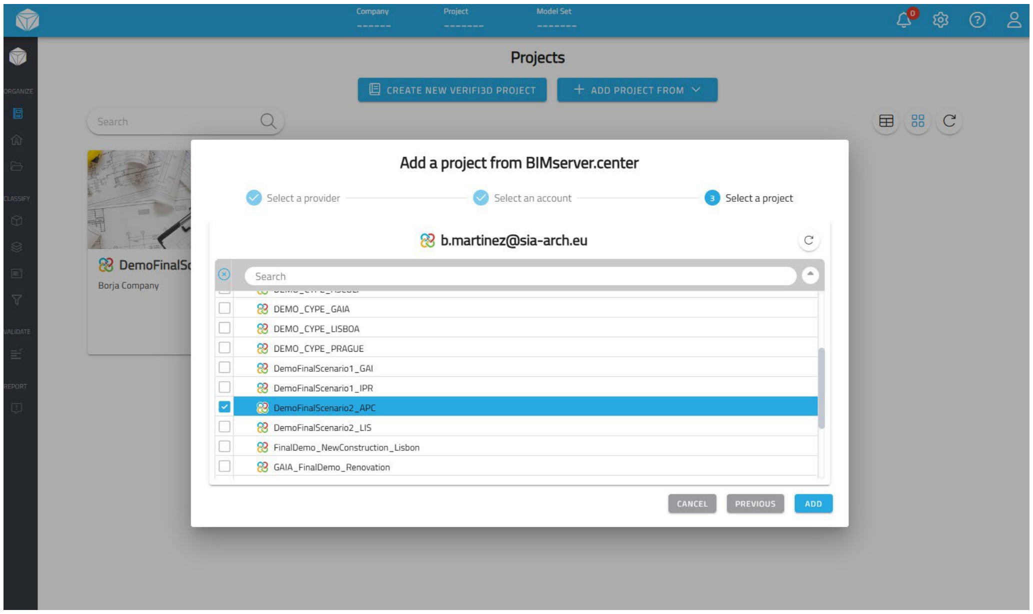


Figure 135 Exploring existing projects in the CDE, to select the APC Scenario 2 one

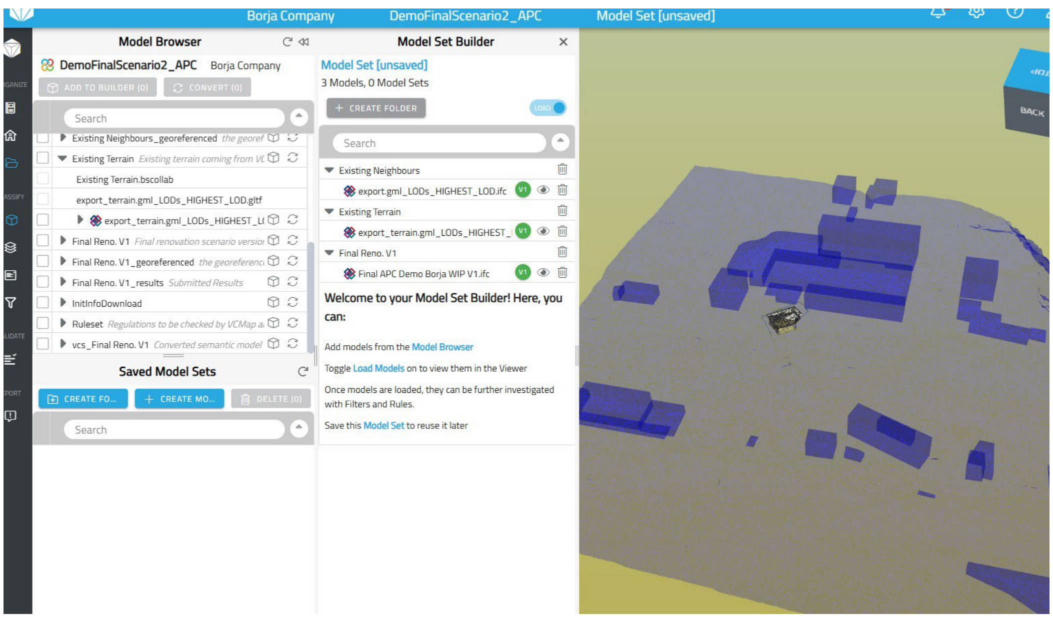


Figure 136 Federation of all geometrical contributions excepting the existing building

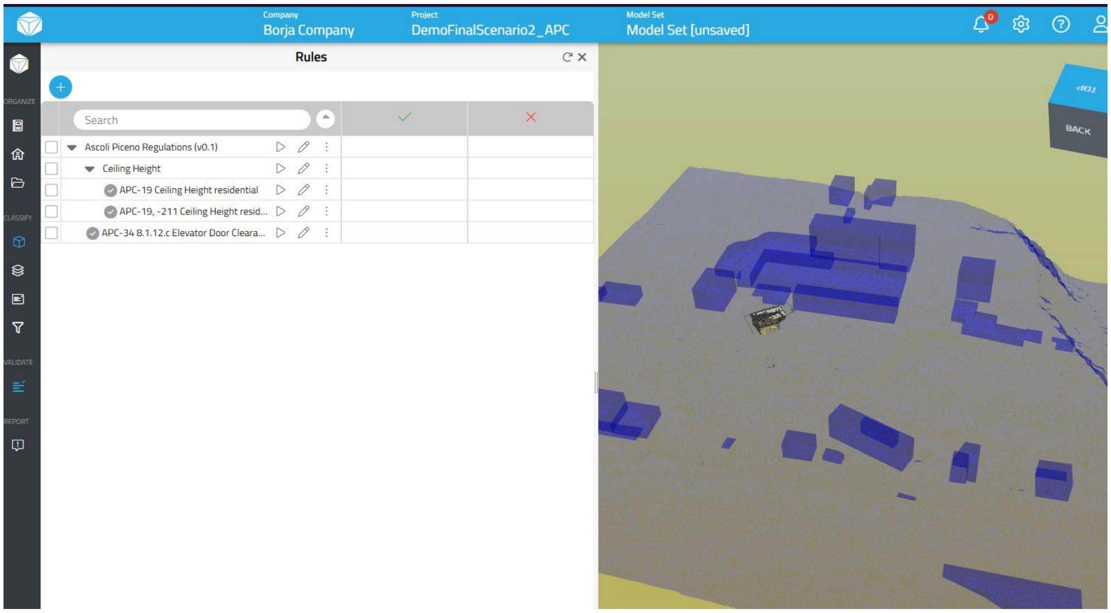


Figure 137 Loaded Ruleset ready to perform assessments

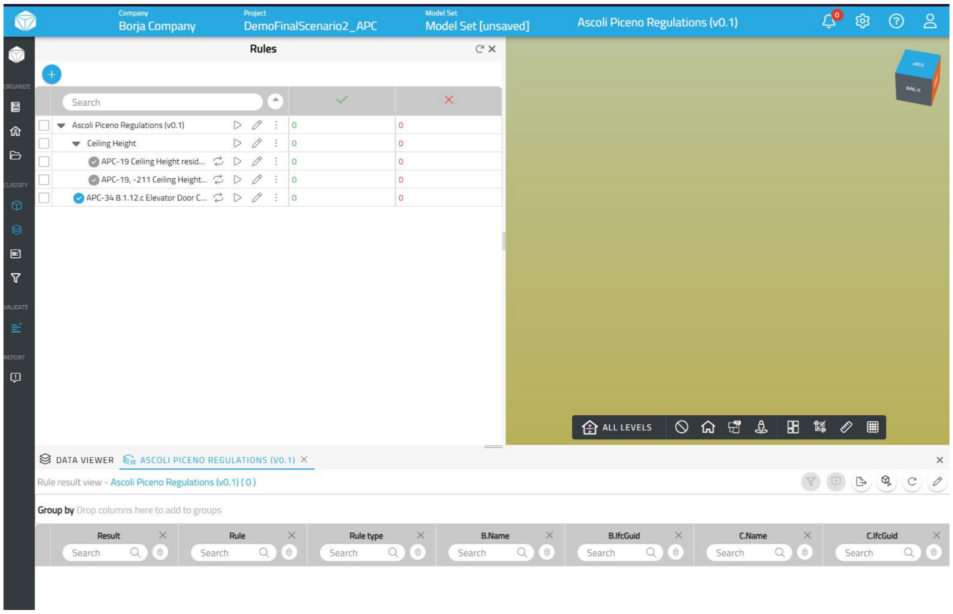


Figure 138 No results in appearance. After project was edited, the same result was shown.

3.4.8 Digital Signature – DiStellar

After completing the relevant validations, the IFC file corresponding to the final version of the model was digitally signed using the DiStellar tool, without any issues.

The signature was applied to the second version of the model, which included a suspended ceiling and had passed the urban compliance validation in VCMap. The signed file was then uploaded as the final contribution to the BIMserver.center platform, making it available for municipal review (Loging in as designer!).

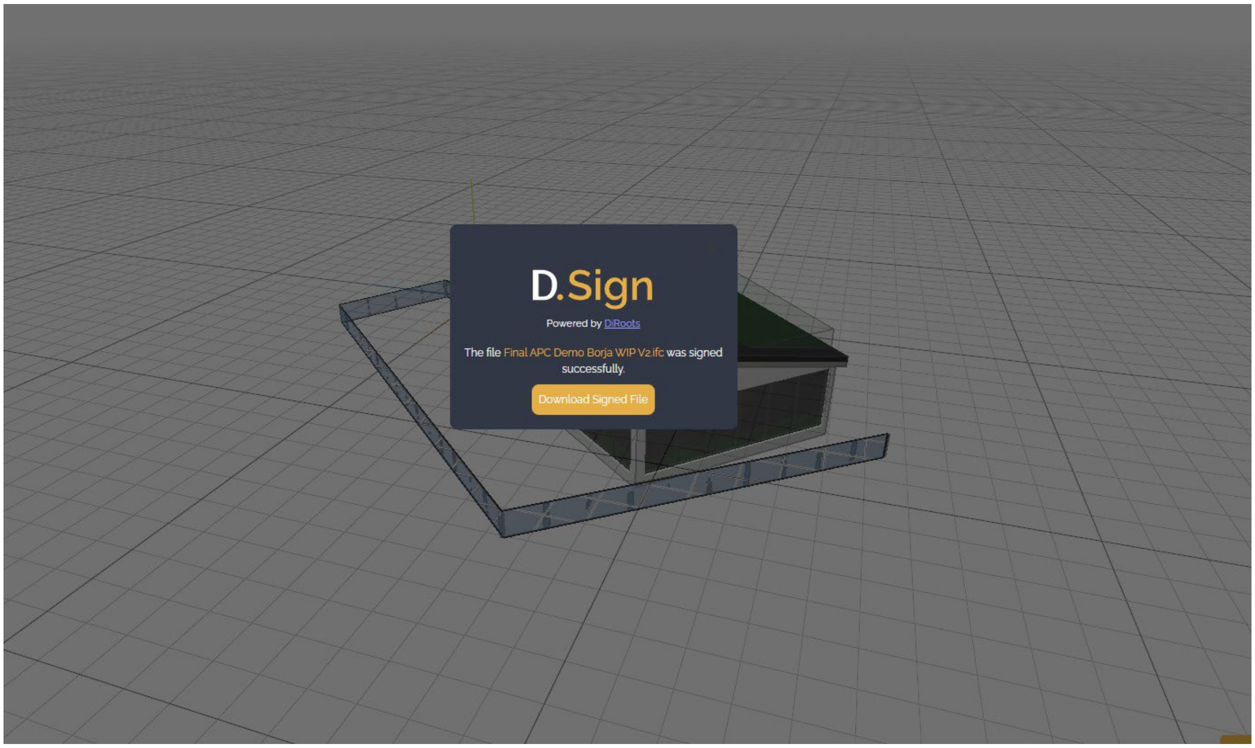


Figure 139 Signing performed with DiStellar/Evrotrust

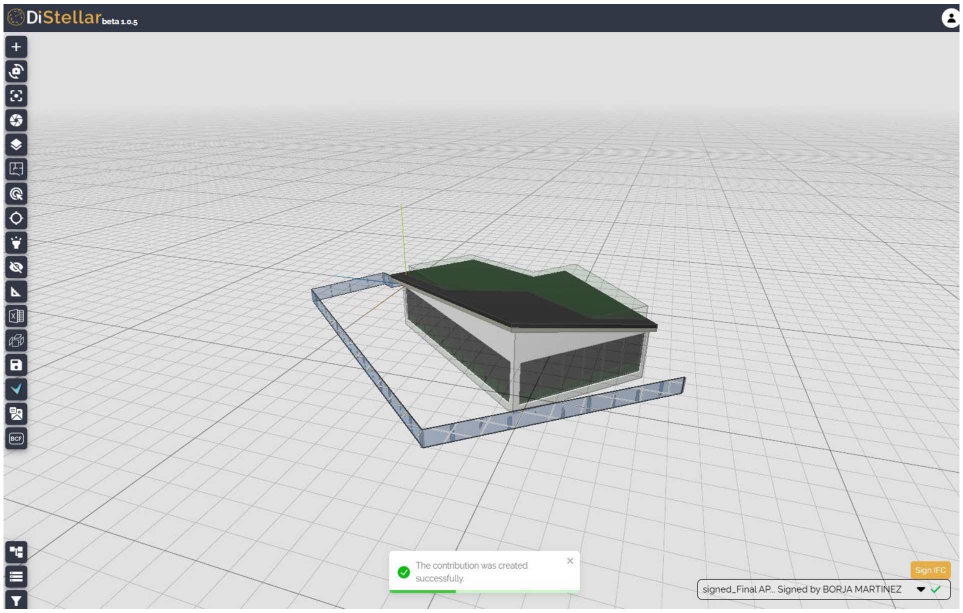


Figure 140 Message indicating the creation of the contribution within the CDE

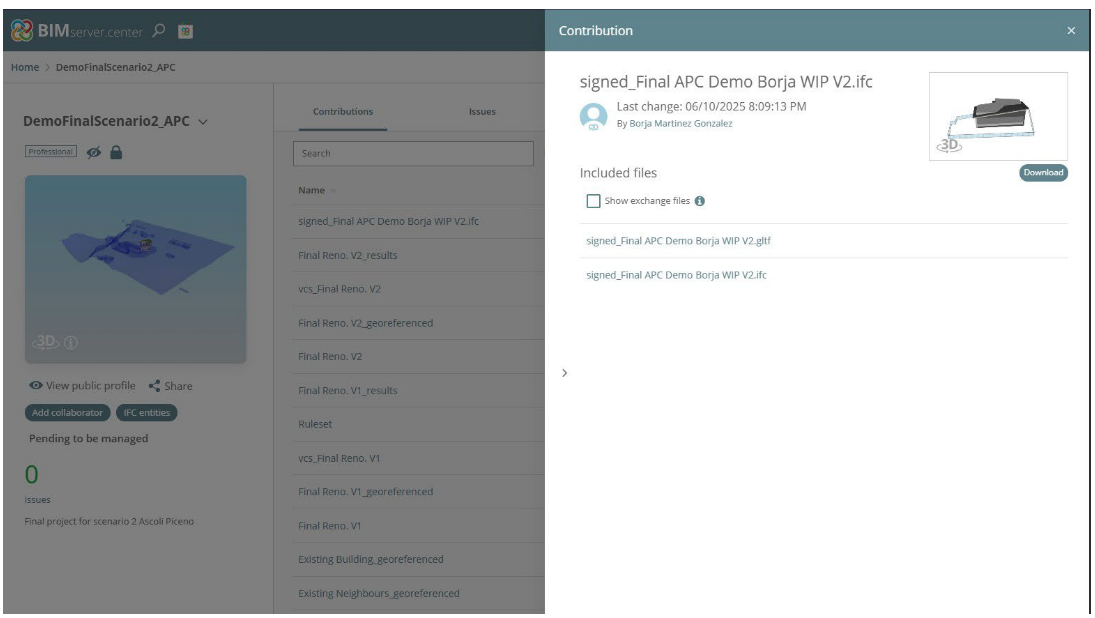


Figure 141 Assessment of the contribution containing the signed file

3.4.9 CHEK permitting tools. Municipality side, using tool [To determine]

After completion of the designer's workflow, the Municipality of Ascoli Piceno received automatically a Request for Review of the submitted results check.

Inputs:

- Digitally signed IFC model
- Validation report / check results from VCMap
- Validation report / check results from Verifi3D
- Contribution files in BIMserver.center

Outputs:

- Validation / Review result by IPR Prague

Process description:

- As designers completed the checks and shared the results, the APC team:
  - started evaluating the validation reports / check results along with
  - Performing checks by themselves using the Verifi3D and
  - Performing checks in VCMap application

- During the validation/checking activities, APC team reported some issues using the checking applications that were communicated with software vendors. The results of the checks performed were documented in a standardized format.

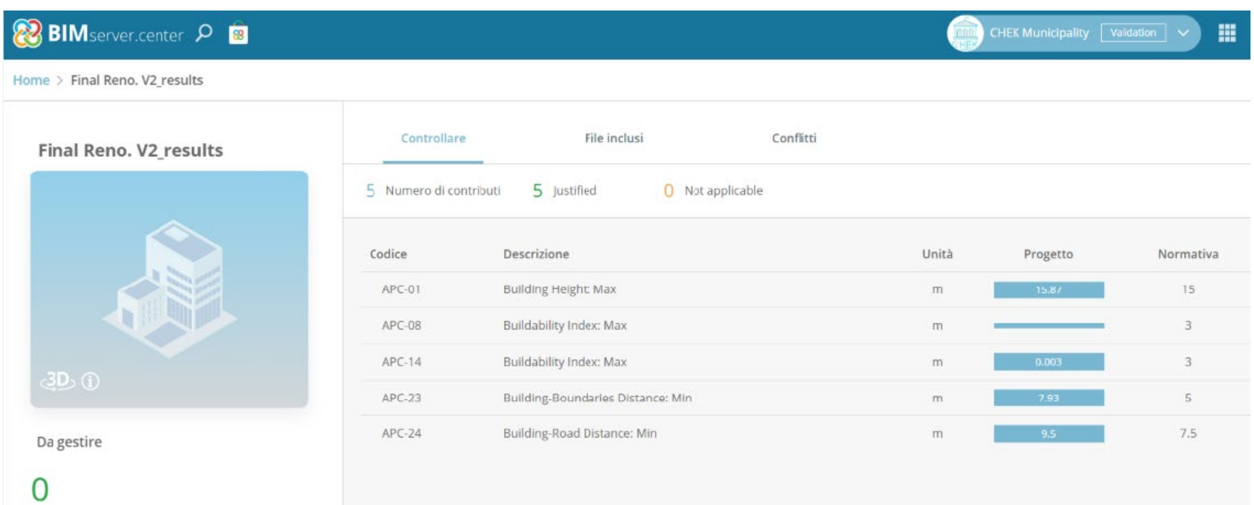


Figure 142 Municipality account in BSC

- In Verifi3D, from 3 available checks, 2 were not applicable for the Renovation scenario, the remaining 1 was successful.

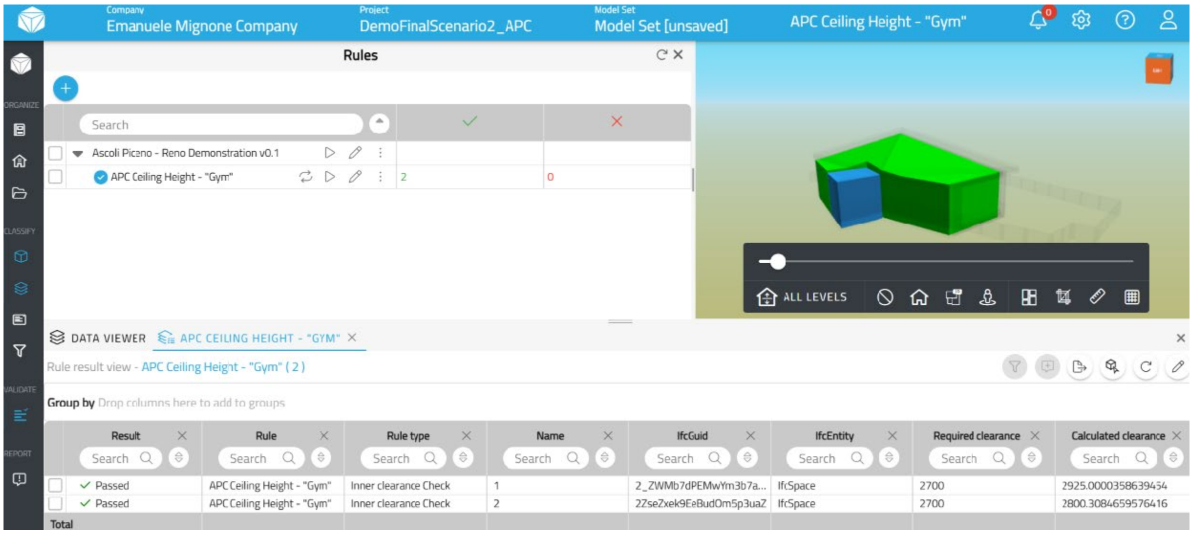


Figure 143 Verifi3D results check

- In VCMap, from 5 available checks, 1 was not applicable for the Renovation scenario, 1 failed and the remaining 4 were successful.

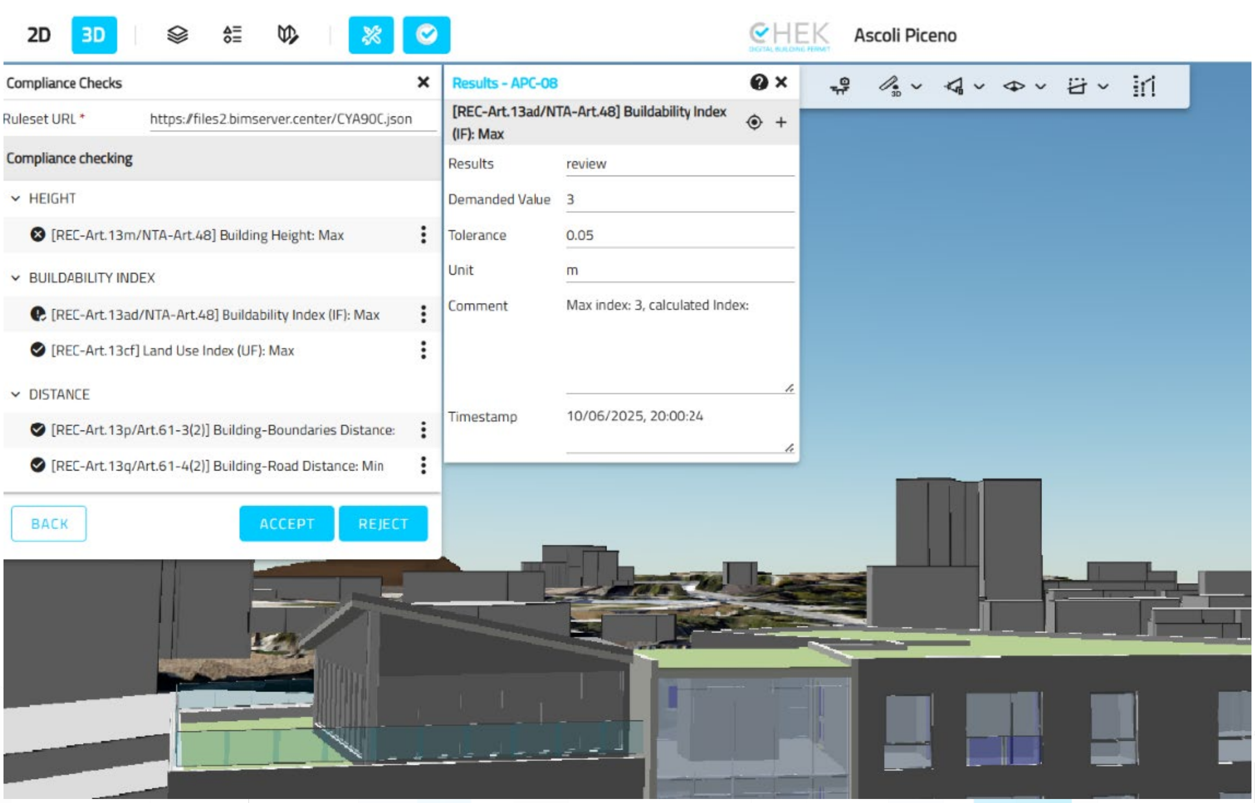


Figure 144 VCMap results check

Conclusion

The APC Renovation Scenario successfully demonstrated the practical application and usefulness of the CHEK digital toolkit in the digital permitting context. The scenario showed that the proposed CHEK DBP workflow is viable, collaboration between the shareholders was achieved, the model was checked against the regulations, and time allocation of the processes was reduced. The tools were user friendly, comprehensive and contributed greatly to the designers and the municipalities processes. During the demonstration, some errors or issues were noticed and communicated further. Some of them were successfully resolved or bypassed, some stayed, but none of them had an adverse impact on the demonstration. Overall, the APC Renovation Scenario provided strong evidence of the potential for digitally enabled, rule-based permit workflows to streamline renovation permitting processes across European cities.

4. Conclusion

The implementation of the pilot scenario under Scenario 2 – Building Renovation, as documented in this deliverable, has provided strong evidence supporting the CHEK project's mission to provide digital toolkit that will support municipalities in introducing digital building permits. Work Package 6 activities, particularly D6.2 and 6.3 demonstrated that provided tools are:

- feasible
- supporting unified digital workflow
- based on open standards that connects renovation-specific planning constraints with BIM design and its automated validation by municipalities.

In the final instance, all these tools are enabling automated validation of the BIM models by municipalities.

Demonstration also tested the applicability of the provided tools in:

- Two different scenarios of New construction and renovation involving
- Four different building types: private house, Multistory Residential building, Mix-use building and primary School in
- Three different countries jurisdiction: Portugal, Italy, Czech Republic and
- Four different local building requirements (Vila Nova de Gaia, Ascoli Piceno, Lisbon and Prague)

During demonstration period, designers noticed certain software limitations that were hindering the demonstration results. These limitations were further communicated with the authors/.software companies and were later solved. Designers also gave their feedback to the software companies that may be useful in future developments. Being able to unify such a different set of digital tools (desktop and web apps) in one DBP workflow, speaks about the importance of the open standards, interoperability, API's etc.

Even though not explicitly mentioned, the pilot demonstrations indirectly tested the practical applicability of digital technologies (BIM, GIS) and standards like IFC, CityGML etc. The results were successful, meaning these technologies and standards are mature enough to support the digital building permits applications.

The demonstration pilot successfully demonstrated that a coherent and traceable process of design, rule-checking, and digital signature can be established in the context of building renovation, despite the added complexity of working with existing structures. The approach was validated in diverse urban contexts, showing its flexibility in adapting to varying technical, regulatory, and municipal environments.

4.1 Tools in use

The renovation scenario was executed using the CHEK provided software application. Each CHEK application had a unique purpose and role in the CHEK demonstration workflow. In the table below, each tool's performance is described in detail:

- CHEK DBP Platform (based on BIMserver.center by CYPE)
    - Purpose:
        - Served as the Common Data Environment (CDE) and orchestration hub for the entire digital permitting demonstration process.
    - Functionality:
        - Hosts projects and connects tools across the CHEK ecosystem.
        - Manages data exchange between designers and municipal authorities.
        - Tracks the status of submitted models and compliance reports.
    - Benefits:
        - Centralized and structured digital collaboration.
        - Transparency and traceability in all permit stages.
        - Supports secure and interoperable workflows via openBIM standards.
    - Conclusion:
        - In a nutshell, among many benefits, CHEK DBP Platform enabled the single flow process, where input and output files were gathered in one place. Serving as a connection hub for applications and project participants, the app proved to be real timesaver.
        - Its 3d viewer functionality served for reviewing the models too.

- VCMap Plugin (by Virtual City Systems)
    - Purpose:
        - Enabled urban context integration and automated planning regulation checks.
    - Functionality:
        - Visualizes 2D/3D geospatial data and 3D city models (CityGML, CityJSON, etc.).
        - Extracts surrounding building data and terrain models for design reference.
        - Performs rule-based compliance checks (e.g., setbacks, height limits).
        - Sends validation results back to the DBP platform.
    - Benefits:
        - Seamless integration of urban planning data into BIM workflows.
        - Early detection of non-conformities with local urban codes.
        - Increases planning transparency and spatial awareness.
    - Conclusion:
        - From designers' perspective, VCMap offers valuable 3D exploration of the spatial context in which the model will be built. The surrounding buildings, terrain, roads, trees etc can be extracted for further use in BIM authoring tools. This input is of great importance for the design process.

        - On a checking side, VCMap offered selfcheck performed by the designers as well as final check after which the results were shared with the municipalities via the CHEK DBP platform based on BIMserver.center. Possibility to perform selfcheck, saved tremendously the design time.

- CityGML to IFC Converter (by RDF Ltd.)

    - Purpose: Transformed city model data collected from VCMap into IFC format for use in Autodesk Revit, as BIM authoring tools of choice.
    - Functionality:
        - Converts 3D city objects (e.g., buildings, terrain) from CityGML into structured IFC entities.
        - Supports geometry, semantic attributes, and classification mappings.
    - Benefits:
        - Enables use of real-world surroundings in BIM authoring.
        - Bridges GIS-to-BIM interoperability for regulation-aware design.
        - Accelerates site model preparation for permit applications.
    - Conclusion:
        - CityGMLtoIFC converter is important in the design process because it converts GIS data (in CityGML and CityJson file formats) into BIM file format of IFC. This conversion enables designers to use the input data from VCMap into BIM authoring tools.

- IFC Exporter (by DiRoots)

    - Purpose:
        - Assisted designers in exporting BIM models to valid, standardized IFC files.
    - Functionality:
        - Generates clean and semantically correct IFC models from authoring tools (e.g., Revit).
        - Supports mapping of properties and classifications (e.g., Uniclass 2015).
    - Benefits:
        - Ensures consistent IFC outputs needed for automatic validation.
        - Reduces manual errors and mismatches in the compliance workflow.
        - Facilitates openBIM data delivery for permits.
    - Conclusion:
        - DiRoots's IFCExporter plugin greatly simplified the IFC parameter mapping process in Revit, so Designers could easily map the IDS needed parameters with those already provided in the Revit model.

- IfcGref (by TU Delft – Geomatics Group)
    - Purpose:
        - Verified the georeferencing quality of IFC models.
    - Functionality:
        - Checks the spatial positioning and coordinate systems of BIM models.
        - Ensures alignment with local cadastral, city model, or planning coordinate systems.
    - Benefits:
        - Critical for reliable placement of BIM within 3D city contexts.
        - Ensures spatial validity required for distance-based regulation checks.
        - Supports accurate cross-tool data exchange.
    - Conclusion:
        - IfcGref is a very convenient tool for designers to check if their BIM model is properly georeferenced. Moreover, the option to visually check the position of the model on map gives the designers confidence that the model will be used correctly in any GeoBIM application.

- IFCEngine (by RDF Ltd.)
    - Purpose:
        - Validated the structural integrity and rule conformance of IFC files.
    - Functionality:
        - Validates IFC syntax against the official EXPRESS schema.
        - Supports IDS (Information Delivery Specification) validation for use-case-specific requirements.
    - Benefits:
        - Prevents submission of invalid or incomplete models.
        - Helps maintain data quality and compliance with regulation-specific datasets.
        - Facilitates automation by ensuring standardized input.
    - Conclusion:
        - IfcEngine validated the IFC file against the IFC EXPRESS schema as well as against the plot specific IDS data requirements. This validation was performed as a self-check by the designers. The validation checks reported some errors that were reported to the software vendor.

- CypeUrban (by CYPE Software)
    - Purpose:
        - Self-check tool for designers to verify compliance with planning/building rules.
    - Functionality:
        - Provides a visual environment to simulate urban conditions and design parameters.
        - Runs rule-based validations directly within the tool using IFC or linked files.

- Benefits:
  - Allows designers to catch issues before submission to municipalities.
  - Promotes design responsibility and quality.
  - Reduces rejection rate and revision cycles.
- Conclusion:
  - Cypeurban gives great flexibility when checking

- Verifi3D (by Xinaps)

  - Purpose:
    - Advanced rule-checking engine for regulatory compliance.
  - Functionality:
    - Applies configurable rulesets to IFC models to validate conformity with building codes.
    - Offers a modern interface with 3D visualization of results.
  - Benefits:
    - Automates parts of the compliance process.
    - Saves time for both designers and municipal reviewers.
    - Ensures consistency in application of codes and enhances transparency.
  - Conclusion:
    - DiRoots's IFCExporter plugin greatly simplifies the IFC parameter mapping process in Revit, so Designers can easily map the IDS needed parameters with those already provided in the Revit model.

- DiStellar Plugin (by DiRoots)

  - Purpose:
    - Provides digital signature capability for BIM/IFC models.
  - Functionality:
    - Applies digital cryptographic signatures to IFC files.
    - Ensures authenticity, integrity, and non-repudiation of models at submission.
  - Benefits:
    - Aligns with legal requirements for official document submission.
    - Guarantees model provenance and authorship.
    - Adds legal accountability to digital processes.
  - Conclusion:
    - DiRoots's IFCExporter plugin greatly simplifies the IFC parameter mapping process in Revit, so Designers can easily map the IDS needed parameters with those already provided in the Revit model.

5. ANNEX I. Detailed List of Regulations Implemented in Renovation Scenario

Vilanova De Gaia – CYPEURBAN

Table 1 – Implemented regulations for GAIA by CYPEURBAN

Assessment	Articles	Rule Identifier
Plot - Area	[PDM-Art.38] Minimum Plot Area	GAIA-07
Building - Number of floors	[RMUE Gaia - Art. 44] Maximum number of floors above level	GAIA-02-01
Max- Plot Fence height	[RMUE - Art.44] Maximum Height of plot fencing	GAIA- 03-01
Building - Size	[PDM Art. 43] Buildable depth	GAIA-11-01, GAIA-11-02, GAIA-11-03
Building - Distance	[RMUE - Art 36] Minimum distance between buildings of the same plot	GAIA-12-10
Building - Front Setback	[PDM - Art. 42] Minimum setback of the building to the front of the plot	GAIA-08
Building - Setback	[RMUE - Art 36] Minimum setback of the building to plot boundaries (general)	GAIA-12-04/GAIA-12-05
Building - Index coefficient	[PDM - Art 66b] Maximum occupancy coefficient of floors above ground level	GAIA-04
Building - Index coefficient	[PDM - Art 66b] Maximum occupancy coefficient of floors below ground level	GAIA-04
Building - Buildability	[PDM -Art 66, 73,82] Maximum buildable area of the net plot	GAIA-05
Building - Dwellings	[RGEU - Art. 66] Minimum net floor area of the rooms	GAIA-13
Car Park - Number of Spaces	[PDM Art. 122] Number of parking spaces depending on computable built area	GAIA-09

Vilanova De Gaia – VCMAP

Table 2 – Implemented regulations for GAIA by VCMAP

Assessment	Articles	Rule Identifier
Height	[PDM-Art.41-1] Building Height: Max	GAIA-01-01
Buildability Index	[PDM-Art.66b] Gross Buildability Index: Max	GAIA-04, GAIA-05
Buildability Index	[PDM-Art.38] Implantation Area: Max	GAIA-07
Distance	[RMUE-Art.36b] Building-Boundaries Distance: Min	GAIA-12-04
Distance	[RMUE-Art.36c] Building-Boundaries Distance: Min	GAIA-12-05

Lisbon – CYPEURBAN

Table 3 – Implemented regulations for LISBON by CYPEURBAN

Assessment	Articles	Rule Identifier
Building - Number of floors	[PUALZE - Art. 17P2(c) (c1)] Maximum number of floors depending on the adjacent buildings	LIS-02-01
Building - Maximum Heights	[PUALZE - Art. 17P2] Total maximum height depending on adjacent buildings	LIS-04-01
Building - Maximum Heights	[PUALZE Article 17 (d)] Maximum facade height depending on adjacent buildings	LIS-04-01
Building - Floor Heights	[(1) RGEU, Article 65, P 1, 2, 3 ,4 (2) RMUEL Article 45 P1.)] Minimum floor height of the ground floor.	
Building - Floor Heights	[RGEU, Article 65, P 1, 2, 3,4] Minimum floor height of the floor	
Building - Floor Heights	[RGEU, Article 65, P 1, 2, 3,4] Height of floor below ground level	
Building - Floor Heights	[RGEU, Article 65, P 1, 2, 3,4] Minimum free height of a floor	
Building - Floor Heights	[RGEU, Article 65, P 1, 2, 3,4] Minimum free height of ground floor	
Building - Floor Heights	[REMUEL 34] Minimum free height of mezzanine floor	
Building - Floor Heights	[RGEU - Art. 77] Minimum free height of basement and semi-basement	
Building - Setback	[] Minimum setback of the building to plot boundaries (general)	
Building - Overhangs	[RMUEL - Art. 46p1a] General maximum overhang	LIS-09-02
Building - Overhangs	[RMUEL - Art. 46p1a] Minimum overhang height	LIS-09-01
Building - Dwellings	[RGEU - Art. 66] Minimum net floor area of the rooms	LIS

Lisbon – VCMAP

Table 4 – Implemented regulations for LISBON by VCMAP

Assessment	Articles	Rule Identifier
Height	[RGEU-Art.I-5/RPDML-Art.42.3] Building Height: Max	GAIA-LIS-01/LIS-01
Buildability Index	[RPDML - Art. -Art.38-1/Art.46-4c] Buildability Index: Max	LIS-05, LIS-06
Distance	[RMUAL - Art.46-1b] Building-Sidewalk Distance: Min	LIS-10

Prague – VERIFI3D

Table 5 – Implemented regulations for PRAGUE by VERIFI3D

Assessment	Articles	Rule Identifier
Buildability Index	[Annex 1_Urban Plan] Buildability Index	IPR-05, -09 -
Buildability Index	[Annex 1_Urban Plan] Land Index	IPR-05, -09 -
Height	[Art. 12m_PSP2018 - Art. 44 (2)_PSP2018 - Art. 44 (4)_PSP2018] Ceiling Height	IPR-11, -14, -15
Building - Occupancy	[Art. 3, paragraph 1] Room Area per pupil	IPR-19, -20
Distance	[Art.28 (1)_PSP2018 - Annex 1_PSP2018] Distance to Existing Buildings	IPR-31, -34
Distance	[Annex 1(3)_PSP2018] Elevator Entry Clearance	IPR-39-01

Prague – VCMAP

Table 6 – Implemented regulations for PRAGUE by VCMAP

Assessment	Articles	Rule Identifier
Height	[UP-Art.27-1/25-2] Building Height: Max	IPR-01, IPR-03
Buildability Index	[UP-Sec7-Art.7a-5] Land Index: Max	IPR-05, IPR-07, IPR-09
Distance	[PSP-Art.29] Building-Boundaries Distance: Min	IPR-33

Ascoli Piceno – VERIFI3D

Table 7 – Implemented regulations for ASCOLI PICENO by VERIFI3D

Assessment	Articles	Rule Identifier
Ceiling Height residential	[Art.3_DM 75 5 luglio 1975] APC-19	APC-19
Ceiling Height residential, red height	[Art.1_DM 75 5 luglio 1975] APC-19 -211	APC-19 -211
Elevator Door Clearance	APC-34 8,1,12,c	APC-34 8,1,12,c

Ascoli Piceno – VCMAP

Table 8 – Implemented regulations for ASCOLI PICENO by VERIFI3D

Assessment	Articles	Rule Identifier
Height	[REC-Art.13m/NTA-Art.48] Building Height: Max	APC-01, APC-03, APC-05
Buildability Index	[REC-Art.13ad/NTA-Art.48] Territorial Buildability Index: Max	APC-08, APC-09, APC-10
Buildability Index	[REC-Art.13cf] Gross Area Index: Max	APC-14
Distance	[REC-Art.13p/Art.61-3(2)] Building-Boundaries Distance: Min	APC-23
Distance	[REC-Art.13q/Art.61-4(2)] Building-Road Distance: Min	APC-24

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List of used abbreviations

DoA	-	Description of the Action
EC	-	European Commission
EU	-	European Union
GA	-	Grant Agreement
WP	-	Work Package
WPL	-	Work Package Leader
BIM	-	Building Information Modelling
GIS	-	Geographic Information System
TUD	-	Delft University of Technology
CDE	-	Common Data Environment
DTM	-	Digital Terrain Model
BSC	-	BIMserver.center
VCS	-	Virtual City Systems
APC	-	Municipality of Ascoli Piceno
IPR	-	Prague Institute of Planning and Development
GAIA	-	GaiURB, Vila nova de Gaia
SIA	-	SIA.Architects (Designer company)
ZWE	-	ZWEI (Designer company)
T	-	Task