CHRONICLE

Building Performance Digitalisation and Dynamic Logbooks for Future Value-Driven Services

Deliverable 4.2 Enhanced Building Performance Assessment tool and user-friendly UIs

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Disclaimer

Executive Summary

The present public deliverable "*D4.2 Enhanced Building Performance Assessment tool and user-friendly UIs*" offers a detailed description of three User Interfaces (UIs), along with the testbed pilot in Greece used as a common case study.

The three UIs are: (i) *ChroViewFM*, related to the 3D BIM tool interfaces for Facility Managers and the AECO (Architecture, Engineering, Construction, and Operations) sector; (ii) *ChroViewOcc*, a mobile app designed for homeowners and tenants; and (iii) *ChroViewPlus*, a dashboard for ESCOs and other professionals seeking insights into building operations. Each of the three UIs is covered in a dedicated section (sections 3, 4 and 5) including a functionality overview, user needs, technical description, and a final demonstration featuring a use case walkthrough.

Finally, the conclusions and further developments section provides the summary of the main development of the task along with the next steps to deliver the CHRONICLE solution.

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ABBREVIATIONS

Abbreviation	Definition
AC	Air Conditioning
AECO	Architecture, Engineering, Construction, and Operations
API	Application Programming Interface
BIM	Building Information Model
BRP	Building Renovation Passport
CDE	Common Data Environment
CSS	Cascading Style Sheets
DBL	Digital Building Logbook
EC	European Commission
EPC	Energy Performance Certificate
ESCO	Energy Service Company
FM	Facility Manager
FPS	Frames per Second
HTML	Hypertext Markup Language
HVAC	Heating, Ventilation and Air-Conditioning
IAQ	Indoor Air Quality
IFC	Industry Foundation Classes
IoT	Internet of Things
KPI	Key Performance Indicator
LC	Life Cycle
MVP	Minimum Viable Product
MIT	Massachusetts Institute of Technology (refers to the licence)
SRI	Smart Readiness Indicator
TRL	Technology Readiness Levels
UC	Use Case
UI	User Interface
WP	Work Package

1 Introduction

This deliverable demonstrates the project results related to "*Task 4.2 Enhanced Building Performance Assessment*". The task covers the development of user-friendly interfaces alongside the backend services involved. Three individual UIs have been designed and tailored for different stakeholder' groups: AECO, Facility Managers, homeowners, occupants and ESCOs

The UIs provide a wide range of capabilities; such as performance benchmarking, building operations monitoring and BIM. The key outcomes include:

- **ChroViewFM:** 3D interface for Facility Managers and AECO stakeholders, enabling mesh-based (OBJ/FBX) transformation of BIM models for enhanced 3D visualisation.
- **ChroViewOcc:** Mobile applications for homeowners and tenants, providing insights into comfort, well-being, and energy performance.
- **ChroViewPlus:** Dashboard for ESCOs and technical stakeholders for building operations insights. It enables near real-time and offers expert recommendations and in-depth insights to effectively reduce energy consumption.

Finally, the UIs delivered in this task will serve as the co-creation in Living Lab workshops (T6.2), contributing to the CHRONICLE MVPs.

1.1 Scope and Objectives

The objective of this task comprises the design, development, and deployment of three key UI solutions that will enhance building assessment. Therefore, "*D4.2 Enhanced Building Performance Assessment tool and user-friendly UIs"* includes a detailed description and a practical demonstration with the testbed located in Greece of all UIs. The primary objectives of this task are:

- **Implementation of the Use Cases** defined in WP2 addressing requirements from stakeholders.
- **Develop intuitive UIs** tailored to the needs of diverse user groups (e.g., facility managers, homeowners and ESCOs).
- **Demonstration** with common case study across all UIs to ensure consistency and ensure the tools are part of the final solution.
- **Facilitate stakeholder engagement and co-creation** through mock-ups, functional prototypes, and Living Lab workshops in WP6.

1.2 Relationship with other tasks

The development of the "*Enhanced Building Performance Assessment Tool and user-friendly UIs*", primarily depends on the performance metrics defined in WP2, along with the tools and engines developed in "*WP3 (Digital Twins and Common Data Model)"*. Also, the implementation and installation of devices coming from task 5.1 is essential to deliver the final tools of CHRONICLE. Figure 1 shows a chart mapping those tasks and their interdependencies.

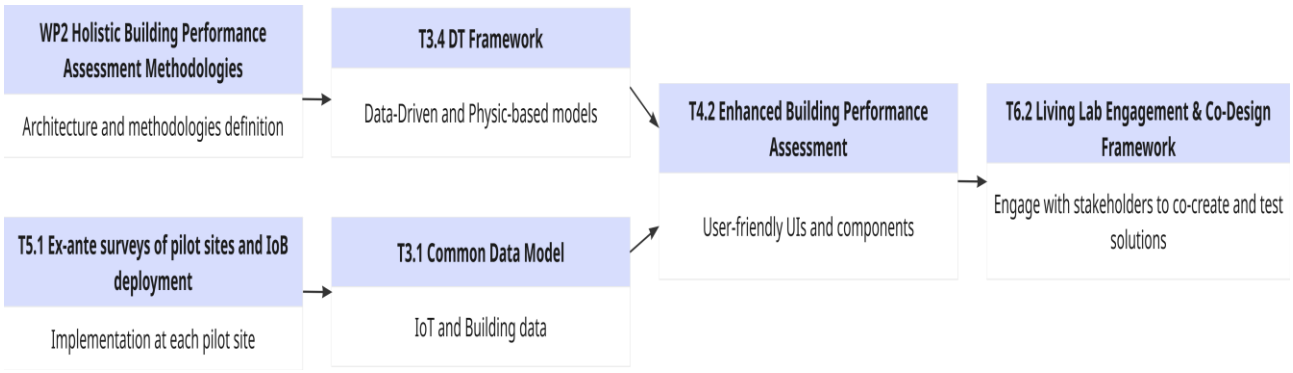


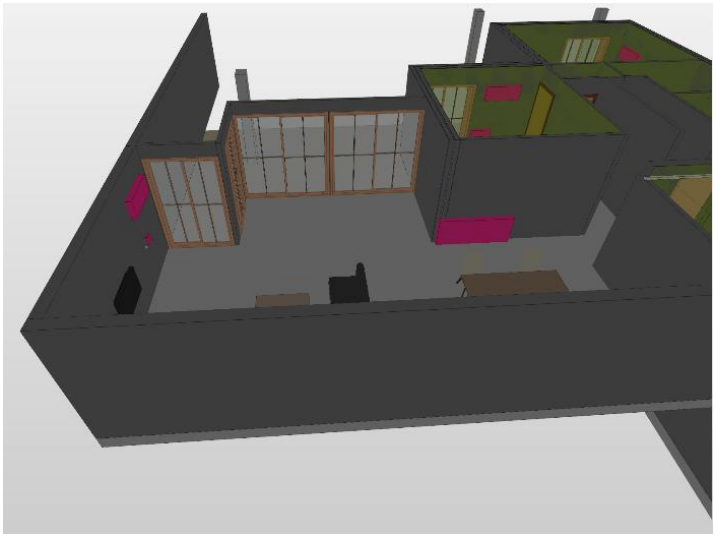
Figure 1. Tasks interdependencies

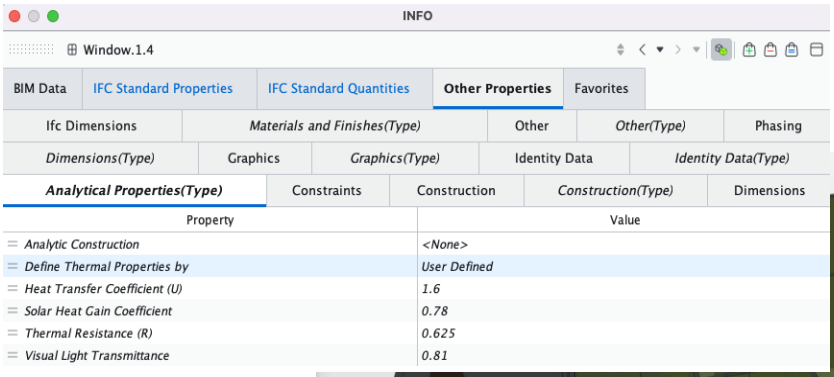
2 Case Study Description

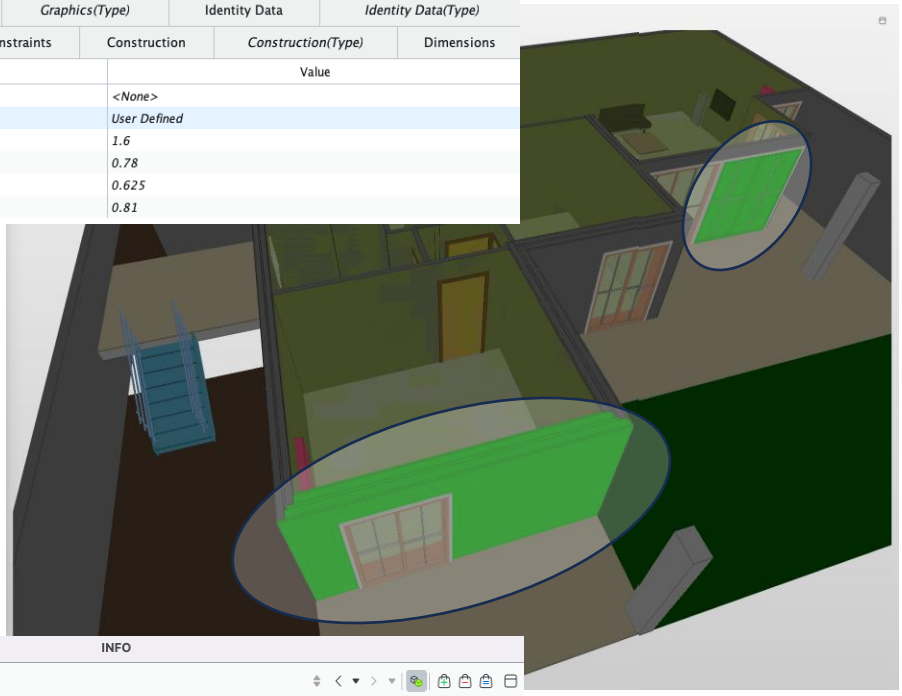
All the developed UIs within task 4.2 are showcased through a common practical use case walkthrough.

The testbed pilot is located in Athens, Greece. It's a residential apartment consisting of two floors and built in 1987 with a further renovation in 2022. The systems include electric water heating, solar thermal heater, AC split units and gas boiler for heating. Regarding IoT equipment; there are energy meters, smart plugs, multisensor devices and IAQ (Indoor Air Quality) sensors. Furthermore, this pilot provided a BIM file with information on the building geometry, structural details and building fabrics. Figure 2 on the following page depicts the 3D representation of the testbed pilot we are using for this demonstration.

The use of a shared case study based on real-world data from this pilot, enabled us to showcase the distinct interfaces in a realistic environment, demonstrating the practical relevance and utility. Each interface successfully collects specific data from the testbed and provides valuable insights into buildings performance across a variety of scenarios as described in the next sections.







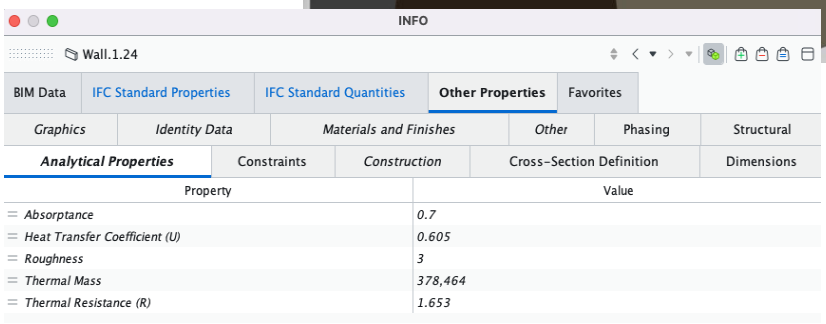


Figure 2. Case Study: Hypertech's Testbed, Greece

3 User Interface 1: ChroViewFM for AECO/FM Professionals

3.1 Functionality Overview

The ChroViewFM is a web-based tool that integrates BIM models and combines three-dimensional (3D) visualization with near-real-time monitoring of building data from smart equipment, including energy consumption, environmental conditions, and key performance indicators such as costs, CO_2 emissions, and indoor air quality. Its user-friendly interface allows users - such as facility managers, architects and BIM modelers - to upload and explore IFC files, track energy usage and comfort levels, and receive notifications for maintenance and unexpected equipment behaviour.

3.2 Discussion of User Needs and Cases addressed

Table 1 below presents the coverage of functional requirements introduced in "*D2.1 - CHRONICLE Business requirements, Use cases & System architecture*"

ID	Title	Description	Priority	Coverage
FR-16	ChroViewFM integration with the CDE	The ChroViewFM should be integrated with the CDE for data exchange	High	Completed
FR-17	ChroViewFM Document upload	The ChroViewFM should allow users to upload documents	High	Completed
FR-18	ChroViewFM Document search	The ChroViewFM should allow the user to search for specific documents to be visualized	High	Completed
FR-19	ChroViewFM KPIs retrieve and display	The ChroViewFM should be able to retrieve from the CDE and display the requested-by-the-user KPIs	High	Completed
FR-20	ChroViewFM IFC display options	The ChroViewFM should be able to visualise the IFC elements in a tree-view style and allow for individual element selection	High	Completed
FR-21	ChroViewFM 3D visualization	The ChroViewFM should allow the 3D visualization of the building geometry for the investigated IFC scenario	High	Completed
FR-22	Predictive and Preventive maintenance notifications	The ChroViewFM should inform the user if planned maintenance activities are upcoming or if an irregular consumption behaviour might be indicating a device malfunction	Moderate	In progress; testbed lacked relevant use case scenarios for maintenance or malfunctions.

Table 1. ChroViewFM: Functional requirement coverage

3.3 Technical Description of Tool Operation

Table 2 outlines the technology stack, corresponding versions, and licenses that form the foundation of ChroViewFM.

Technology/Package name	Version	License
TypeScript	4.7.2	Apache 2.0
Angular	14.2.0	MIT
Angular Material	14.2.0	MIT
Three.js	0.152.2	MIT
OpenBIM Components	1.3.1	MIT
Node.js	18.x	MIT
IfcOpenShell	0.7.0	LGPL-3.0
Tailwind CSS	4.1.3	MIT

Table 2. Technology stack for the ChroViewFM

3.3.1 Backend Architecture and Data Management

ChroViewFM serves as the front-end component of CHRONICLE's Common Data Environment (CDE), retrieving relevant data via its documented APIs. These APIs are detailed in the deliverable "*D3.1 - CHRONICLE Data Model and Common Data Environment*" while the component's input and output data dependencies are outlined in the deliverable "*D2.1 - CHRONICLE Business requirements, Use cases & System architecture*".

ChroViewFM is a web-based application accessible through a browser and access is restricted to authorized users only.

3.4 Demonstration — Practical Use Case Walkthrough

3.4.1 Authentication, user access

Only authorized users can log in, as shown in Figure 3. Depending on their assigned project, different stakeholders have varying access rights to the web application. The authentication system used in ChroViewFM is based on Keycloak, a widely adopted open-source identity and access management solution, enabling secure and flexible user management.

After logging in, users can select a project to view, as displayed in Figure 4. In this example, the user has access to Hypertech's testbed. Projects are distinguishable by their names and/or thumbnails.

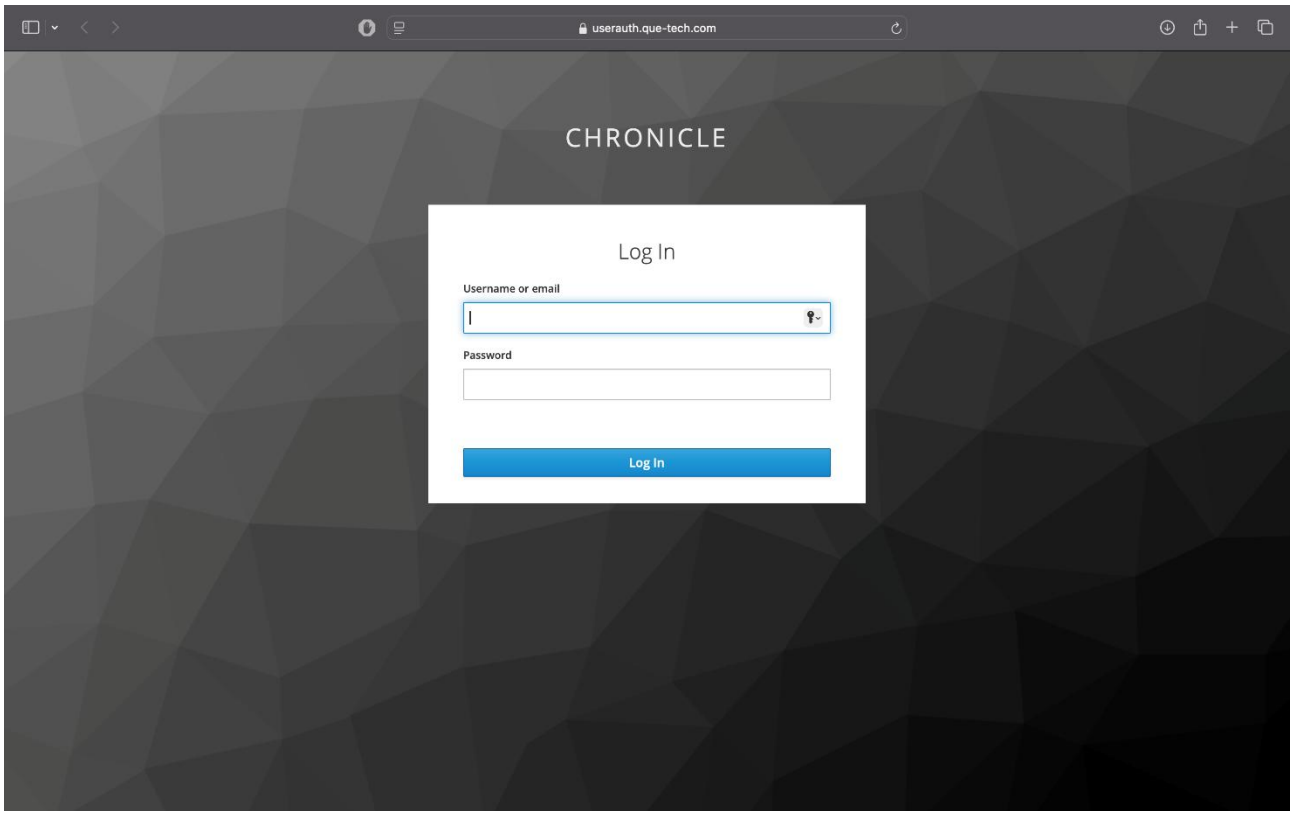


Figure 3. ChroViewFM: Log in window

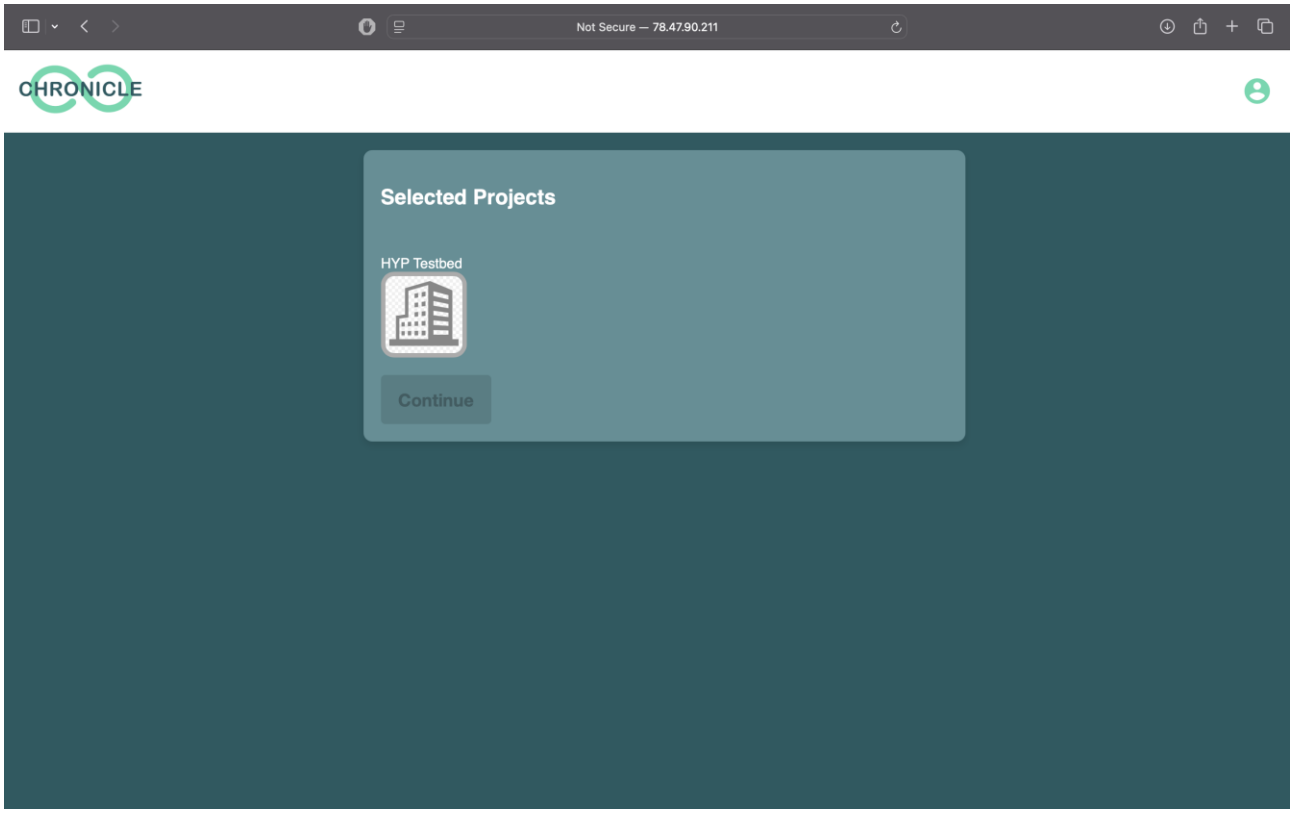


Figure 4. ChroViewFM: Project selection

3.4.2 User Interface Overview

The ChroViewFM interface is designed for intuitive navigation. At the centre, the 3D model of the building is displayed, allowing users to explore its structure. In the top-right corner, buttons provide controls for interacting with the 3D model. On the top-left, three tabs allow users to switch between BIM data (currently selected), IoT data, and KPIs. Below these tabs, the model tree presents a hierarchical view of building elements for easy selection and navigation. The orientation box, located at the bottom-left corner, enables quick adjustments of the viewing angle. (Figure 5)

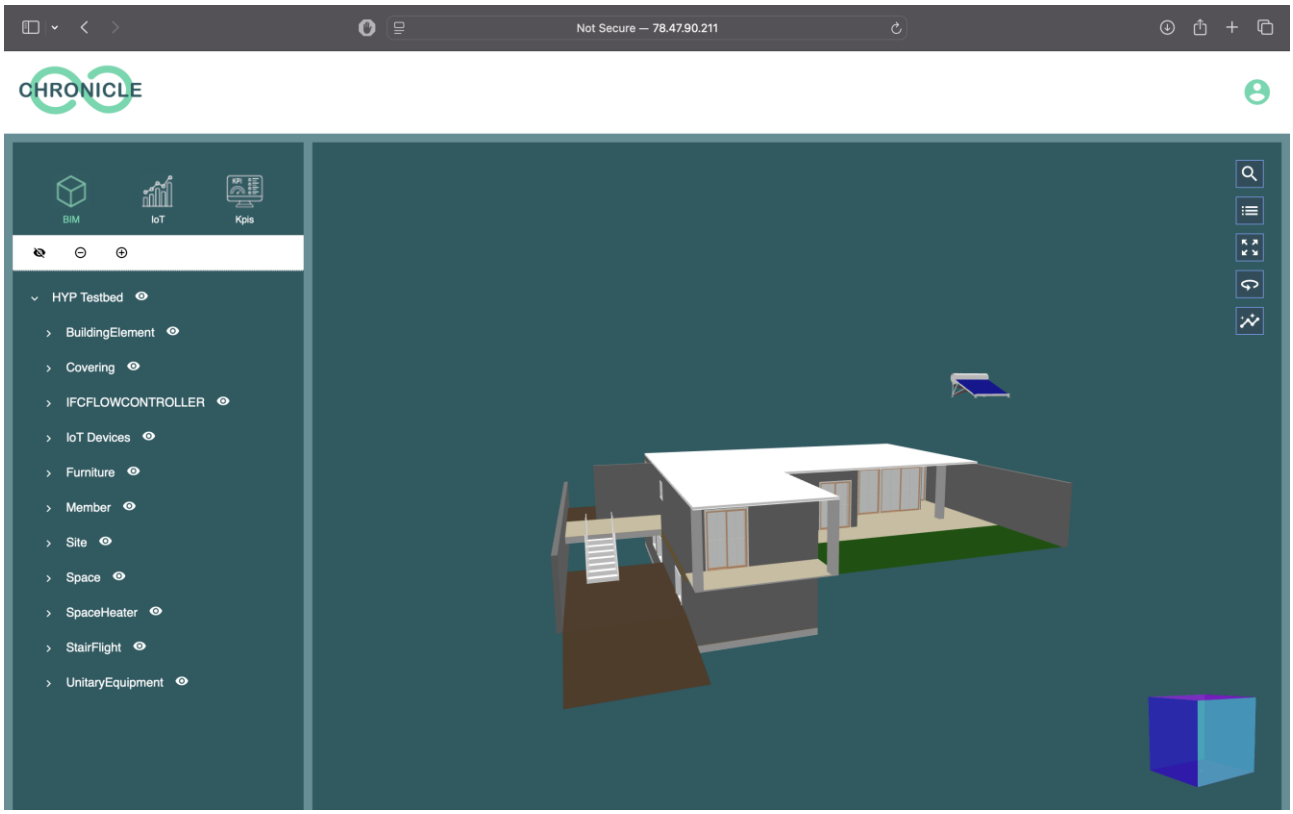


Figure 5. ChroViewFM: Application Layout

Model Tree Navigation

Users can explore the hierarchy of building components by expanding categories in the model tree. For instance:

- Selecting the 'Columns' tab displays all column elements (Figure 6).
- Clicking on a specific column highlights it in blue within the 3D model, making it easier to locate and inspect (Figure 7).
- Plus button ⊕: Expands all elements in the hierarchy tree (Figure 8).
- Minus button ⊖: Collapses the hierarchy tree, returning it to its original state (Figure 9).
- Visibility button 👁‍🗨: Toggles the visibility of elements in the model.

When pressed at the top of the model tree, all elements toggle between visible and hidden. In (Figure 10), the Visibility button hides all elements in the 3D model.

When elements are hidden, pressing the Visibility button next to a category or element makes only that selection visible. In Figure 11, the “Slab” category is toggled on, displaying all slabs. In Figure 12, the “Wall” category is added, making both walls and slabs visible in the 3D model.

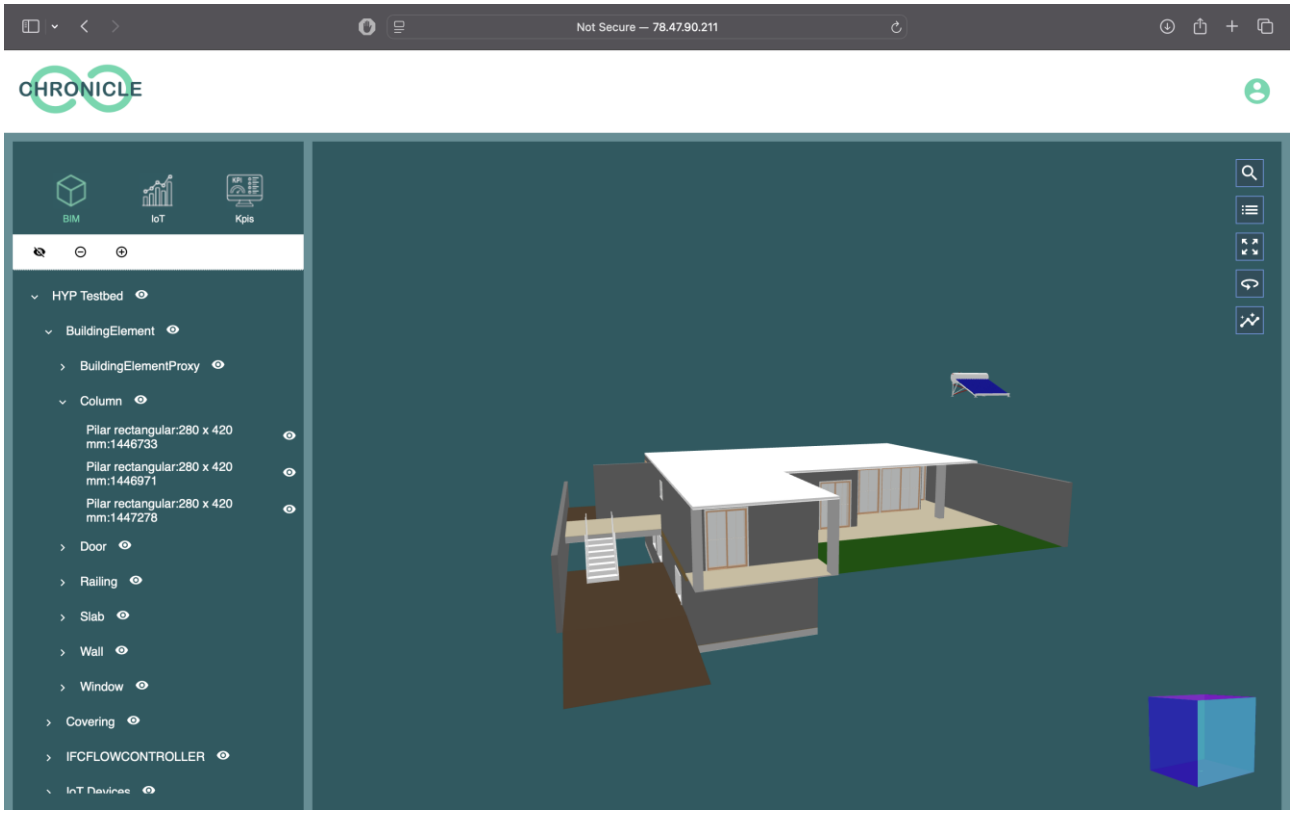


Figure 6. ChroViewFM: Expanded BuildingElement with Column

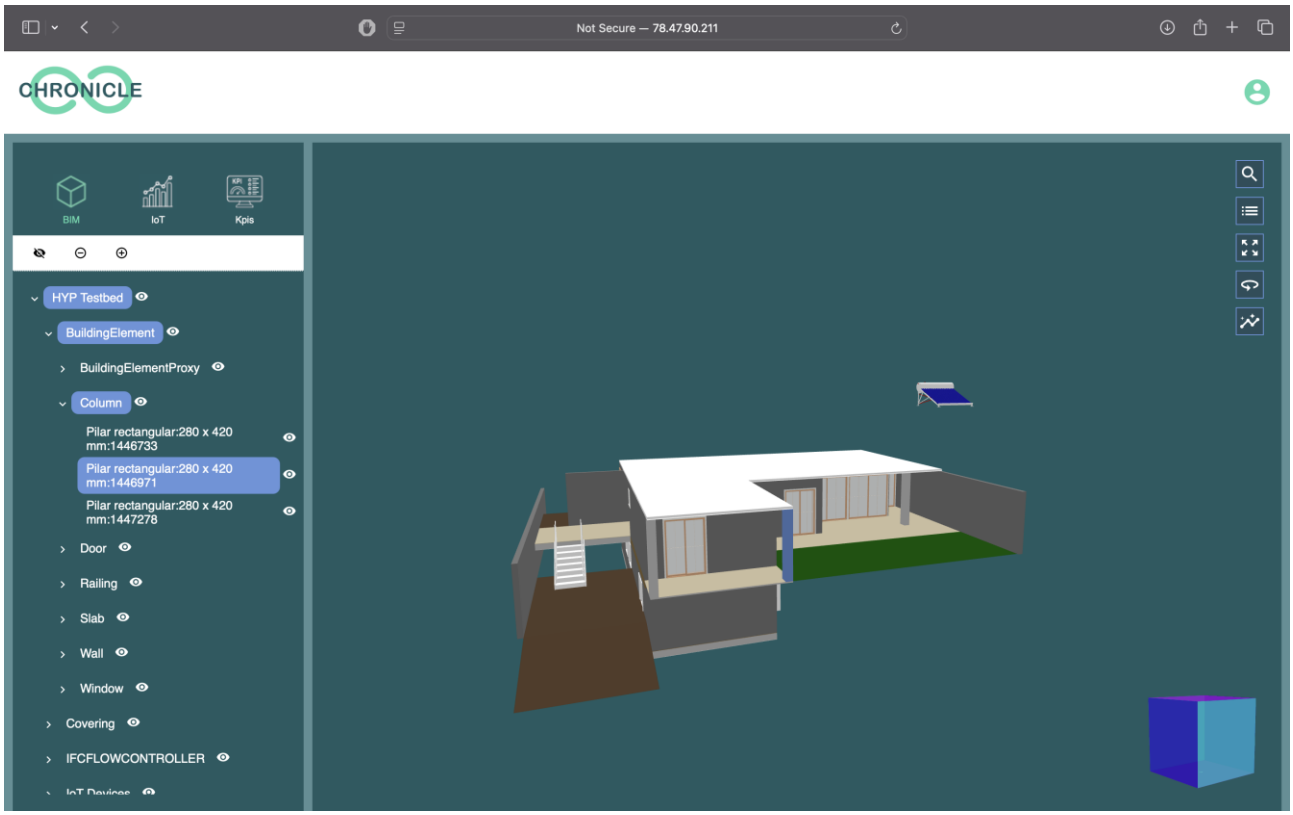


Figure 7. ChroViewFM: Column “Pilar rectangular:1447278” selected and highlighted

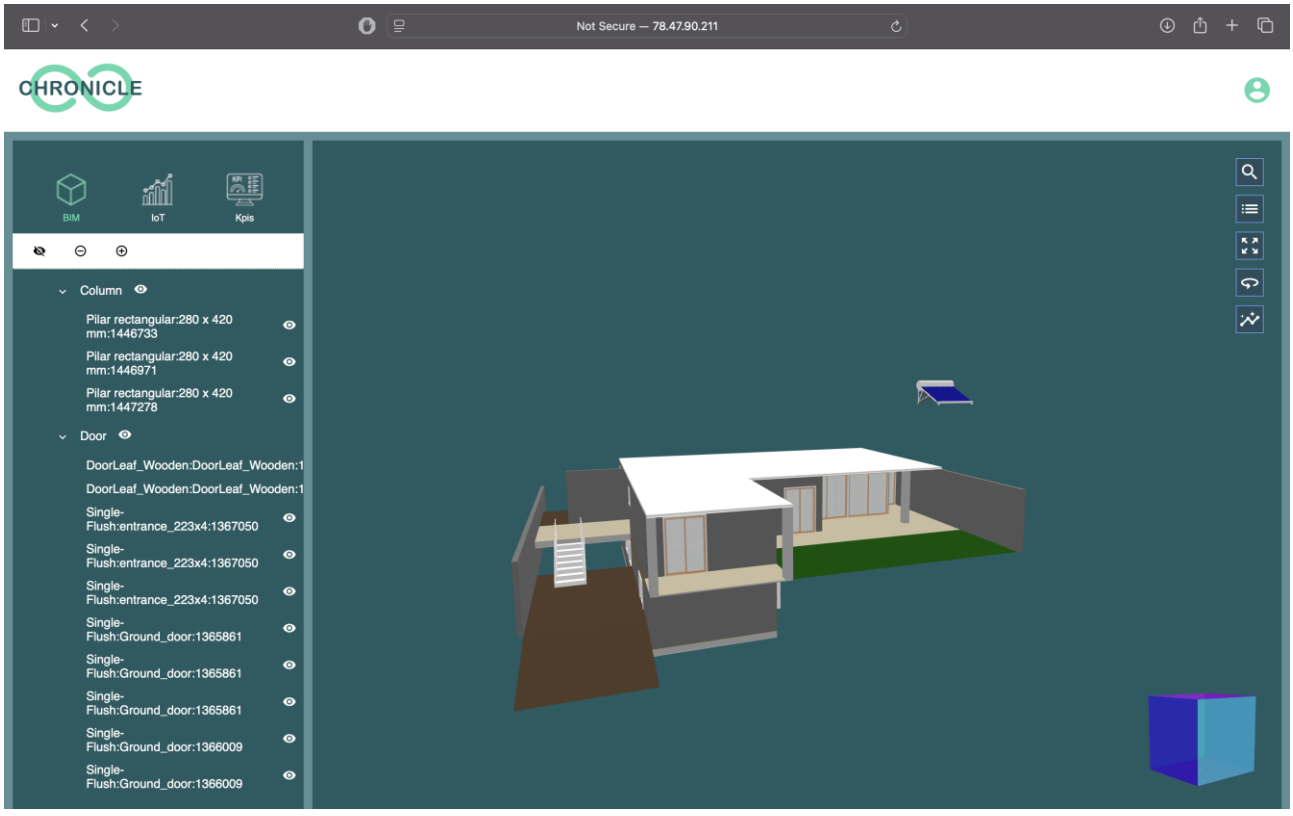


Figure 8. ChroViewFM: The “Plus” button expands all elements in the hierarchy tree

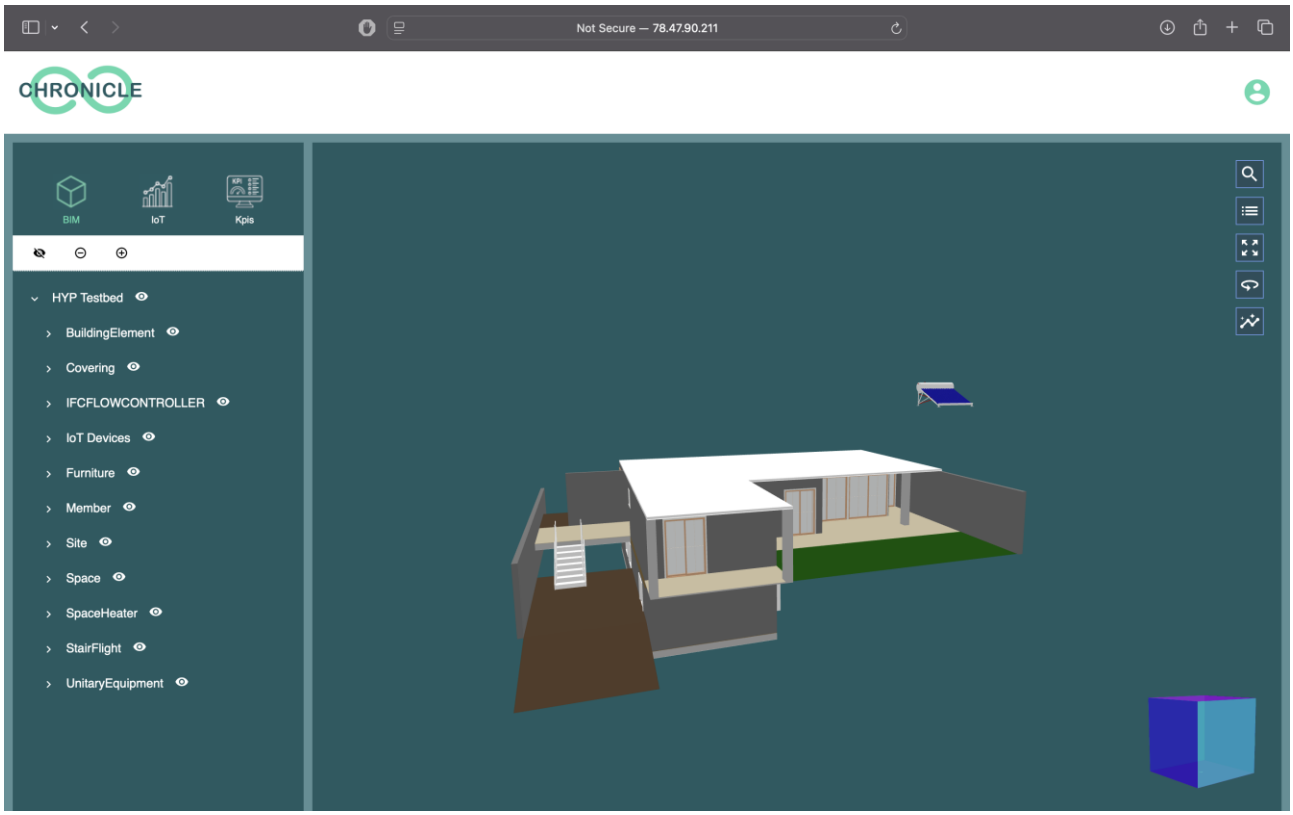


Figure 9. ChroViewFM: The “Minus” button collapses the hierarchy tree to its default state

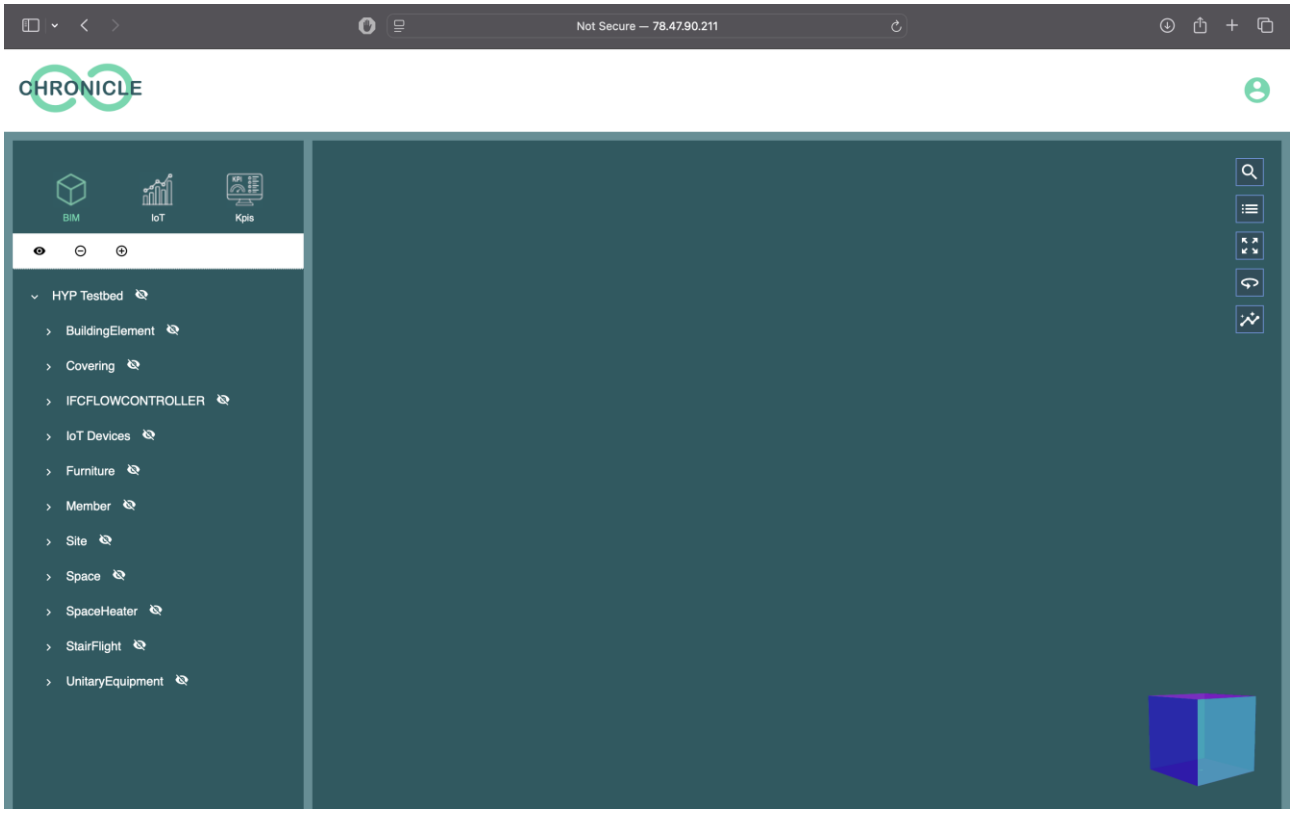


Figure 10. ChroViewFM: All model elements hidden using the “Visibility” button.

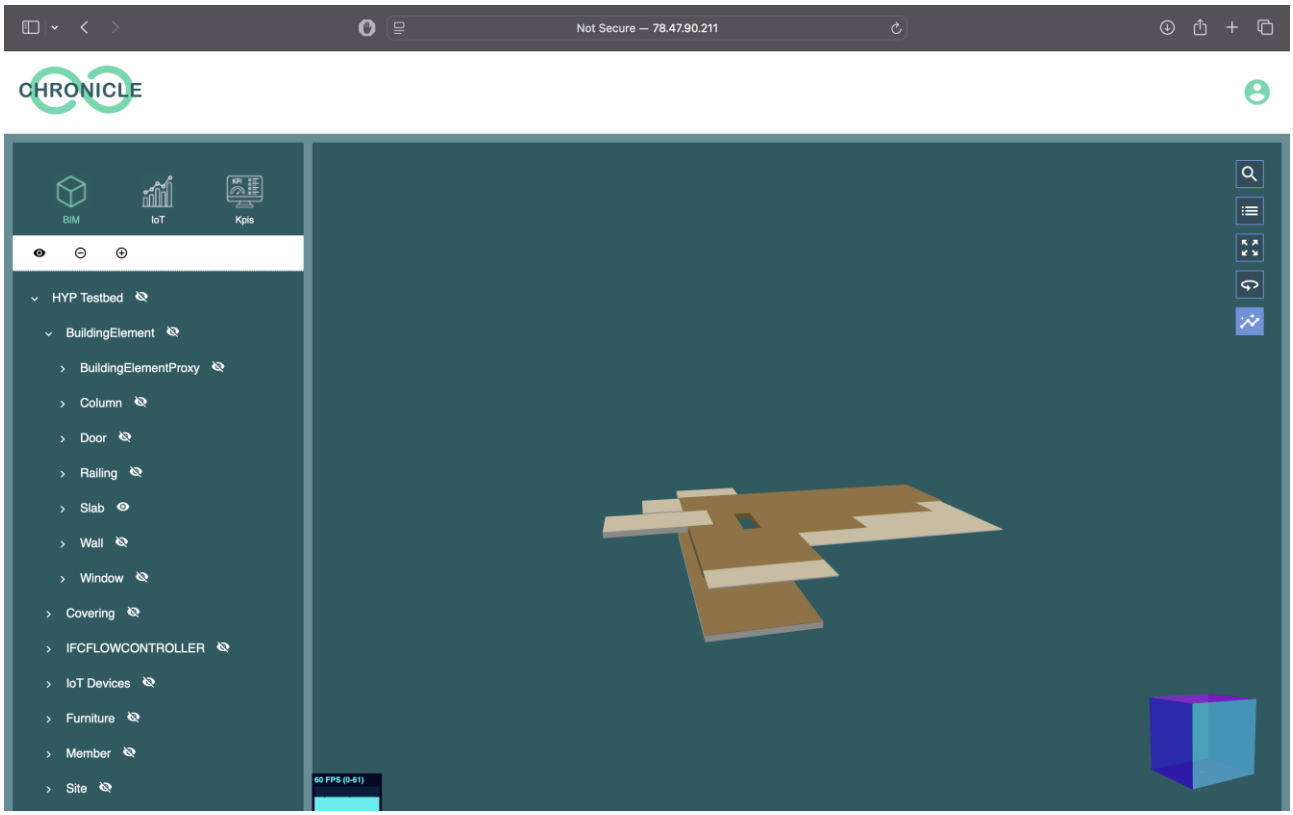


Figure 11. ChroViewFM: The “Slab” category is toggled on, making all slabs visible

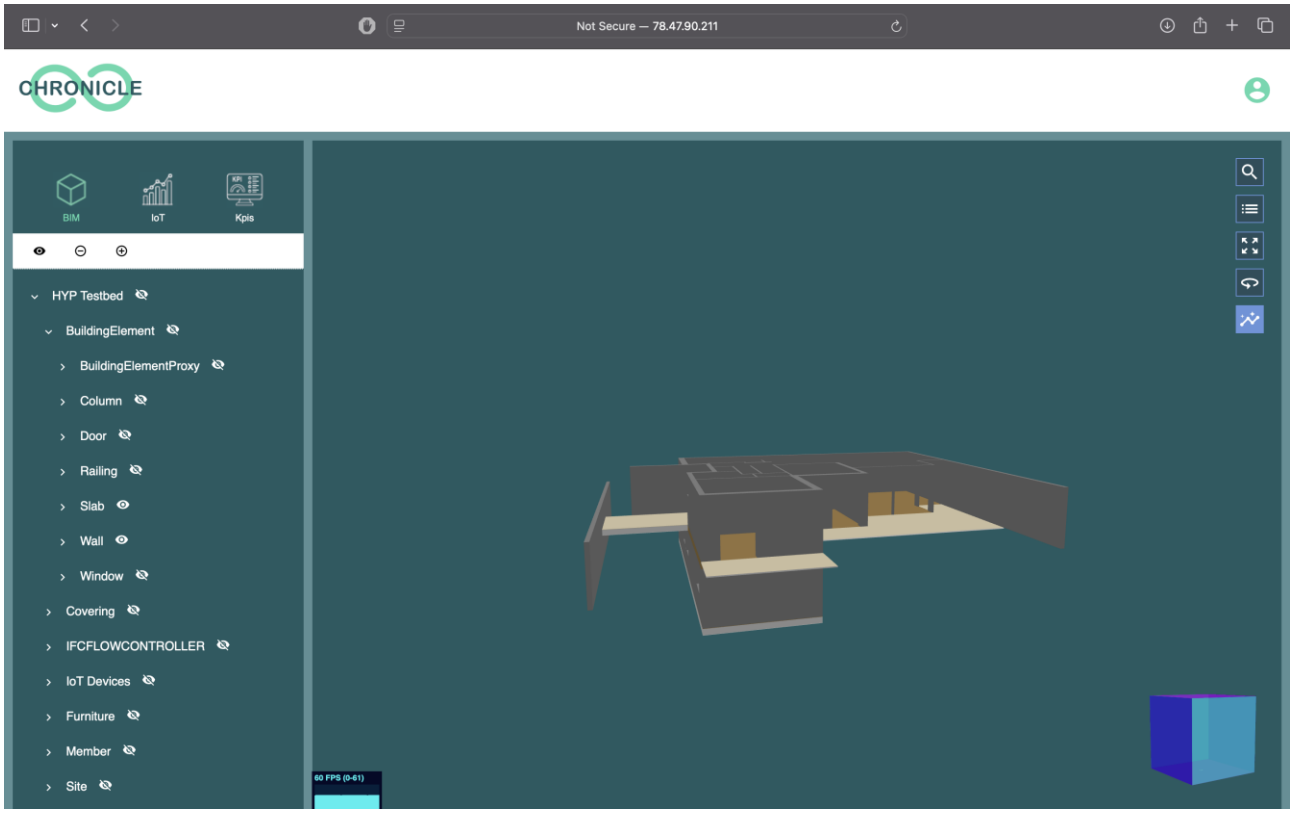


Figure 12. ChroViewFM: The “Wall” category is added, displaying both walls and slabs in the 3D model

Additional Navigation Tools

- The *Search* button Opens a search bar for locating specific elements or categories, which are highlighted in the 3D model (Figure 13).
- The *Properties* button Displays IFC file information for the selected element, this may include its unique ID, materials, position, elevation, and attributes (Figure 14).
- The *Focus* button Centres and zooms in on the selected element, whether chosen from the model tree or directly from the 3D model (Figure 15).
- The *Reset* View button Resets the model to its default position and zoom level (Figure 16).
- The *Performance* button Toggles a performance box at the bottom left of the model, displaying FPS and system ping (Figure 17).

- Lastly, on the bottom left of the screen the orientation box is located, which allows quick navigation between different model perspectives. (Figure 18)

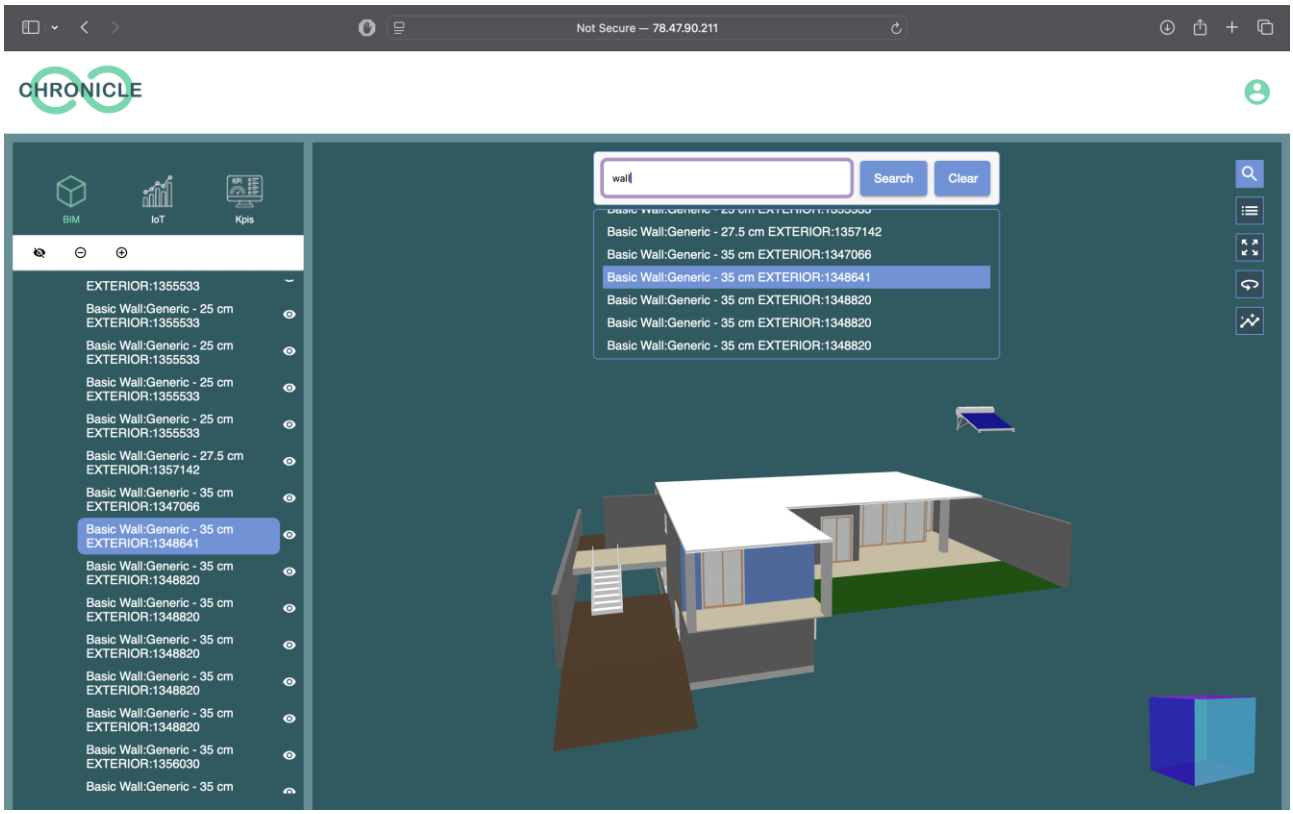


Figure 13. ChroViewFM: The search bar for locating specific elements or categories in the model tree

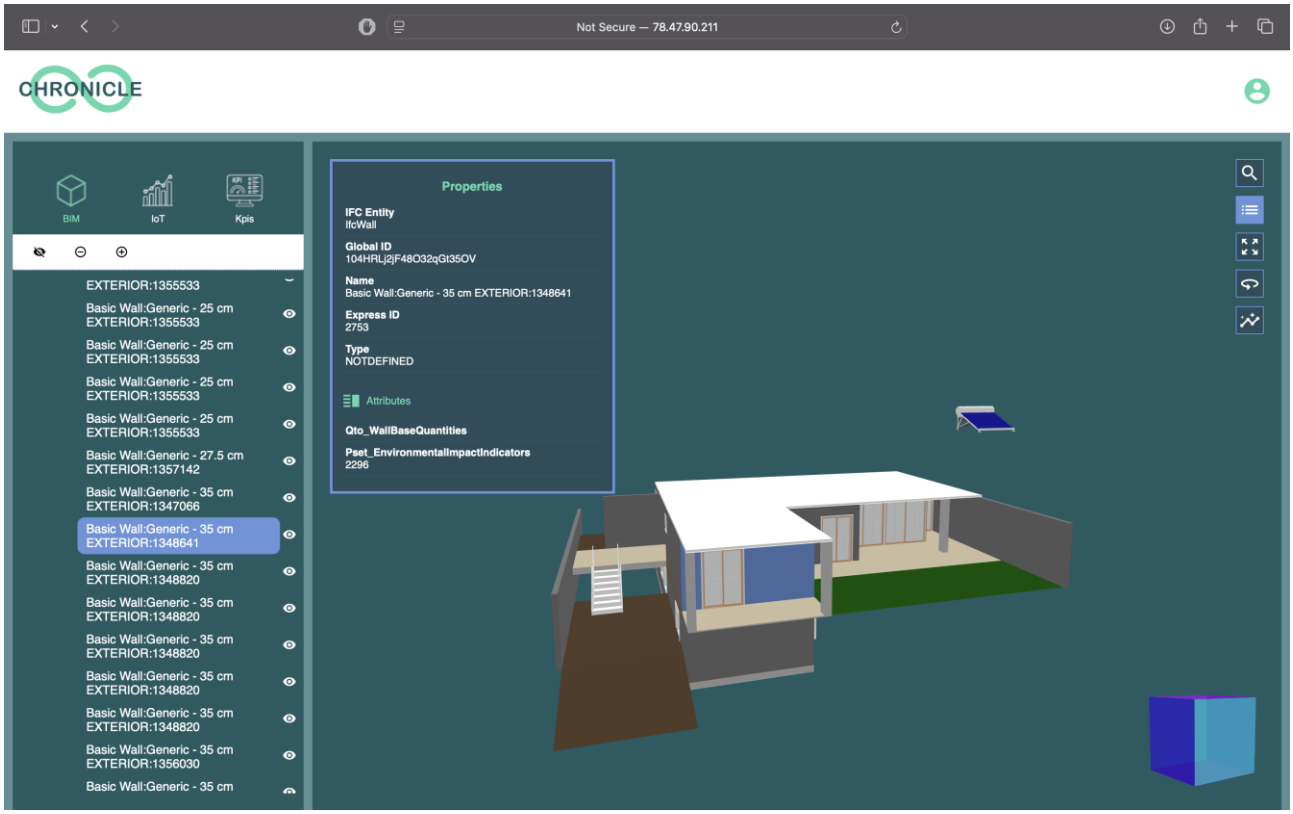


Figure 14. ChroViewFM: The “Properties” panel displaying information for a selected element

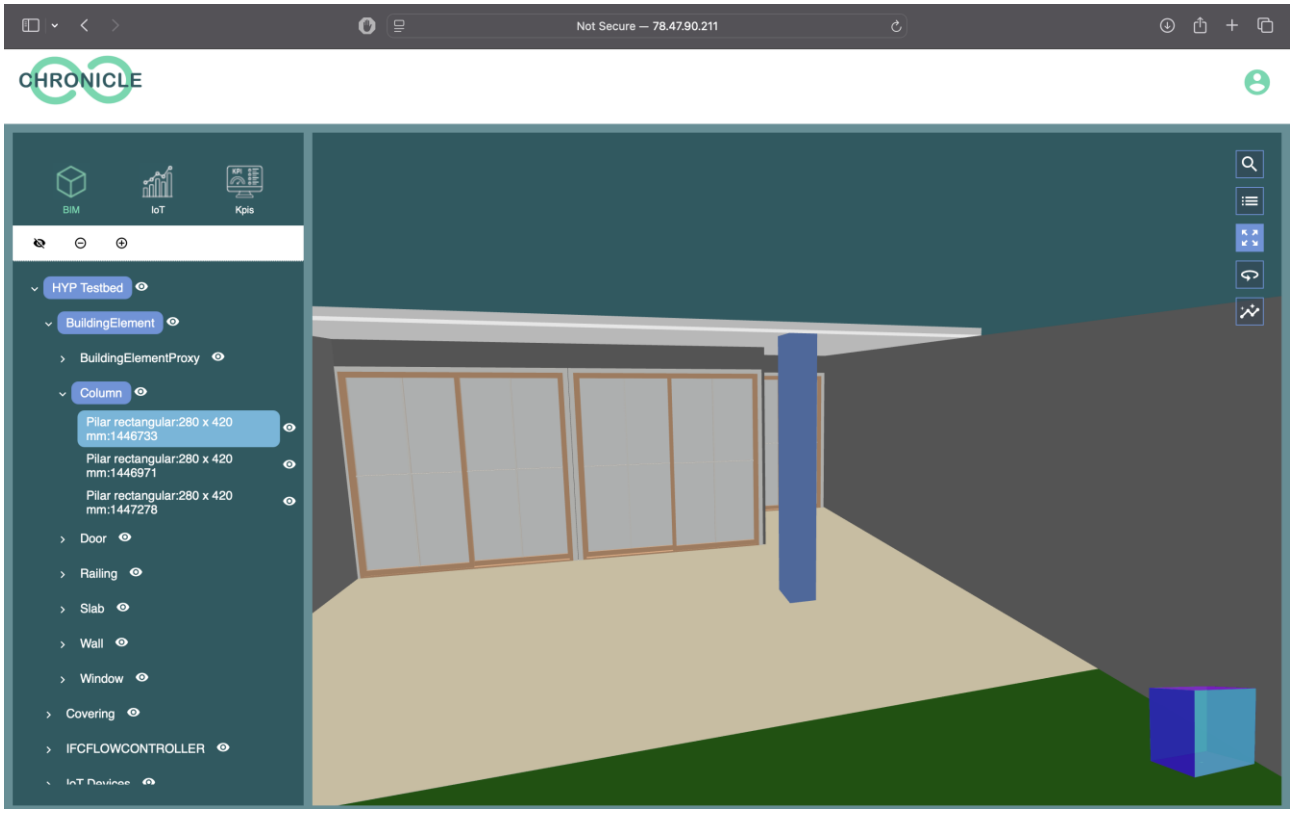


Figure 15. ChroViewFM: The “Focus” button cantering and zooming in on a selected element

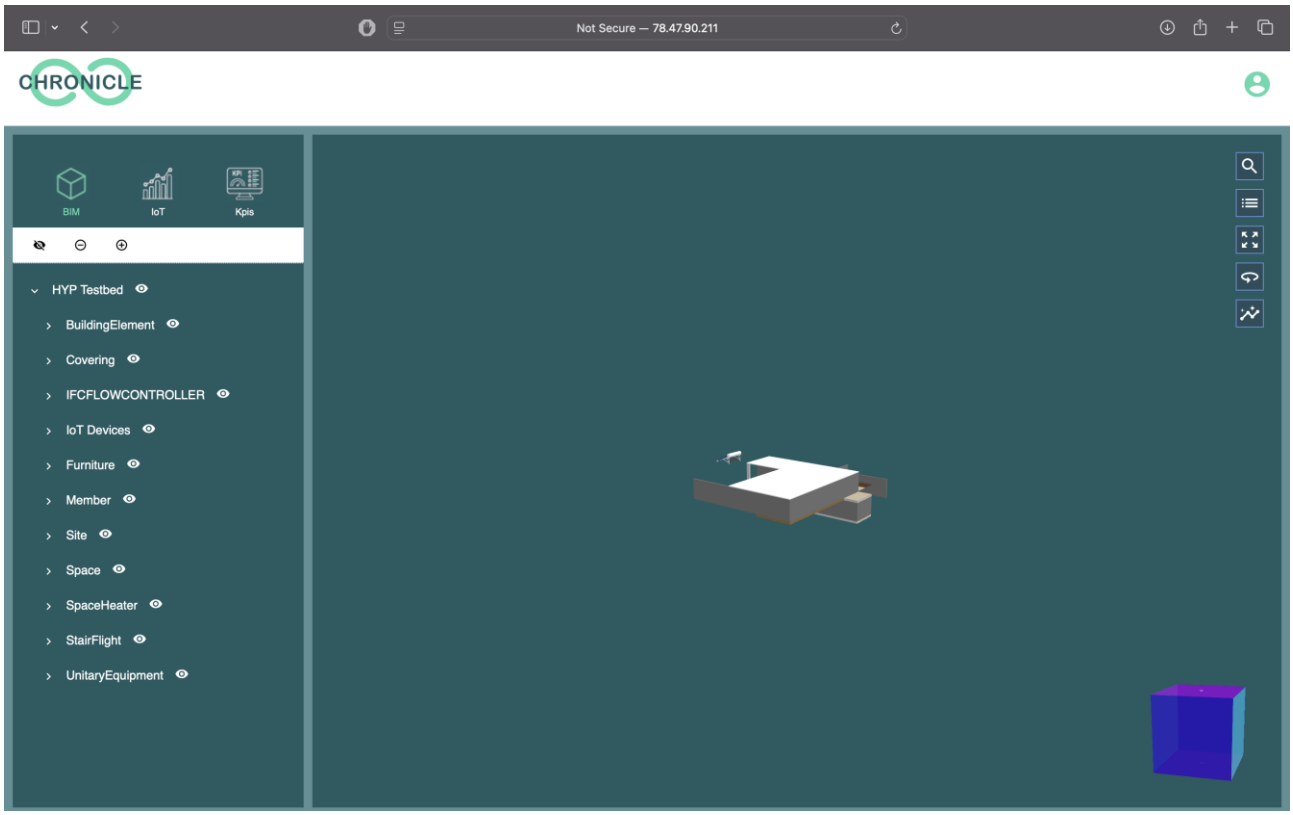


Figure 16. ChroViewFM: The “Reset View” button restoring the model to its default position and zoom level

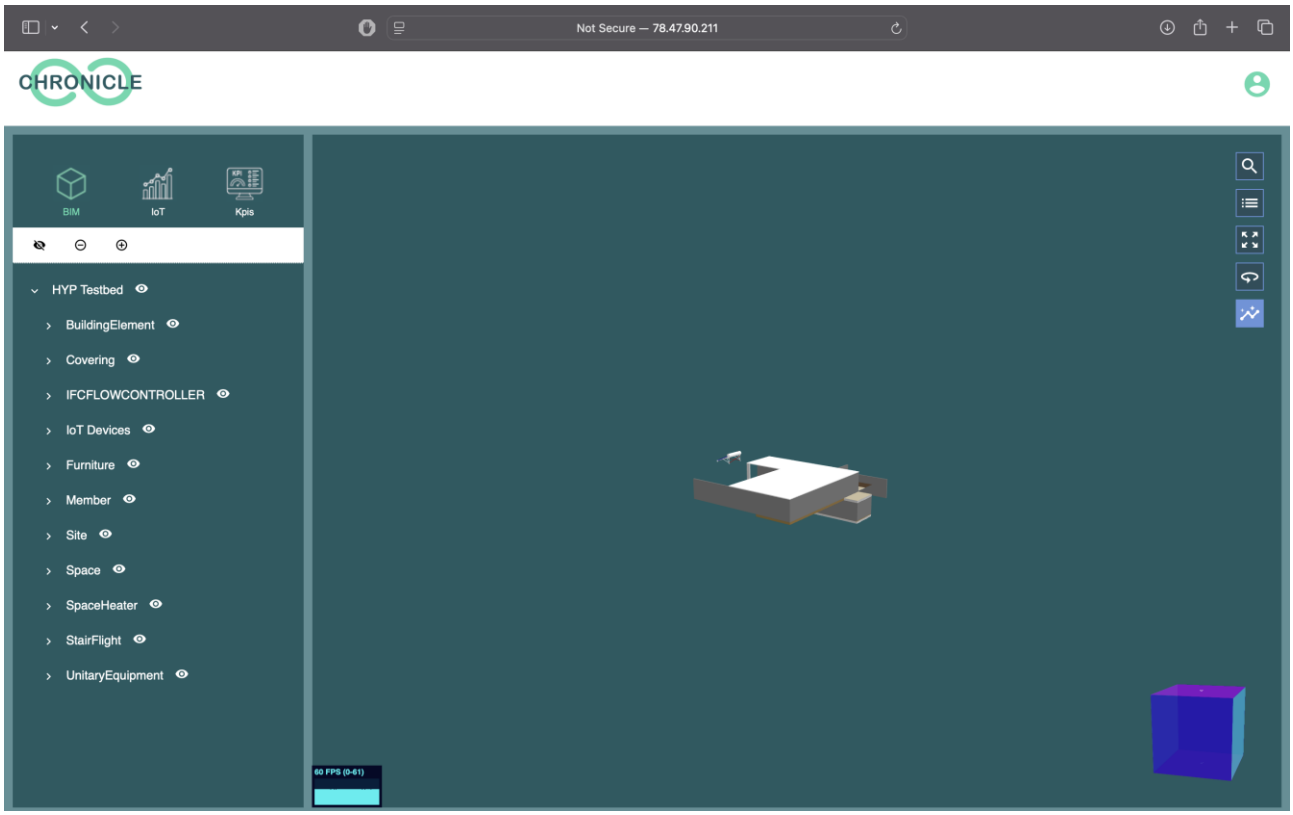


Figure 17. ChroViewFM: The “Performance” panel displaying system FPS and ping statistics

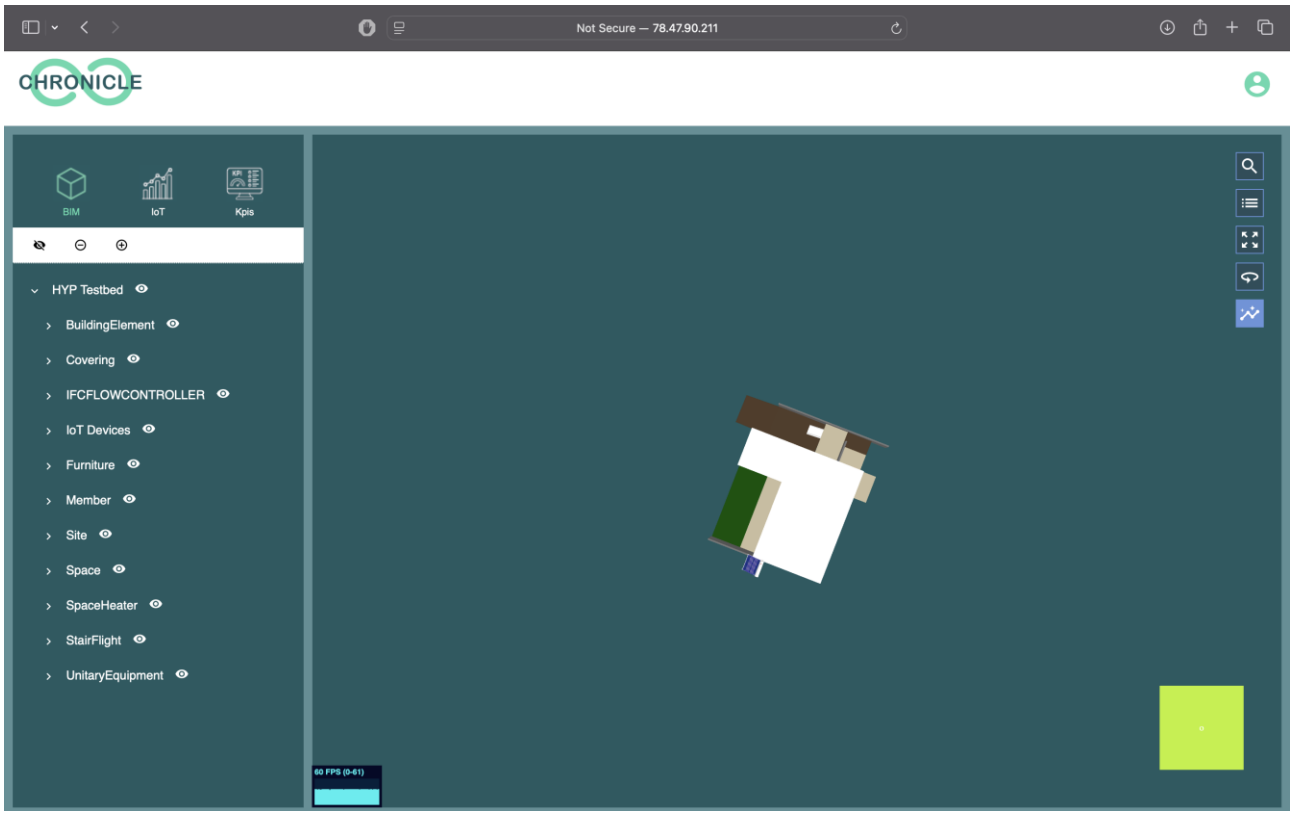


Figure 18. ChroViewFM: Top View on the orientation box

3.4.3 IoT Data Visualization

The IoT tab presents available IoT devices in a structured hierarchy. Users can select a period using a start and end date calendar, which determines the displayed data (Figure 19).

Each device lists its associated metrics (Figure 20). Upon selecting a metric, its data is plotted for the chosen period. In (Figure 21), the temperature metric from the basement multisensor is plotted for a February day. Users can hover over the graph to view precise timestamps and values.

Multiple metrics can be plotted simultaneously, even from different devices. In (Figure 22), the luminance from the basement sensor and the temperature from the living room sensor are displayed together.

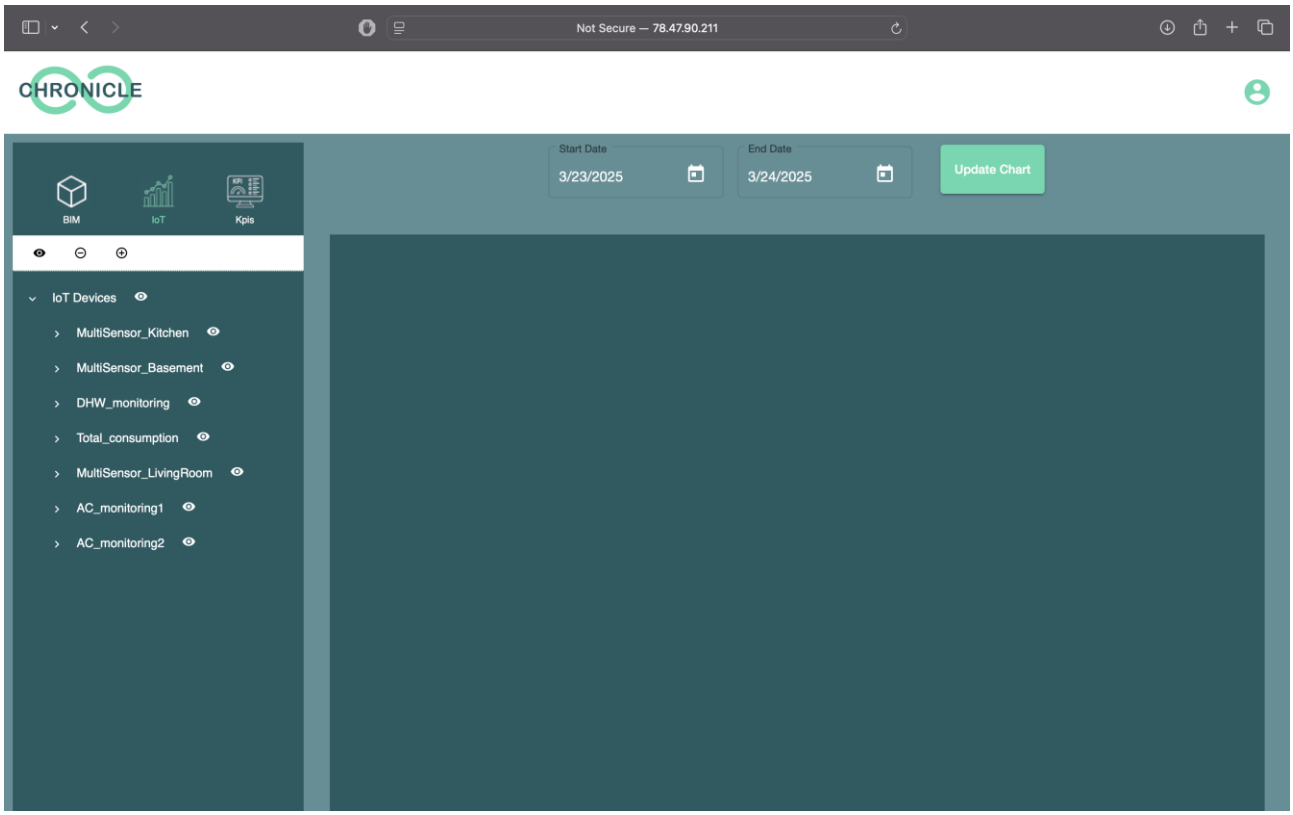


Figure 19. ChroViewFM: The IoT tab displaying available IoT devices in a hierarchical structure

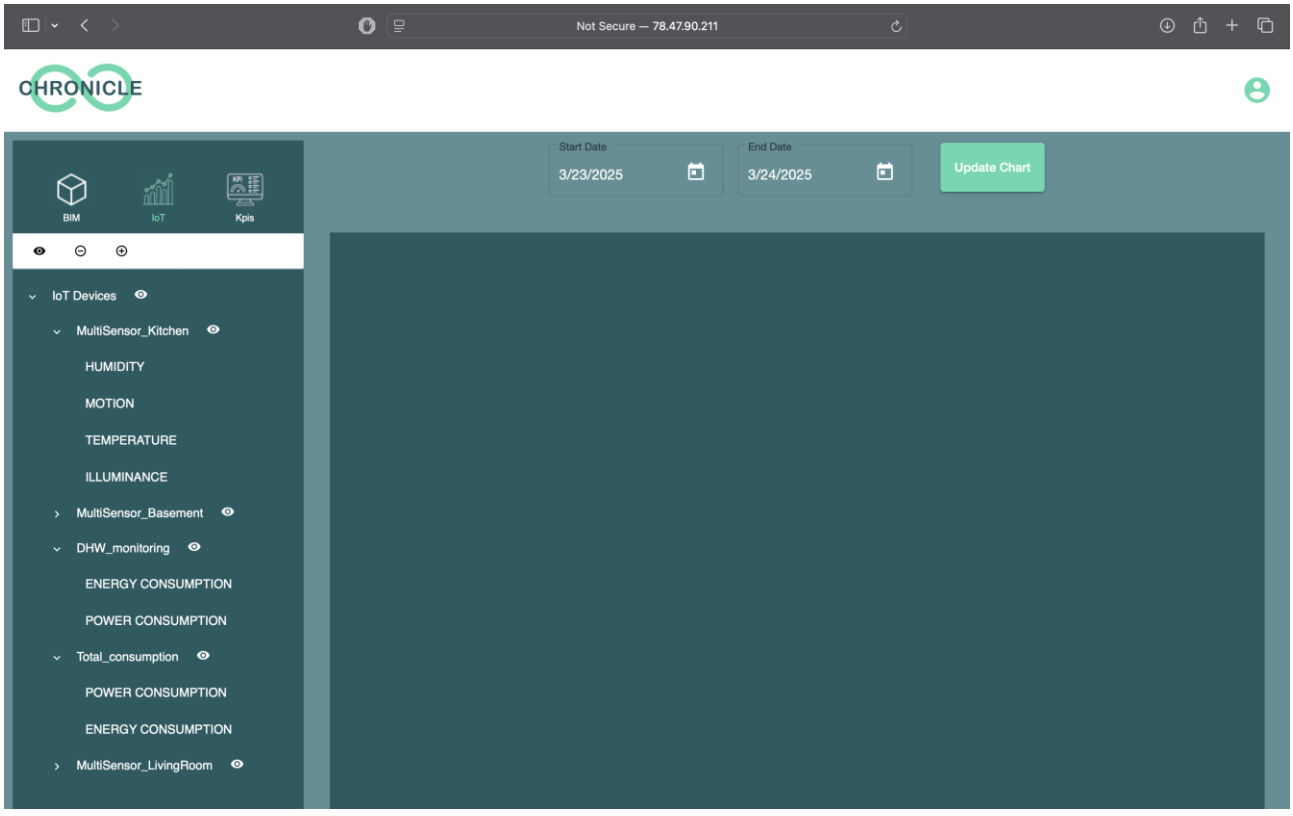


Figure 20. ChroViewFM: List of IoT device & metrics available for selection

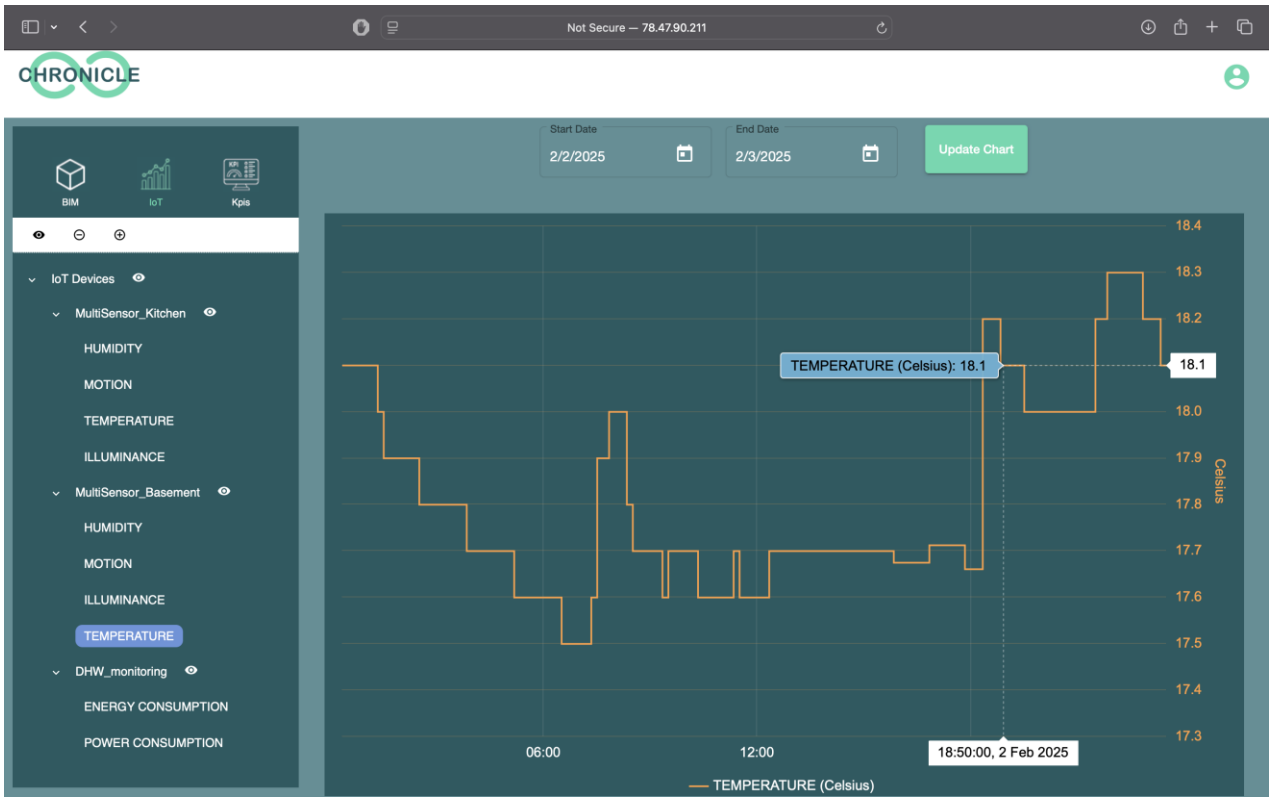


Figure 21. ChroViewFM: A graph plotting the temperature metric from the basement multisensor for a selected day

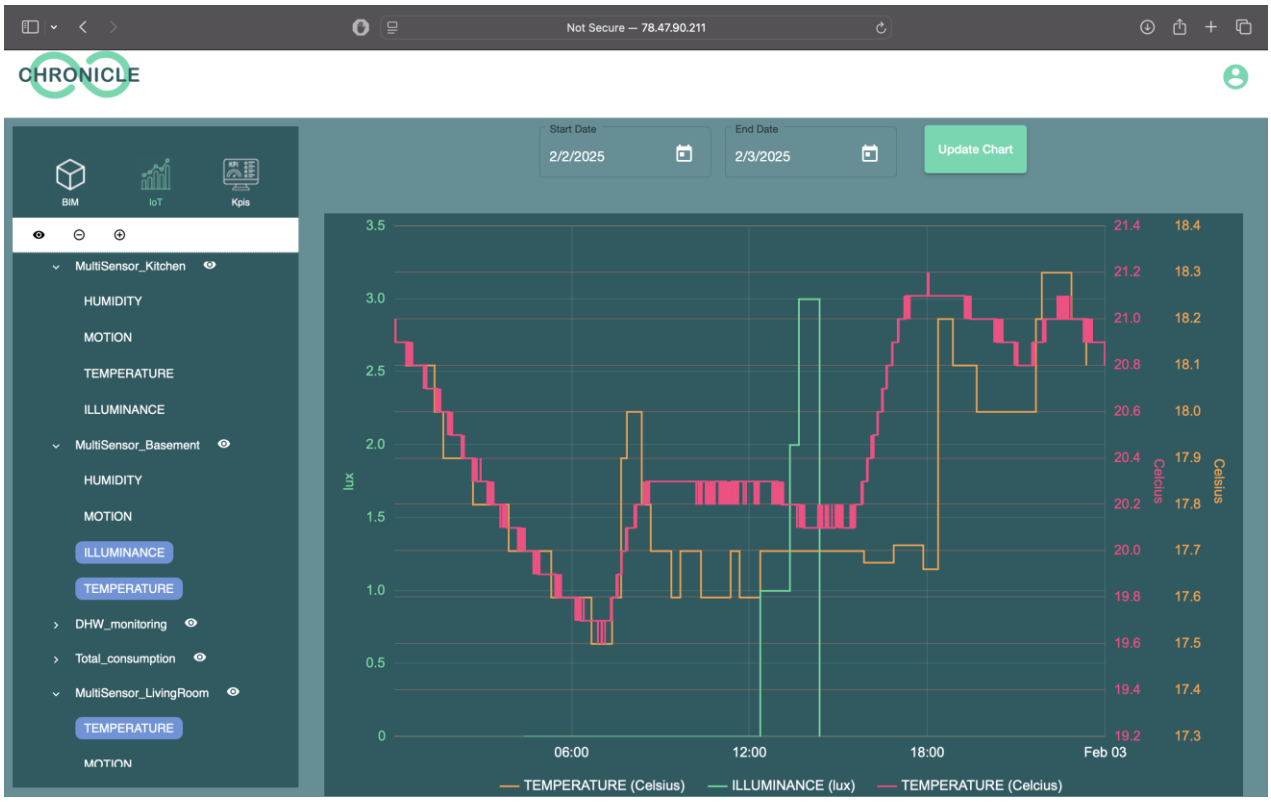


Figure 22. ChroViewFM: A graph combining luminance and temperature from the basement sensor and temperature from the living room sensor

3.4.4 KPI Data Visualization

The KPI tab organizes KPIs in a hierarchical structure based on their type (Figure 23). Users can hover over a KPI's name to view its description (Figure 24).

Multiple KPIs can be selected for display, including time-series KPIs (Figure 26), which can be combined for comparative analysis (Figure 25).

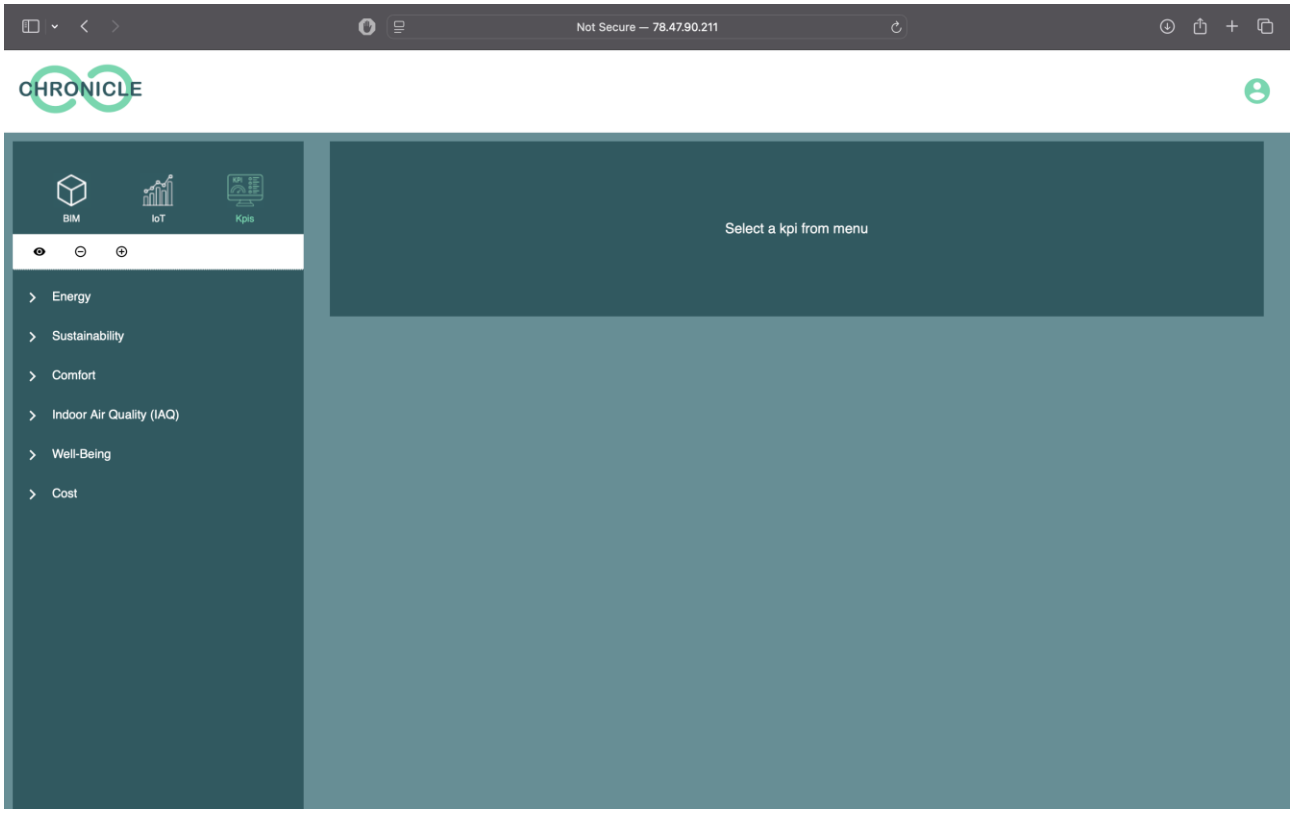


Figure 23. ChroViewFM: KPIs in their hierarchical structure, according to types

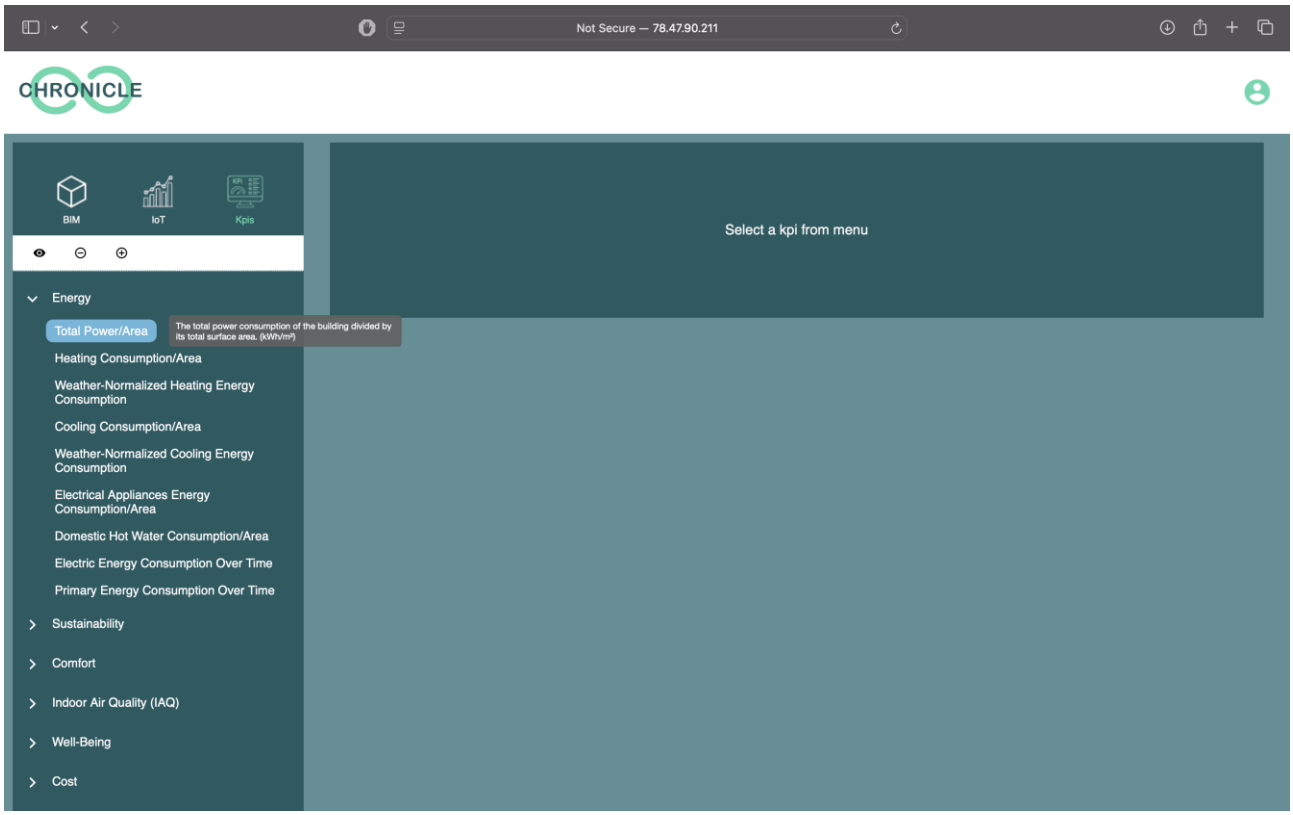


Figure 24. ChroViewFM: KPI descriptions displayed on hover

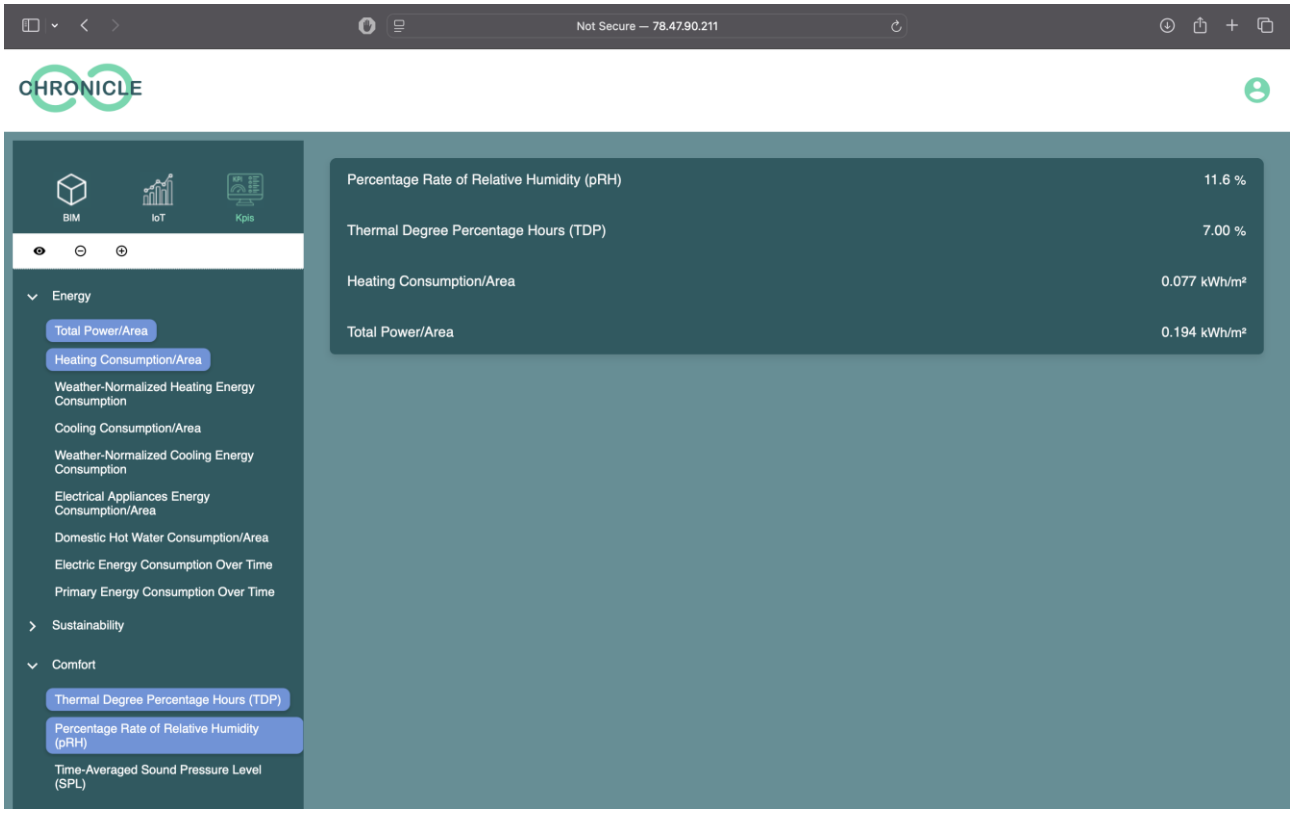


Figure 25. ChroViewFM: Multiple KPIs selected for display

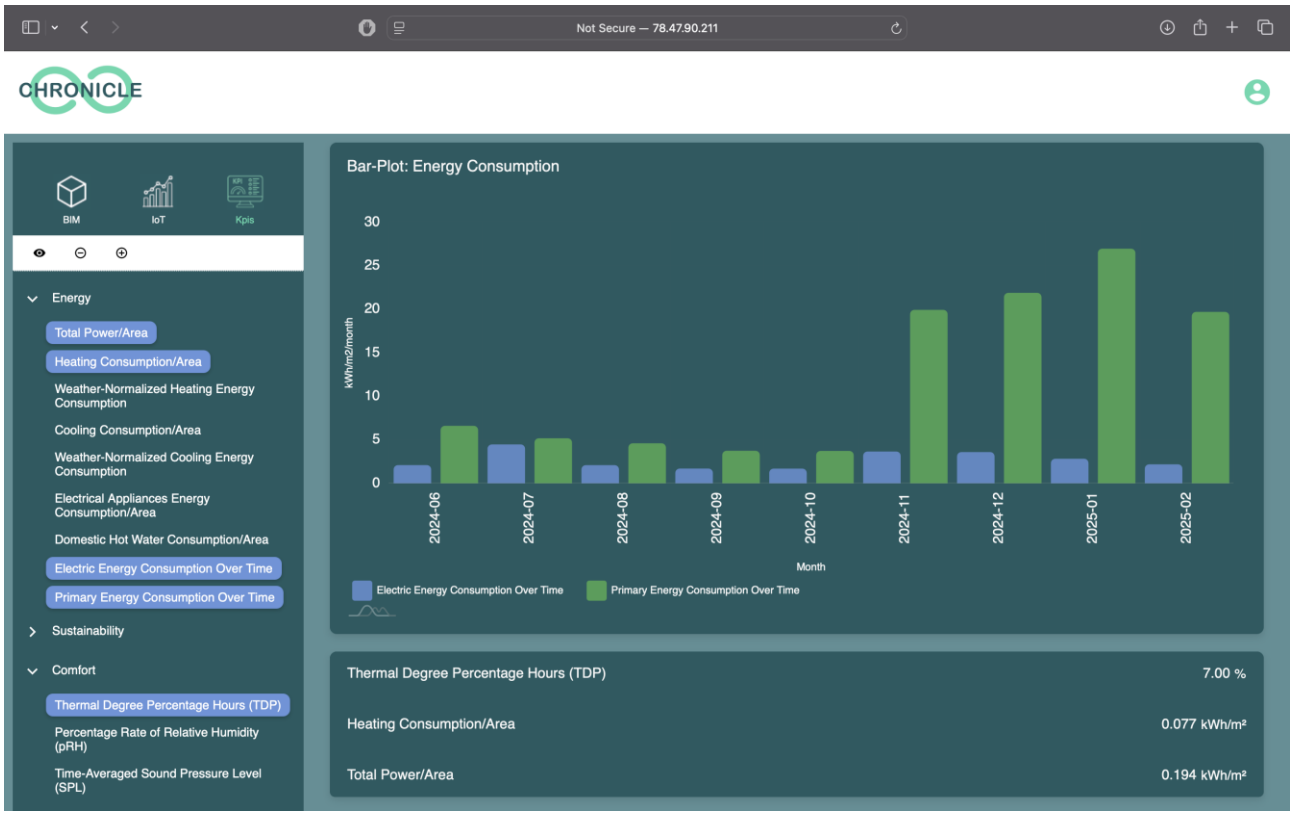


Figure 26. ChroViewFM: Timeseries KPIs plotted with static KPIs

4 User Interface 2: ChroViewOcc for Building Occupants

4.1 Functionality Overview

The ChroViewOcc is a mobile application created for the tenants of residential buildings and is designed to interpret and visualize the data collected from the IoT sensors installed on site in a simple and comprehensive manner. This data includes the current indoor environmental conditions at the premises, and monthly performance analytics of the household depending on its measured energy consumption.

During the design phase of the CHRONICLE solution, to support the application design and the requirements collection process, a survey was circulated to potential ChroViewOcc users from the CHRONICLE pilot sites, as part of the T2.1 activities, to identify the major points of interest from their side. These surveys of residential stakeholders, reported in D2.1, revealed a strong preference for mobile applications and a high interest in receiving information from the sensors installed on site. In addition, most of the residential users stated their limited knowledge in relation to their energy performance and efficiency. This feedback formulated the concept of a mobile application that would allow residential users to monitor and interpret their energy performance and better understand their energy bills on a monthly basis.

More specifically, following the requirements defined through the T2.1 activities, ChroViewOcc was developed. A straightforward and minimal interface design was adopted addressing users with limited technical background who cannot interpret complex data streams, and are therefore, more interested in already processed analytics rather than raw data sets. The application views were designed to be self-explanatory, ensuring accessibility to a wider audience and to delivering simplified and unambiguous information.

More complex and detailed scenarios, including raw data streams and financial figures, can be found within other CHRONICLE applications (i.e. ChroViewPlus and ChroViewFM). However, ChroViewOcc remains focused on the most basic understanding of the household's performance at different levels, identifying the average building tenant as the key stakeholder, regardless of whether they own the building or not. The implementation of the mobile application is described in *UC2.1 Dynamically updated user-friendly energy performance reports for residential users*, described in D2.1.

4.2 Discussion of User Needs Addressed by the Tool

ID	Title	Description	Priority	Coverage
FR-37	ChroViewOcc - SRI+ score for past month visualisation	The SRI+ score should be visualised in an intuitive manner and updated based on the actual building operation with a monthly frequency	High	Completed as described in section 4.4.3
FR-38	ChroViewOcc - Dynamic performance rating	The dynamic performance rating should be visualised in an intuitive manner and updated based on the actual building operation with a monthly frequency	High	Completed as described in section 4.4.3
FR-39	Retrieval of historical performance ratings	The user should be able to select and visualise performance ratings from previous months	High	Completed as described in section 4.4.3
FR-41	Visualisation of current indoor conditions	ChroViewOcc should provide access to the current values of the environmental sensors installed on site, frequently updated	High	Completed as described in section 4.4.2
FR-42	Visualisation of current energy consumption	ChroViewOcc should provide access to the current values of current energy consumption aggregated to different levels, day, week, month	High	Completed as described in section 4.4.2
FR-43	Energy efficiency recommendati-ons	ChroViewOcc should provide mobile notifications when a new energy efficiency recommendation is available	Low	Due to low priority it was not implemented
FR-44	Mobile app	ChroViewOcc should be made available to users as a mobile app	High	Completed

Table 3. ChroViewOcc: Functional requirement coverage

4.3 Technical Description of Tool Operation

The mobile app is developed in Angular the details of which are included in the following table. The app will be distributed under the official Android & iOS marketplaces.

Technology/Package name	Version	License
Angular	13.2.7	MIT
Capacitor	V6	MIT

Table 4: Technology stack and implementation tools of ChroVIewOcc

4.3.1 Backend Architecture and Data Management

The requirements in terms of IoT equipment and pilot infrastructure identified for the implementation of the full ChroViewOcc functionalities, at household level, are collected in Table 5. It is important to highlight that the application relies on the near real time data collected on site in order to deliver a representative overview of the current household conditions to the resident. Therefore, it is necessary the information collected on site is regularly sent to the CDE, before becoming available to the end users through the mobile application (see CHRONICLE architecture in D2.1). If this information is not regularly collected or it is sent to the CDE at a frequency lower than the minimum frequency defined within the IoT requirements, the quality of the application performance will be reduced. Moreover, the application only displays data which can be measured through the sensorial network installed on site, as all figures reflect the actual household situation. If no IoT equipment is available for the measurement of specific metrics, these metrics will not be included, e.g. if no IAQ sensors are available, air quality will not be displayed in the app.

IoT device Requirement	Equipment details
Temperature & Relative humidity sensors	Intra-day values are required in order for the app to deliver meaningful information to the users. For the optimal app performance, the measurement timestep is required to be at least hourly, and the values should be uploaded to the CDE also on an hourly timestep.
IAQ sensors including one or more of the following (CO_2, TVOC, PM2.5)	Intra-day values are required in order for the app to deliver meaningful information to the users. For the optimal app performance, the measurement timestep is required to be at least hourly, and the values should be uploaded to the CDE also on an hourly timestep.
Energy meters for total energy consumption	Min. measurement granularity: hourly. As will be explained in the following sections, energy consumption analytics are delivered for a daily/weekly/monthly granularity. For the optimal app performance, the measurement timestep should not be larger than one hour, and the values should be uploaded to the CDE daily.
Energy meters per electric load (asset: HVAC and/or water heaters)	Min. measurement granularity: daily The consumption of major individual electric loads, and more specifically HVAC and electric water heaters, is required for the more detailed analysis of the household's energy performance. For the optimal app performance, the measurement timestep is required to be at least hourly, and the values should be uploaded to the CDE also on an hourly timestep.

Table 5. ChroViewOcc: IoT equipment requirements

In addition to the IoT equipment, the BIM file of the household is also necessary for the implementation of the performance analytics of the application. More specifically, the dynamic smart readiness of the building is calculated based on the SRI+ methodology described in T2.5 (reported in D2.2) which requires the BIM-to-SRI calculation in addition to energy consumption/production data. In addition, for the energy performance rating, the building IFC is required for the implementation of the energy performance simulation model, used for the definition of the monthly boundaries per household which act as the reference point for the monthly performance rating calculation.

4.4 Demonstration — Practical Use Case Walkthrough

4.4.1 Log in Screen

The application log in page allows the users to insert their unique personalized credentials and ensure security. When registering in the app for the first time, the users are provided with temporary credentials which are requested to be changed upon the first log in. The log-in view of the application is presented in Figure 27.

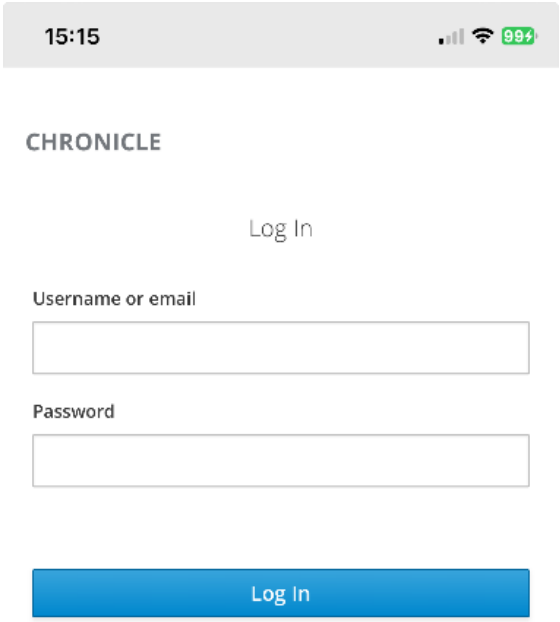


Figure 27. ChroViewOcc: Log in screen

4.4.2 Home Screen

Upon logging in, the user is redirected to the *Home* screen of the application (Figure 28). The environmental conditions available in the *Home* screen (Figure 29) are automatically updated when new measurements become available in the CDE, and the values displayed always refer to the latest measurements on site available in the CDE. Every time the environmental measurements are updated, the previous values are discarded. In case more than one sensor of the same kind are available on site, e.g. multiple temperature sensors in

different rooms, the displayed value corresponds to the average of the latest measurements of all available devices of the same type.

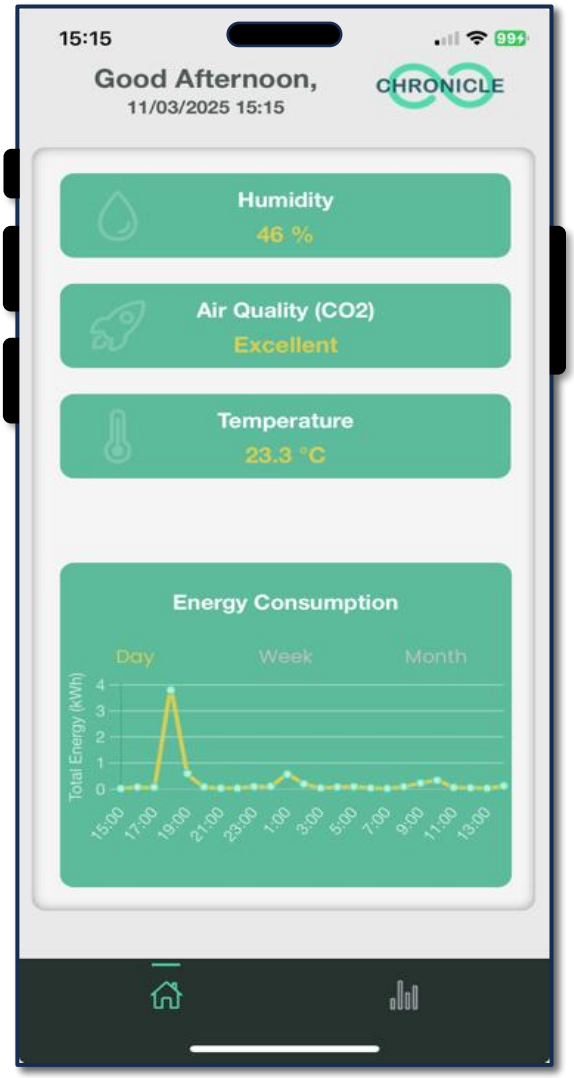


Figure 28. ChroViewOcc: Home Screen

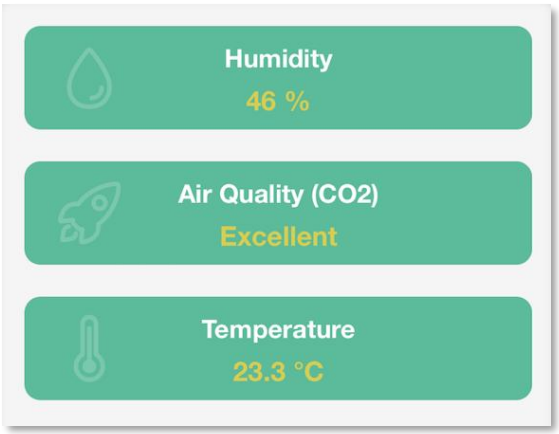
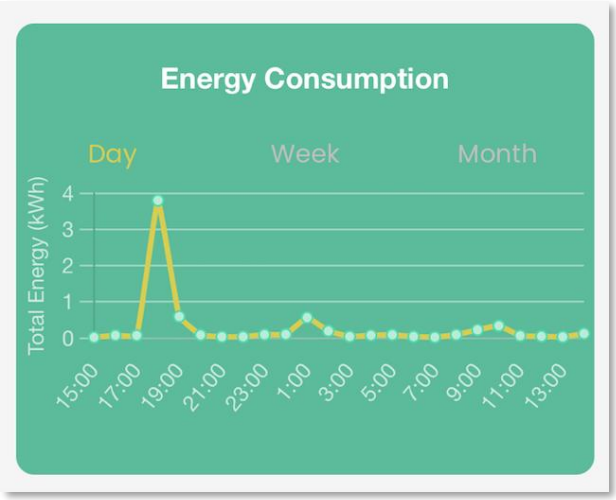
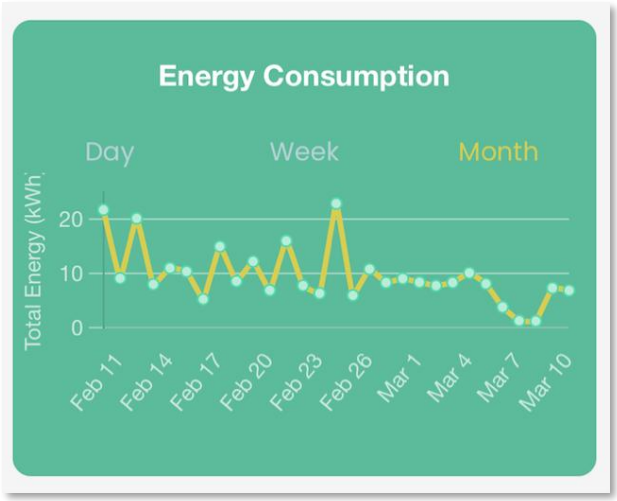


Figure 29 ChroViewOcc - Environmental conditions

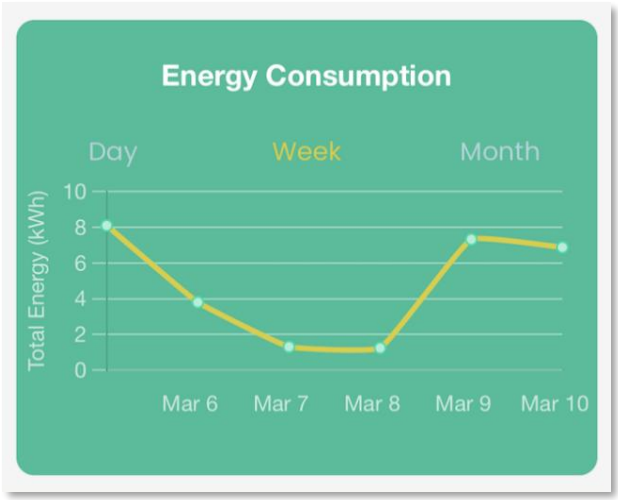
Apart from the environmental conditions, the electricity consumption of the household is also displayed in the *Home Screen* of the ChroViewOcc, allowing the overview of previous periods: day (24-hours earlier), week (7-days earlier), and month (30-days earlier) (Figure 30 (a), (b), and (c) respectively). The user can select the preferred time-window of consumption to be displayed by clicking on the Day, Week, and Month buttons on top of the electricity consumption graph. The selected option lights up in yellow indicating the time period displayed. The default option is set to Day.



a) Day level



b) Week level



c) Month level

Figure 30 ChroViewOcc - Electricity consumption

4.4.3 Performance Rating Screen

To iterate between the *Home* screen and the *Performance Rating* Screen, two buttons are available at the bottom of the *Home* screen (Figure 31).

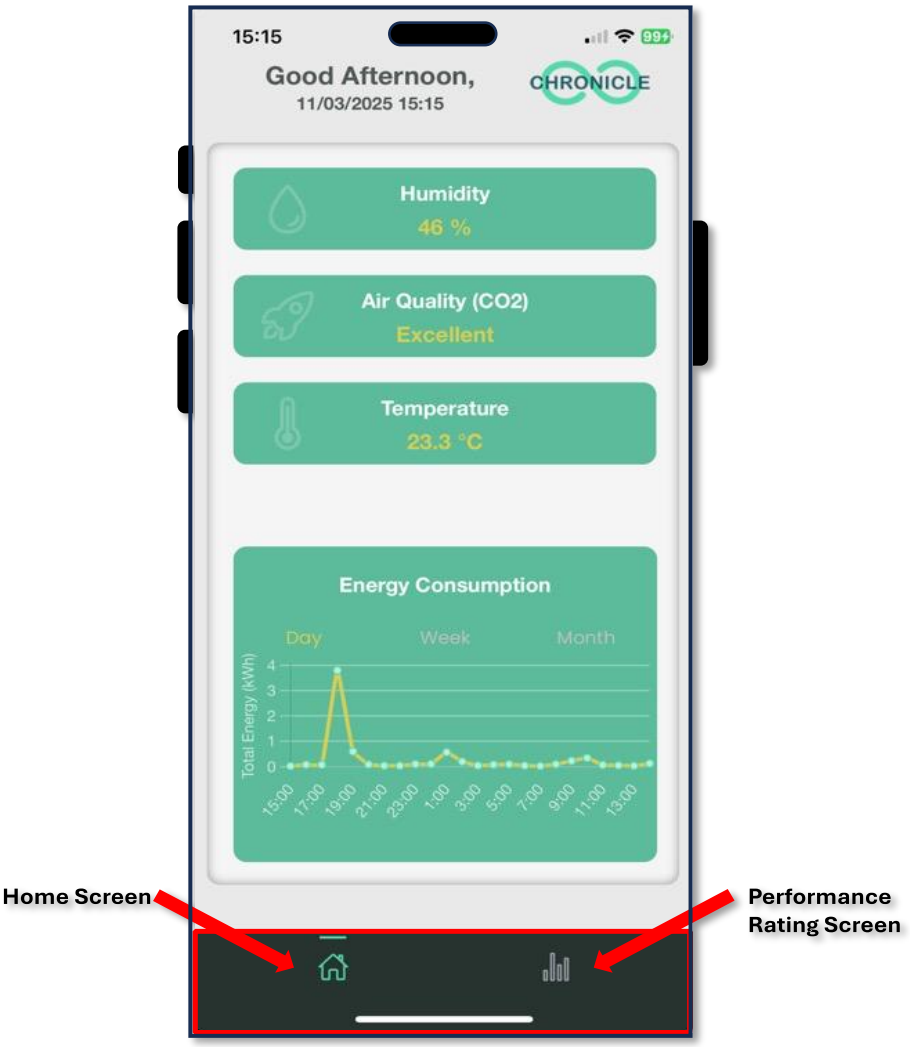


Figure 31 ChroViewOcc - Screen selection Buttons

In the Performance Rating Screen (Figure 32), the monthly household performance is evaluated under two aspects, Smart Readiness and Energy performance, using energy consumption data collected through the IoT equipment installed on site. The ratings are presented through two dedicated charts, presenting the values for the month selected by the user.

Smart Readiness is calculated on an automated manner based on a BIM-to-SRI approach while every month, the score calculation weights are re-adjusted based on actual energy data collected on site. This approach is developed based on the calculation methodology developed in T2.5 (reported in D2.2). The Energy Performance refers to the building's ratings against boundaries which are defined based on a best (most efficient usage) and a worst-case scenario (least efficient usage). These boundaries are building specific and are calculated anew per month through a physics-based, energy performance simulation model.

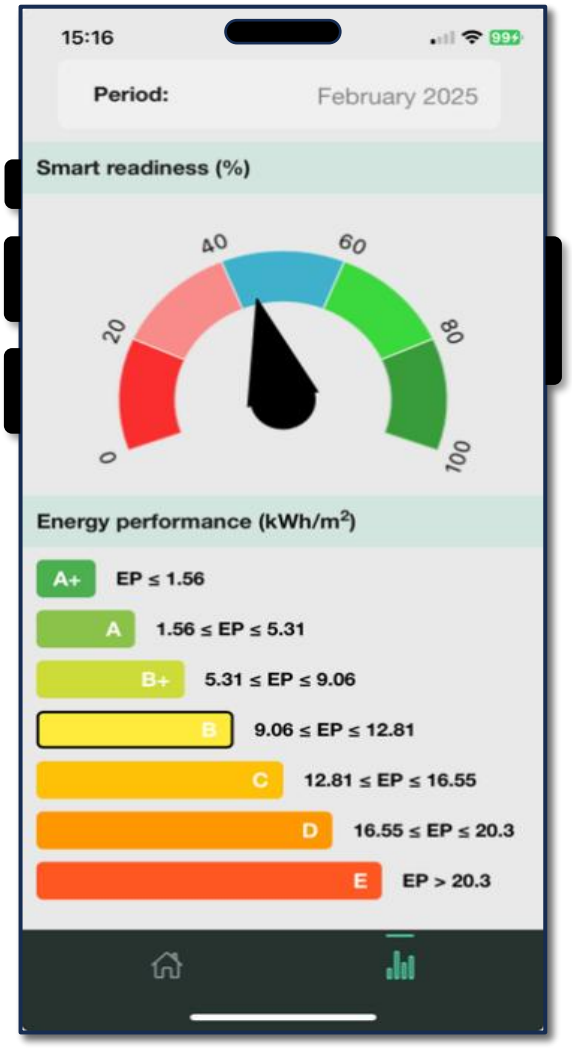


Figure 32 ChroViewOcc - Performance Rating Screen

Both charts display the monthly ratings which are updated taking into account the total energy consumption of the previous month and provide a friendly and comprehensive overview of the tenant's monthly performance. More specifically, the energy performance graph has stepped on the standard EPC representation in to create a familiar and comprehensive experience for the app users.

Historical ratings are available depending on the IoT data collection period on site, and the users can select the month for which they want to inspect their household performance (Figure 33).

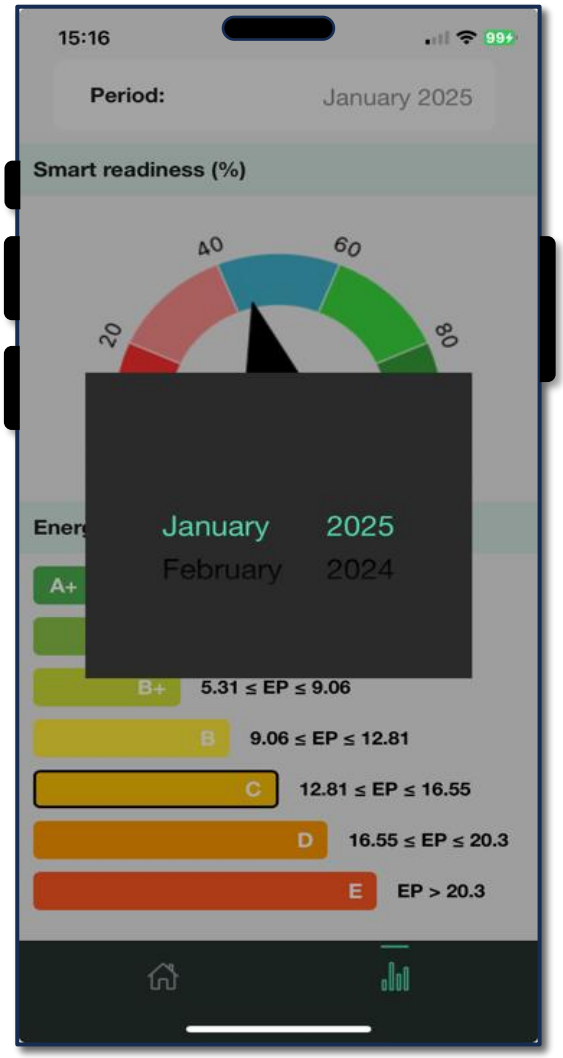
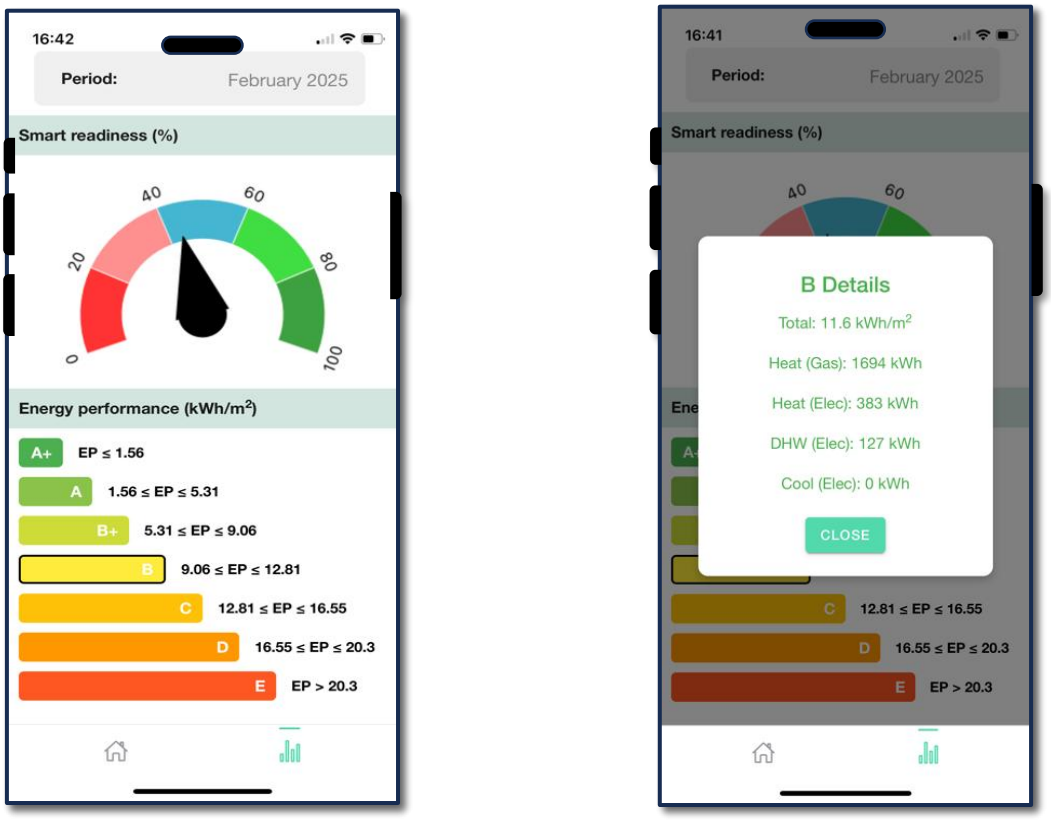
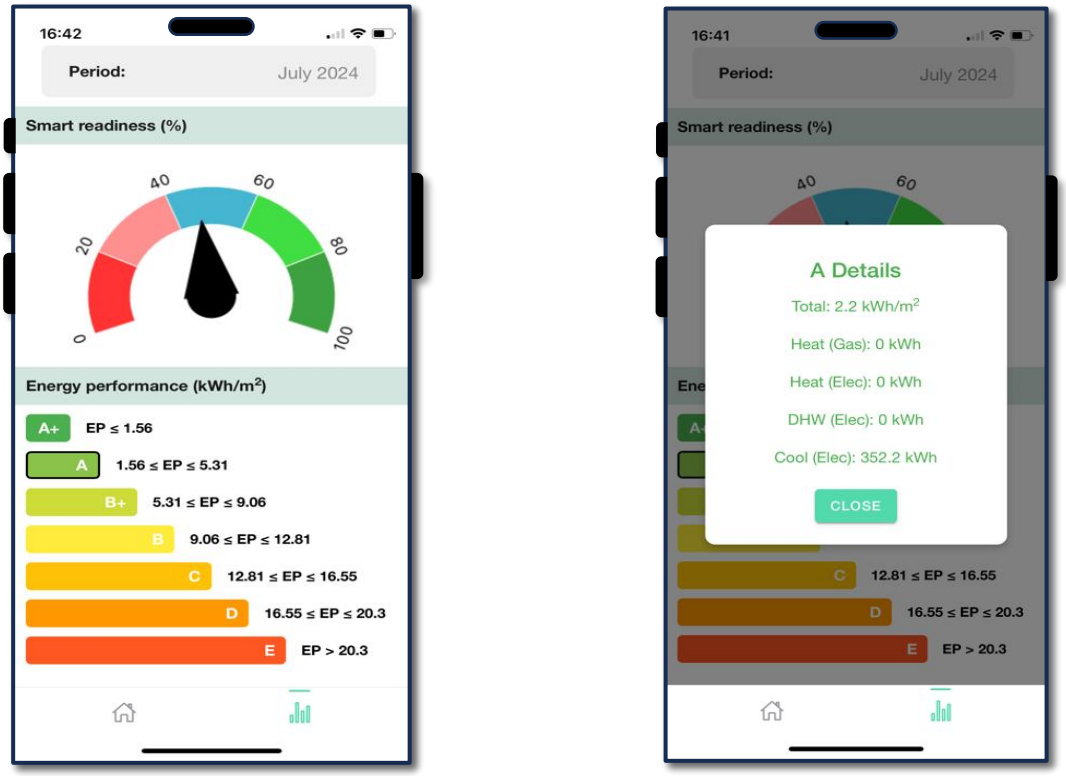


Figure 33 ChroVewOcc - Performance rating date selection

Upon selecting a month, the graphs are updated to display the respective rates. By tapping on the standing energy performance value, the user can drill into the month's energy details including the total household consumption per square meter (defining the final monthly rating), and total monthly consumption of the loads for which measurements are available on site (Figure 34). This allows the user to identify how energy consumption is distributed per month, and which are the factors influencing their performance. It is worth noting that only the most energy intensive loads are considered for this analysis (heating, cooling, domestic hot water) and only if they are measured by the IoT equipment installed on site.



- Rating (left) & details (right) for a winter month (February 2025)



(a) Rating (left) & details (right) for a summer month (July 2025)

Figure 34 ChroViewOcc - Energy performance ratings

5 User Interface 3: ChroViewPlus for ESCOs and technical users

5.1 Functionality Overview

This chapter outlines the main features of ChroViewPlus and explains what the purpose of this UI is and what it is designed for.

ChroViewPlus is a **dashboard mainly designed for building operation insights and recommendations** on strategies for optimising energy usage. The interface allows users to visualise monitoring live data such as energy consumption per source, as well as sensors readings and location (i.e. temperature, CO_2). Additionally, it provides actionable recommendations for energy performance improvements. The main users are technical specialists or industry practitioners.

As described in submitted *D2.1 Business requirements, Use cases & System architecture*, the use case for ChroViewPlus aims to provide insights for commercial buildings, focusing on the following key aspects:

- **Energy & Carbon Performance**: display metrics like energy consumption, usage intensity, costs and carbon emissions.
- **Recommendations and Actionable Intelligence**: analyse the impact of improvements on energy, cost, and carbon savings.
- **Indoor Air Quality** (IAQ): monitored CO2 levels, temperature, and humidity to ensure optimal indoor air quality for occupant comfort and health.

Table 6 below lists the primary functional requirements defined during the initial design phase in WP2, forming the foundation for the user interface and its future development.

ID	Title	Description	Priority	Coverage
FR67	Recommended actions	Provide recommendations for energy performance improvements taking into account comfort, energy and cost	High	Completed
FR68	Current and historical building performance	Display analytics on current and historical building operations and building energy performance.	High	Completed
FR69	LC performance	Display indicators of the building's LC performance	High	Completed
FR70	Recommendations on cost saving opportunities	Look through real systems patterns, compare them with forecast behaviour and recommend cost-saving opportunities.	High	Recommendation services is all included in FR67.

Table 6. ChroViewPlus: Initial Functional Requirements

5.2 Discussion of User Needs Addressed by the Tool

In this section, we will focus on the target users for ChroViewPlus and the problem we are trying to solve.

The use case behind this tool is UC 2.2 Building operations insights for professional users described in "*D2.1 Business requirements, Use cases & System architecture".* The main actors involved are ESCOs, building owners and professionals seeking live performance insights and recommendations about energy, carbon and occupant comfort in buildings.

The problem we are addressing with ChroViewPlus is helping commercial buildings with recommendations and insights on how to improve energy use. The dashboard will assist those who need to identify performance gaps, reduce energy inefficiencies, address carbon emission targets and finally, make data-driven decisions on building performance.

5.3 Technical Description of Tool Operation

ChroViewPlus is a tool helping Building Decarbonisation and Energy Management. It connects to a timeseries data platform to fetch real data from the target pilots. This platform exchanges data with the CDM via APIs.

The **pre-conditions** for ChroViewPlus deployment are summarized below:

- IoT equipment must be installed on site and monitored.
- Data related to HVAC systems must be collected (heating/cooling operational status and energy consumption).
- Measured Indoor ambient conditions and occupancy status must be available.
- The dashboard should be integrated with the CDE to access live data, or alternatively, be configured to collect static data through other means

The **monitored data** for ChroViewPlus full deployment are summarized below

- Utility consumption data: electricity, Natural Gas etc. If applicable, information about the metering/submetering relationships
- IoT or sensor IEQ data: Temperature, Humidity and CO2. Locations are required.
- Baseline Energy Simulation file/results. Applicable when we compare measure against simulated data.
- Floorplans at building and dwelling level

5.3.1 Backend Architecture and Data Management

ChroViewPlus serves as the front-end interface for CHRONICLE's Performance Evaluator. It retrieves time series data on relevant metrics through a robust API connection integrated with CDE. This setup ensures seamless access to live data that supports decision-making and building performance assessments.

As explained in the earlier sections, ChroViewPlus not only tracks live performance data, but also offers a recommendations service on building performance. This service analyses

building data streams and utilises rule-based and data mining techniques. It helps identify deficiencies or operational issues with actionable insights.

The following Figure 35 outlines the general workflow for this dashboard described above.

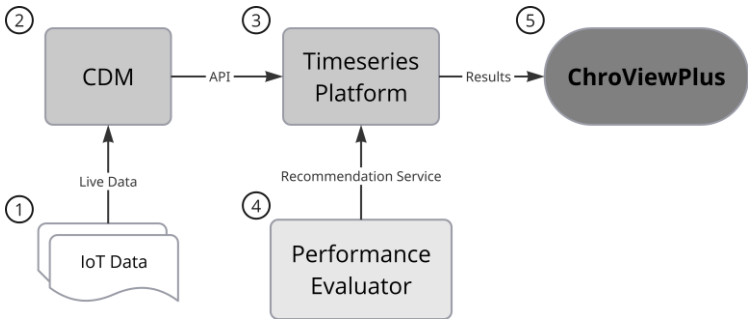


Figure 35. Overall Data Flow for ChroViewPlus Functionality

5.4 Demonstration — Practical Use Case Walkthrough

The functionality of the ChroViewPlus dashboard is illustrated in this section by employing a practical case study. A detailed walkthrough is provided below to guide users through its features and use cases (buttons, navigation, forms, etc.).

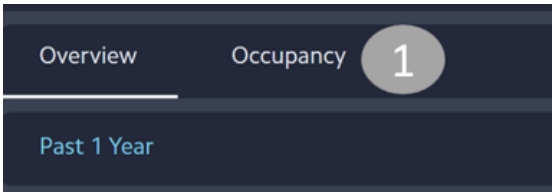
The user interface allows authorised users to access their building site and monitor near real-time performance data. As shown in Figure 36, the landing page depicts a clear overview of key performance metrics and navigation options.

The next Figure 36 demonstrates the entire landing page with all markers described above.

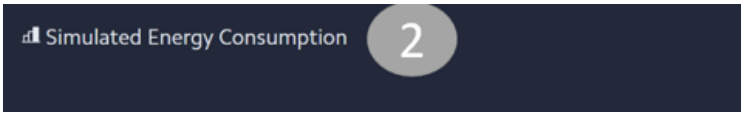
Figure 36. ChroViewPlus: Homepage

Numbered markers in this figure are described below.

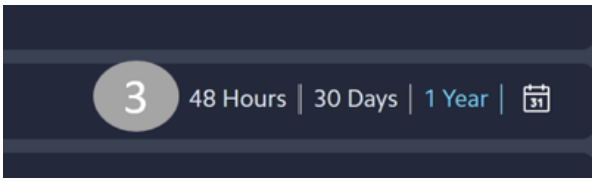
- **Marker 1** positioned at the top of the screen shows the main navigation menu including an overview and occupancy tabs (the available tabs may vary depending on the data accessible, including submetering data).



- **Marker 2** located below 1 reveals the total energy consumption by month during a full year period. This can be simulated, measured and the energy breakdown can be potentially included in a separate tab.

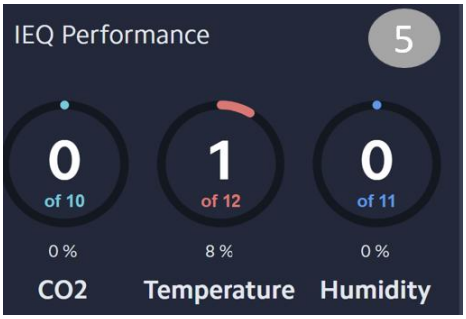


- **Marker 3** at the top right of the screen indicates the time period for wich the data is displayed. The user can select one year, monthly or hourly

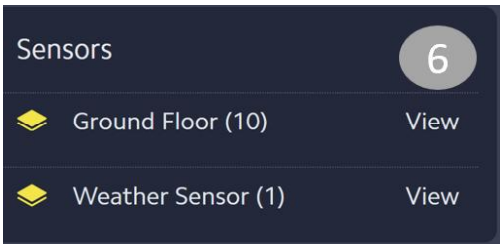


- **Marker 4** at bottom of the screen illustrates an example of relevant KPIs related to weather, energy and comfort (depending on the data accessibility and user needs). Figure 37 provides a detailed view of this feature.

- **Marker 5** located on the left-hand side, provides overall information on Indoor Environmental Quality Sensor; temperature, CO2 and humidity.



- **Marker 6** placed in the middle of the left side displays the list of sensors and corresponding locations (more details in Figure 38)



- **Marker 7** portrays the recommendation service, offering tailored and actionable suggestions based on the data. (more details in Figure 39).

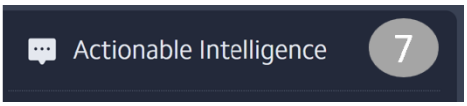


Figure 37. ChroViewPlus: Homepage_Marker 4

Figure 38 presents a more detailed visualisation of marker 6 with the full list of sensors associated to each room of the building. In the centre of the screen, the user is able to see a 3D view of the designated floor and the sensor location.

Figure 38. ChroViewPlus: Visualisation of Sensors_Marker 6

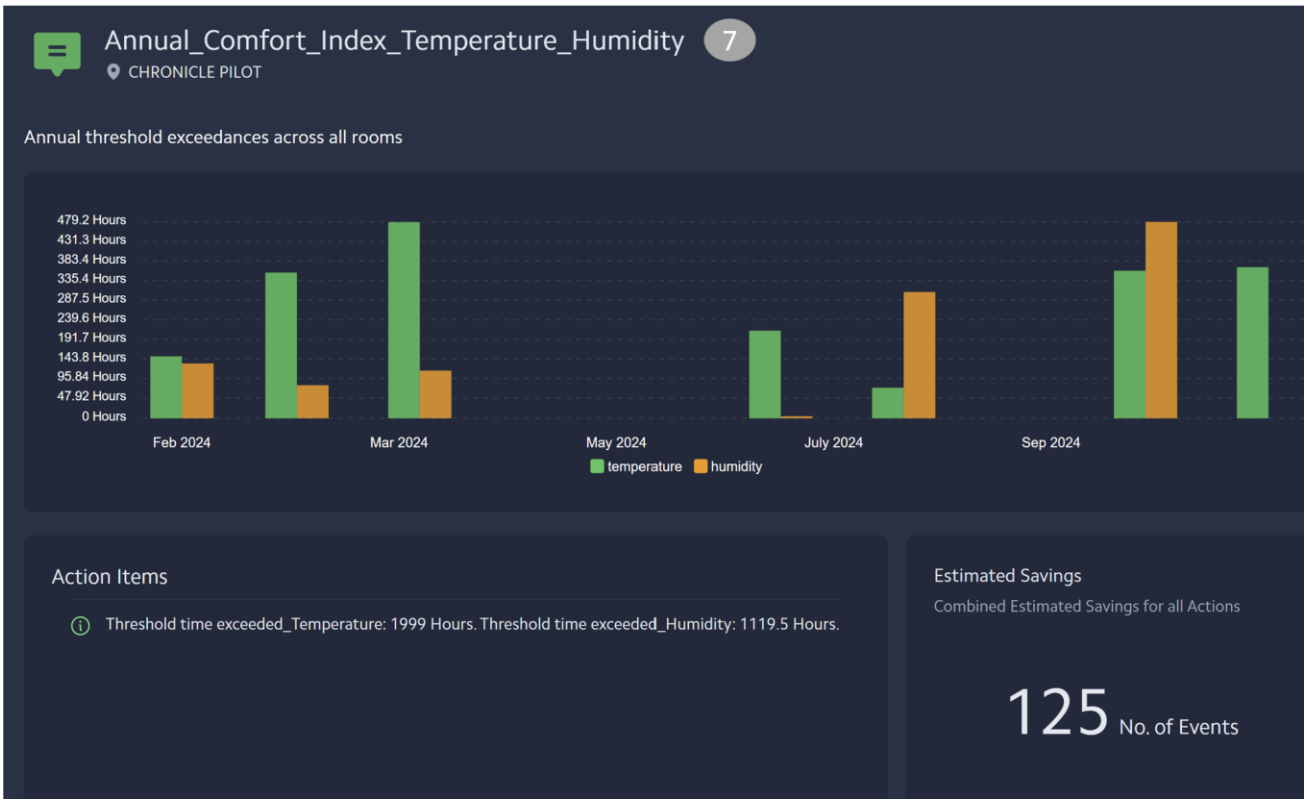


Figure 39. ChroViewPlus: Recommendations_Marker 7

Finally, Figure 39 highlights the key details of Marker 7 related to the actionable intelligence and recommendations service. Currently, the dashboard provides visibility into how often our systems operate outside the defined thresholds. In this demonstration, the main graph

clearly shows the hours when the monitoring of temperature and humidity have exceeded a certain threshold. A fault notification is displayed on the bottom right corner when the temperature has surpassed that threshold for a specific period time. This service is currently in the demo phase and will rely on data provided by pilot projects for its development.

6 Conclusion and further developments

In conclusion, three individual user interfaces have been fully developed and demonstrated using a common case study to showcase their real-world implementation.

ChroViewFM enables users to interact with 3D building models while monitoring real-time data. It is in its final deployment phase, with all core functionalities implemented. Moving forward, efforts will focus on minor bug fixes, performance optimisations, and ensuring system stability. No major feature developments are planned, but continuous monitoring and user feedback will help refine the tool for optimal usability.

The development of **ChroViewOcc** presented a mobile application designed for residential tenants, providing clear visualisations of indoor environmental conditions and monthly energy performance analytics. It is progressing with the final version being refined based on feedback from pre-validation testing. The next steps for the roll-out ensuring mobile compatibility and preparing the app for use across different devices (T5.5), followed by full-scale deployment at the CHRONICLE pilots once the integration of the IoT clouds with the CDE is completed (T5.5). Continuous technical support will be provided for bug fixes and performance tuning based on user feedback during the validation period (T5.4 – T5.5). Minor bug fixes and optimizations will continue as IoT integration is finalized.

The core functionalities of **ChroViewPlus** have been successfully developed and deployed. The dashboard provides valuable insights into building operations, focusing primarily on energy performance and occupant comfort**,** while also delivering actionable recommendations to optimize building usage and efficiency. It is specifically designed for ESCOs**,** building owners**,** commissioning agents, and other industry stakeholders, supporting them with decision-making and efficient building management.

These UIs form part of an iterative development process, where continuous feedback and refinement are integrated in the workflow. Full rollout and deployment will take place in WP5, once real data from the pilot sites becomes available. During this last phase, user testing and feedback will also play a critical role in WP6, ensuring the interfaces are refined based on actual user experience and operational needs.

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