BUILDSPACE

Enabling Innovative Space-driven Services for Energy Efficient Buildings and Climate Resilient Cities

Digital Twins generation and enrichment in BUILDSPACE Pilots

Step by Step Guidelines Use for BUILDSPACE

Service 2. Digital Twin Enrichment

July 2025

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ABBREVIATION AND ACRONYMS

Acronym	Description
BIM	Building Information Modeling
EDL	Eye Dome Lighting
FOV	Field of View
GNSS	Global Navigation Satellite System
RGB	Red Green Blue
SE1	Digital Twin Generation
SE2	Digital Twin Enrichment
SLAM	Simultaneous Localization and Mapping
UAV	Unmanned Aerial Vehicle
URL	Uniform Resource Locator

1. INTRODUCTION

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101082575.

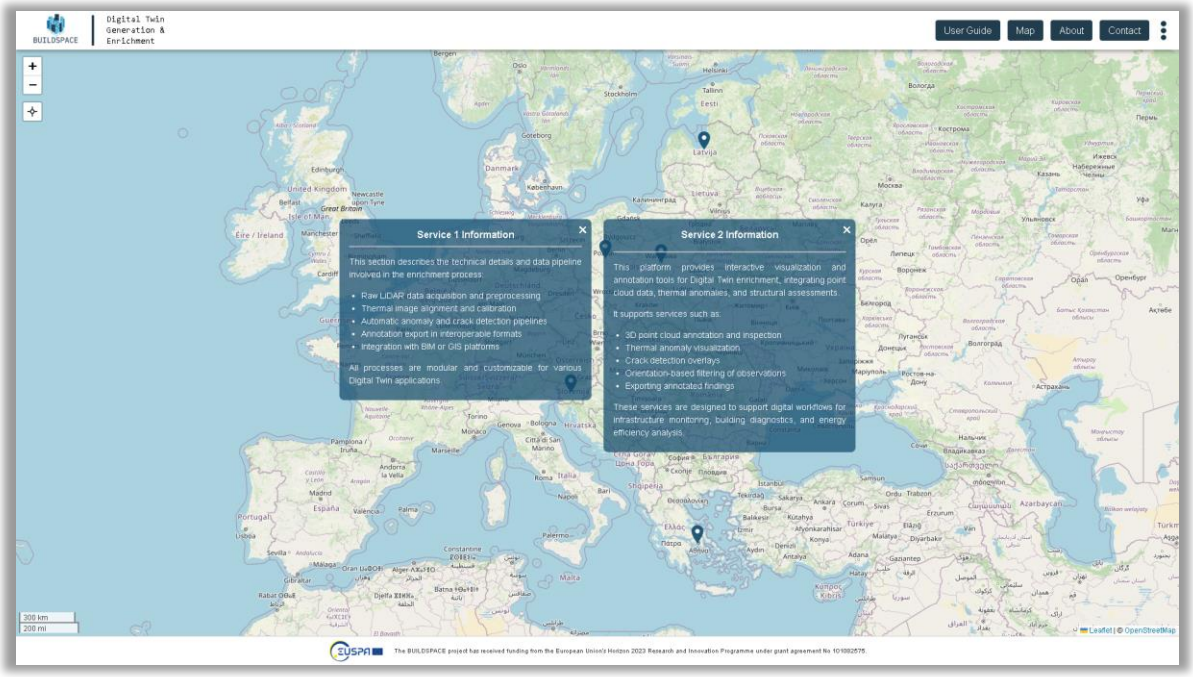
This platform is a central component of the Service 2 - Digital Twin Enrichment, developed under the Horizon Europe project BUILDSPACE (101082575). It is a browser-based geographic information system designed for visualization, analysis, and interaction with multimodal building-related data.

The platform integrates high-resolution datasets such as 3D point clouds, thermal imagery, and BIM models, with GNSS-derived geolocation, offering novel services tailored for stakeholders operating in both building and urban-scale domains. Designed to support Digital Twin (DT) generation and enrichment at the building scale, the platform serves as a user-friendly access point to two core services:

- SE1 – Digital Twin Generation, which builds geometric 3D Bim models using 3D point clouds data.

- SE2 – Digital Twin Semantic Enrichment, which creates enriched geometric 3D models via photogrammetry and laser scanning, enabling in-depth diagnostics and data-driven decision-making.

These services are accessible through a customized visualization platform connected to a pilot map, which serves as the user's navigation tool across project sites.



1.1. Purpose of the platform

The platform has been conceived within SE2 three primary objectives:

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- **Accurate Digital Twin Creation:** Integrate UAV and SLAM-acquired point clouds to generate high-fidelity 3D representations of real-world buildings.
- **Semantic Enrichment and Anomaly Detection:** Automatically classify and detect anomalies such as cracks and thermal inefficiencies (e.g., thermal bridges, anomalies, and photovoltaic panel zones).
- **Support for Stakeholders:** Provide urban planners, facility managers, and researchers with a practical, intuitive interface for extracting actionable information from complex datasets.

Whether you are looking to examine a building's thermal performance or simply navigate through a 3D point cloud of a real building, this guide will walk you through the tools and functionalities available on the platform.

1.2. Key features

- **Pilot Map Navigation:** Explore pilot buildings and test sites across Europe using an interactive map interface, with access to contextual metadata and direct links to services.
- **Integrated Visualization:** Explore RGB, thermal, and classified 3D point clouds, toggle between photorealistic textures and thermal overlays, and customize display settings.
- **Measurement & Inspection Tools:** Measure distances and areas, generate profiles and inspect specific elements (e.g., façade details, windows, and cracks patterns).
- **Automated Reports:** Crack detection and classification outputs, and thermal anomaly clustering.

1.3. What this guide covers

This manual offers step-by-step instructions, annotated visuals, and thorough explanations of the BUILDSPACE SE2 Platform's tools and workflows. It is organized to guide you through:

- Navigating the platforml interface
- Exploring services associated with pilot locations
- Interacting with the 3D viewer tools and reports
- Troubleshooting and best practices for visual diagnostics

2. ACCESS & NAVIGATION

The SE2 browser-based platform is designed for ease of use without requiring additional software installation. This section explains how to access the platform, outlines basic system requirements, and introduces the main interface components.

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2.1. Accessing the platform

To begin using the SE2 platform, open a supported browser such as Google Chrome, Mozilla Firefox, or Microsoft Edge and enter the following public URL https://se2-buildspace.euinno.eu/.

For optimal performance, especially when using 3D visualization, it is recommended to use a device with a dedicated graphics card and a minimum screen resolution of 1366 x 768 pixels. A stable internet connection is also necessary, particularly when loading large point cloud datasets or switching between services.

2.2. Interface overview

Upon loading, the platform presents users with a map-based landing page. This interactive map serves as the main entry point to all available pilot sites and services. Locations across Europe are marked with clickable pins, each representing a BUILDSPACE pilot such as Warsaw, Ljubljana, or Piraeus.

The map is fully interactive and supports intuitive navigation:

- Users can zoom in or out using the mouse scroll wheel or the zoom controls located on the left side.
- To pan across the map, users can click and drag in any direction.
- Hovering over a pin highlights the site; clicking on it opens the location's detailed information window.

At the top of the screen, a persistent navigation bar gives access to essential resources. The "Map" button resets the view to the main landing page, allowing users to quickly return and select a new pilot site. Other menu items include "User Guide", "About", and "Contact", providing easy access to documentation, platform information, and support channels.

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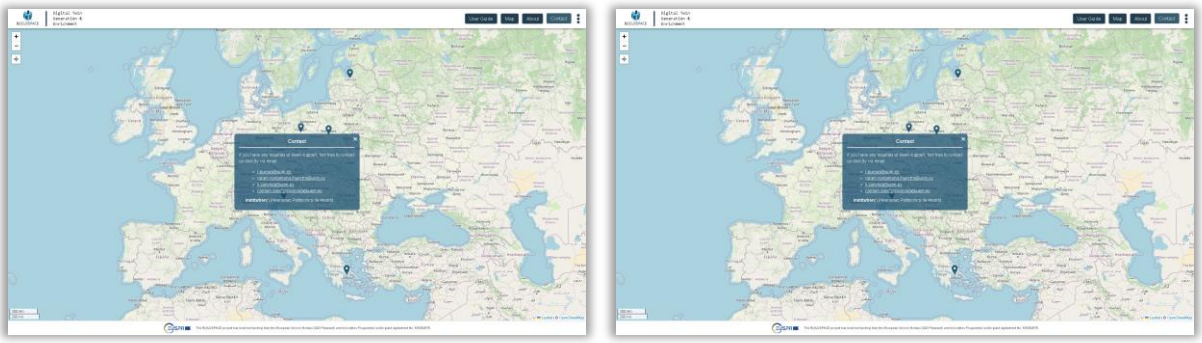

The map interface is designed to be the central navigation hub of the platform. From this view, users can access all pilot data, services, and tools. It is encouraged to explore multiple locations to fully experience the range of digital twin capabilities offered by the platform.

2.3. Accessing platform services

Each pilot site pin opens an information panel containing descriptive metadata about the selected building. This may include the building type, number of floors, use case (e.g., academic, municipal), and any relevant technical details such as sensor deployment or structural characteristics.

Service's interface is customized to reflect the specific data available for the selected pilot site, and within the pop-up, users will find direct links to the platform's two core services:

- **Service 1:** Opens a dashboard for viewing digital twin generation outputs.
- **Service 2:** Launches an interactive 3D viewer, where users can visualize the point cloud, apply semantic classifications, measure structures, and inspect thermal anomalies or façade cracks.

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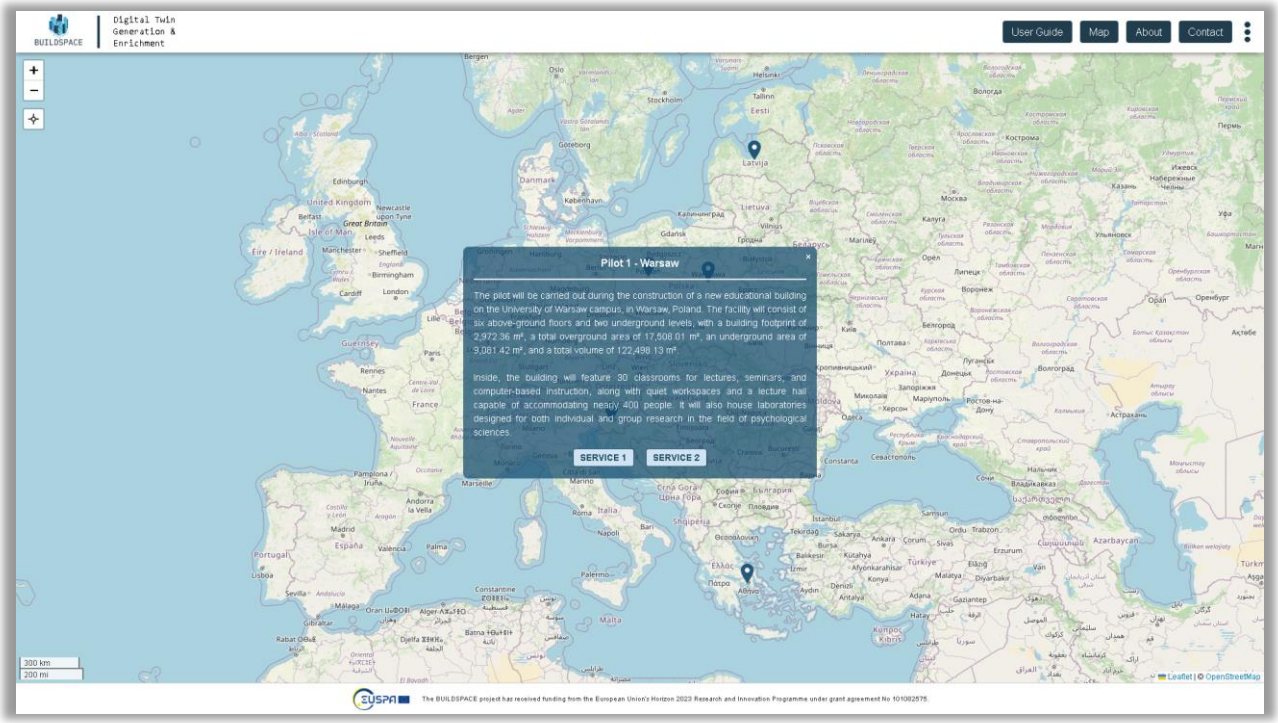

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3. SERVICE 2 3D VIEWER

Service 2 is the most interactive and analytically advanced component of the platform. It is built upon geometric digital twins by integrating semantic layers, thermal imaging, and automated diagnostic tools. Through a browser-based 3D viewer powered by the integration of Potree and Cesium, users can explore complex models of buildings and infrastructures in a seamless and intuitive way.

This service supports a wide range of visual and analytical functionalities tailored for diagnostics, maintenance planning, and energy efficiency assessment without the need for specialized software.

3.1. Interface overview

To access the 3D viewer, navigate to either Warsaw or Piraeus pilot site on the interactive map and click on Service 2 in the corresponding pop-up window. The viewer will automatically load the specific point cloud model associated with that pilot site.

Once the 3D viewer is loaded, the screen is divided into several sections:

- **Main viewport**, this is the central display area where the 3D point cloud model is rendered. Users can zoom, rotate, and pan around the model to explore building structures in full detail. Both Potree (for point clouds) and Cesium (for 3D globe) are integrated into this view.
- **Top toolbar**, providing quick access to common actions such as view resets, and measurement modes.
- **Left sidebar**, containing the project tree and all user-accessible settings grouped under different tabs.
- **Right sidebar**, containing the attribute toggles and legend, which controls how data is visualized.

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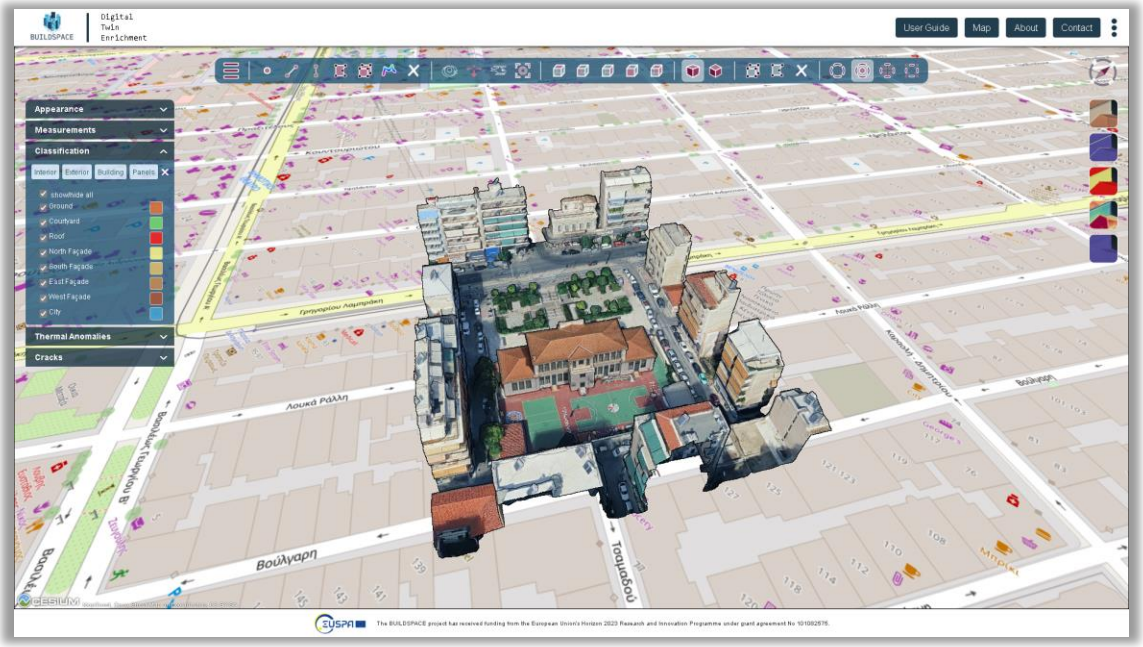

This interface provides all necessary tools for conducting technical assessments and visual exploration of building digital twins in a single, accessible environment.

3.2. Main viewport

The main viewport is the central area of the 3D viewer where the building's 3D point cloud is displayed. It serves as the primary workspace for visual inspection and analysis. Users can navigate within this space using mouse or trackpad controls:

- **Left click and drag** to rotate the model
- **Right click and drag** to pan across the scene
- **Scroll wheel** to zoom in and out
- **Double click** on any surface to center the view on that point

The viewport dynamically responds to changes made in the sidebars, such as activating thermal layers, toggling classifications, or isolating geometry using clipping tools. For spatial orientation, a small compass indicator appears, showing the current viewing direction relative to North.

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3.3. Top toolbar

3.3.1. Menu toggle

- This section controls the visibility of the **left sidebar**, which contains all core tools, settings, and model controls. By clicking the menu icon, users can **collapse or expand the sidebar** to maximize the viewing area.

3.3.2. Measurement tools

This section provides essential tools for geometric analysis within the 3D model. Users can measure distances, heights, and surface areas, as well as create vertical profiles of structural elements. These tools are particularly useful for understanding spatial relationships and verifying dimensions directly within the 3D point cloud.

Point: Select a single point to display its coordinates and attribute data.

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Distance: Measure the linear distance between two or more points in space.

Height: Measure vertical distance between two selected points.

Area: Calculate the surface area of a polygon.

Profile: Create a vertical cross-section of the point cloud along a user-defined line.

Clear Measurements: Remove all existing measurement annotations.

3.3.3. Navigation

This section provides advanced navigation settings that enhance the visual clarity and interactivity of the 3D viewer. Users can toggle between orbit and first-person navigation modes for optimal data interpretation.

Navigation modes: Earth control, orbit control and fly mode.

Full extent: Overview to locate the model.

3.3.4. Visualization controls

This section offers quick access to standard view orientations, and to choose between perspective or orthographic camera for optimal data interpretation. These predefined camera angles help users align the model for inspection, take consistent screenshots, or conduct precise measurements aligned with building geometry.

View orientations: Top, front, back, left, and right

Camera projection: Perspective or orthographic

The camera projection toggle allows for switching between perspective view (realistic depth) and orthographic view (parallel lines, no depth distortion nor 3D globe).

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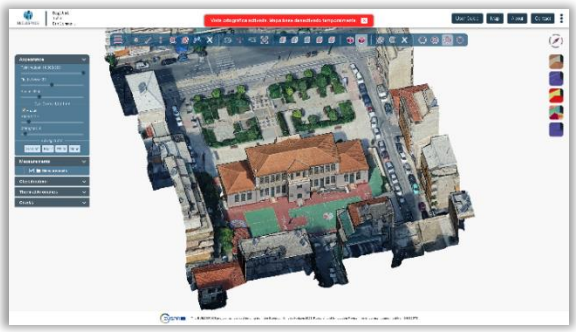
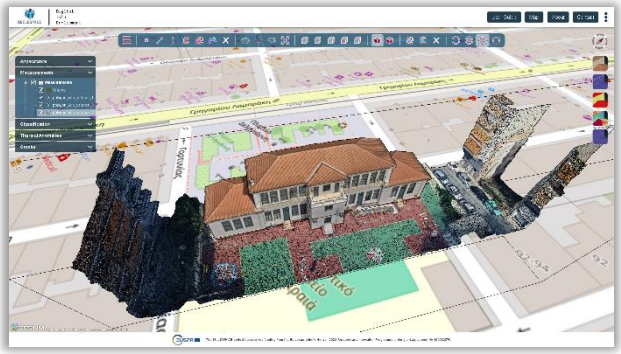


3.3.5. Clipping tools

This section allows users to isolate specific regions of the point cloud for focused inspection. By drawing custom clipping polygons or volumetric boxes, users can hide irrelevant areas and concentrate on sections of interest. Clipping is especially helpful for analyzing façades, interior spaces, or complex structures without visual distractions, optimizing data interpretation and exploration efficiency.

Volume Clipping: Create a 3D clipping box to cut out and examine volumetric regions



Polygon Clipping: Define a custom 2D polygon to extract specific areas of the model

None: No clipping action is applied.

Highlight: The selected area is emphasized visually while the rest of the model remains visible.

Inside: Only the content within the selection remains visible.

Outside: The content inside the selection is hidden, showing only the unselected portions of the model.

3.4. Left sidebar

The left sidebar provides access to the core analytical and visualization controls within the 3D viewer. Organized into collapsible sections, this panel enables users to interact with the 3D point cloud in a structured manner.

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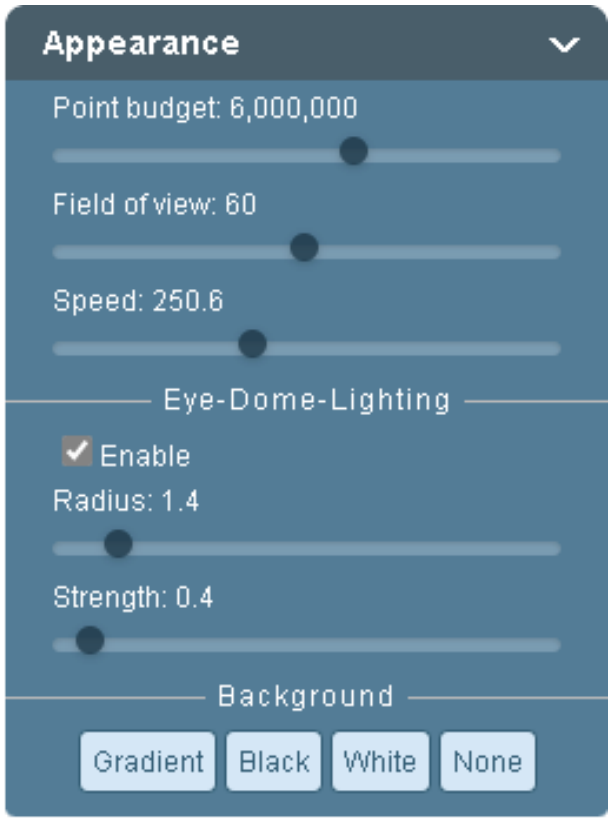
From adjusting rendering to accessing precise measurements, applying semantic classifications, or reviewing diagnostics, each section is purposefully designed to support specific analytical tasks making it easy to manage complex digital twin data in an intuitive and user-friendly way.

3.4.1. Appearance

This section enables users to control how the point cloud is visually rendered in the viewer. These settings affect performance, depth perception, and the user's ability to interpret spatial details in the 3D environment.



Point Budget: This parameter allows users to define the maximum number of points considered for display, directly influencing the visual density of the model. The default setting is 6 million points, with an upper limit of 10 million. Reducing it may improve performance.

Field of View: FOV controls the camera's viewing angle from the user's perspective. The default setting of 60 degrees offers a balanced perspective suitable for most analysis tasks.

Speed: This parameter adjusts the sensitivity of camera movement within the 3D environment. A higher value allows for faster navigation across large models, while lower values are preferable for fine inspection.

Eye Dome Lighting: EDL enhances depth perception and edge visibility by simulating ambient shading between nearby points. It adds soft shadows that emphasize the geometry of the model. Users can toggle this feature on or off and fine-tune it using:

- Radius: Controls the width of the shading effect.
- Strength: Determines the intensity of the shading.

Background: The background setting changes the color scheme of the viewer canvas to suit different visual needs or presentation styles.

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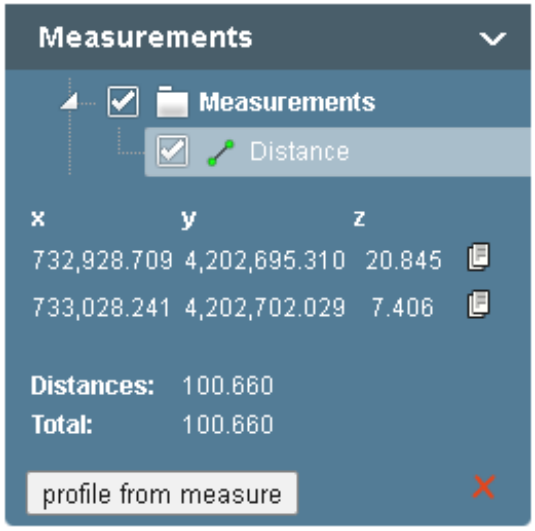
3.4.2. Measurements

The Measurements section allows users to create, manage, and review spatial annotations directly within the 3D environment. Each tool provides geometric insights essential for inspection, diagnostics, and reporting.

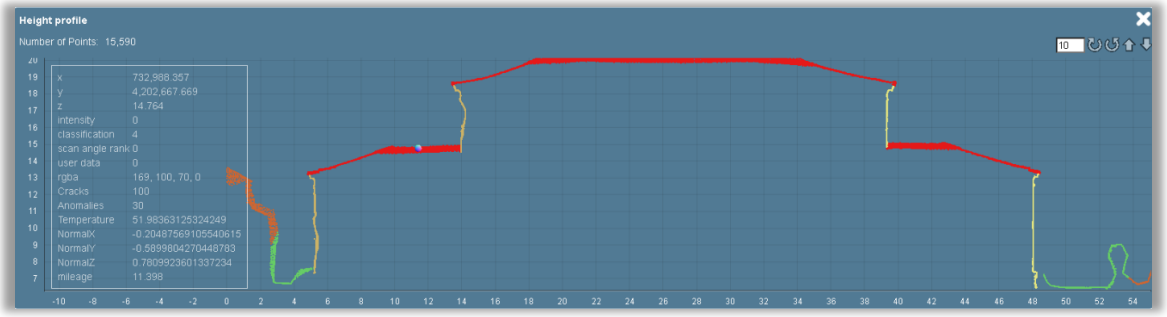


All measurements created using the toolbar are listed here. By selecting one from the list, users can view its specific characteristics, such as coordinates, dimensions, or derived properties. These annotations can be toggled on/off or removed from the scene.

Point, Distance, and Height: In addition to the measurement itself, the system displays the coordinates (x, y, z) and available attribute data of each selected point. This information is valuable for cross-referencing spatial data or verifying positioning.

Area: It provides the coordinates of each vertex, the calculated surface area in square meters, and, if applicable, the total enclosed volume within the defined boundary.

Profile: It includes the start and end coordinates of the selected profile line, along with a 2D profile graph displaying point distribution along the section.



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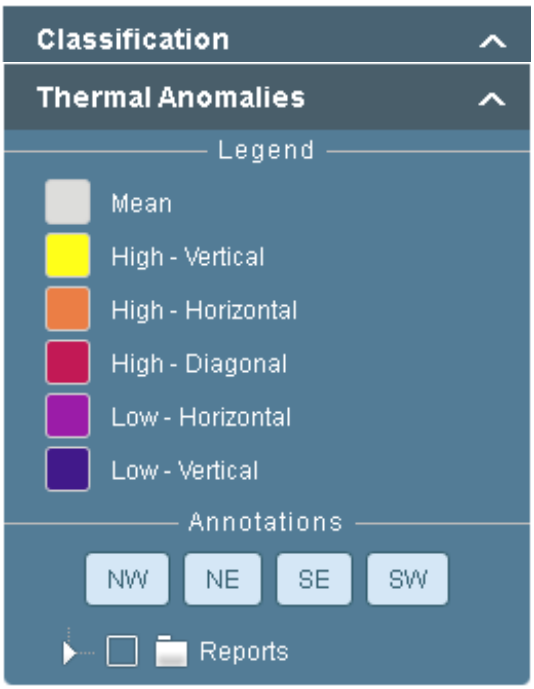
3.4.3. Classification

The Classification section allows users to control the visibility of semantically labeled elements within the point cloud. These classifications are automatically assigned during the semantic enrichment process and represent different building components and surrounding elements.

Users can toggle between predefined filter modes to quickly adjust the visibility of model layers:



Interior: Displays all elements classified as internal.

Exterior: Shows only the building envelope or façade.

Building: Combines both interior and exterior view.

Panels: Highlights photovoltaic surfaces.

Below these, a detailed checkbox list allows for manual control of individual components. Each element is color-coded for quick identification in the 3D view.

A “Show/Hide All” option is also available to toggle all layers on or off simultaneously.

3.4.4. Thermal anomalies

The Thermal Anomalies section provides visual diagnostics based on thermal imaging data integrated into the point cloud. It allows users to quickly identify areas of inefficiencies across the building envelope.

A color-coded legend helps interpret thermal conditions at a glance:

Mean: Represents baseline or average surface temperatures. These areas are considered thermally "normal" and shown in gray.

High: Areas with above-average temperatures. These values may be further broken down by pattern.

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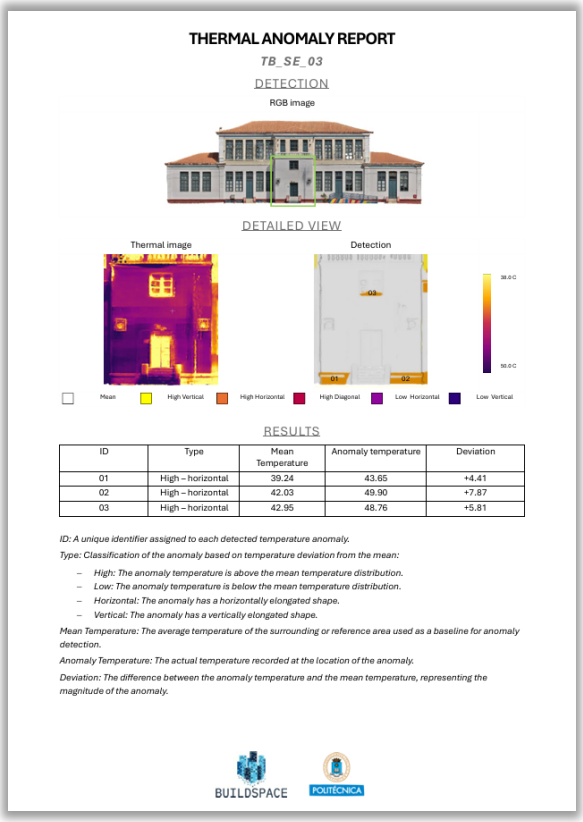
Low: Highlights surfaces with below-average temperatures. These may also be classified by pattern.

Annotations are displayed on the model with directional labels to indicate the specific building zones where anomalies were detected. Clicking on these will toggle the visibility of all annotations assigned to that orientation, making it easier to isolate and inspect anomalies in that specific region.

Clicking on an individual annotation will automatically zoom the camera to the affected area, allowing for close inspection. Linked reports provide further insights, clustering summaries and retrofitting suggestions.



THERMAL ANOMALY REPORT

TB_SE_03

DETECTION

RGB image

DETAILED VIEW

Thermal image

Detection

Mean | High Vertical | High Horizontal | High Diagonal | Low Horizontal | Low Vertical

RESULTS

ID	Type	Mean Temperature	Anomaly temperature	Deviation
01	High – horizontal	39.24	43.65	+4.41
02	High – horizontal	42.03	49.90	+7.87
03	High – horizontal	42.95	48.76	+5.81

ID: A unique identifier assigned to each detected temperature anomaly.

Type: Classification of the anomaly based on temperature deviation from the mean:

- *High: The anomaly temperature is above the mean temperature distribution.*
- *Low: The anomaly temperature is below the mean temperature distribution.*
- *Horizontal: The anomaly has a horizontally elongated shape.*
- *Vertical: The anomaly has a vertically elongated shape.*

Mean Temperature: The average temperature of the surrounding or reference area used as a baseline for anomaly detection.

Anomaly Temperature: The actual temperature recorded at the location of the anomaly.

Deviation: The difference between the anomaly temperature and the mean temperature, representing the magnitude of the anomaly.

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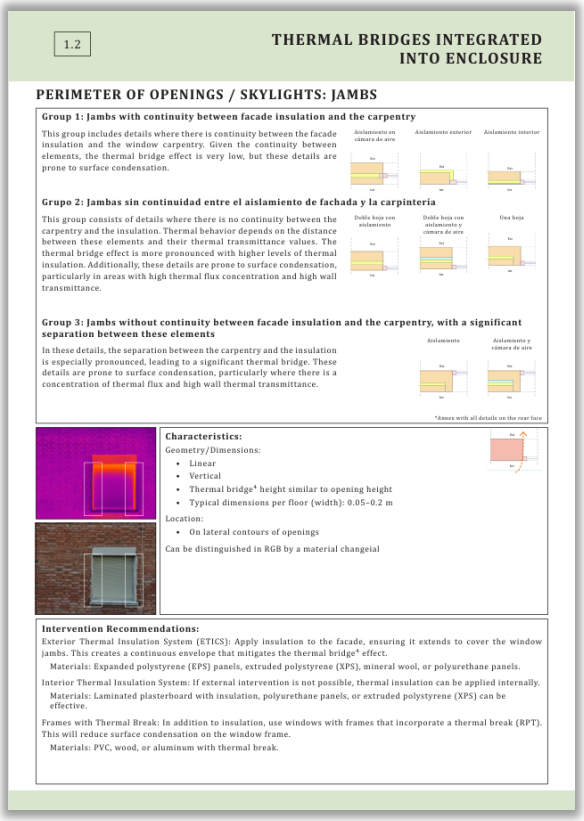

1.2 THERMAL BRIDGES INTEGRATED INTO ENCLOSURE

PERIMETER OF OPENINGS / SKYLIGHTS: JAMBS

Group 1: Jambs with continuity between facade insulation and the carpentry

This group includes details where there is continuity between the facade insulation and the window carpentry. Given the continuity between elements, the thermal bridge effect is very low, but these details are prone to surface condensation.

Grupo 2: Jambas sin continuidad entre el aislamiento de fachada y la carpintería

This group consists of details where there is no continuity between the carpentry and the insulation. Thermal behavior depends on the distance between these elements and their thermal transmittance values. The thermal bridge effect is more pronounced with higher levels of thermal insulation. Additionally, these details are prone to surface condensation, particularly in areas with high thermal flux concentration and high wall transmittance.

Group 3: Jambs without continuity between facade insulation and the carpentry, with a significant separation between these elements

In these details, the separation between the carpentry and the insulation is especially pronounced, leading to a significant thermal bridge. These details are prone to surface condensation, particularly where there is a concentration of thermal flux and high wall thermal transmittance.

Characteristics:

Geometry/Dimensions:

- Linear
- Vertical
- Thermal bridge[4] height similar to opening height
- Typical dimensions per floor (width): 0.05–0.2 m

Location:

- On lateral contours of openings

Can be distinguished in RGB by a material changeial

Intervention Recommendations:

Exterior Thermal Insulation System (ETICS): Apply insulation to the facade, ensuring it extends to cover the window jambs. This creates a continuous envelope that mitigates the thermal bridge[4] effect.

Materials: Expanded polystyrene (EPS) panels, extruded polystyrene (XPS), mineral wool, or polyurethane panels.

Interior Thermal Insulation System: If external intervention is not possible, thermal insulation can be applied internally.

Materials: Laminated plasterboard with insulation, polyurethane panels, or extruded polystyrene (XPS) can be effective.

Frames with Thermal Break: In addition to insulation, use windows with frames that incorporate a thermal break (RPT). This will reduce surface condensation on the window frame.

Materials: PVC, wood, or aluminum with thermal break.

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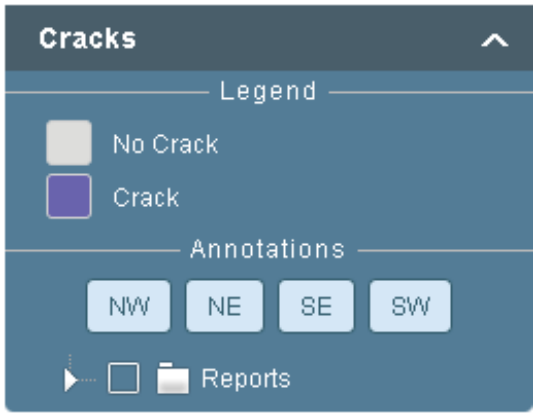
3.4.5. Cracks

The Cracks section highlights structural pathologies detected on building façades, specifically focusing on visible surface cracks identified through semantic enrichment and image-based analysis.



Cracks are visualized as color-coded overlays on the 3D point cloud, allowing users to quickly detect and assess areas that may require maintenance or further structural evaluation. The legend includes:

No Crack: Areas without detected damage are displayed in gray.

Crack: Areas where cracks have been identified are highlighted in purple.

As with thermal anomalies, directional annotations are used to label façade zones. Clicking on any of these labels toggles the visibility of all crack annotations for that region, making it easy to focus inspection on specific building orientations.

Clicking on an individual crack annotation zooms the viewer into the affected area for detailed examination. When available, linked reports can be accessed through icons in the panel, offering summaries that include crack location and distribution, and recommended follow-up actions.

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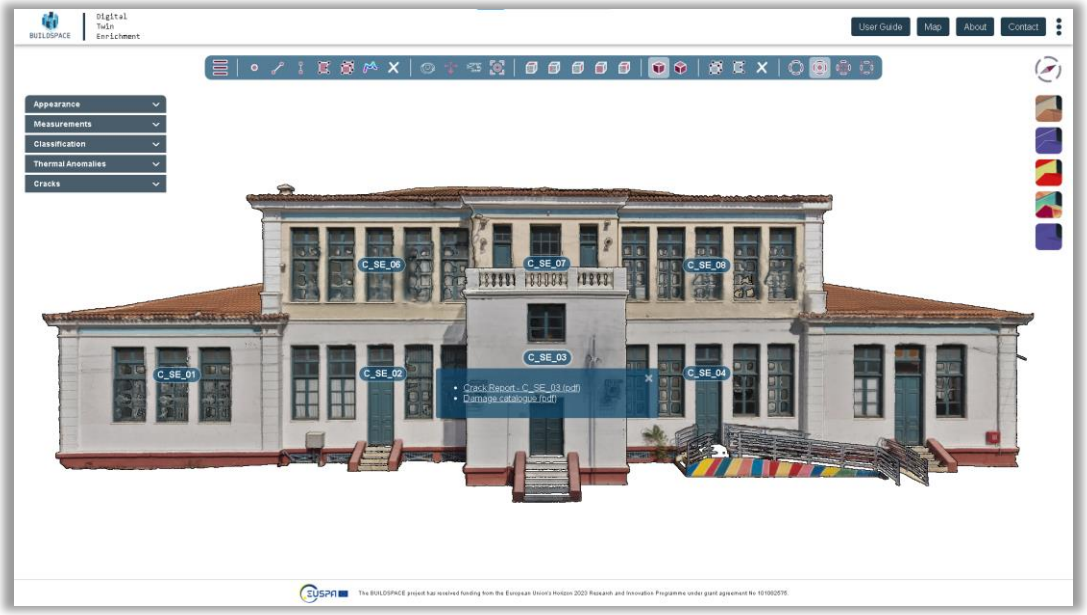

3.5. Right sidebar

The Right Sidebar is dedicated to attribute visualization and data interpretation tools. It allows users to switch between different modes of rendering the point cloud, providing access to thematic overlays such as RGB color, thermal data, and semantic classifications. Users can use this sidebar to tailor the visual context of the 3D model based on the type of analysis they are performing. Whether identifying temperature anomalies or reviewing classification outputs.

3.5.1. RGB toggle

Displays the model using true-color textures captured from photogrammetric reconstruction. This mode provides a realistic representation of the building, making it ideal for visual inspections and presentations.

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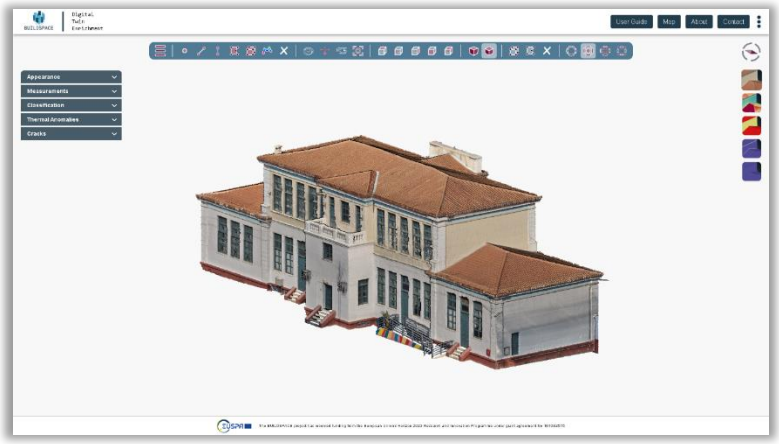
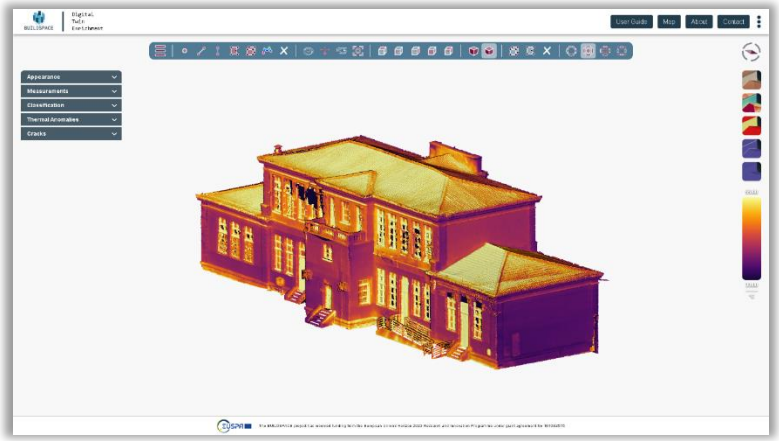


3.5.2. Temperature toggle

Renders the point cloud according to surface temperature values obtained through thermal imaging. This mode visualizes thermal behavior across the building envelope, enabling users to detect anomalies.



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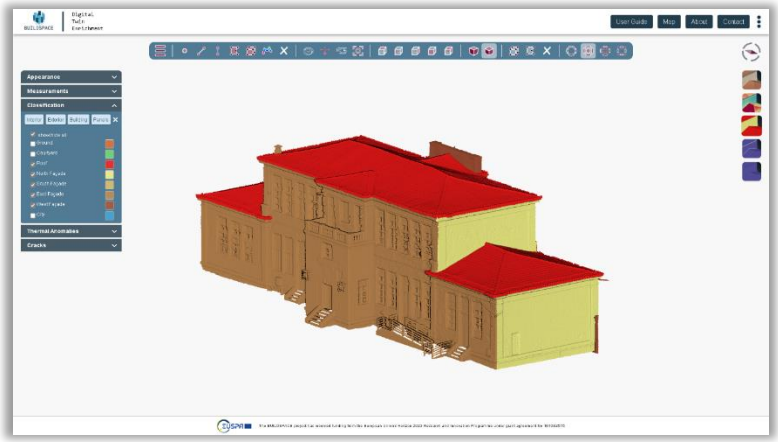
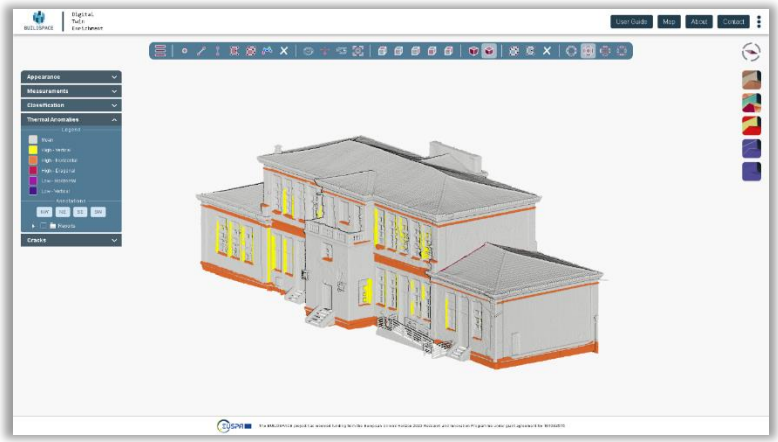
3.5.3. Classification toggle

Color-codes each point based on semantic labels automatically assigned during the enrichment process. These labels correspond to specific building elements helping users isolate and conduct targeted analysis.



3.5.4. Thermal anomalies toggle

Highlights areas of the model that exhibit abnormal thermal signatures, as identified by automated processing. These are categorized relative to the mean surface temperature and further classified by pattern rientation.



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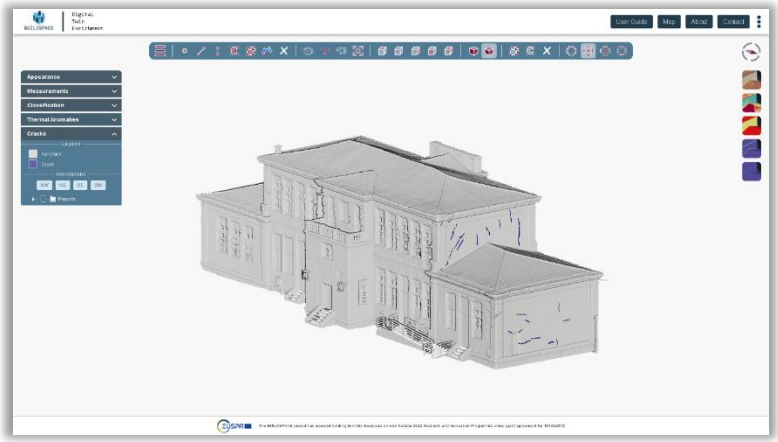
3.5.5. Cracks toggle

Displays detected surface cracks identified through semantic analysis and image-based enrichment. Areas labeled are visually highlighted allowing users to locate and inspect damage without manual annotation.



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4. Support

If you encounter technical issues, need assistance with specific tools, or require clarification on how to use the platform, please use the contact options available within the Geoportal. Your feedback is highly valuable and contributes to the ongoing improvement and expansion of the platform's features and usability.

4.1. When to reach out

Consider contacting support if:

- A service (e.g., Service 1 or Service 2) does not load or respond properly.
- You experience persistent errors, loading issues, or interface malfunctions.
- A feature is not working as expected, and you need further help despite reviewing the user guide.

4.2. Best practices for reporting issues

To help the support team resolve your issue efficiently, please include the following details in your message:

- Your browser name and version (e.g., Chrome 122).
- The operating system you are using (e.g., Windows 11, macOS).
- The name of the pilot site and service (e.g., Warsaw – Service 2).
- Screenshots or a screen recording, if possible.
- A description of what you were doing when the issue occurred.
- This information will allow the support team to reproduce the problem, provide accurate guidance and apply fixes.

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