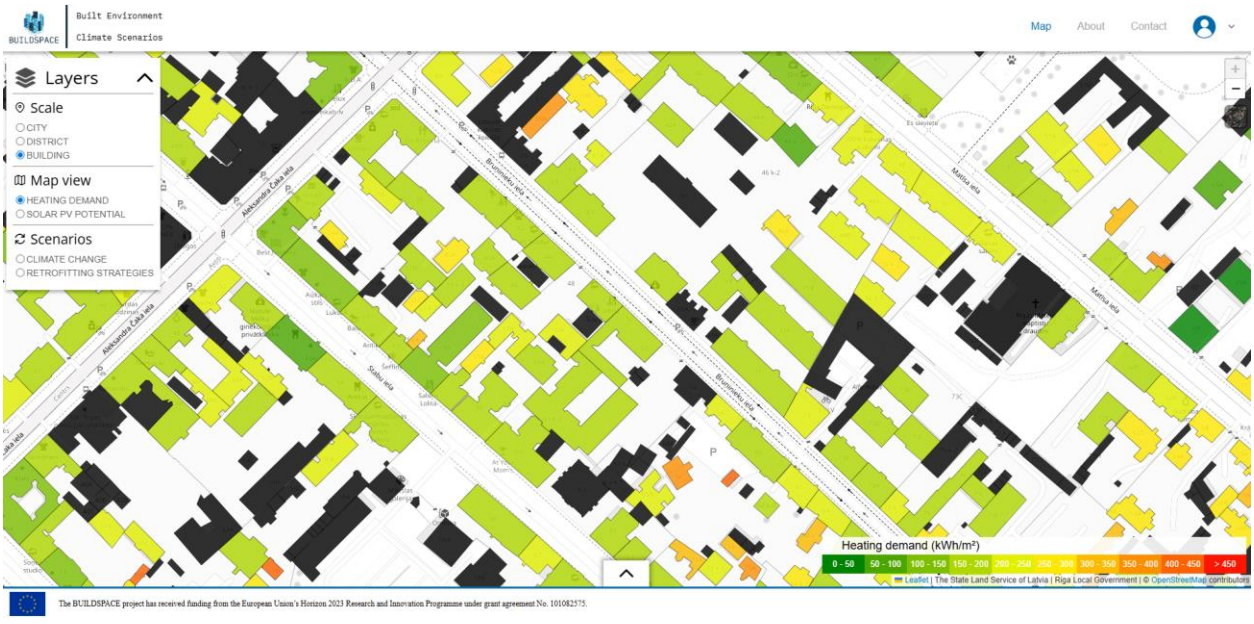
BUILDSPACE

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

BUILDSPACE Service: Built Environment Climate Scenarios – Step-by-step user guide



BUILDSPACE offers a set of interactive, city-scale services that help urban planners, municipalities, and decision-makers understand how climate change affects buildings and neighbourhoods. These services combine satellite data (Copernicus, EGNSS), local information and advanced modelling to visualise risks and opportunities for energy, heat and floods. Through intuitive map-based tools, cities can explore their current situation, test future scenarios, and assess strategies for resilience and sustainability. Each service focuses on a different aspect of urban resilience, but together they provide a common decision-support framework for climate-smart planning.

Contents of this guide

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

1. Introduction

The **Built Environment Climate Scenarios** service supports cities in understanding how their building stock performs under current and future climate conditions. It visualises and analyses heating and cooling energy demand, allowing users to simulate the impact of climate scenarios, retrofitting strategies and rooftop solar photovoltaic (PV) potential.

Whether you are an energy planner, climate officer or policy advisor, the service provides a clear, map-based environment to **explore**:

- Current energy demand across the city or district level, using EPC-based colour scales
- Projected changes in energy demand under IPCC climate scenarios (SSP245, SSP370, SSP585)
- The effectiveness of renovation strategies in reducing demand
- Solar PV potential and associated investment opportunities

The service integrates Copernicus climate data, building geometry and energy modelling results into an intuitive web interface, helping decision-makers identify energy hotspots, prioritise retrofitting actions and support climate adaptation planning.

Figure 1 summarises the service workflow, from analysing current building performance to exploring future scenarios, testing retrofitting measures and assessing solar PV potential on the path toward more sustainable and resilient cities.

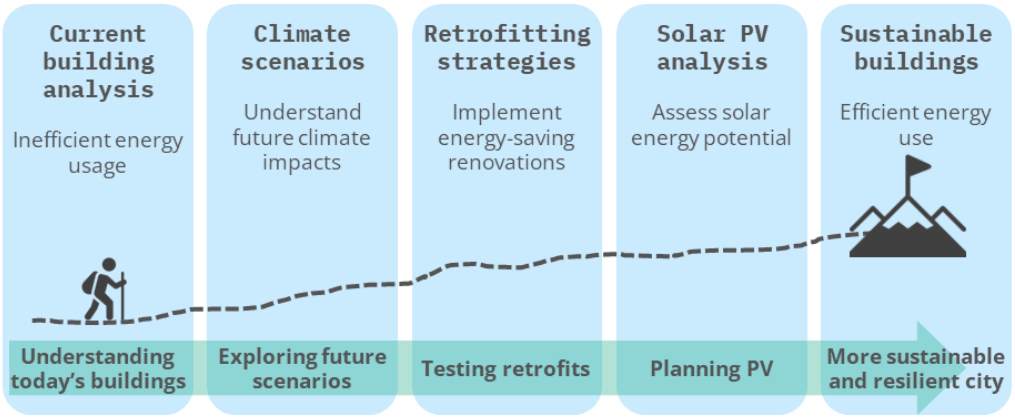


Figure 1. Overview of the service workflow for building climate scenario analysis

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2. Getting started

Once you receive your credentials from the BUILDSPACE team, you can begin exploring the Built Environment Climate Scenarios web application, an interactive, map-based tool that visualises and analyses the energy and climate performance of buildings across a city.

2.1. Log in

1. Open the web browser (Chrome is recommended for best performance).
2. Visit: **https://tools.cartif.es/built-climate-scenarios**
3. Enter the username and password provided to you.

You will see a login window prompting you to input your credentials (Figure 2). After successful authentication, the application will automatically open the main interface.

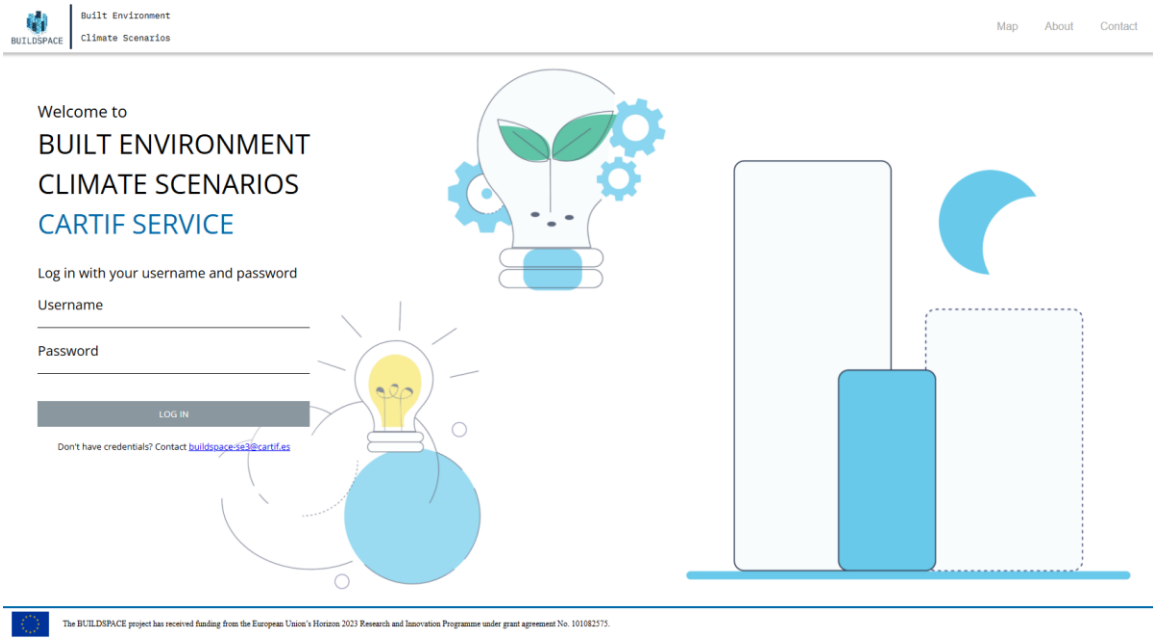

Figure 2. Login page

Note: Account creation and password recovery are not available directly through the platform. For access or technical assistance, contact the BUILDSPACE team through the email provided (buildspace-se3@cartif.es).

2.2. Landing on the main interface

After logging in, the main interface appears: a map-based view displaying the city's building stock colour-coded by estimated **heating energy demand** (Figure 3).

You'll immediately notice several key components:

- **Interactive map:** shows buildings across the selected city or district
- **Side panel:** opens when clicking on a building to display detailed information

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- **Bottom analytics bar:** summarises statistics for the visible buildings (expandable from the bottom tab)
- **Map controls:** zoom, pan and background selection tools located in the top corners of the interface.

Figure 3. Main map interface showing building-scale view and energy demand colouring

From here, you can start exploring:

- Current energy demand distribution
- Future climate scenarios and timeframes
- Retrofitting strategies and their effects
- Solar PV potential

Each of these functionalities is explained step by step in the following sections.

2.3. About

The ***About*** section introduces the purpose of the Built Environment Climate Scenarios tool, its main functionalities, and the scientific sources behind its calculations. It explains how the service estimates the current and future energy demand of the building stock under different climate scenarios and supports the evaluation of retrofitting measures and solar-energy opportunities.

This section (Figure 4) is the best starting point for new users before exploring the interactive maps and dashboards. It can also be accessed directly from the login page, allowing users without credentials to learn more about the service.

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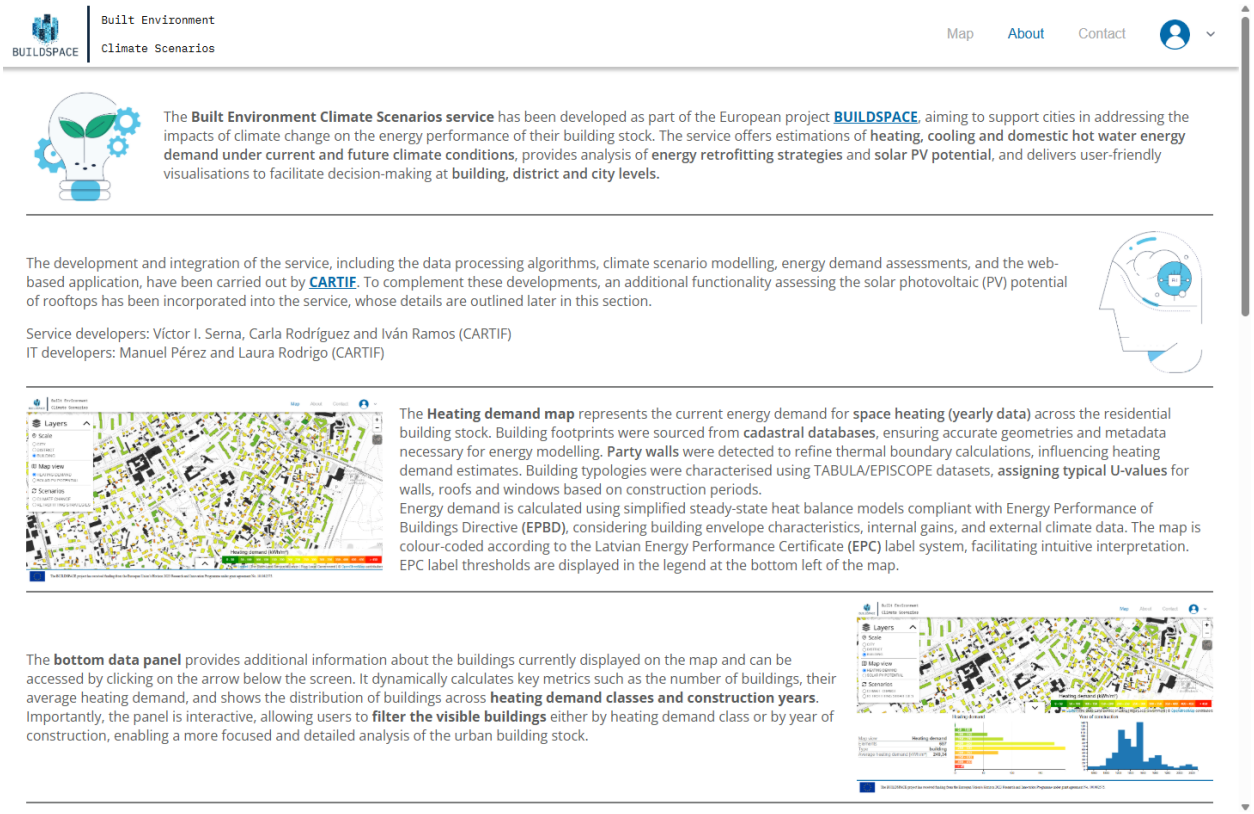

Figure 4. The "About" section introduces the Built Environment Climate Scenarios service, its objectives and credits

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3. Navigating the interface

Once logged, the application gives access to an interactive city map where users can explore the energy performance of buildings, compare climate scenarios, simulate renovation strategies, and assess solar photovoltaic (PV) potential.

This section introduces the main components of the interface to help you move easily through its panels and tools.

3.1. Map controls

The central element of the interface is the **interactive map**.

You can navigate and explore different city areas using the following controls:

- **Zoom in or out:** use your mouse wheel or the + / – buttons located in the top-right corner.
- **Pan:** click and drag the map with your mouse to move around.
- **Change background:** switch between two map types using the background selector:
  - ***Default map***: a clean, neutral base that highlights colour-coded data layers.
  - ***Coloured imagery map***: a coloured imagery background that helps identify rooftops, streets and urban features (Figure 5).

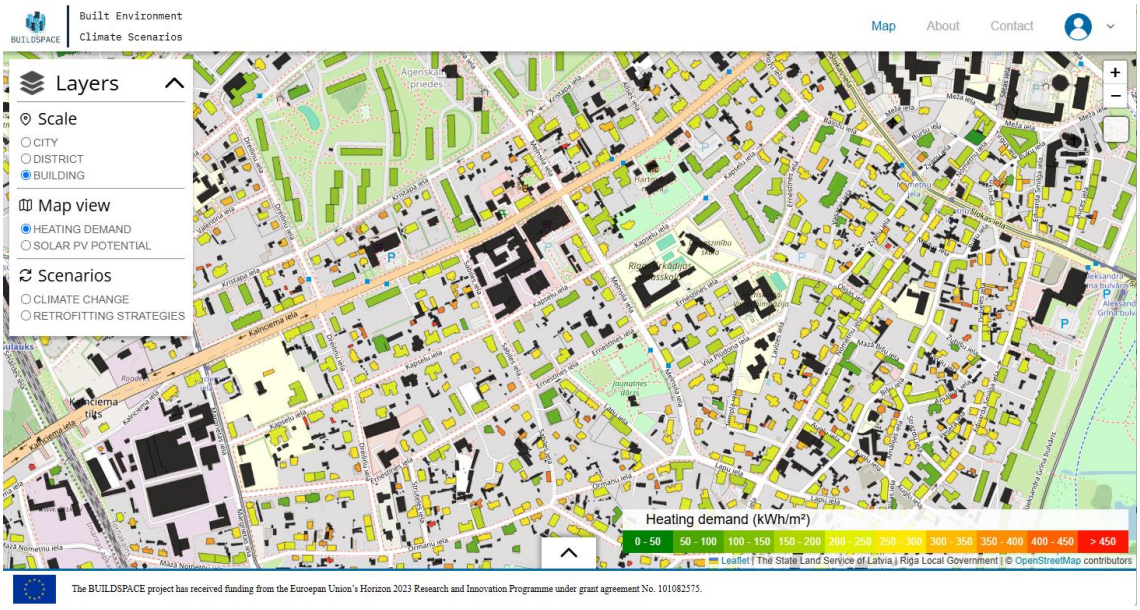

Figure 5. Basic map controls and navigation tools (coloured map background)

As you hover the cursor over the map, **pop-ups** automatically display quick insights on heating energy demand (Figure 6):

- At **building level**, the estimated annual heating demand (kWh/m²).
- At **district level**, the neighbourhood name and its average demand.
- At **city level**, the overall average heating demand.

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This allows you to scan energy performance quickly before applying filters or scenarios.

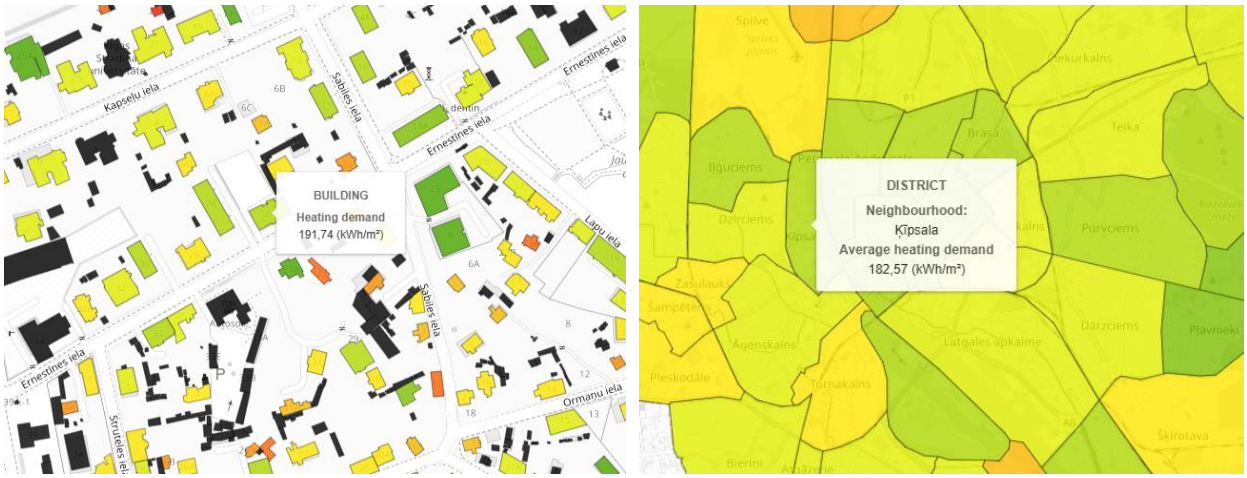

Figure 6. Building- and district-level pop-ups displaying estimated heating demand colouring

The map uses a colour scale inspired by national *Energy Performance Certificate (EPC)* labels (Figure 7).

Buildings are coloured from green (low energy demand, high efficiency) to red (high energy demand, low efficiency), while non-residential buildings are shown in grey.

This intuitive visualisation helps users immediately identify areas with lower or higher energy performance across the city.

Figure 7. EPC-based colour scale for heating energy demand

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3.2. Layers and scenario panel

At the top left of the screen, you'll find the **Layers and Scenarios panel**, which controls what information is displayed on the map (see Figure 8).

Use this panel to select the spatial scale, choose data layers or activate scenario and strategy tools.

- **Scale**: switch between *city*, *district*, or *building* level views.
- **Map view**: toggle between:
  - ***Heating demand view***
  - ***Solar PV potential view***
- **Scenarios**: expand one of the available tools to access:
  - ***Climate change scenarios***: to explore future energy demand under future assumptions.
  - ***Retrofitting strategies***: to test renovation measures and compare results.

You can collapse the section using the small arrows on the left side of the main title.

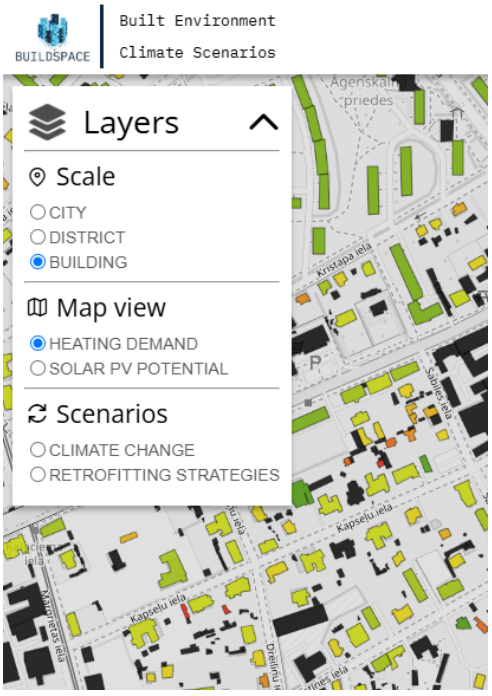

Figure 8. Layers and scenario selection panel

3.3. Building information panel

When you click on a building, detailed information panel appears on the left-hand side of the screen.

This panel provides building-specific data, including (Figure 9):

- Building characteristics, such as year of construction, number of floors, floor area and building type
- Estimated energy demand (heating, cooling, and domestic hot water)
- Envelope assumptions (walls, windows, roof)
- Energy Performance Certificate (EPC) class and compactness indicators

The information shown in this panel refers to the selected building and updates automatically when another building is clicked.

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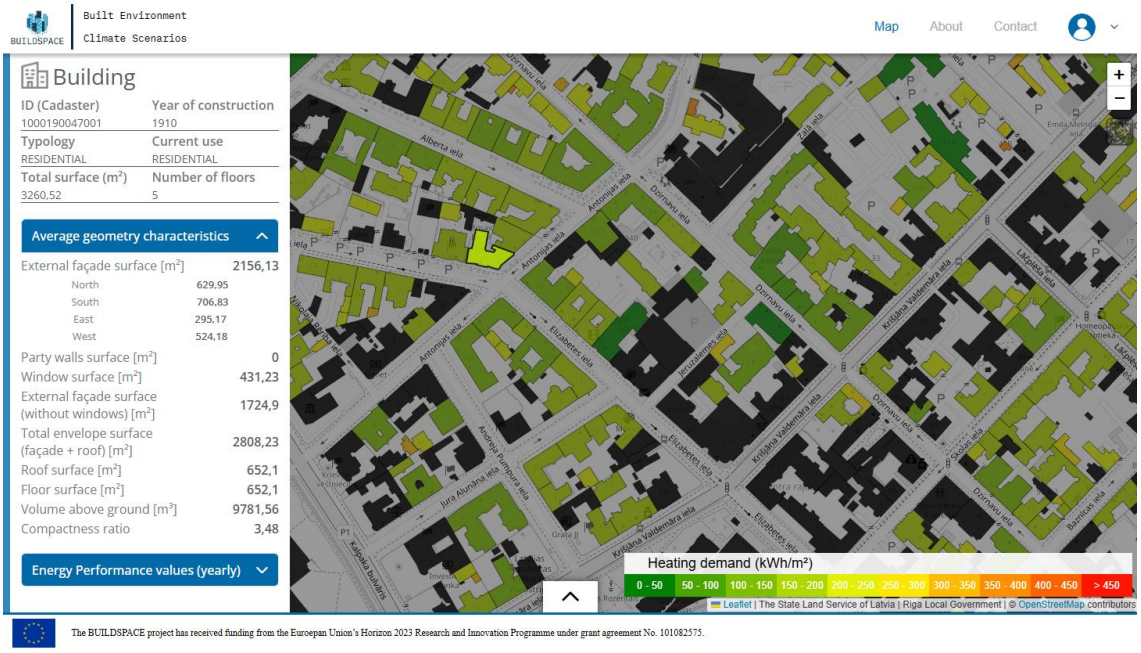

Figure 9. Building information panel

3.4. Summary statistics panel

The **bottom analytics bar** provides an overview of the building stock visible on the map (Figure 10).

It can be expanded by clicking on the tab at the bottom of the interface.

The panel summarises key statistics such as:

- Total number of buildings currently visible
- Average heating demand
- Distribution of EPC classes
- Year of construction categories

Users can apply quick filters from this panel to refine results. for instance, focusing on specific EPC classes or construction periods. See an example in Figure 11, where buildings are highlighted on the map according to the selected EPC classes, showing the best performing buildings (from 0 to 250 kW/m²) in the area.

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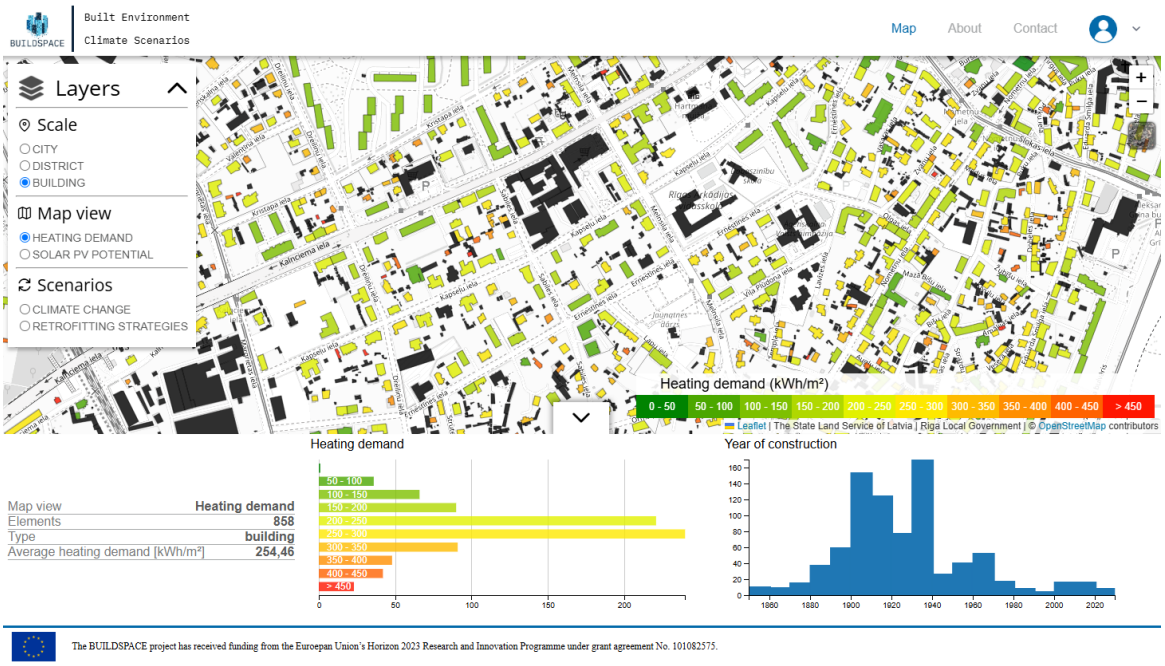

Figure 10. Bottom analytics bar with summary statistics

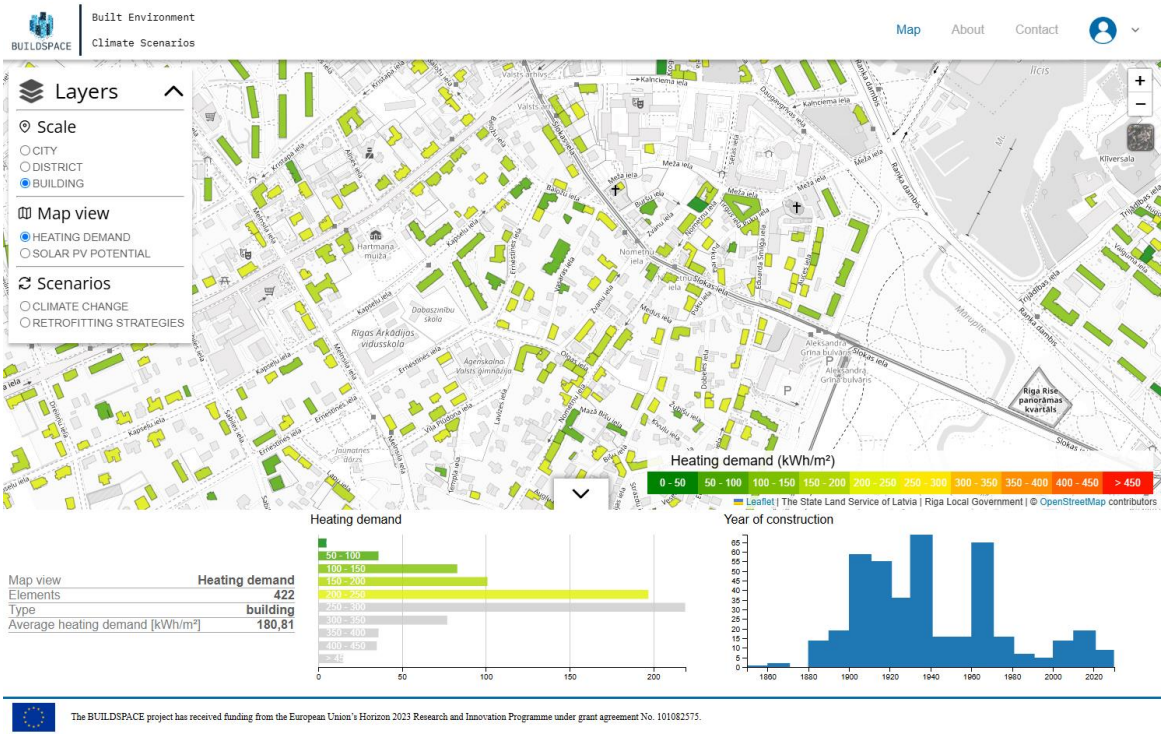

Figure 11. Example of EPC-class filter applied in the summary statistics panel

4. Core functionalities

The application offers three main functionalities that allow users to explore, simulate and plan energy and climate strategies for the building stock:

- **Energy demand and climate scenarios**: visualise current energy performance and assess how it may change under future climate conditions.
- **Retrofitting strategies:** simulate renovation measures and estimate their energy and cost impact.
- **Solar photovoltaic (PV) potential:** evaluate opportunities for rooftop renewable energy generation.

Each functionality can be accessed from the left panel under *Map view* and *Scenarios*.

4.1. Energy demand and climate scenarios

The map visualises the **heating energy demand** of residential buildings across the city, based on their geometry, typology, and energy modelled parameters.

This view helps identify energy-intensive zones, compare performance between neighbourhoods and plan interventions for efficiency improvement.

In addition to analysing current conditions, users can simulate how heating demand might evolve under **future climate scenarios** following the IPCC's *Shared Socioeconomic Pathways (SSPs)* framework.

Available climate scenarios

- **SSP245 – Moderate mitigation:** mid-range emissions and moderate warming.
- **SSP370 – High emissions**: limited mitigation, strong regional differences.
- **SSP585 – Very high emissions**: fossil-fuelled development and severe warming.

Each scenario can be projected for **2030**, **2040** or **2050**.

How to explore and compare scenarios

1. Open the Climate change scenarios section in the left panel
2. Select an SSP scenario and projection year (Figure 12)
3. The map updates automatically to display the projected heating demand (Figure 13)
4. To visually compare the projection with current conditions, click Compare with baseline to open the split-screen view (Figure 14)

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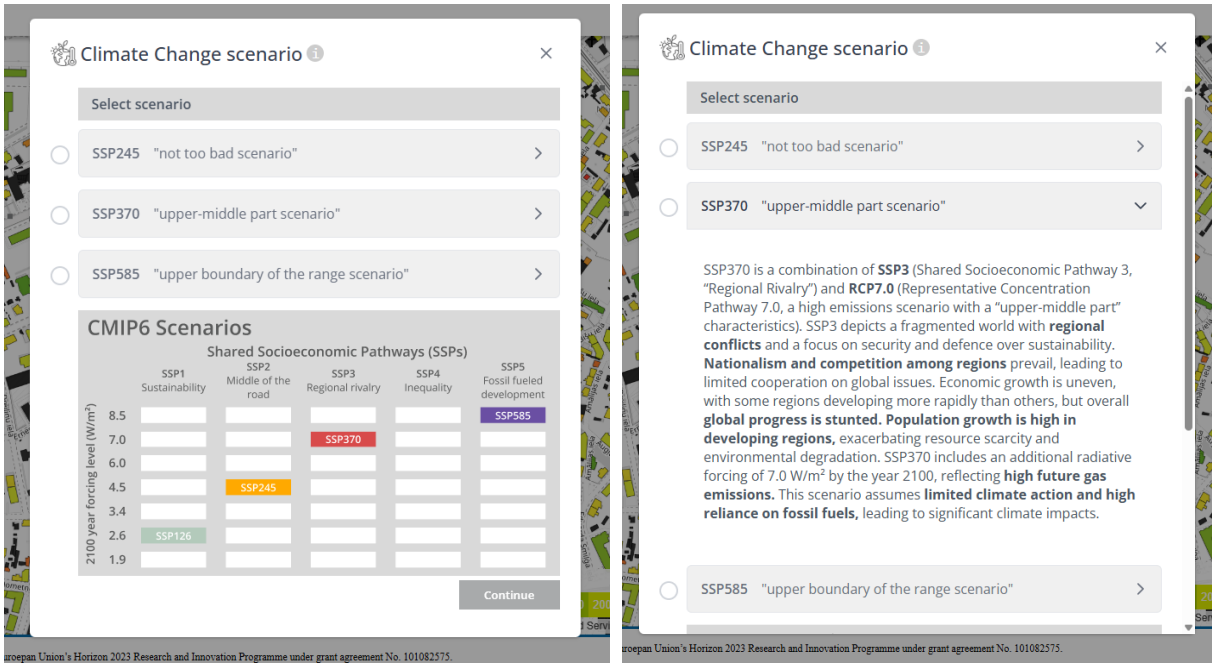

Figure 12. Climate change scenario selection panel in the service, and explanatory description for SSP370 scenario

Figure 13. Heating demand projections for SSP370 in 2040 (pointed out in the layers panel)

Figure 14. Split-screen comparison of baseline and future scenario (SSP370, 2040)

At building level, the information panel presents side-by-side demand values for heating, cooling and domestic hot water (DHW), allowing detailed inspection of how climate change may affect individual buildings (Figure 15).

Figure 15. Building-level comparison between baseline and future scenario (SSP370 at 2040), showing changes in heating, cooling, and DHW demand

4.2. Retrofitting strategies

This functionality helps assess how passive renovation measures can reduce heating and cooling energy demand at the building level and estimate associated costs.

Applying a strategy

1. Open Retrofitting strategies from the left panel (Figure 16)
2. Click on a building on the map to display its current heating demand
3. Select one or more measures, such as (Figure 17):
    - Window improvement
    - Façade insulation
    - Roof insulation
    - Basement floor insulation
4. Configure parameters (e.g., insulation thickness, U-value, cost per m²) (examples in Figure 18 and Figure 19)
5. Run the simulation to view updated energy demand and total investment

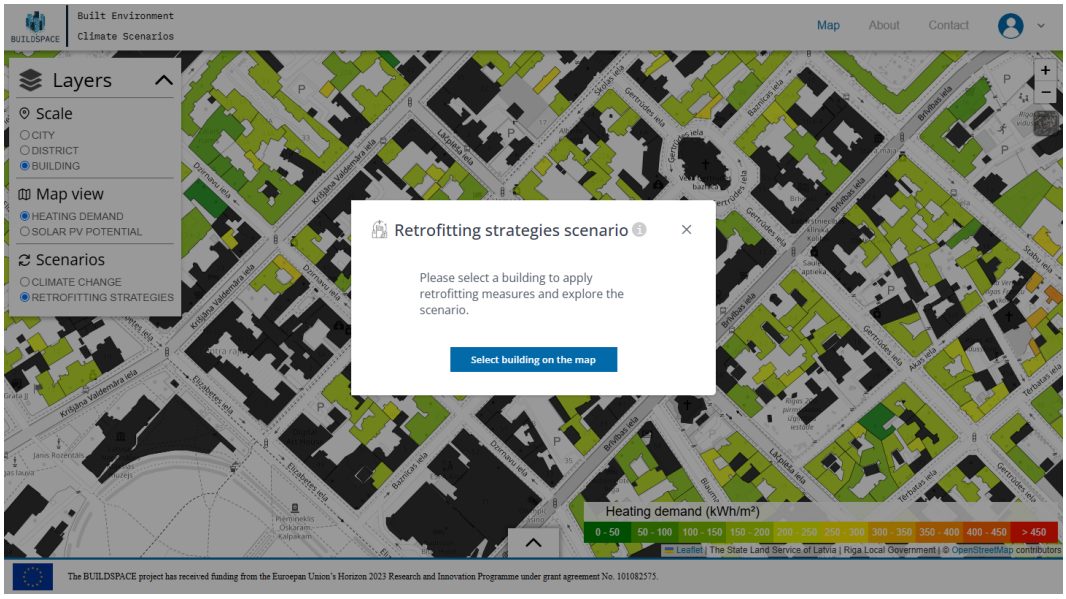

Figure 16. Retrofitting tool welcome screen. Users are prompted to select a building before applying any measures

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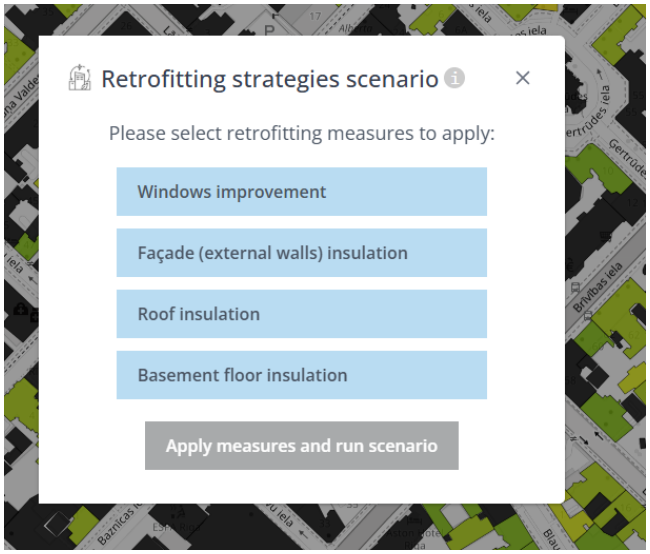

Figure 17. Retrofitting scenario interface displaying available measures

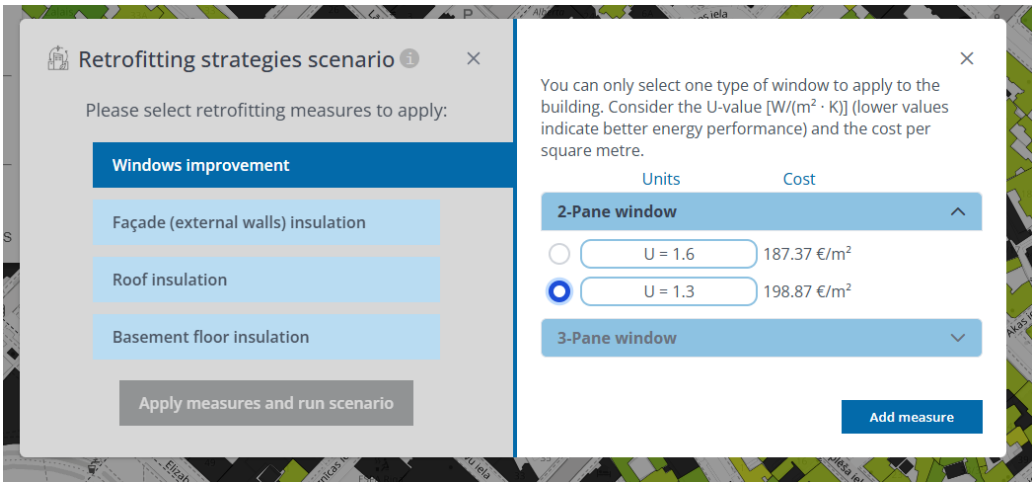

Figure 18. Window upgrade options with selectable U-values and cost per unit area

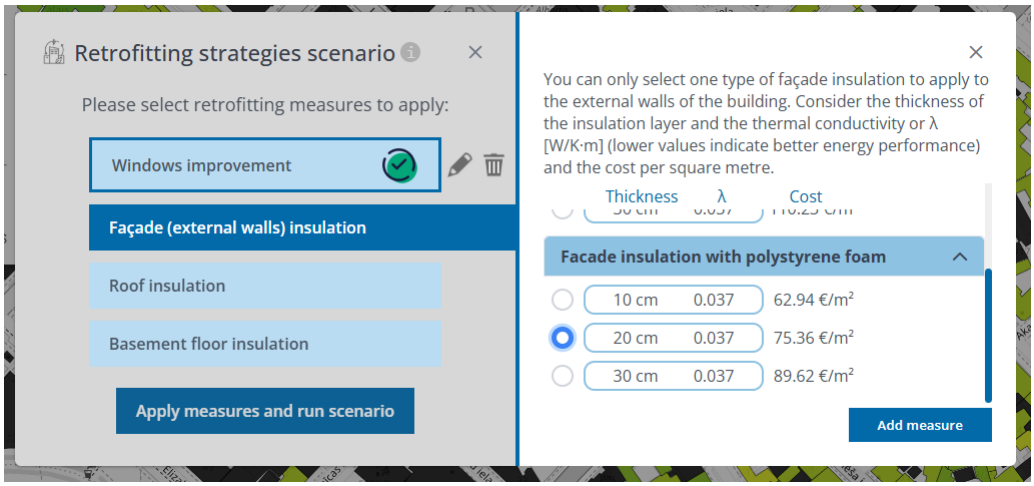

Figure 19. Façade insulation configuration screen showing thickness, performance and cost

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Viewing results

The results panel presents (Figure 20):

- Heating and cooling energy demand before and after renovation (kWh/m²·year).
- Estimated costs and summary of applied measures
- Comparison of performance improvement

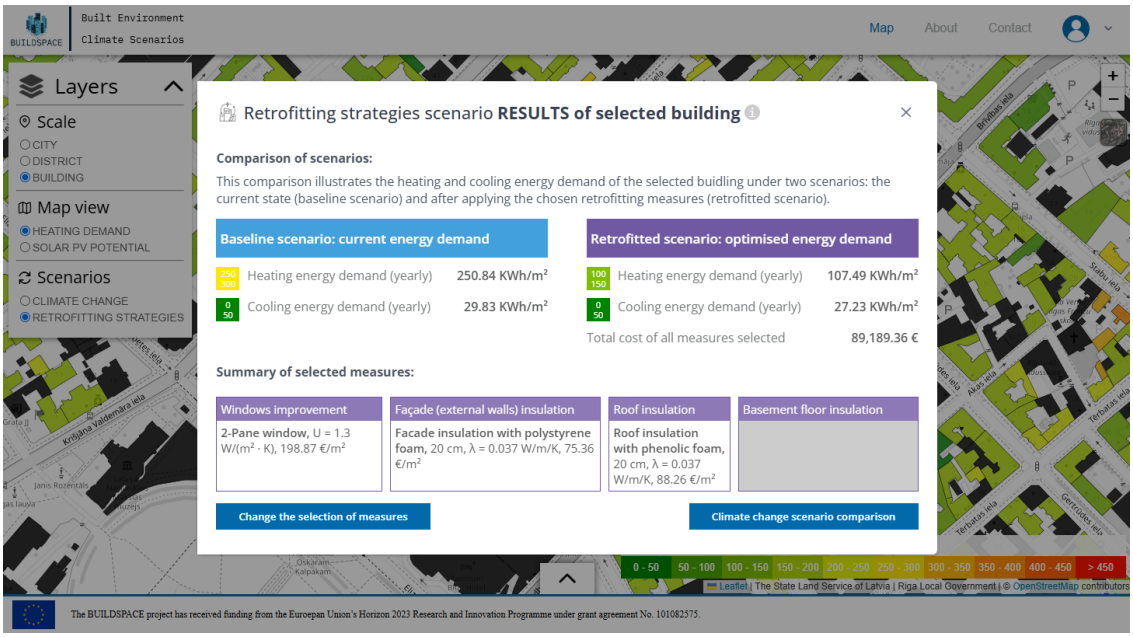

Figure 20. Comparison of current vs. retrofitted energy demand, including cost and summary of selected measures

Users can also evaluate the same retrofitting package under a future climate scenario by selecting *Compare under future conditions* (Figure 21).

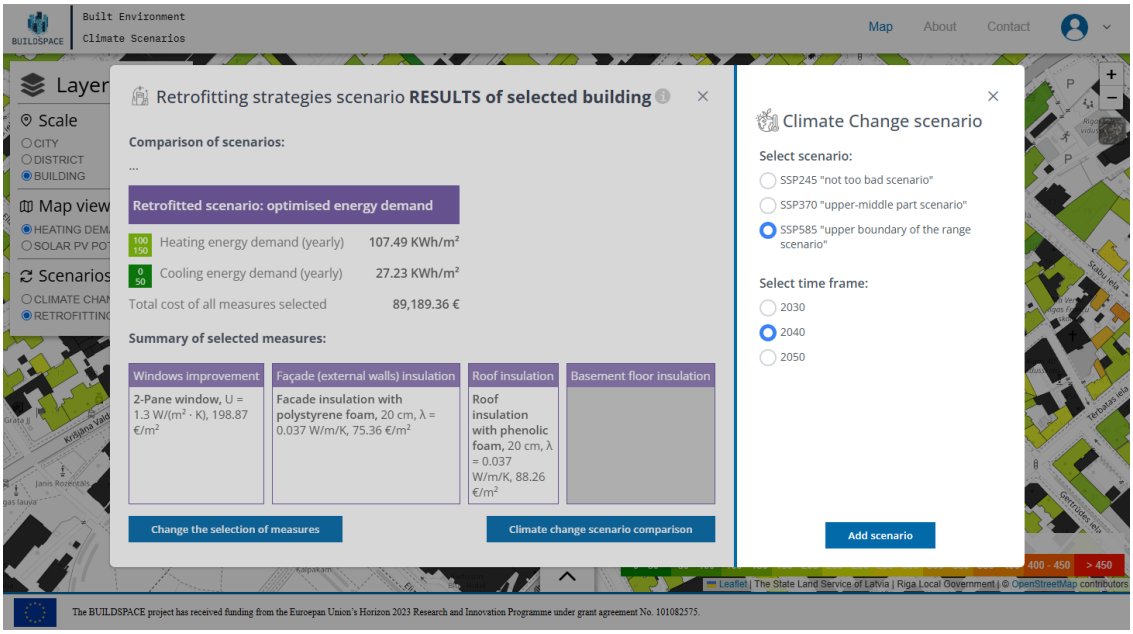

Figure 21. Scenario selection panel for evaluating retrofitting performance under future climate conditions

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And the results are provided in a comparative way between the retrofitted scenario with current climate conditions and the performance of the retrofitted scenario in future climate selected (Figure 22).

This helps assess the long-term effectiveness and return of investment of renovation actions.

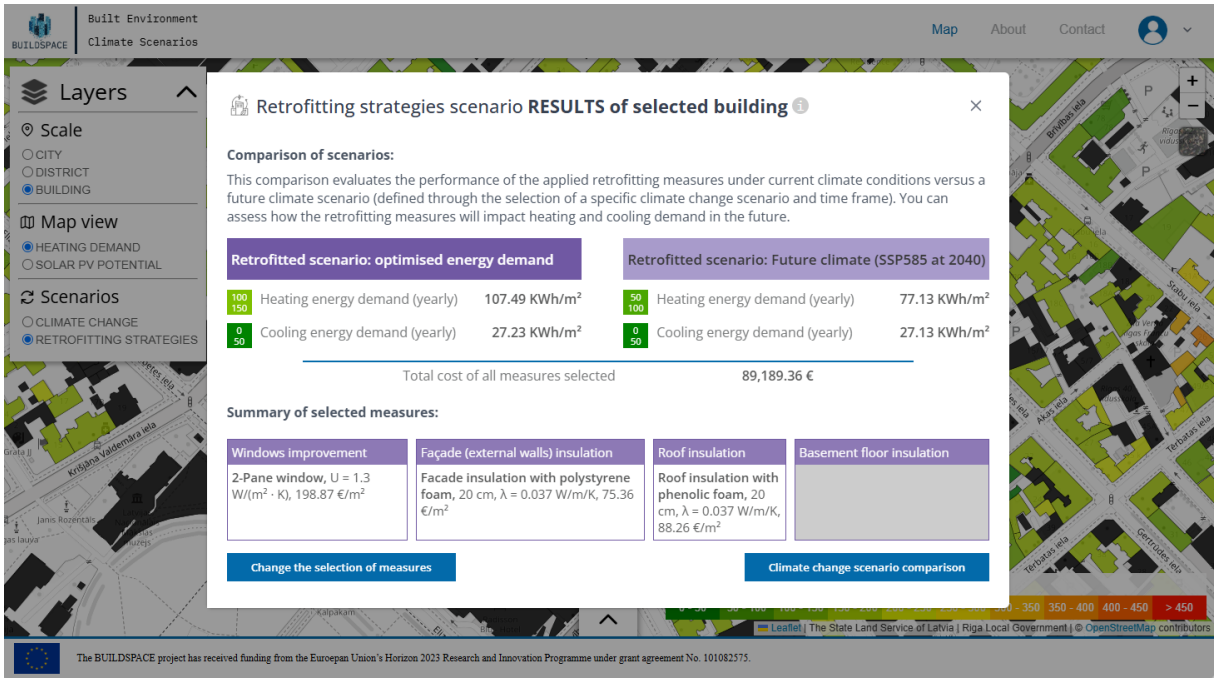

Figure 22. Comparison of retrofitted building performance under current and future climate (SSP585, 2040)

4.3. Solar PV potential

The **Solar PV potential** functionality estimates the annual electricity generation capacity of rooftops, supporting renewable-energy planning.

How to use it

1. In the *Map view* section, select *Solar PV potential*
2. The map recolours to display the estimated solar generation in megawatt-hours per year (MWh/year) (Figure 23).
3. The legend in the lower-left corner shows the scale of potential generation values, helping interpret the map colours
4. Hovering the cursor over a building displays a pop-up with its estimated PV output and key parameters. This allows users to quickly identify promising rooftops without selecting them individually

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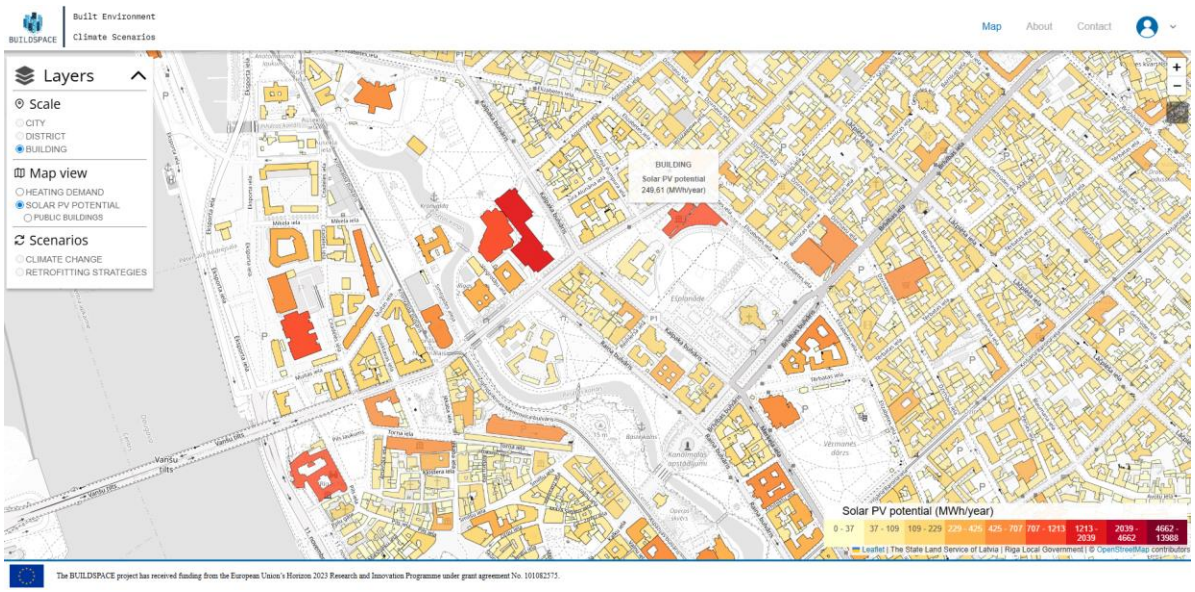

Figure 23. Solar PV potential map layer with hover pop-up showing estimated output for a selected building

Building-level PV details

Clicking on a building opens detailed information on (Figure 24):

- Total and suitable rooftop area for panels
- Nominal solar radiation
- Estimated PV output (MWh/year)
- Installed peak capacity (kWp) and investment cost (€)

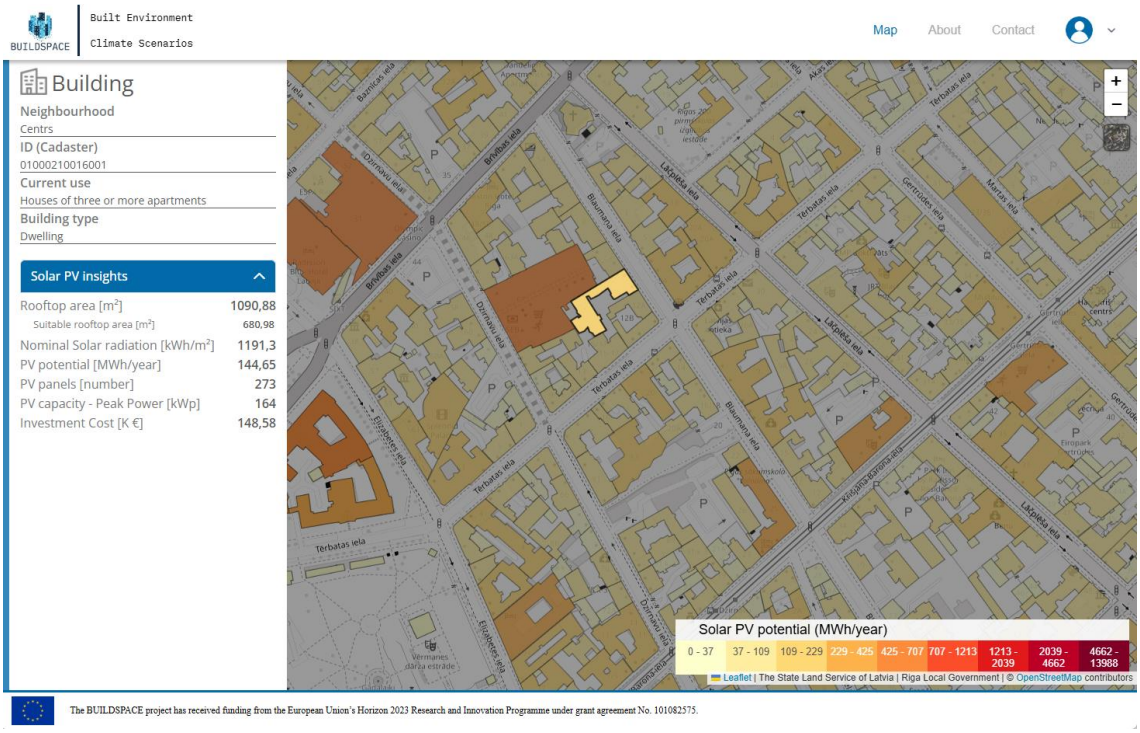

Figure 24. Building-level PV details panel PV

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Public buildings filter

Activating the Public buildings filter below the *Solar PV potential* in *Map view* section highlights only public-use buildings and adds further indicators such as (see Figure 25):

- Annual electricity demand
- Expected CO_2 reduction (%) and bill savings (%)

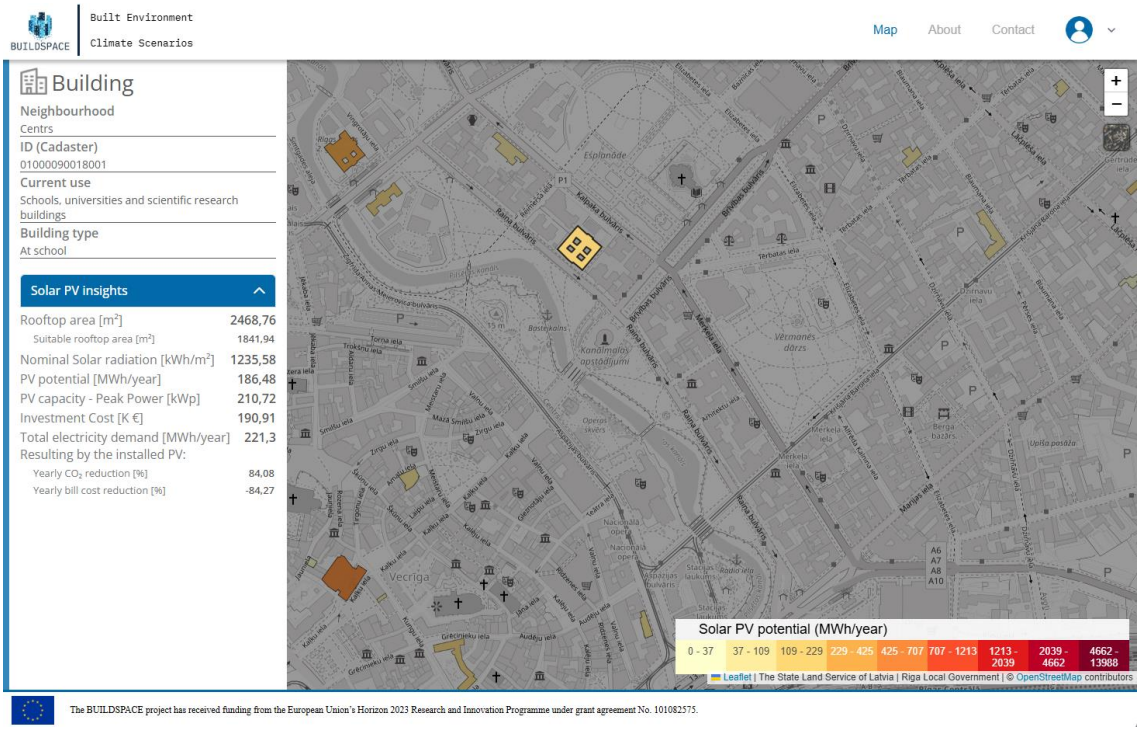

Figure 25. Building-level PV details panel with additional details for public building

This view helps cities identify high-potential rooftops and integrate solar installations into broader renovation and decarbonisation plans.

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5. Support and feedback

The ***Built Environment Climate Scenarios*** service has been developed by **CARTIF Technology Centre** within the BUILDSPACE project.

It integrates energy demand modelling, climate scenario analysis, and an interactive, web-based interface to support cities in planning for energy-efficient and climate-resilient building stock.

The **solar PV potential** module was developed as a pilot for the city of **Riga** by the **EPU-NTUA** team (National Technical University of Athens), in collaboration with CARTIF.

Development team:

- **Service development**: Víctor I. Serna, Carla Rodríguez, Iván Ramos (CARTIF)
- **IT development**: Manuel Pérez, Laura Rodrigo (CARTIF)
- **Solar PV mapping**: Iason C. Dimitrou, Apostolis Arsenopulos (EPU-NTUA)

Need help?

For technical support or feedback about the *Built Environment Climate Scenarios* service, please contact the CARTIF team at:

buildspaceSE3@cartif.es

For general information about the BUILDSPACE project, visit:

https://buildspaceproject.eu/contact

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Annex – Glossary of terms

This glossary provides concise explanations of the main technical terms used throughout the *Built Environment Climate Scenarios* guide.

It is intended to help users unfamiliar with energy modelling, building physics or climate scenario terminology to better understand the key concepts used in the service.

Term	Definition
Baseline scenario	The default condition of a building without any retrofitting measures or future climate projections applied.
CMIP6	The sixth phase of the Coupled Model Intercomparison Project, which provides global climate projections used in SSP scenarios.
Compactness ratio	A geometric indicator that compares a building's surface area to its volume. Lower ratios often lead to higher heat losses.
DHW (Domestic Hot Water)	The energy required to heat water for residential use, such as showers, washing, or cooking.
EPC (Energy Performance Certificate)	A rating scale that categorizes buildings based on their energy efficiency, typically from A (most efficient) to G (least efficient).
Heating energy demand	The estimated annual energy needed to maintain indoor comfort through space heating, expressed in kWh/m²·year.
Insulation (façade, roof, basement)	Building envelope improvements that reduce heat loss. Thickness and material choice influence performance and cost.
kWh/m²·year	A unit measuring the amount of energy used per square meter of building area in one year.
PV (Photovoltaic)	Technology that converts sunlight into electricity, typically through rooftop solar panels.
PV potential	The estimated electricity a building's roof could generate in one year, expressed in MWh/year.
Retrofitting	Upgrading existing buildings with energy-saving measures like better insulation or new windows.
SSP (Shared Socioeconomic Pathway)	Future climate scenarios used in climate modelling, based on different assumptions about global development and emissions.
U-value	A measure of thermal transmittance through a building element (e.g., window or wall). Lower values indicate better insulation performance.

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Thank you for using the *Built Environment Climate Scenarios* service

For more information about the BUILDSPACE project and its city-level tools, visit
https://www.buildspaceproject.eu/

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