D7.15 ECF4CLIM Digital Platform Integration/ Validated

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WHO WE ARE

The ECF consortium consists of ten partners. The project is coordinated by Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas-CIEMAT.

Name	Country	Logo
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas CIEMAT	ES	
Instituto Superior Técnico. University of Lisbon. IST	PT	
Universidad de Sevilla USE	ES	
University of Jyväskylä JYU	FI	
Universitat Autònoma de Barcelona UAB	ES	
Meda Research Ltd MedaResearch	RO	
Instituto de Soldadura e Qualidade ISQ	PT	
Trebag Szellemi Tulajdon Es Projektmenedzser Korlatolt Felelossegu Tarsasag TREBAG	HU	
Smartwatt Energy Services SA Smartwatt	PT	
ENLITIA SA ENLITIA		
Que Technologies Kefalaiouchiki Etaireia QUE	GR	

About the Project

Through a multidisciplinary, transdisciplinary and participatory process, ECF4CLIM develops, tests and validates a European Competence Framework (ECF) for transformational change, which will empower the educational community to take action against climate change and towards sustainable development.

Applying a novel hybrid participatory approach, rooted in participatory action research and citizen science, ECF4CLIM co-designs the ECF in selected schools and universities, by: 1) elaborating an initial ECF, supported by crowdsourcing of ideas and analysis of existing ECFs; 2) establishing the baseline of individual and collective competences, as well as environmental performance indicators; 3) implementing practical, replicable and context adapted technical, behavioural, and organizational interventions that foster the acquisition of competences; 4) evaluating the ability of the interventions to strengthen sustainability competences and environmental performance; and 5) validating the ECF.

The proposed ECF is unique in that it encompasses the interacting STEM-related, digital and social competences, and systematically explores individual, organizational and institutional factors that enable or constrain the desired change. The novel hybrid participatory approach provides the broad educational community with: an ECF adaptable to a range of settings; new ways of collaboration between public, private and third-sector bodies; and innovative organizational models of engagement and action for sustainability (Sustainability Competence Teams and Committees).

To encourage learning-by-doing, several novel tools will be co-designed with and made available to citizens, including a digital platform for crowdsourcing, IoT solutions for real-time monitoring of selected parameters, and a digital learning space. Participation of various SMEs in the consortium maximizes the broad adoption and applicability of the ECF for the required transformational change towards sustainability.

Legal Notice

TABLE OF CONTENTS

1. Executive Summary

The following document - deliverable D7.15 - belongs to task 7.6 of the ECF4CLIM project.

As the European Competence Framework (ECF) developed within ECF4CLIM is designed to support educational communities in taking practical steps against climate change and fostering sustainability, our digital platform integrates educational materials, tools, and applications to encourage engagement and knowledge-sharing within and beyond the school community.

The ECF4CLIM platform functions as a collaborative hub, providing a purposeful space for tools developed by different partners. These tools are easily accessible to the entire school community and, notably, have the potential to extend their reach beyond, engaging external individuals.

The report analyses the key components of the platform, presenting a concise overview of **Crowdsourcing**, detailed insights into the **Simulators Space**, a brief mention of the **IoT Ecosystem**, and a focus on the **Learning Space**. Within the Simulators Space, specific applications such as the Footprint Calculator and Retrofitting Toolkit are explored.

Additionally, the report outlines the technical processes governing the frontend structure of the web platform. It also includes information on the applications testing phase and outlines the next steps in the development process.

ECF4CLIM Project has been funded by the European Commission under the H2020-European Green Deal Call, under the grant agreement no. 101036505.

2. General overview

The ECF4CLIM platform[1] – Figure 1 – is a user-centric platform providing a comprehensive suite of tools, applications, and collaborative spaces to actively involve the scholar community – teachers, students, and managers, as well as other individuals from the community – in the pursuit of sustainability and low carbon economy.

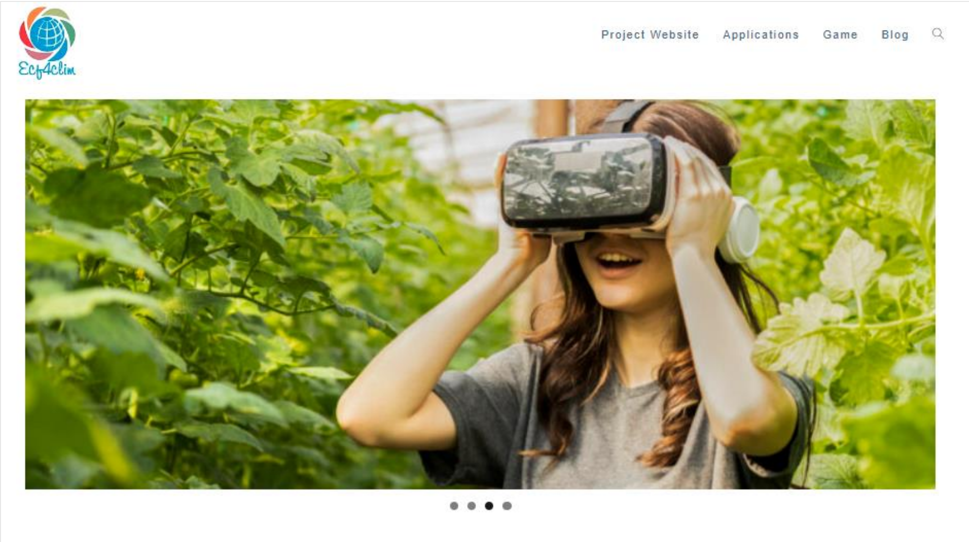


Figure 1 – Digital platform landing page snapshot

The user-friendly interface on the homepage guides to four key components – Crowdsourcing, Simulators Space, IoT Ecosystem and Learning Space - Figure 2.

Figure 2 – Key Components of the Web Platform

These four components will be described in more detail in the next section.

[1] https://ecf4clim.smartwatt.net/

Through the landing page menu, users can access different applications, as show in Figure 3:

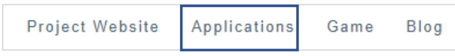


Figure 3 – Entry point on the main menu of the landing page leading to the Applications section

In the applications are the users can access the Footprint Calculator and the Retrofitting Toolkit (1 and 2) developed by CIEMAT and programmed and made available online by Enlitia, as well as the KPIs module that is still in progress - Figure 4.

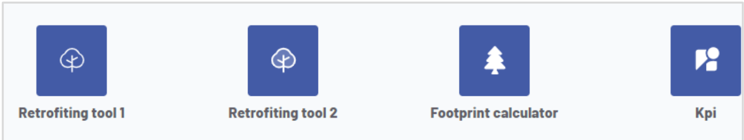


Figure 4 – Suite of tools

These applications are described in section 4 of this deliverable.

An interactive and educational game - Serious Game, developed by *Treabag*, is also accessible through the initial menu - Figure 5.

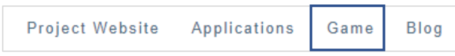


Figure 5 - Entry point in the main menu to access the Educational Game.

Additionally, the platform hosts a ***blog*** - Figure 6 - where users can share experiences and best practices aligned with ECF4CLIM goals, creating a global community dedicated to sustainability and climate resilience.

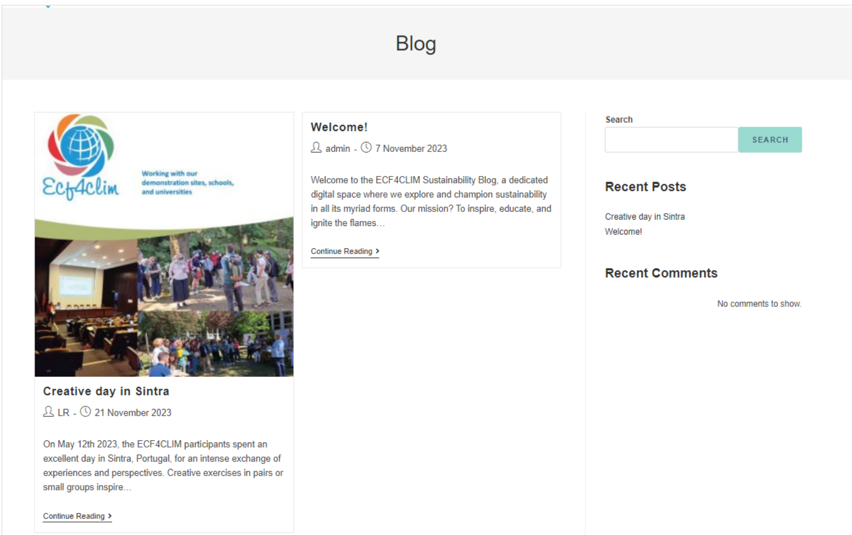


Figure 6 – ECF4CLIM blog

3. Platform components

The ECF4CLIM platform stands as a comprehensive ecosystem designed to address challenges related to climate change through a multifaceted approach. With a focus on participation and education, the platform seamlessly integrates four principal components that collectively contribute to a comprehensive strategy for climate action.

Crowdsourcing

The Crowdsourcing[2] section of the ECF4CLIM digital platform intends to leverage the power of collective intelligence to explore the dynamics of sustainability education in schools and universities. Through an innovative digital platform, participants engage in two key activities: Discussion Workshops and Online Discussions via eDELPHI (Figure 7).

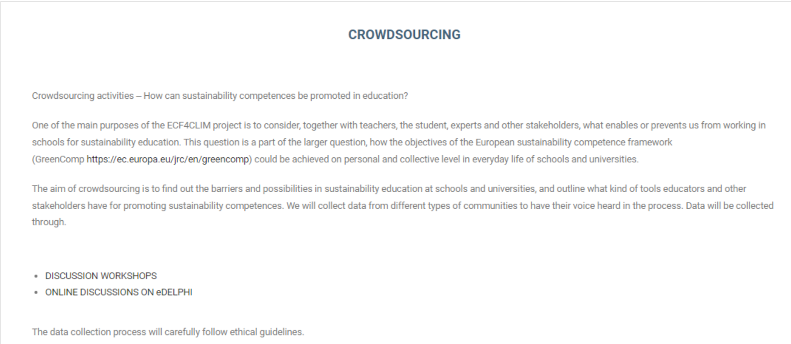


Figure 7 - Crowdsourcing section.

Discussion Workshops provide a structured and interactive environment for teachers, students, experts, and stakeholders to collaboratively identify barriers and possibilities in sustainability education. These real-time, face-to-face discussions enable a nuanced exploration of challenges and opportunities within educational settings.
Complementing this, the Online Discussions on eDELPHI offer a virtual space for asynchronous conversations, allowing a broader range of participants to contribute insights. This online platform ensures inclusivity and facilitates the collection of diverse perspectives on promoting sustainability competences in education.

The digital platform adheres to rigorous ethical guidelines, ensuring data collection respects privacy and confidentiality. Through these collaborative efforts, the project seeks to empower educators and stakeholders in fostering a more sustainable future within educational communities.

Simulators Space

The Simulators Space functions as a gateway for applications within the ECF4CLIM platform, aggregating the tools tailored by partners to assess and enhance environmental sustainability in educational settings (Environmental Footprint Calculator, Retrofitting Toolkit and Sustainability Interventions Evaluation).

[2] 101036505_Deliverable_25_ (ECF4CLIM digital platform - Module 1 - Crowdsourcing collaborative space)

It is important to note that it serves as the only entry point for the Sustainability Interventions Evaluation tools developed by USE (Figure 8):

- simulation tool for buildings
- tool to evaluate sustainability in educational centers

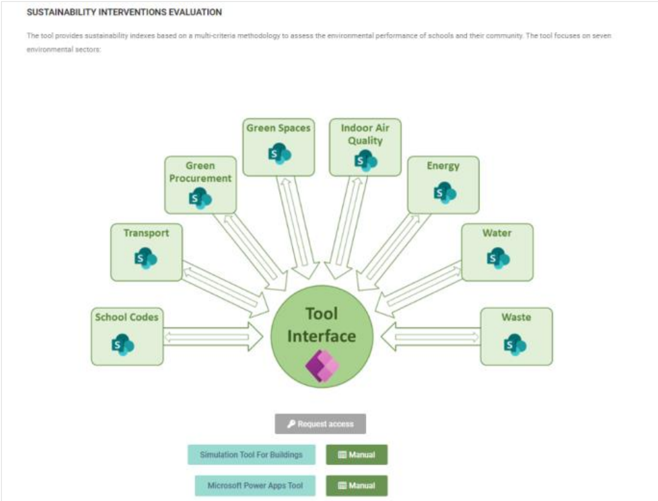


Figure 8 - Sustainability Interventions Evaluation tools

Within the Simulators Space, users can access concise summaries outlining each tool's objectives. Specifically, for the Sustainability Interventions Evaluation tool, comprehensive user manuals and support videos are available (Figure 9), providing users with detailed guidance and assistance in navigating and utilizing the tool effectively.

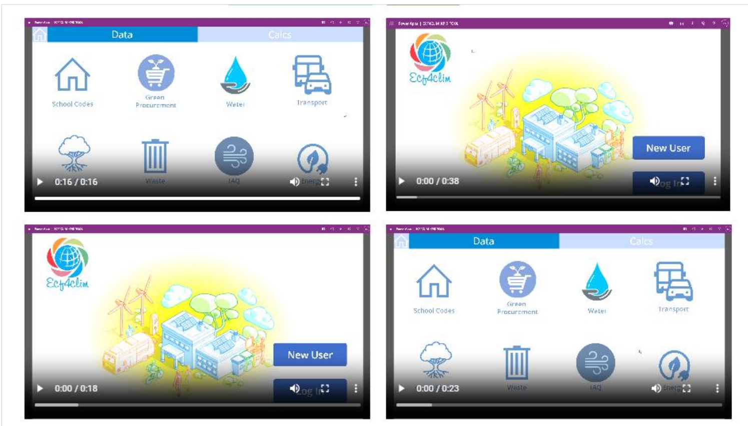


Figure 9 - Sustainability Interventions Evaluation tools support videos

Additionally, the Simulators Space allows users to submit feedback, fostering continuous improvement and refinement of the tools (Figure 10).

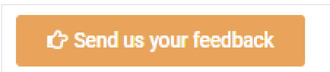


Figure 10 – Sending Feedback in the Simulators Space

IoT Ecosystem[3]

Within the IoT Ecosystem Space on the digital platform, Key Performance Indicators (KPIs) related to air quality and energy consumption will be displayed. These KPIs, defined by ECF4CLIM partners, especially those engaged in WP4/5, will be presented using diverse formats such as tables and graphs, tailored to the nature of the information. The IoT Ecosystem will contribute to the KPI calculations and visualizations – carried out by the digital platform – using data from various sensors installed and configured by QUE in different schools. This data, collected through a REST API, provided by QUE, will then be securely stored in Enlitia databases, ensuring a comprehensive and accurate representation of air quality and energy consumption metrics.
This area is still under development, specifically regarding the front-end layer, which involves creating visualizations and calculating KPIs for display.

Learning Space

Education and awareness form the cornerstone of ECF4CLIM impact. The Learning Space (Figure 11) is a dedicated area that offers resource and collaborative learning experiences. It serves as a knowledge hub where users can deepen their understanding of climate change, sustainable practices, and the role of technology.

Figure 11 – illustration of the initial page of the Learning Space

This space fosters a continuous learning environment, equipping individuals and organizations with the knowledge needed to make informed contributions to climate resilience.
The available resources are categorized for both teachers and students. These include lesson plans, interactive activities, and serious games for teachers (Figure 12).

[3] For detailed technical information about the IoT Ecosystem refer to *101036505_Deliverable_27_(ECF4CLIM digital platform - Module 3 - IoT Ecosystem space)* and *101036505_Deliverable_34_(ECF4CLIM IoT Platform v.2 (Final Version After Integration is completed and prior to roll out))*

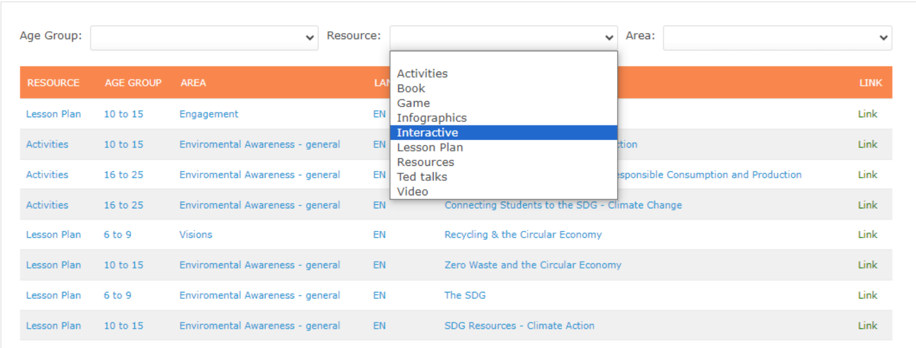


Figure 12 – Examples of various resources available for teachers

Students can find several interactive flipbooks (Figure 13) about climate change and sustainable development.

Figure 13 – Example of an interactive flipbook available through the Learning Space

Also, the Serious Game[4] developed by Treabag is available through the Learning Space. The game presents a diverse range of digital learning content and engaging mini-games, including quizzes, decision trees, true or false questions, memory cards, and more. Users can freely choose their age group from the options of 6-9, 10-15, and 16-25. The game's structure is centred around five modules, aligning with the project roadmap.

4. APPLICATIONS[5]

In the upcoming section, we focus on the APPLICATIONS area—a critical segment of our platform housing tools developed collaboratively by our partners. Key tools in this space include the Footprint Calculator, Retrofitting Toolkit (versions 1 and 2), and KPIs. This section provides an in-depth exploration of each tool, detailing their functions and underscoring their role in advancing our mission of meaningful climate action.

[4] For a comprehensive description, please refer to D7.13 ECF4CLIM Learning Game (gamification)
[5] https://ecf4clim-app.smartwatt.net/

Footprint calculator[6]

The environmental footprint calculator enables users to evaluate their performance by offering insights into key environmental impacts. This tool generates results for self-assessment, helping users identify crucial areas and opportunities for environmental improvement.

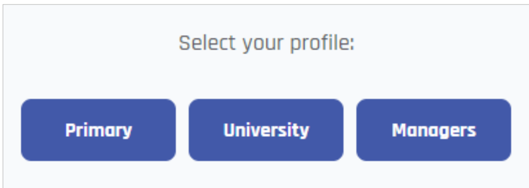


Figure 14 – Available profiles in Footprint calculator

Upon entering the tool, users are presented with the option to choose between three distinct profiles: primary, university, and manager (Figure 14). These profiles distinguish themselves not only in the type and complexity of information they are required to input but also in the complexity of analysis associated with the results.
For all levels, there is support information available that describes and explains the tool specific to that level.

Primary

This tool version empowers primary students (the users) to evaluate their performance regarding key environmental impacts. The tool concentrates on the actions of primary level students both within the school environment and at home. The inventory, Figure 15, encompasses essential materials for learning activities: energy consumption at home, waste production, clothing, as well as transportation for holidays and other trips (transport) and commuting to school (mobility).

[6] For a detailed description refer to 101036505_Deliverable_30_(Environmental footprint calculator version I and II.)_1 and 101036505_Deliverable_26_(ECF4CLIM digital platform - Module 2 - Simulators space)

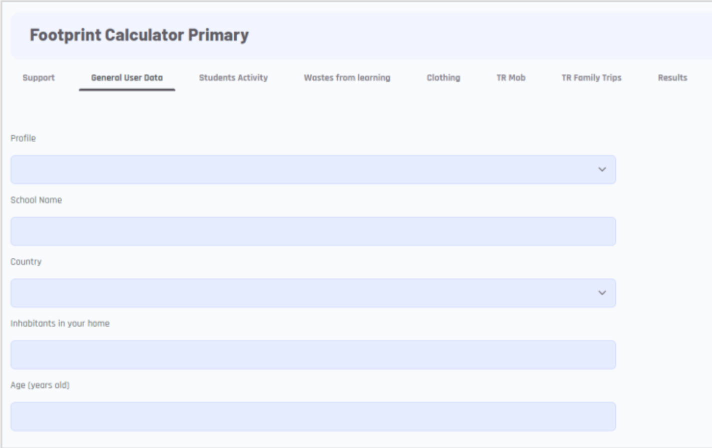


Figure 15 - Initial Tab of Footprint Calculator for Primary Level

For primary level the students have to fill the followings tabs:

- General User Data
- Students Activity
- Wastes from learning
- Clothing
- TR Mob
- TR Family Trips

Input data may be multiple-choice (Figure 16), numeric (Figure 17), or short free text (Figure 18).

Figure 16- Multiple choice input

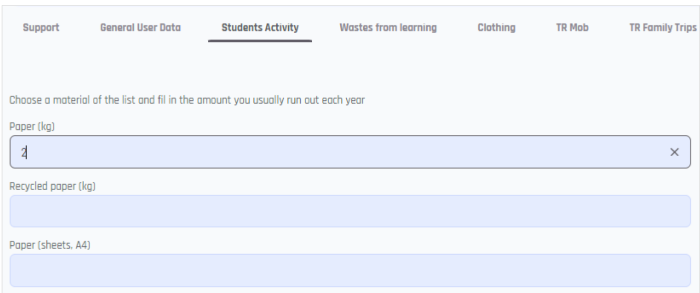


Figure 17 – Numeric input

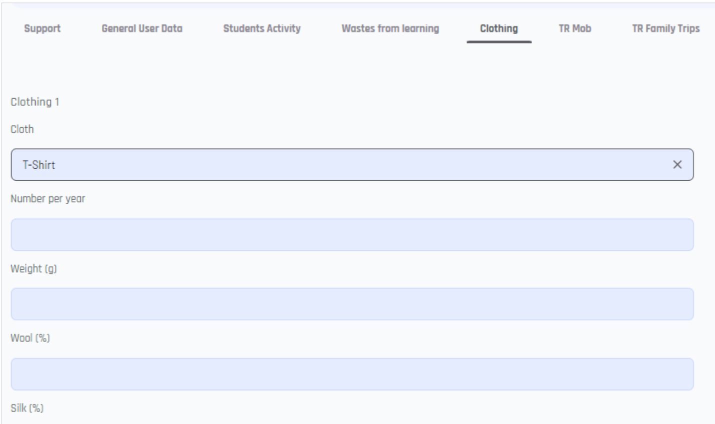


Figure 18 – Short free-text input

Not all fields are mandatory, and students can fill out the forms either in full or partially. The outcomes – see an example in Figure 19 – are presented in terms of two key impact categories: the ***Carbon footprint*** and the ***Water footprint***. The Carbon footprint measures the Global Warming Potential, expressed in kilograms of CO2 equivalents, illustrating the impact of increased global warming emissions, which contribute to Climate Change and its far-reaching consequences. The Water footprint gauges water consumption, expressed in cubic meters of water. Regional water availability is factored in, with consideration given to the local scarcity of water in each specific region.

Figure 19 – Results from Primary level

University

This tool provides **high school and university** students with the means to assess their environmental performance. The tool's scope encompasses students' activities throughout the school year, concentrating specifically on both school and home-related activities.

The school system includes three subsystems, and users navigate through tabs to input their data and preferences, covering all three systems during the data collection process:

- Subsystem 1 encompasses routine activities and processes crucial for the effective functioning of a household. Users can access most of this data by consulting bills (electricity, heating, and water), observing their homes, and checking appliance labels (cooling, kitchen, and lighting). Inquiry and searching for information may be necessary to characterize behavioural data (operation hours, etc.) or estimate waste production
- Subsystem 2 focuses on the consumption of materials provided by students for learning and teaching activities, including gym equipment, library resources, and administrative goods. Information gathering for this subsystem can be facilitated using a supporting questionnaire.
- Subsystem 3 encompasses activities related to transportation and mobility. Transportation includes trips during holidays, camps, excursions, family outings, and visits with friends. Mobility covers daily habits related to commuting to the high school or university.

The users have access to the following tabs to input information (Figure 20):

- General Data
- Heating (subsystem 1)
- Power Production (subsystem)
- Water Consumption (subsystem 1)
- Cooling (subsystem 1)
- Lighting (subsystem 1)
- Kitchen (subsystem 1)
- Wastes (subsystem 1)
- Learning activities (subsystem 2)
- Aux Material at home (subsystem 2)
- Clothing (subsystem 2)
- TR Mobility (subsystem 3)
- TR Family Trips (subsystem 3)

Figure 20 – Input tabs for university level

As with the primary level, input data for high schools and universities may be numeric, short free text, or multiple-choice (Figure 21):

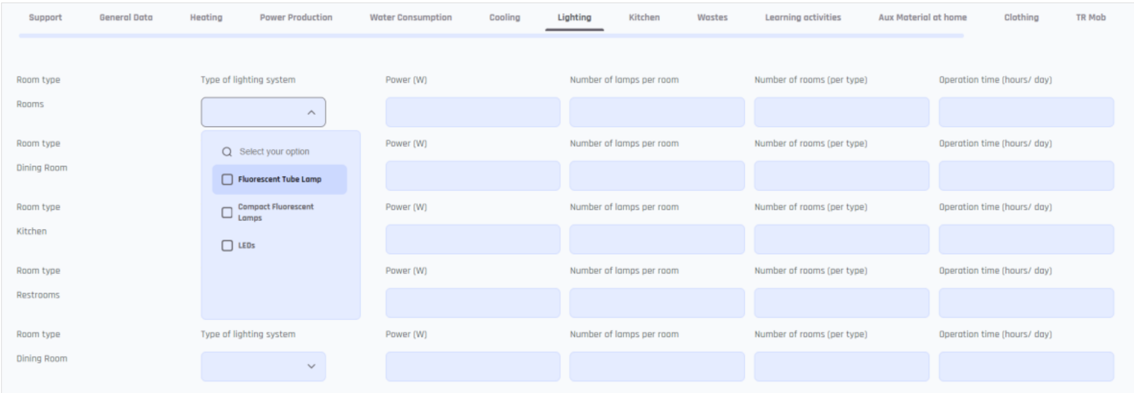


Figure 21 – Example of filling out input at the university level.

The Environmental Footprint Calculator's objective is to enable students to conduct a self-assessment, identifying areas for improvement and recognizing significant aspects. To ensure a comprehensive assessment of the environmental footprint, the tool incorporates ten pertinent impact categories. These categories can be grouped as follows: Global impacts, Human Health, Ecosystem, and Resources Depletion -Figure 22.


Footprint Calculator University

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
Household Footprint	0.86	0	0	0	0	0	0.01	0	0	-0.01	8.95	0
Learning Activities	0	0	0	0	0	0	0	0	0	0	0	0
Clothing	6.72	0	0	0	0	0	0	0	0	0	200	0
Mobility and Transport	2.23	0	0	0	0	0.03	0.02	0	0	0	0	0
Total	**9.81**	**0**	**0**	**0**	**0**	**0.03**	**0.03**	**0**	**0**	**-0.01**	**208.95**	**0**

Figure 22 – Example of results for University level

Managers

For managers' level, the tool is designed to focus on the collective activities of the entire school community, including both staff and students. Data collection for this comprehensive assessment involves users inputting information related to school building management, learning and teaching activities, and transportation used for outings:

- General School Data
- Power Production (subsystem)

- Heating (subsystem 1)
- Water Consumption (subsystem 1)
- Hot Water (subsystem 1)
- Cooling (subsystem 1)
- Ventilation (subsystem 1)
- Lighting (subsystem 1)
- Gardening (subsystem 1)
- Cleaning and Maintenance (subsystem 2)
- Food Service (subsystem 1)
- Wastes (subsystem 1)
- ACTST – student (subsystem 2)
- Lab (subsystem 2)
- Gym (subsystem 2)
- Lib – Library (subsystem 2)
- ACTADM – administrative activities (subsystem 2)
- TR Sch – Transport use (holidays, outing, trips, exchange, excursion, etc...) (subsystem 3)

Figure 23 – Input tabs for university level

At the managers' level, like the university level, the School System's boundaries are clearly defined, consisting of three subsystems:

- Subsystem 1 centers on the management of the school building, utilizing data primarily sourced from utility bills (electricity, heating, and water), audit records, and appliance labels (cooling, canteen, and lighting). Some assistance from school staff may be required to characterize data, such as goods consumption for cleaning, maintenance, gardening, and waste estimation.
- Subsystem 2 focuses on the consumption of materials provided by students for learning and teaching activities, including gym equipment, library resources, and administrative goods. Information gathering for this subsystem can be facilitated using a supporting questionnaire.
- Subsystem 3 encompasses activities related to transportation and mobility. Transportation includes trips during holidays, camps, excursions, family outings, and visits with friends. Mobility covers daily habits related to commuting to the high school or university.

As for the primary and university level, input data may be numeric, short free text, or multiple-choice.
To ensure a comprehensive environmental footprint quantification, the tool assesses twelve impact categories, which are further classified into four groups: Global impacts, Human Health, Ecosystem, and Resources Depletion. These results are analysed globally (Figure 24) and for each subsystem (Figure 25).

Results total (total results / per student / per cubic meter)

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
School management activities	239.19	0	0	0	1.39	0.93	1.36	0.12	0	-74.51	19.56	0
Teaching and learning activities	815.0799999999999	0	0	0	1.22	2.65	5.5	0.38	0	3770.7	13.490000000000002	0
Transport	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1054.27**	**0**	**0**	**0**	**2.61**	**3.58**	**6.86**	**0.5**	**0**	**3696.1899999999996**	**33.05**	**0**

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
School management activities	0.08	0	0	0	0	0	0	0	0	-0.02	0.01	0
Teaching and learning activities	0.27	0	0	0	0	0	0	0	0	1.26	0	0
Transport	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0.35**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.23**	**0.01**	**0**

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
School management activities	Infinity	0	0	0	Infinity	Infinity	Infinity	Infinity	0	-Infinity	Infinity	0
Teaching and learning activities	Infinity	0	0	0	Infinity	Infinity	Infinity	Infinity	0	Infinity	Infinity	0
Transport	0	0	0	0	0	0	0	0	0	0	0	0
Total	**Infinity**	**0**	**0**	**0**	**Infinity**	**Infinity**	**Infinity**	**Infinity**	**0**	**Infinity**	**Infinity**	**0**

Figure 24 – Results global analysis for Managers Level

School Management Activities (total results / per student)

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
Other electricity consumption	0	0	0	0	0	0	0	0	0	0	0	0
Electricity credit	0	0	0	0	0	0	0	0	0	0	0	0
Water	239.19	0	0	0	1.39	0.93	1.36	0.12	0	-74.51	19.56	0
Heating	0	0	0	0	0	0	0	0	0	0	0	0
Hot water	0	0	0	0	0	0	0	0	0	0	0	0
Cooling	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	0	0	0	0	0	0	0	0	0	0	0	0
Gardening	0	0	0	0	0	0	0	0	0	0	0	0
Cleaning & maintenance	0	0	0	0	0	0	0	0	0	0	0	0
Wastes	0	0	0	0	0	0	0	0	0	0	0	0
Food services	0	0	0	0	0	0	0	0	0	0	0	0
Total	**239.19**	**0**	**0**	**0**	**1.39**	**0.93**	**1.36**	**0.12**	**0**	**-74.51**	**19.56**	**0**

	Global Impacts		Human Health				Ecosystems Damage			Resources Depletion		
	Climate change kg CO2 eq	Ozone Depletion kg CFC-11 eq	Human Toxicity, non-cancer effects CTUh	Human Toxicity, cancer effects CTUh	Particulate Matter kg PM2.5 eq	Photochemical Ozone Formation kg NMVOC eq	Acidification mol H+ eq	Freshwater Eutrophication kg P eq	Freshwater Ecotoxicity CTUe	Land Use kg C deficit	Water Resource Depletion m3 water eq	Mineral, fossil & ren resource depletion kg Sb eq
Other electricity consumption	0	0	0	0	0	0	0	0	0	0	0	0
Electricity credit	0	0	0	0	0	0	0	0	0	0	0	0
Water	0.08	0	0	0	0	0	0	0	0	-0.02	0.01	0
Heating	0	0	0	0	0	0	0	0	0	0	0	0
Hot water	0	0	0	0	0	0	0	0	0	0	0	0
Cooling	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	0	0	0	0	0	0	0	0	0	0	0	0
Gardening	0	0	0	0	0	0	0	0	0	0	0	0
Cleaning & maintenance	0	0	0	0	0	0	0	0	0	0	0	0
Wastes	0	0	0	0	0	0	0	0	0	0	0	0
Food services	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Figure 25 – Results for Subsystem 1 (school management activities)

Retrofitting toolkit

The Retrofitting Toolkit plays a crucial role in assessing building performance, offering a set of valuable functionalities. It features visualization tools that are instrumental in the design phase of energy-saving retrofitting measures for buildings. Alongside this, the toolkit incorporates a specialized tool that evaluates the energy savings resulting from the implementation of various retrofitting measures. These features collectively contribute to a comprehensive and effective approach within our platform to enhance the energy efficiency of structures.

Retrofitting toolkit 1

Within the Retrofitting toolkit 1, users enter the platform and choose their profile from four available options: Primary, Secondary, University, or Teacher (Figure 26).

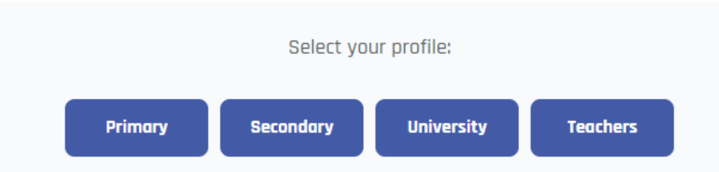


Figure 26 - Profiles available for Retrofitting toolkit 1

Within the Retrofitting Calculator section, students are provided with the capability to analyse various environmental variables such temperature, relative humidity, global solar radiation, and wind speed across different cities. This analysis spans not only across different cities but also varies over the course of a day and throughout the year.

For users with primary and secondary profiles, their exploration is somewhat constrained as they can only access data for their own city. For the primary level, users can choose the variable they want to analyse from four options represented by suggestive icons (Figure 27). The initial graph presented is the annual temperature diagram, illustrating the values of this variable throughout the day for each season - Figure 27.

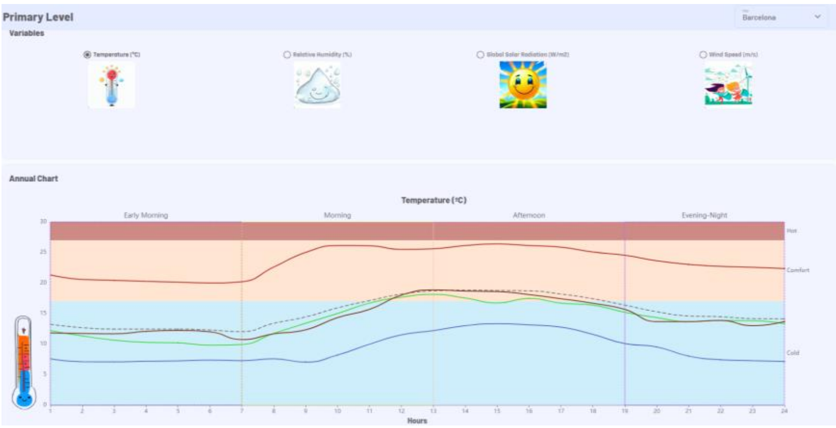


Figure 27 – Entry page for primary profile

However, there is an added dimension to their analysis – they can examine the variations in these variables across different seasons (Figure 28).

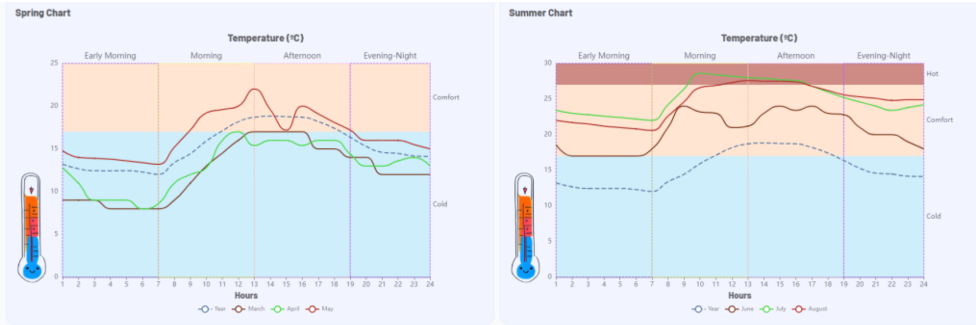


Figure 28 – Example of variables variation across two different seasons (primary level)

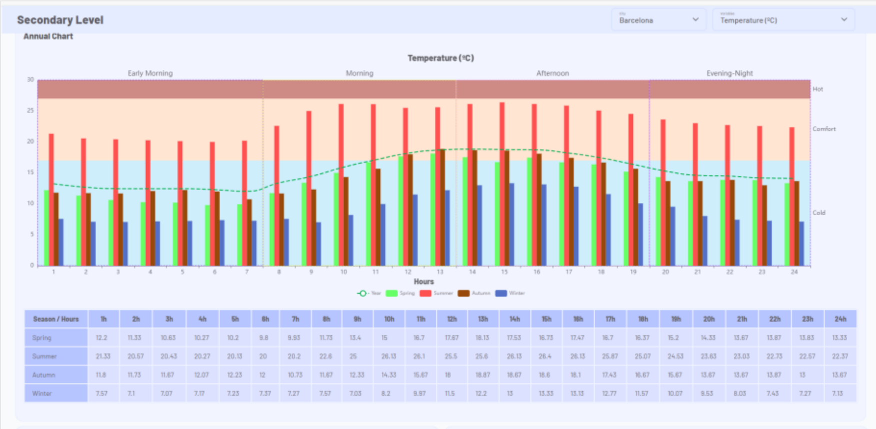
Following the utilization of the tool, the bioclimatic diagram (Figure 29) is presented, illustrating the yearly Heating Degree Days (red) and Cooling Degree Days (blue) across the 12 months of the year).

Figure 29 – Bioclimatic diagram for primary level

Additionally, potential strategies for achieving thermal comfort within the building are depicted, such as the radiator icon indicating the activation of heating or the window icon suggesting the utilization of direct solar radiation.

The complexity of the graphs presented at the primary and secondary levels is deliberately adjusted to cater to the age group and educational level of these users. The graphs are designed to be comprehensible and engaging while offering valuable insights into how environmental factors change over time.

The hourly data throughout the year and across the four seasons is presented using a bar chart for the secondary level, with additional information - Figure 30. The data is presented for each of the 24 hours in a day, categorized into four periods - early morning, morning, afternoon, and early night. Additionally, three wind chill levels are represented (hot, comfort and cold). Furthermore, a table displaying the hourly values for the four seasons is presented at the bottom of the graph.



Season / Hours	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h	24h
Spring	12.2	11.33	10.63	10.27	10.2	9.8	9.93	11.73	13.4	15	16.7	17.67	18.13	17.53	16.73	17.47	16.7	16.37	15.2	14.33	13.67	13.87	13.83	13.33
Summer	21.33	20.57	20.43	20.27	20.13	20	20.2	22.6	25	26.13	26.1	25.5	25.6	26.13	26.4	26.13	25.87	25.07	24.53	23.63	23.03	22.73	22.57	22.37
Autumn	11.8	11.73	11.67	12.07	12.23	12	10.73	11.67	12.33	14.33	15.67	18	18.87	18.67	18.6	18.1	17.43	16.67	15.67	13.67	13.67	13.87	13	13.67
Winter	7.57	7.1	7.07	7.17	7.23	7.37	7.27	7.57	7.03	8.2	9.97	11.5	12.2	13	13.33	13.13	12.77	11.57	10.07	9.53	8.03	7.43	7.27	7.13

Figure 30 – Annual temperature graph for secondary level

Additionally, the presentation of variable variations across different seasons becomes more detailed at the secondary level (Figure 31). The line graphs are substituted with bar charts, and an additional dimension is introduced, analysing the hourly values of the variable for a typical day in each of the months within the respective seasons of the year.

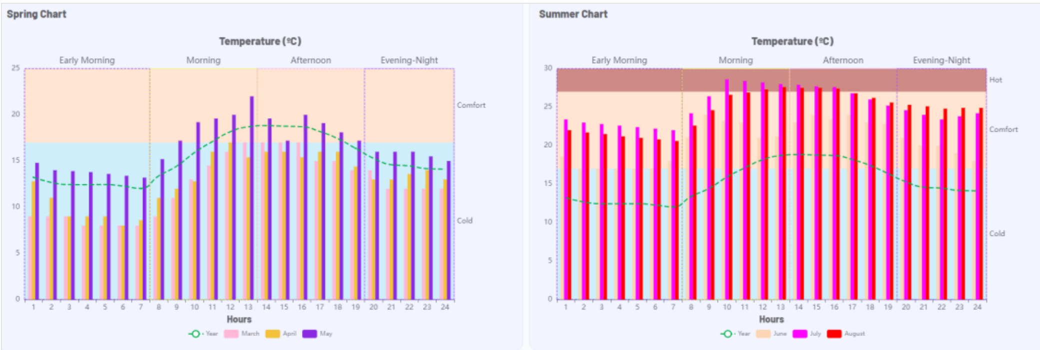


Figure 31 – Example of variables variation across two different seasons (secondary level)

The bioclimatic diagram – Figure 32 – at the secondary level takes on a more formal representation, depicting the annual and seasonal heating degree days as well as the annual cooling degree days. These degree days indicate the heating or cooling requirements based on outdoor temperatures and setpoint values (22°C for heating and 25°C for cooling).

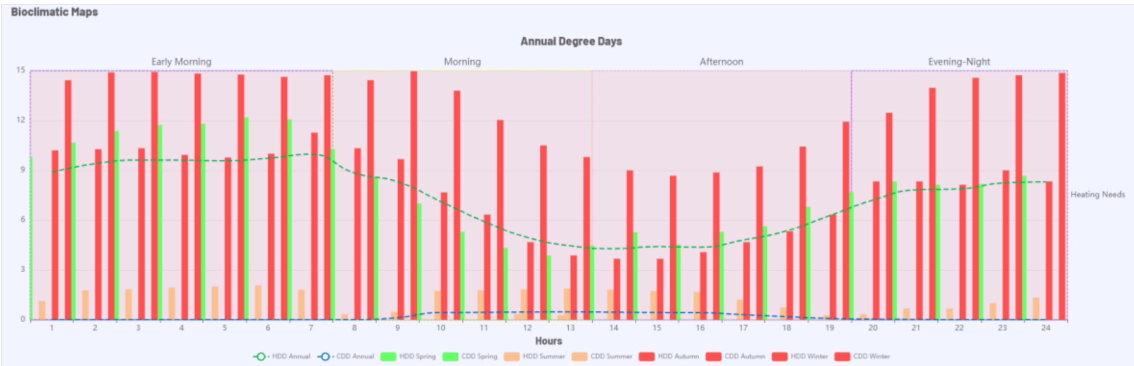


Figure 32 – Bioclimatic diagram for secondary level

As users progress to the university and teacher levels, the platform's capabilities expand. At these higher levels, users have the possibility of examining data for multiple cities concurrently. This feature enables them to make comparisons between different locations, fostering a deeper understanding of how environmental variables behave across diverse geographical areas. Importantly, the graphs become more complex at these levels, presenting a greater depth of information and analysis. This complexity is intentional, designed to challenge users and encourage a more advanced exploration of the subject matter.
For university and teachers' level, the first visualizations represent the climograms of each of the variables over the 24 hours of the day and the 12 months of the year. The primary goal is to present the distinctions and similarities among various climatic zones, facilitating a more profound understanding for the users.

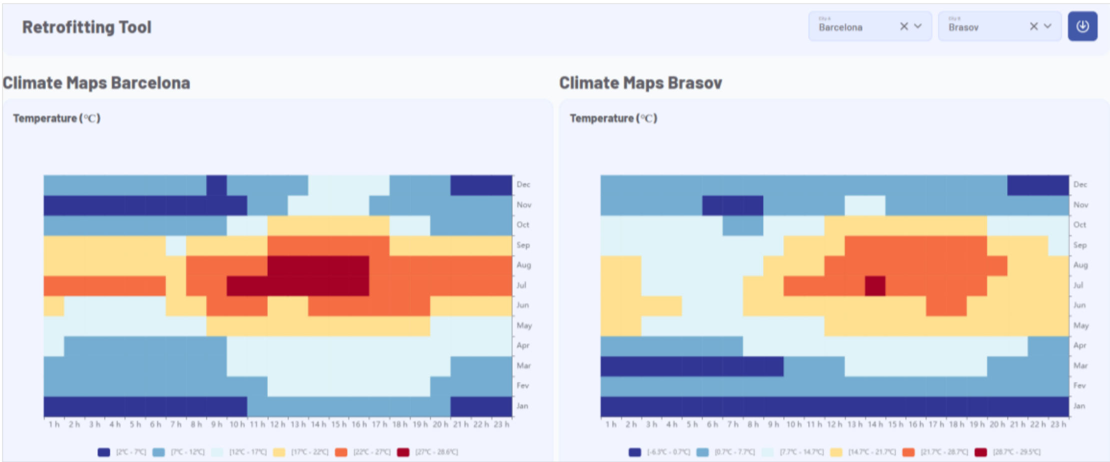


Figure 33 – Comparison between the climograms (temperature) of two different cities (teachers and university level)

The heating and cooling degree days of the 2 selected zones are also displayed (Figure 34), with the possibility of choosing and varying the temperature that is established as a reference in the calculation of these thermal needs.

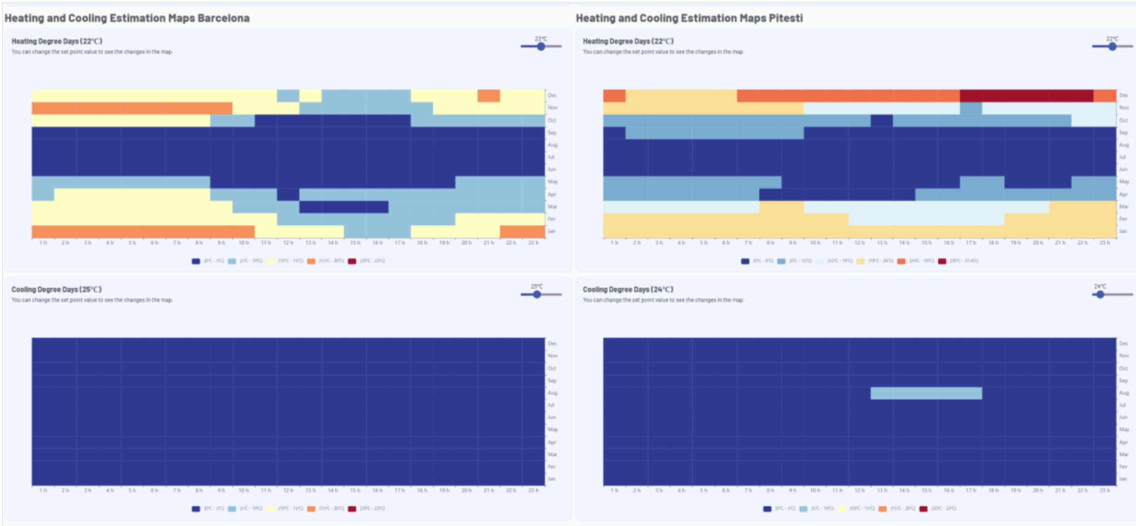


Figure 34– Heating and cooling degree days (teachers and university level)

The final visualization represents the proposed bioclimatic strategies for each hour and for each month (Figure 35). They are fixed maps for each location.

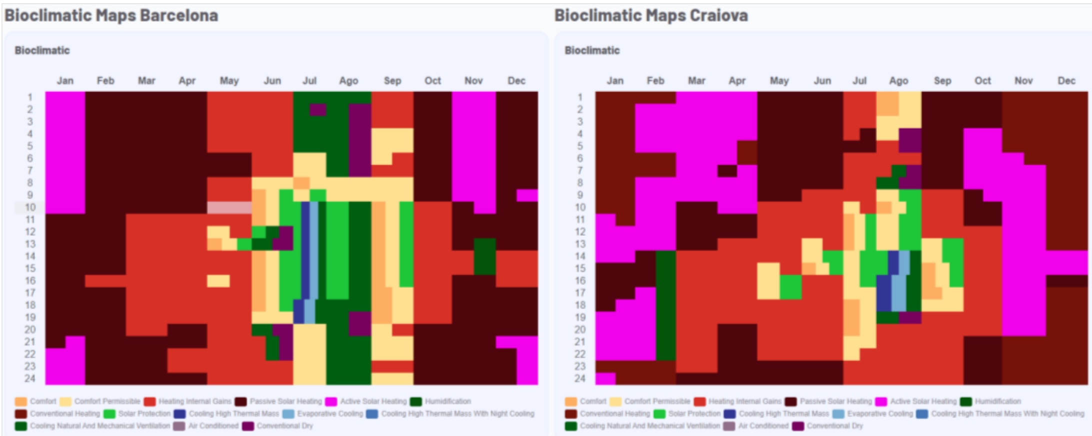


Figure 35 – Bioclimatic diagram for university and teacher's level

These maps display up to fourteen zones corresponding to twelve bioclimatic design strategies adapted to the climatology of the area, whose implementation allows reaching a thermal comfort sensation inside the schools.
In addition to providing the user with a comprehensive annual overview of bioclimatic strategies, they will have the freedom to select and visualize specific strategies of interest. This interactive feature enables them to identify, with greater ease, the ideal hours, and months in the graph where these strategies would best achieve thermal comfort. This personalized approach enhances the user's ability to grasp and apply the most suitable techniques for their specific needs and preferences.

In summary, the Retrofitting Calculator offers a progressive learning experience. It starts with a focused exploration for primary and secondary users in their own city, incorporating seasonality. As users advance to the university and teacher levels, they gain the ability to make cross-city comparisons, accompanied by more intricate graphs that align with their higher level of expertise and understanding. Offering users a more advanced level of information enables them to compare not only selected variables across different cities but also variables within the same city or across multiple cities. The primary objective is to highlight the differences and similarities among different climatic zones, promoting a deeper understanding for the student. Furthermore, users can customize their experience by selecting specific value ranges to be displayed on the map, thereby enriching their interactive learning experience.

Retrofitting toolkit 2

Within the Retrofitting toolkit 2, users enter the platform and choose their profile from four available options: Primary, Secondary, University, or Teacher.
At the Primary level, users can choose their school from a list of all Primary level schools. Once a representative image of the selected school is chosen, users can then select the classroom floor (upper, middle, or lower).

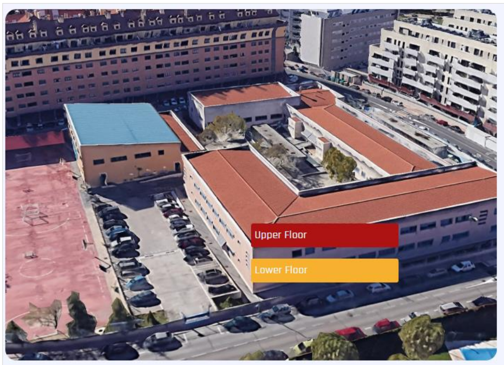


Figure 36 – Example of initial input for Primary level in Retrofitting toolkit 2

After selecting the floor level, users are directed to a new window displaying a visual representation of a classroom (Figure 37).

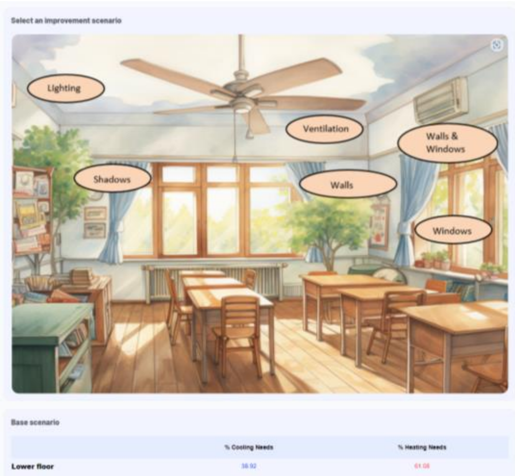


Figure 37 – Improvement scenarios and results for the base scenario

Upon entering the page, the cooling and heating needs values for the chosen school and floor's base scenario are provided. Users have the option to choose an improvement measure from the following options:

- shadows
- walls
- illumination
- ventilation
- windows
- walls and windows

Upon selecting an improvement option, a green indicator highlights the chosen item, and data related to the performed improvement become immediately available. The cooling and heating savings values, along with the annual thermal savings values, are presented (Figure 38). For more detailed information about the configurations of the base and improvement scenarios, users can click on 'See more.'

Base scenario

	% Cooling Needs	% Heating Needs
Upper floor	51.97	48.03

Improvement scenario

	% Cooling Savings	% Heating Savings	% Annual Thermal Savings
Windows	-37.75	81.73	0

See less

Base scenarios by floor

Base case	Area	Building insulation	Floor	Normative	Window	Illumination	Ventilation	% Heating Needs	% Cooling Needs
Upper floor	50.41	After 2006 Poorly insulated (Infiltration=0.67)	0	Between 2000-2010	Simple glass	Fluorescent lighting	No ventilation	48.03	51.97

Improvement scenario by measurements

Retrofitting measures	Area	Building insulation	Normative	Window	Illumination	Ventilation	Shading 1F	% Heating Savings	% Cooling Savings	% Annual Thermal Savings
Illumination	50.41	After 2006 Poorly insulated (Infiltration=0.67)	Between 2000-2010	Simple glass	LED	No ventilation	0	26.37	-11.09	12.37
Shadows	50.41	After 2006 Poorly insulated (Infiltration=0.67)	Between 2000-2010	Simple glass	Fluorescent lighting	No ventilation	0.75	30.33	77.76	48.05
Ventilation	50.41	After 2006 Poorly insulated (Infiltration=0.67)	Between 2000-2010	Simple glass	Fluorescent lighting	Summertime	0	27.98	-21.87	9.35
Walls	50.41	After 2006 Poorly insulated (Infiltration=0.67)	After 2010	Simple glass	Fluorescent lighting	No ventilation	0	47.74	-19.42	22.65
Walls and windows	50.41	After 2006 Poorly insulated (Infiltration=0.67)	After 2010	Low emissive double glass	Fluorescent lighting	No ventilation	0	89.75	-42.77	40.23
Windows	50.41	After 2006 Poorly insulated (Infiltration=0.67)	Between 2000-2010	Low emissive double glass	Fluorescent lighting	No ventilation	0	81.73	-37.75	37.08

Figure 38 – Improvement scenarios for primary level: selection and results

For the secondary level, in the initial input, the user, in addition to choosing the floor, must also select the classroom orientation: North, South, East, West (Figure 39).

Figure 39– Example of initial input for Secondary level in Retrofitting toolkit 2

Regarding the selection of improvement scenarios, everything remains as in the primary level. The other difference lies in the visualization, as the energy savings results appear in the form of a graph rather than a table (Figure 40).

Figure 40 – Improvement scenarios for primary level: selection and results

At the university level, aimed at enhancing students' learning experience, users are unrestricted in their selection of potential base cases for each city. Moreover, the system allows for a more efficient comparison between the various chosen rehabilitation measures. This facilitates a smoother and more comprehensive assessment process. Once the location has been selected, each one will have a number of base cases defined for the user to select from. In all of them there is a fixed common part corresponding to predetermined variables and user-selected variables: number of external facades, Classroom Orientations, Floor, area.

Regarding the selection of improvement scenarios, the user will be able to select multiple improvements, so in each option user have to select between no change and the improvement to.

KPIs

The main goal of the KPIs module is to actively engage students, teachers, and administrators in improving indoor air quality (IAQ) and energy efficiency. While the primary objective is to offer real-time insights into IAQ and energy consumption within school environments, a crucial aspect of this module lies in the development, implementation, and visualization of Key Performance Indicators (KPIs).

Users will have access to real-time data, historical trends, and benchmarking information against other schools. The platform is thoughtfully designed to be user-friendly, ensuring engagement from diverse stakeholders within the educational community. Various permissions and functionalities will be tailored for different user types.

Data from various sensors installed in different school buildings within the project are collected through a dedicated API and stored in the Enlitia database. Data is efficiently distributed through the provided API at a minimum granularity of 15 minutes, ensuring timely and accurate information. The available variables include temperature, humidity, VOC concentrations, PM2.5 concentrations, CO2 concentrations, energy consumption, and power consumption.
The planned IAQ Key Performance Indicators (KPIs) to be included in the platform, such as

- Thermal Comfort KPI
- Ventilation KPI
- Pollutant KPI
- Indoor Air Quality KPI

are derived from literature, WHO guidelines, and national legislations. These KPIs play a vital role in effectively assessing indoor air quality. Also energy KPIs are planned to be included such as

- Energy consumption per student
- Energy consumption per area

It is expected the KPIS module to have 3 main areas:

- Map of Europe with the location of all schools

- School area that enables users to visualize sensor measurements within their school premises
- Monitoring Places Information area where users can access detailed insights into specific monitoring places within the school, enhancing the understanding of IAQ and energy consumption at a more granular level.

Aligned with IST's provided requirements for platform visualizations and user interface., the possible structure for visualizing the KPIs module, as depicted in Figure 41, is as follows:

- upon entering the area of a specific school, users can visualize and download information about present and historic concentrations of air pollutants.
- users can visualize IAQ, ventilation, and comfort KPIs, establishing a connection between measured levels and established guidelines.
- each classroom features a traffic light system, informing users if pollutant levels are exceeding (red) or approaching (yellow) the Threshold Limit Value (TLV).
- users can compare measured values in their school with those from other schools by selecting the Benchmarking option. The values from other schools are displayed in a table, as shown in the Figure 41 - for KPI_{IAQ}.

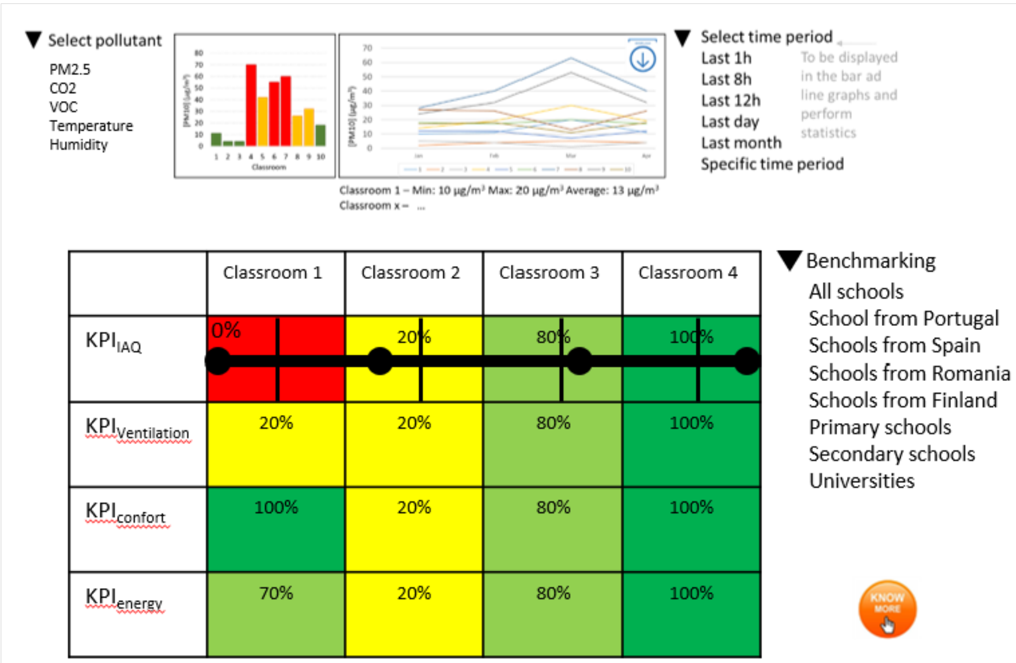


Figure 41 – Possible structure for visualizing the KPIs module

It is also planned that distinct permissions and functionalities will be defined for different user types, ensuring relevance and accessibility for all stakeholders.

5. TECHNICAL DESCRIPTION

This section provides an overview of the architecture, technologies, and design principles employed in the development of the web platform. The platform aims to provide a robust and scalable solution to meet the diverse needs of the project, incorporating cutting-edge technologies for both the frontend and backend. The web platform combines innovative technology and thoughtful design to offer a high-performance, scalable solution tailored to the goals and user-friendly for younger users.

Backend Infrastructure

Node.js and NestJS

The backend infrastructure relies on the efficiency and versatility of Node.js, complemented by the modular architecture of the NestJS framework. These choices ensure optimal handling of server-side operations, supporting the dynamic requirements of the platform. The NestJS framework facilitates the creation of robust and scalable APIs, crucial for data communication with the frontend.

PostgreSQL

Data persistence is handled by the PostgreSQL relational database management system. The choice of PostgreSQL is driven by its proven reliability, scalability, and support for complex data structures. This ensures efficient storage and retrieval of project-related data, critical for the success of the platform. The database design accommodates the particulars and complexities of dynamic graphs, allowing for efficient representation and querying of graph-related data structures.

Frontend Development

React, TypeScript, and ECharts

The frontend, developed with React and TypeScript, integrates seamlessly with the ECharts library for powerful and customizable data visualization. ECharts provides a rich set of charting options, allowing the platform to present dynamic graphs that are interactive and informative. TypeScript enhances the development process by ensuring type safety and maintainability.

Sass for Styling

Styling is managed using the Sass (Syntactically Awesome Stylesheets) preprocessor. Sass allows for the use of variables, nesting, and modularization in stylesheets, contributing to a more organized and maintainable styling approach. This ensures a consistent and visually appealing user interface across the platform.

Form Input and Calculation Modules

React Forms

To enhance user interaction, the platform incorporates dynamic forms implemented with React. These forms allow users to input options and parameters for various functionalities within the applications.

Calculation Processes
The platform facilitates complex calculations through dedicated modules. Users can input parameters through forms, triggering backend processes that perform intricate calculations. The results are then dynamically updated in the frontend, providing users with real-time feedback.

Blog

WordPress
The ECF4Clim blog was developed using WordPress, a versatile content management system. WordPress simplifies blog creation with its user-friendly interface, customizable themes, and extensive plugin options. This platform empowers users, allowing effortless publishing, organization, and personalization of content. It serves as an ideal solution for establishing an engaging online presence.

Modular Architecture

The platform's modular architecture extends to the dynamic graph visualization and form input functionalities. Different modules seamlessly integrate, allowing for the incorporation of applications that utilize dynamic graphs, user forms, and calculation processes. This design approach ensures extensibility and adaptability as the project evolves.

6. TESTING

Testing the web platform is a pivotal and ongoing aspect of the development strategy, involving both internal evaluations with the different partners, particularly the owners of the integrated tools, and external assessments from the demonstration sites. This comprehensive approach ensures a thorough examination of the platform's functionality, usability, and alignment with user expectations throughout the entirety of the project.

Internally, the tool owners, contribute significantly to the testing process. Their role encompasses data validation, ensuring the accuracy and reliability of information within the platform. Additionally, their feedback provides crucial insights into user expectations, enabling us to refine and enhance the platform to meet the unique needs of each tool. This collaborative effort ensures that the platform not only accommodates existing tools seamlessly but also evolves in response to the dynamic requirements of our partners.

Simultaneously, external testing involves active participation from demonstration sites, including teachers, students, and managers. Although all partners are encouraged to contribute, this external engagement adds a real-world perspective to our testing process. A user-friendly questionnaire[7], embedded in the platform, facilitates feedback collection on design, style, user-friendliness, and bug identification. The diverse perspectives from teachers, students, and managers enrich our understanding of the platform's usability and guide us in addressing specific user needs. The questionnaire explores various aspects, seeking input on the platform's visual design, navigation, and overall style. It also places a strong emphasis on user-friendliness, evaluating how easily users can navigate and perform tasks within the platform. Furthermore, users are encouraged to report any bugs or issues encountered during their testing, contributing to a continuous improvement cycle.

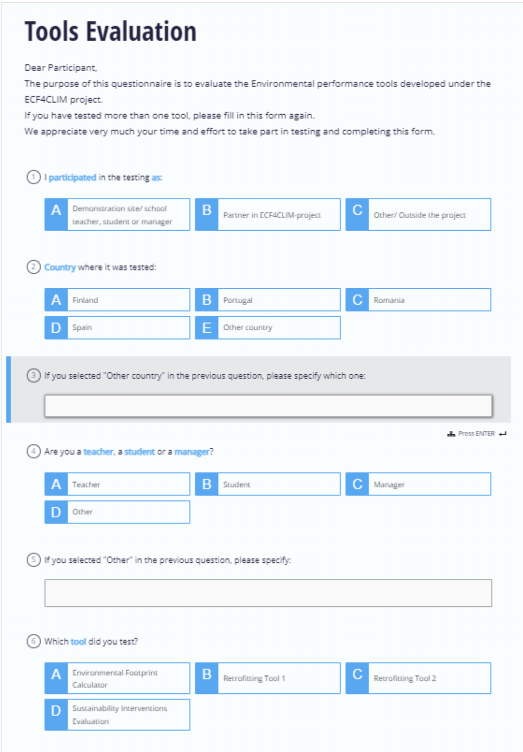


Figure 42 – Illustration of Feedback Questionnaire

It's crucial to note that testing is not a one-time event but an ongoing process that persists until the conclusion of the project. This continuous evaluation ensures that the web platform evolves, adapting to changing requirements and remaining relevant to the goals and expectations of users at all levels. The iterative nature of the testing approach aligns with the commitment to delivering a web platform that is not only suitable for all levels but also capable of achieving diverse project goals throughout its entire duration.

[7] https://freeonlinesurveys.com/s/ECF4CLIM-Tools

7. NEXT STEPS

Ensuring a robust platform aligned with the project goals involves employing an iterative development approach alongside thorough testing and validation procedures.

In the subsequent phase of Work Package 7, particularly Task 7.6, the focus will shift towards enhancing and developing all modules, with a particular emphasis on the development the Key Performance Indicators (KPIs) module. This step is critical to make all the applications available for the ECF4CLIM community,

Concurrently, there are plans in progress for updates and corrections to the other project modules. These adjustments result from thorough internal testing and validation processes, conducted in close collaboration with project partners. The insights gained from this collaborative effort will guide the refinement of the modules, addressing any identified issues and ensuring optimal functionality.

Furthermore, in the upcoming stages, there is an intention to fine-tune aspects based on the testing phase carried out at demonstration sites. This hands-on testing in real-world scenarios offers invaluable insights, enabling necessary adjustments to optimize the modules' performance and align them seamlessly with project goals.