D7.10

Interventions sustainability tools

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WHO WE ARE

The ECF consortium consists of ten partners. The project is coordinated by Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas-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	
ENLITIA Energy Services SA **ENLITIA**	PT	
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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 organisational 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, organisational 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 organisational 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 maximises the broad adoption and applicability of the ECF for the required transformational change towards sustainability.

LEGAL NOTICE

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1. EXECUTIVE SUMMARY

WP7 aims to strengthen environmental awareness amongst citizens and promote the engagement of the entire educational community in action towards behavioural changes towards sustainability. A digital platform is set up to support activities and processes in this line, including simulation tools (task 7.3).

Deliverable D7.10 includes the **Interventions Sustainability Tools**, elaborated by the University of Seville. This document describes the tools, the methodology and the validation process. The tools have been tested and validated and is already in a full version. During the rest of the project, they will be updated with the feedback from the demonstration site users.

The design of the tools aimed to support the strengthening of individual and collective sustainability competences as well as the evaluation of the improvement of the sustainability performance of the involved schools and universities.

Moreover, these tools are incorporated within our hybrid participatory approach and can be used for the co-design, co-testing, and co-evaluation of sustainability measures. In this way, the tools are aimed at improving the competences in systemic thinking, future thinking, and critical thinking in the evaluation of the initial baseline (before the implementation of a measure) and the possible impact of the measure on the individual and collective competences, and on the environmental performance of the educational establishment in question.

The tool is available on the ECF4CLIM Simulators Space, together with explanatory manuals and short videos. The user manuals are included as annexes. Both the tools and the manuals will be continuously updated and improved.

2. CONTEXT, AIMS AND STRUCTURE

WP7 aims to strengthen environmental awareness amongst citizens and promote the engagement of the entire educational community in action towards behavioural changes for sustainability. This is done by developing a digital platform that will include, among other things, simulation tools (task 7.3). This document describes the **Sustainability Interventions tools (SIT package), D 7.10**, including the methodological design and the validation process. It has been designed by the ECF4CLIM team of the University of Seville. These tools are open to minor modifications and updates during the rest of the project's lifetime.

On the one hand, the SIT package includes a main **Sustainability Intervention tool** that allows the evaluation of the environmental performance of the school/university, in seven environmental areas. On the other hand, the SIT package it comprises an auxiliary **Energy Engine** for a more detailed evaluation of sustainability interventions in the area of energy.

The deliverable describes the procedure and rationale for the design of the software, and the results of the validation process.

The **Sustainability Intervention tool** works with sustainability indexes, employing a multi-criteria methodology to assess the environmental performance of schools/universities and their communities. The tool focuses on seven environmental sectors: transport, green procurement, green spaces, indoor air quality, energy, water, and waste. These environmental sectors are assessed via key performance indicators (KPIs) adapted to the particularities of the educational sector. These KPIs are the same as the ones in WP4 (except for energy and Indoor Air Quality-IAQ) to characterise the environmental baseline of the schools and universities and, at the same time, evaluate the impact of different projects and initiatives on their performance. The tool is customized for different ages and levels of expertise. It estimates the impact of the interventions on environmental performance, allowing the selection of adequate measures.

The design of the tools aimed at providing support for the acquisition of individual and collective sustainability competences, as well as assisting in the evaluation of the sustainability performance of schools and universities. In this way, the tools could also serve as stimulus within the Sustainability Competence Teams and Sustainability Competence Committees.

The tools enhance individual and collective competences in systems thinking, future thinking (possible impact of the implementation of the measures), characterisation and contextualisation of sustainability-related problems, and promoting collective and individual actions.

The tools are available on the ECF4CLIM Simulators Space, along with the manuals and short explanatory videos. Until the end of the project, the tools and manuals will be continuously updated and improved to incorporate suggestions and feedback from the demonstration sites.

Based on a hierarchical method, the navigation system and the user interfaces (UI) allow an ad-hoc structure of the applications that prioritise the user experience (UX). Thus, the user does not lose interest in the use of the tools and can work with modules in a more organised way.

3. METHODOLOGY

3.1. Structure and design of applications

The development of the tools in D7.10 aims to combine the user interface design and user experience with the data generated in the baseline assessment of sustainability areas in Wp4.

The design and the structure of the tools combine linear and layered user interfaces (UI) in the different parts of the apps. On the other hand, in the general menus for capturing information, a mosaic-type scheme has been used, following the Modern UI style (Basu, 2013)(Basu, 2013)(Basu, 2013)(Basu, 2013)(Basu, 2013)(Basu, 2013)(Basu, 2013)(Basu, 2013), where the applications follow the navigation model hierarchically.

This type of structure has been designed to condense the information of the different sustainability areas following a mosaic style but seeking a hierarchical data collection system.

3.2. Calculation methodologies

3.2.1 Sustainability Intervention Tool

Regarding this application, a Likert scale (Bertram, n.d.), from 1 to 5, has been used to visualise the calculated scores, reflecting the situation of the school/university in the seven sustainability areas, as explained in deliverable *D4.3. Baseline Assessment of the Environmental Performance*, n.d. On this scale, a score of 1 means having a performance/attitude/outcome far from sustainable, and a score of 5 means that the performance in that area is sustainable. The definition of the KPIs to measure the acquisition of sustainability competences corresponds with the design of indicators and scores in deliverable D4.3. The KPIs used in the Sustainability Intervention tool are presented in Table 1.

Table 1. KPIs used in the Sustainability Intervention tool.

Sector	KPI designation	KPI calculation
Waste	Weekly production of urban solid waste (USW) per student	$\mathrm{KPI}_{W1} = \frac{\text{weekly production of USW}}{\text{no. of students}}$
	Weekly production of recyclables per student	$\mathrm{KPI}_{W2} = \frac{\text{weekly production of recyclable waste}}{\text{no. of students}}$
	Weekly production of reusables per student	$\mathrm{KPI}_{W3} = \frac{\text{weekly production of reusable waste}}{\text{no. of students}}$
Water	Water consumption per useful area	$\mathrm{KPI}_{Wr1} = \frac{\text{annual water consumption}}{\text{useful area}}$
	Water consumption per student	$\mathrm{KPI}_{Wr2} = \frac{\text{annual water consumption}}{\text{no. of students}}$
	Water costs per useful area	$\mathrm{KPI}_{Wr3} = \frac{\text{annual water costs}}{\text{useful area}}$

	Water costs per student	$\mathrm{KPI}_{\mathrm{Wr4}} = \frac{\text{annual water costs}}{\text{no. of students}}$
Transport	Charging stations for electric cars per student	$\mathrm{KPI}_{\mathrm{T1}} = \frac{\text{no. of charging stations for electric cars}}{\text{no. of students}}$
	Parking places for bicycles per student	$\mathrm{KPI}_{\mathrm{T2}} = \frac{\text{no. of parking places for bicycles}}{\text{no. of students}}$
	Public transport per hour	$\mathrm{KPI}_{\mathrm{T3}} = \text{no. of public transport journeys per hour within a 1000 m radius}$
	Annual CO2 emissions per student	$\mathrm{PE_i} = \frac{\left(\#_{\text{never}} \text{ x } 0 + \#_{\text{almost never}} \text{ x } \frac{1}{3} + \#_{\text{almost always}} \text{ x } \frac{2}{3} + \#_{\text{always}} \text{ x } 1\right) \text{x no.of people of the school}}{\text{no.of people that answered the questionnaire}}$ Where: i = transport mean (motorbike; car; boat; tram; train; metro; bus; bicycle; on foot) $\mathrm{PE_i}$= person equivalent of the transport mean i. $\mathrm{CO_{2\,i}\ Emissions} = \sum_{\mathrm{i}} (\mathrm{FE_i \text{ x } PE_i}) \text{ x daily average distance x } 22 \text{ x } 10$ Where: $\mathrm{CO_{2\,i}}$ Emissions = Annual emissions associated with the transport mean i. FEi = emission factor of the transport mean i $\mathrm{KPI}_{\mathrm{T4}} = \frac{\sum_{\mathrm{i}} \mathrm{CO_{2\,i}\ Emissions}}{\text{no. of students}}$
Green Spaces	Trees per non-covered area	$\mathrm{KPI}_{\mathrm{GS1}} = \frac{\text{no. of trees}}{\text{non} - \text{covered area}}$
	Trees per student	$\mathrm{KPI}_{\mathrm{GS2}} = \frac{\text{no. of trees}}{\text{no. of students}}$
	Green area per non-covered area	$\mathrm{KPI}_{\mathrm{GS3}} = \frac{\text{green area}}{\text{non} - \text{covered area}} \text{ x } 100$
	Green area per student	$\mathrm{KPI}_{\mathrm{GS4}} = \frac{\text{green area}}{\text{no. of students}}$
	Annual CO2 sequestration per non-covered area	$\mathrm{KPI}_{\mathrm{GS5}} = \frac{\text{no. of trees x } \mathrm{SR}_{\text{dominant species}} + \text{lawn area x } \mathrm{SR}_{\text{lawn}}}{\text{non} - \text{covered area}}$
	Annual usage of chemicals per green area	$\mathrm{KPI}_{\mathrm{GS6}} = \frac{\text{quantity of fertilisers and pesticides}}{\text{green area}}$
	Annual CO2 emissions for maintenance per non-covered area	$\mathrm{KPI}_{\mathrm{GS7}} = \frac{\text{Fuel x } \mathrm{FE}_{\text{fuel}} + \text{water x } \mathrm{FE}_{\text{water}} + \text{electricity x } \mathrm{FE}_{\text{electricity}}}{\text{non} - \text{covered area}}$ Where: FE = factor emission.
Green Procurement	Equipment efficiency	$\mathrm{KPI}_{\mathrm{GP1}} = \frac{\text{no. of equipment A + or higher EU energy label}}{\text{total no. of equipments}}$
	Paper used per student per year	$\mathrm{KPI}_{\mathrm{GP2}} = \frac{\text{quantity of used paper x } 10}{\text{no. of students}}$
	Recycled paper used	$\mathrm{KPI}_{\mathrm{GP3}} = \frac{\text{quantity of recycled paper}}{\text{total quantity of paper}}$
	Training in green procurement	$\mathrm{KPI}_{\mathrm{GP4}} = \frac{\text{no. of employees with training in green procurement}}{\text{total no. of employees}}$

	Organic food	$\text{KPI}_{\text{GP5}} = \frac{\text{quantity of food with organic production certificate}}{\text{total quantity of food}}$
	Local suppliers	$\text{KPI}_{\text{GP6}} = \frac{\text{no. of local suppliers}}{\text{total no. of suppliers}}$
Energy	Energy consumption per useful area	$KPI_{E1} = \frac{\sum_i annual\ electricity\ consumption_i + \sum_j (annual\ fuel\ consumption_j\ x\ density_j\ x\ FC_j)}{useful\ area}$ Where: i = type of electricity (provided by the grid; on-site produced) j = type of fuel (diesel; LPG; natural gas) FCj = conversion factor to kWh of fuel j
	Energy consumption per student	$KPI_{E2} = \frac{\sum_i annual\ electricity\ consumption_i + \sum_j (annual\ fuel\ consumption_j\ x\ density_j\ x\ FC_j)}{no.of\ students}$ Where: i = type of electricity (provided by the grid; on site produced) j = type of fuel (diesel; LPG; natural gas) FCj = conversion factor to kWh of fuel j
	Percentage of renewable energy production	$KPI_{E3} = \frac{Renewable\ energy\ for\ onsite\ consumption + renewable\ energy\ sold\ to\ grid}{3\ x\ [\sum_i annual\ electricity\ consumption_i + \sum_j (annual\ fuel\ consumption_j\ x\ density_j\ x\ FC_j)]}$ Where: i = type of electricity (provided by the grid; on-site produced) j = type of fuel (diesel; LPG; natural gas) FCj = conversion factor to kWh of fuel j)
	Energy costs per useful area	$\text{KPI}_{E4} = \frac{annual\ energy\ costs}{useful\ area}$
	Energy costs per student	$\text{KPI}_{E5} = \frac{annual\ energy\ costs}{no.of\ students}$
	Annual CO2 emissions	$KPI_{E6} = \frac{(EC - REP\ x\ GL)\ x\ FE_e + \sum_i (aFC_i\ x\ density_i\ x\ FC_i)\ x\ FE_i}{no.of\ students}$ Where: EC = electricity consumption aFC = annual fuel consumption i = type of electricity (provided by the grid; on-site produced) j = type of fuel (diesel; LPG; natural gas) FCi = conversion factor to kWh of fuel i FCe = emission factor associated with electrical energy consumption FEi = emission factor associated with fuel i REP = renewable electrical production GL = grid losses
Indoor Air Quality	Air pollutant concentration	$\text{KPI}_{IAQ1} = \frac{\text{No. of air pollutants exceeding the guideline}}{\text{Total no. of air pollutants evaluated}}$
	Ventilation 1	$\text{KPI}_{IAQ2} = \frac{\text{CO}_2\text{ concentration between } 1000 - 1700\text{ ppm (time)}}{\text{Occupancy period (time)}}$
	Ventilation 2	$\text{KPI}_{IAQ3} = \frac{\text{CO}_2\text{ concentration over } 1700\text{ ppm (time)}}{\text{Occupancy period (time)}}$
	Thermal comfort	$\text{KPI}_{IAQ1} = \frac{\text{Period between } 20\ ^{\cdot}\text{C and } 26\ ^{\cdot}\text{C (time)}}{\text{Occupancy period (time)}}$

Table 1.- Definition of environmental indicators.

In the definition of the intervention, general school/university data are used in different KPIs. These include, for example, data regarding school areas or the number of students. This

information has been integrated into a common section, School Codes, which defines the general characteristics of the school/university, used both in the Sustainability Intervention tool and the auxiliary Energy engine tool.

Scores based on the Likert scale were obtained by weighting the indicators and assigning them different weights. On the other hand, the scores have considered related parameters among the audits recorded, taking maximums and minimums in each case for the definition of the scale.

Sector	Score designation	Score calculations	Less favourable scenario	More favourable scenario	Weighting for the final score
Waste	Urban Solid Waste	$S_{W1} = \frac{(\max(KPI_{W1}) - KPI_{W1}) \text{ x } 5}{\max(KPI_{W1}) - \min(KPI_{W1}) \text{ x } 0.95}$	Highest KPI_{W1} found	$\text{Min}(KPI_{W1} - (KPI_{W2} + KPI_{W3}))$ less 5%	2
	Waste recycled	$S_{W2} = \frac{KPI_{W2} \text{ x } 5}{1.05 \text{ x } \max(KPI_{W2})}$	Without recyclable waste	Highest KPI_{W2} found plus 5%	1
	Waste reused	$S_{W3} = \frac{KPI_{W3} \text{ x } 5}{1.05 \text{ x } \max(KPI_{W3})}$	Without reusable waste	Highest KPI_{W3} found plus 5%	1
Water	Water consumption per useful area	$S_{Wr1} = \frac{(\max(KPI_{Wr1}) - KPI_{Wr1}) \text{ x } 5}{\max(KPI_{Wr1}) - \min(KPI_{Wr1}) \text{ x } 0.95}$	Highest KPI_{Wr1} found	Lowest KPI_{Wr1} found less 5%	1
	Water consumption per student	$S_{Wr2} = \frac{(\max(KPI_{Wr2}) - KPI_{Wr2}) \text{ x } 5}{\max(KPI_{Wr2}) - \min(KPI_{Wr2}) \text{ x } 0.95}$	Highest KPI_{Wr2} found	Lowest KPI_{Wr2} found less 5%	1
	Water costs per useful area	$S_{Wr3} = \frac{(\max(KPI_{Wr3}) - KPI_{Wr3}) \text{ x } 5}{\max(KPI_{Wr3}) - \min(KPI_{Wr3}) \text{ x } 0.95}$	Highest KPI_{Wr3} found	Lowest KPI_{Wr3} found less 5%	1
	Water costs per student	$S_{Wr4} = \frac{(\max(KPI_{Wr4}) - KPI_{Wr4}) \text{ x } 5}{\max(KPI_{Wr4}) - \min(KPI_{Wr4}) \text{ x } 0.95}$	Highest KPI_{Wr4} found	Lowest KPI_{Wr4} found less 5%	1
Transports	Parking	$S_{T1} = \frac{(KPI_{T1} + KPI_{T2}) \text{ x } 5}{1.05 \text{ x } [\max(KPI_{T1}) + \max(KPI_{T2})]}$	Without charging stations	Highest $(KPI_{T1} + KPI_{T2})$ Found plus 5%	2
	Public transport	$S_{T3} = \frac{KPI_{T3} \text{ x } 5}{1.05 \text{ x } \max(KPI_{T3})}$	Without public transports	Highest KPI_{T3} found plus 5%	1
	Annual CO2 emissions	$S_{T4} = 5 - \frac{\text{school emissions x } 5}{\text{maximum emission}}$	100% of students go by car	100% of the students go on foot or by bicycle	2
Green Spaces	Green areas	$S_{GS1} = \frac{(KPI_{GS1} + KPI_{GS3}) \text{ x } 5}{1.05 \text{ x } [\max(KPI_{GS1}) + \max(KPI_{GS3})]}$	Without green areas	Highest $(KPI_{GS1} + KPI_{GS2})$ Found plus 5%	1
	Annual CO2 sequestration	$S_{GS2} = \frac{KPI_{GS5} \text{ x } 5}{1.05 \text{ x } \max(KPI_{GS5})}$	Without green areas	Highest KPI_{GS5} found plus 5%	1
	Annual usage of chemicals	$S_{GS3} = 5 - \frac{KPI_{GS6} \text{ x } 5}{\max(KPI_{GS6})}$	Highest KPI_{GS6} found	Without chemicals	1
	Annual CO2 emissions in maintenance	$S_{GS4} = 5 - \frac{KPI_{GS7} \text{ x } 5}{\max(KPI_{GS7})}$	Highest KPI_{GS7} found	Without emissions	1

Green Procurement	Equipment efficiency	$S_{GP1} = KPI_{GP1} \times 5$	Without certified equipment	100% of certified equipment	1
	Paper	$S_{GP2} = KPI_{GP3} \times 5 + 5 - \frac{KPI_{GP2} \times 5}{\max(KPI_{GP5})}$	Highest $KPI_{GP2}$and KPI_{GP3} found plus 5%	Without use and 100% recycled paper	2
	Training in green procurement	$S_{GP3} = KPI_{GP4} \times 5$	Without training	100% trained employees	0.25
	Organic food	$S_{GP4} = KPI_{GP5} \times 5$	Without food with an organic production certificate	100% certified food	0.25
	Local suppliers	$S_{GP5} = KPI_{GP6} \times 5$	Without local suppliers	100% local suppliers	0.25
Energy	Energy consumption	$S_{E1} = \frac{((\max(KPI_{E1}) - KPI_{E1}) + (\max(KPI_{E2}) - KPI_{E2})) \times 5}{2 \times [\max(KPI_{E1}) - \min(KPI_{E1}) + \max(KPI_{E2}) - \min(KPI_{E2})] \times 0.95}$	Highest KPI_{E1} and KPI_{E2} found	Lowest KPI_{E1} and KPI_{E2} found less 5%	1
	Renewable energy	$S_{E3} = KPI_{E3} \times 5$	0% renewable energy	100% renewable energy	1
	Energy cost	$S_{E4} = \frac{((\max(KPI_{E4}) - KPI_{E4}) + (\max(KPI_{E5}) - KPI_{E5})) \times 5}{2 \times [\max(KPI_{E4}) - \min(KPI_{E4}) + \max(KPI_{E5}) - \min(KPI_{E5})] \times 0.95}$	Highest KPI_{E4} and KPI_{E5} found	Lowest KPI_{E4} and KPI_{E5} found less 5%	1
	CO2 annual emissions	$S_{E6} = \frac{(\max(KPI_{E6}) - KPI_{E6}) \times 5}{\max(KPI_{E6})}$	Highest KPI_{E6} found	Lowest KPI_{E6} found less 5%	1
IAQ	Air pollutants	$S_{IAQ1} = 5 - 5\frac{\text{No.of air pollutants exceeding the guideline}}{\text{Total no.of air pollutants evaluated}}$	-	-	1
	Ventilation	$5 - \left(\frac{2.5}{log10(2)}\right) \cdot log10(1 + KPI_{IAQ1} + 3 \cdot KPI_{IAQ2})$	-	-	1
	Comfort	$5 \cdot KPI_{IAQ4}$	-	-	1

Table 2.- Definition of the scores, along the dimensions of environmental performance.

Within the application, it is possible to exclude the indicators obtained in the calculation of the final scores. It allows users to carry out test studies to assess the possible impact of interventions without affecting the overall indicators of the study.

3.2.2 Energy engine

For the energy engine, a calculation model requiring information on heating and cooling systems, hot water systems, and lighting was applied. This information was combined in the model with general characteristics of the building, such as their geometry, types of spaces (classrooms, departments, canteens, common areas, ...) as well as the occupancy time slots in the school (Lizana et al., 2018). The use of the model also requires meteorological data, obtained from the Climate.OneBuilding repository (Climate.Onebuilding.Org, n.d) for the demonstration sites of the project.

With the data entered into the model, the energy demands for a whole year are calculated, and with the occupancy data, hot water, heating, cooling, and light consumption for the building are obtained. This study also considers the actual energy consumption and the monthly costs reflected in the bills.

The evolution of the outdoor air temperature and the indoor temperature in the building over the year, without cooling or heating, are calculated, to identify the periods in which cooling or heating is required. The model calculates degree days*to determine the heating and cooling requirements of the building (* Degree days relates to the energy demand of a specific building) . This analysis also includes the calculation of thermal gains and losses of the building, considering losses due to ventilation (Qve), heat transmission through walls and windows (Qtr), as well as thermal gains through walls and windows (Qsol opaque, Qsolglazing), gains due to building occupation (Qint oc), gains due to building equipment (Qint ap) and due to lighting (Qint li). This balance sheet is based on the following scheme obtained from the reference article (Lizana et al., 2018):

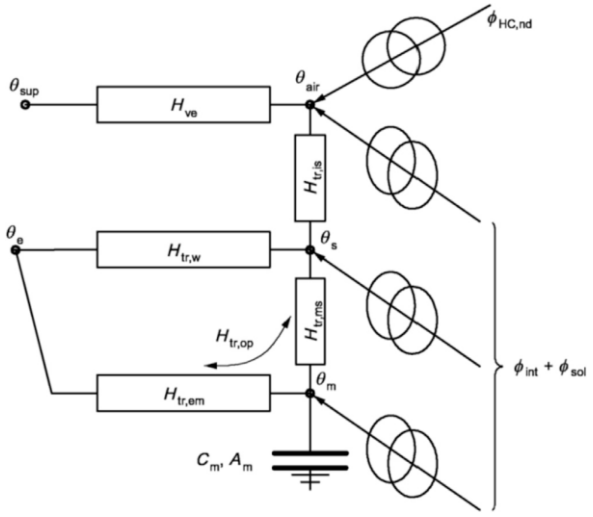

Illustration 1.- Diagram of loads and heat gains defined (Lizana et al., 2018).

The final monthly heating (QH,nd) and cooling (QC,nd) demands are obtained by balancing these loads.

The consumption calculation is related to the occupancy profiles of the school and is defined for each type of lighting and air-conditioning system. This calculation is also done for hot water. The model calibrates and calculates the consumption for each primary energy source by comparing it with the real values of the school bills. It also calculates the CO_2 emissions according to the energy source.

The results of the model for the building are the percentage of hours that the building has an indoor temperature outside the comfort zone (DH), heating demand (QH,nd), cooling demand (QC,nd), final energy consumption (FEC), non-renewable primary energy consumption (PECnr), CO_2 emissions associated with non-renewable primary energy consumption (CO2eq).

	DH (%)	QH,nd (kWh/m2 a)	QC,nd (kWh/m2 a)
	66%	23,95	10,87
Max.	90%	30,00	20,00

	FEC (kWh/m2 a)	PECnr (kWh/m2 a)	CO2eq emissions (kg CO2eq/m2 a)
	23,26	51,94	8,95
Max.	20,00	25,00	5,00

Table 3.- Example of consumption and demand results.

The following parameters are also used in the analysis:

- Thermal comfort: percentage of hours of discomfort during the occupancy period of the building. This represents the time during the occupancy period when heating or cooling is needed.
- Energy demand: annual energy demand for both heating and cooling (kWh/m2/year). This represents the amount of thermal energy that will be needed to maintain the building in thermal comfort conditions.
- Energy consumption: final energy consumption of all energy uses (kWh/m2/year). This represents the amount of energy consumed to keep the building in thermal comfort conditions.
- CO_2 emissions: the amount of CO_2 emitted into the atmosphere due to the energy consumption of the building (kg CO2/m2/year).

An example of the complete report with comments is included in Annex 2.

4. DESCRIPTION OF THE TOOLS

This section describes the use of the tool. The applications are available in the languages of all project partners: English, Finnish, Spanish, Portuguese, Romanian, Hungarian and Greek.

The design and use of the tools served as complementary means of enhancing the acquisition of individual and collective sustainability competences. The design and used of these applications are part of the hybrid participatory approach, involving the co-design, co-testing, and co-evaluation of sustainability interventions. In this way, the tools enhance the development of competences in systemic thinking, future thinking, and critical thinking in evaluating the initial baseline (before the implementation of a measure), the possible impact of its implementation, and its impact on environmental performance.

Both applications share information related to the user and to the general characteristics of the school/university. The flow of information is shown in the following diagram:

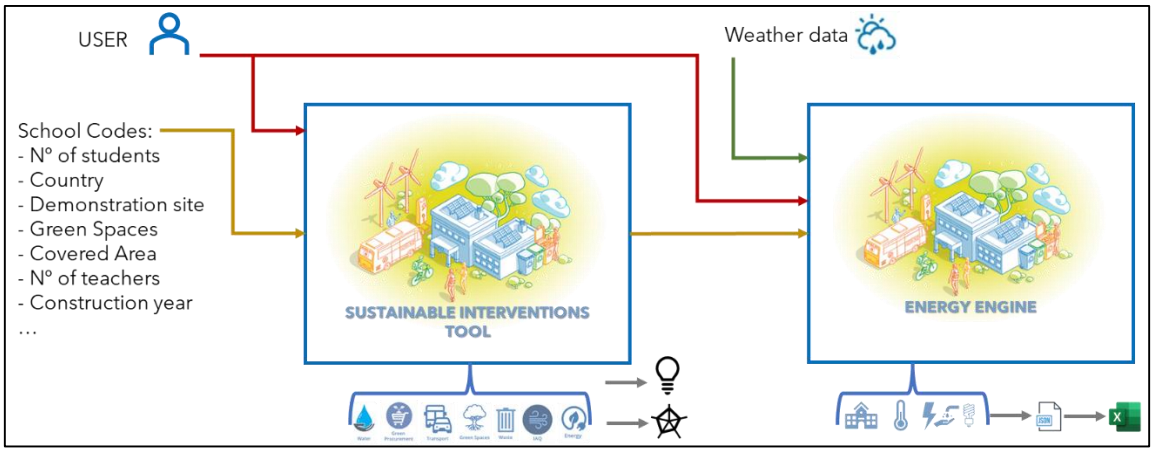

Illustration 2.- Shared information between applications.

4.1. Sustainability Intervention tool

Following the hierarchical structure explained in the previous section, a tool based on PowerApps (from Microsoft) was designed, consisting of three main aspects:

- User management
- Audit data collection (in the seven defined sustainability areas)
- Visualisation of results

The differentiation of the two main parts of the data management (data menu / calculations menu) is illustrated through colours (blue for data collection and green for results visualisation). The application has three levels of users to suit different educational levels, with varying number and complexity of questions. The levels are generally structured as follows:

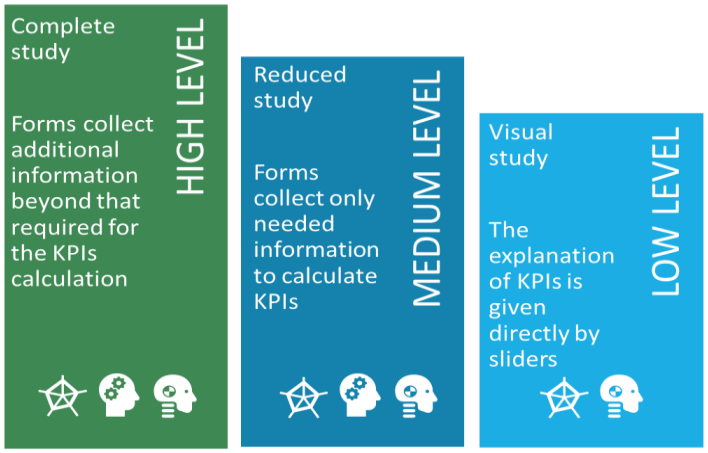

Illustration 3.- Sustainability Intervention Tool levels of use.

All graphs obtained in the tool are downloadable and show the calculated scores. On the other hand, an interpretation of the results is available in the calculations menu.

The process of obtaining data and results is linear and consists of three steps:

- Identification: Login to the application via the user assigned to the demonstration site.

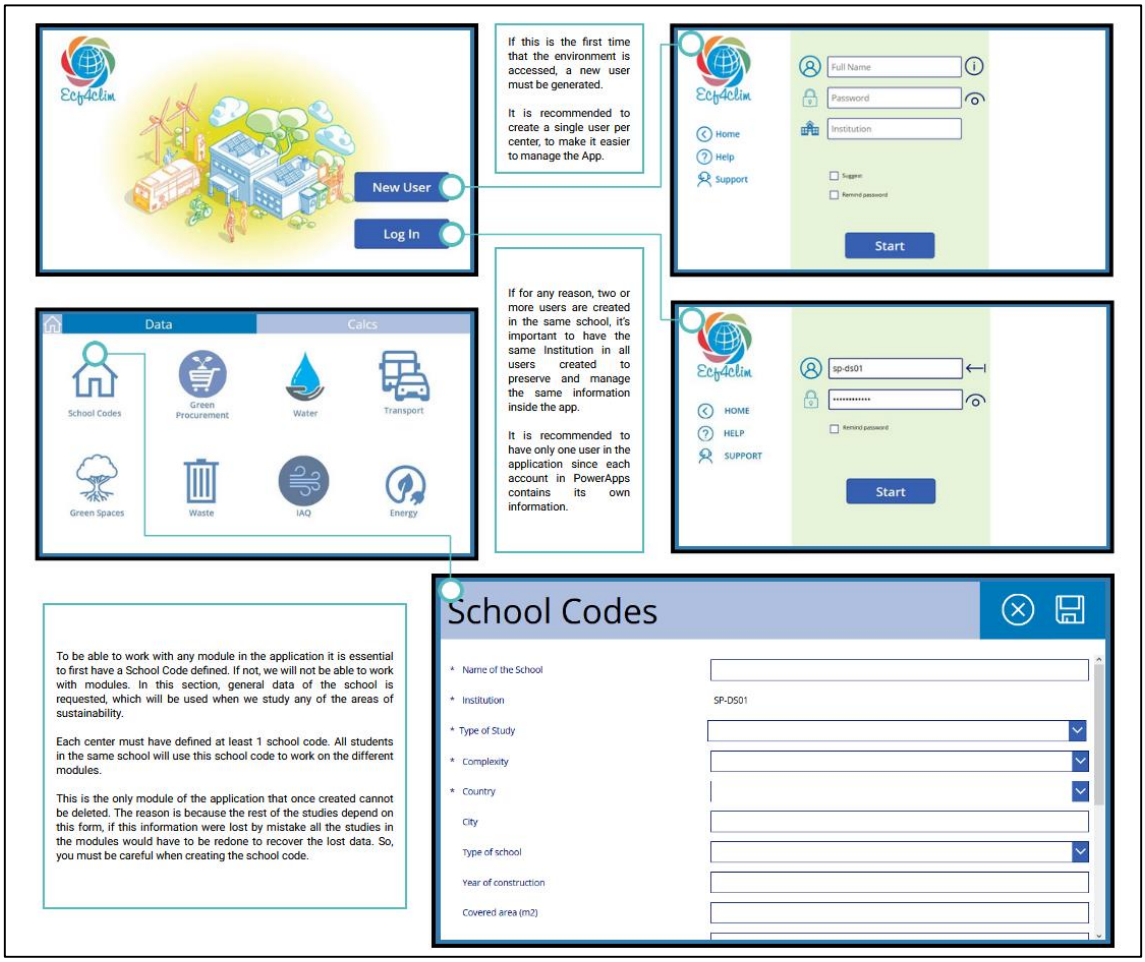

Illustration 4.- Login and initial navigation.

Each user can only create, view, and edit their own data, even if the calculations are based on the information entered by all users. This way, protection of individual data can be ensured.

- Data collection: After a code has been attributed to each school/university, data collected in the audit for each sustainability area can be recorded, viewed, edited or deleted.

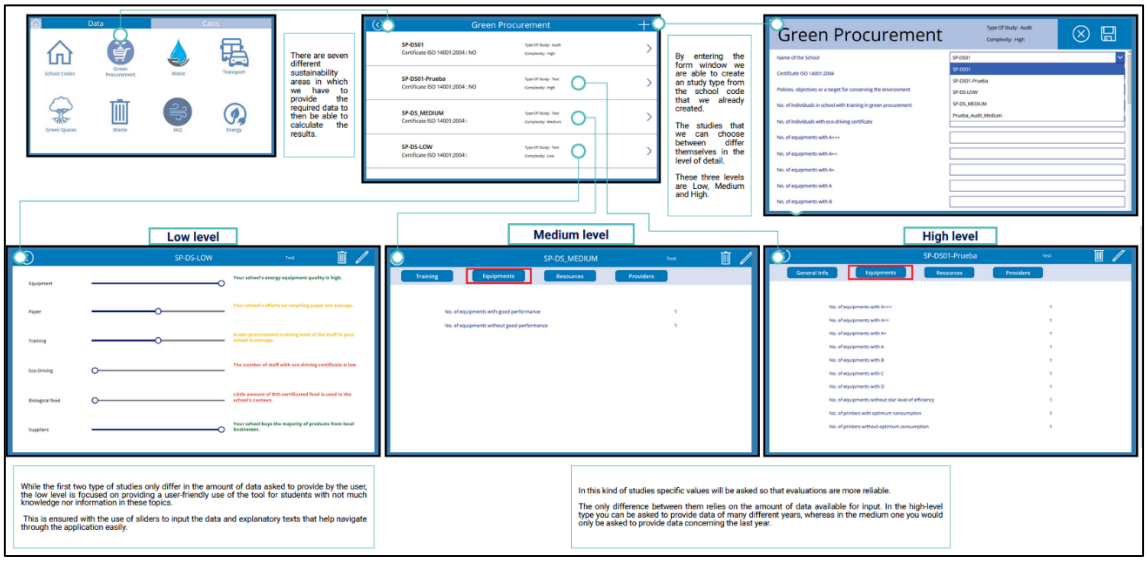

Illustration 5.- Data collection navigation.

- Results display: Once the information is registered, the application calculates the audit results, considering all schools/universities with audit data available in the database.

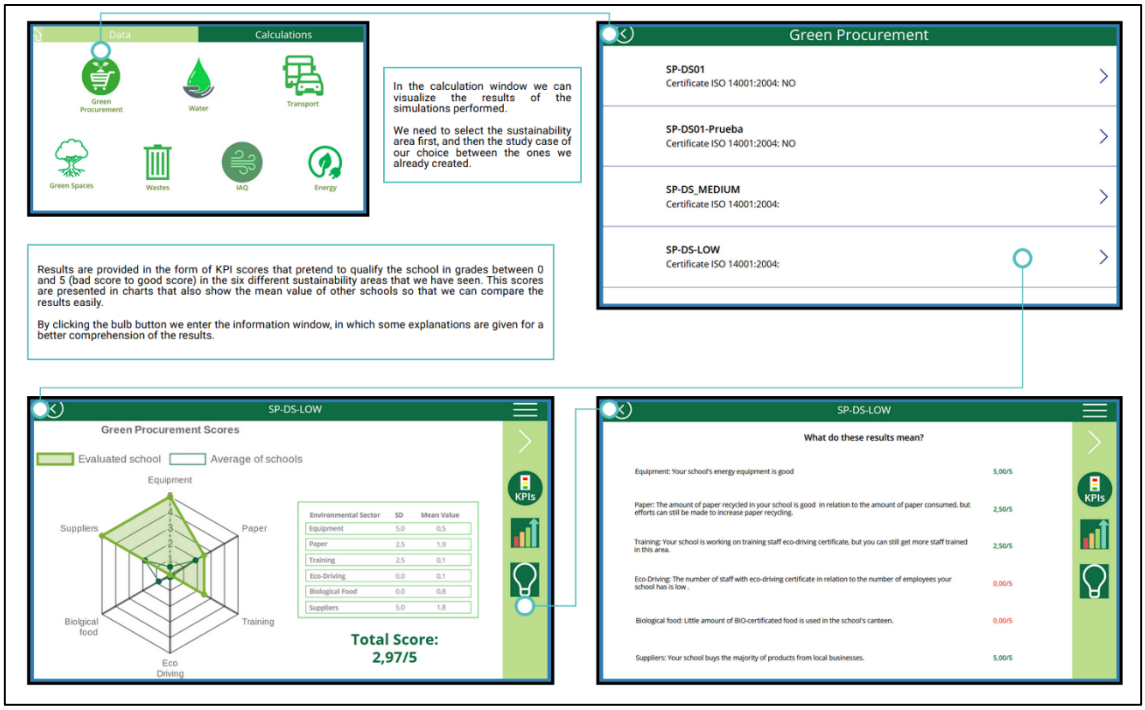

Illustration 6.- Calculation menu navigation.

In studies marked as "Audit", the information is used for the calculation of the overall scores. In the case of studies marked as "Test", this information is used to assess the possible impact of the implementation of the sustainability measure.

In the calculation menu, a screen is displayed through the "light bulb button", where an interpretation of the results is provided, on the basis of the score obtained. This interpretation

helps the educational community to identify areas that require further action. It also gives simple recommendations on how to improve the score. Both the content of the indications and the recommendations may be changed in future updates if appropriate.

4.2. Energy engine

The tool is connected to the Sustainability Intervention tool application. It shares the user information as well as the defined school/university code. This information must be provided in the Sustainability Intervention tool. To simplify the study and improve the user experience, the tool has been divided into three parts:

- Part 1: Definition and characterisation of the building: geometry of the building together with occupancy parameters.
- Part 2: Definition and characterisation of HVAC systems: school's/university's heating and cooling systems.
- Part 3: Definition and characterisation of lighting, water facilities and energy consumption.

As in the Sustainability Intervention tool, this application consists of three blocks:

- Identification and visualisation of meteorological data: Entry into the application via the user assigned to the demonstration site. The application imports the school codes entered in the Sustainability Intervention Tool. Also the locations with available weather data are displayed.

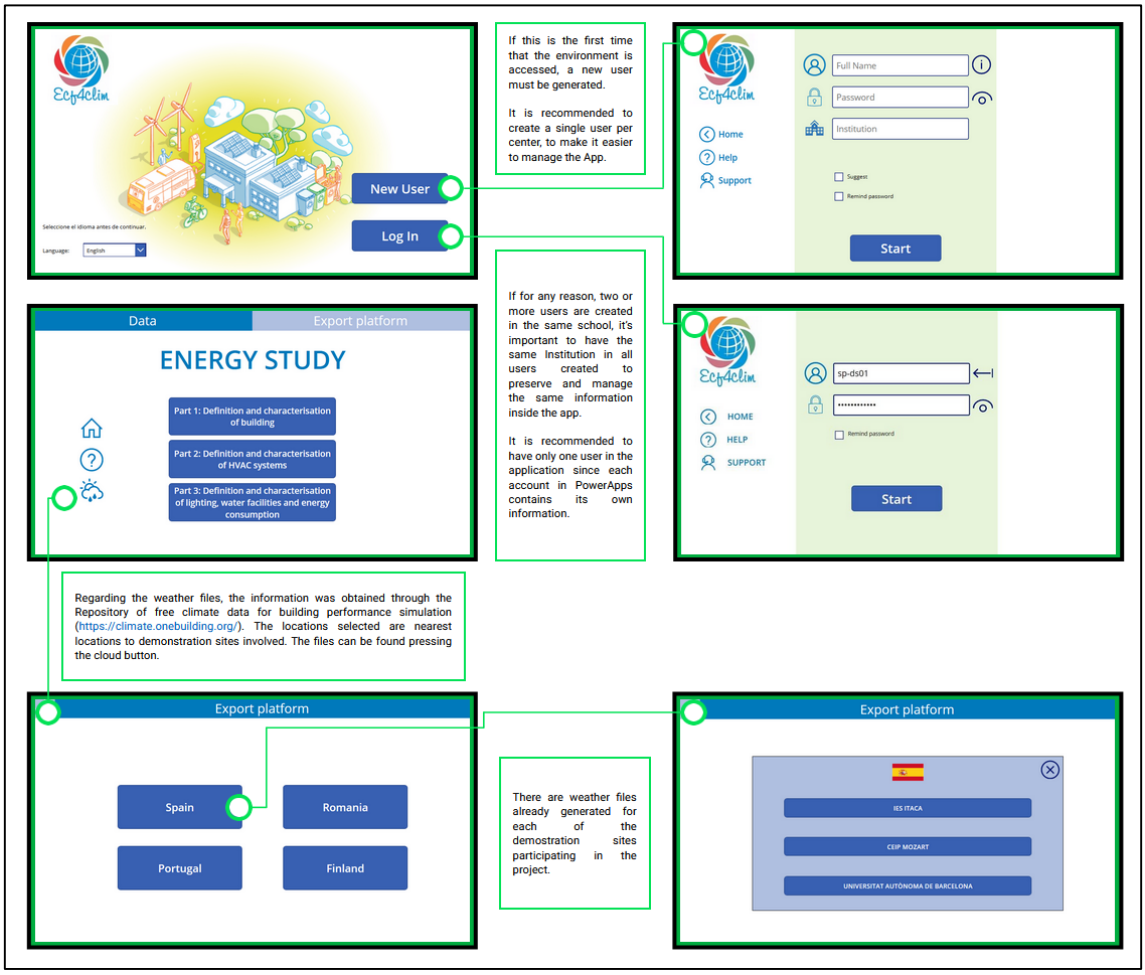

Illustration 7.- Login and weather data localisation.

- Data collection: Using the available school/university codes, the application can be used to record, view, edit and delete the data obtained in the audit.

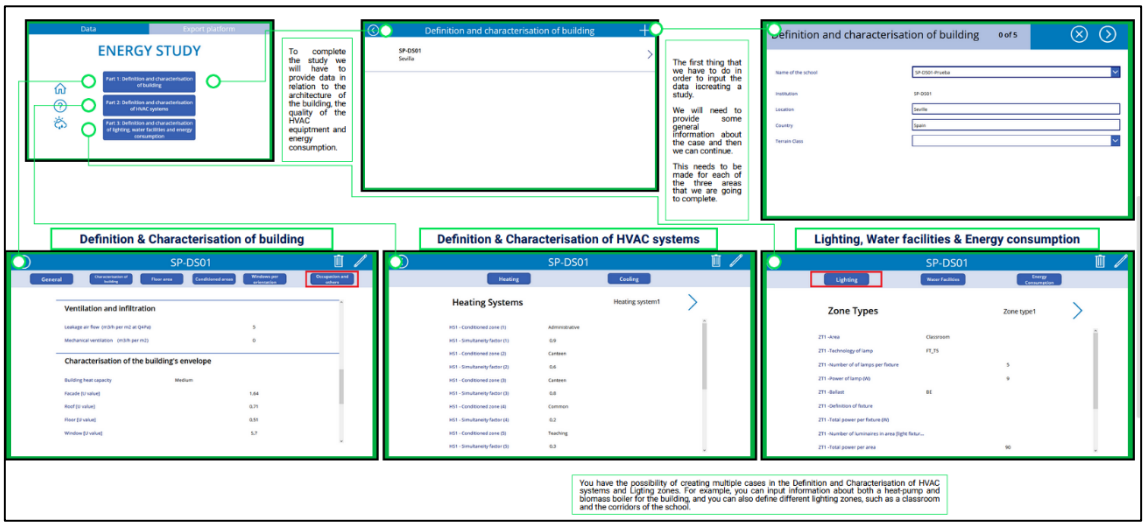

Illustration 8.- Data collection process.

- Data exportation and creating a report: In this last part, all the information obtained in the audits is clustered and downloaded through a JSON format file. The JSON file should be feed in the engine energy and the final report will be obtained.

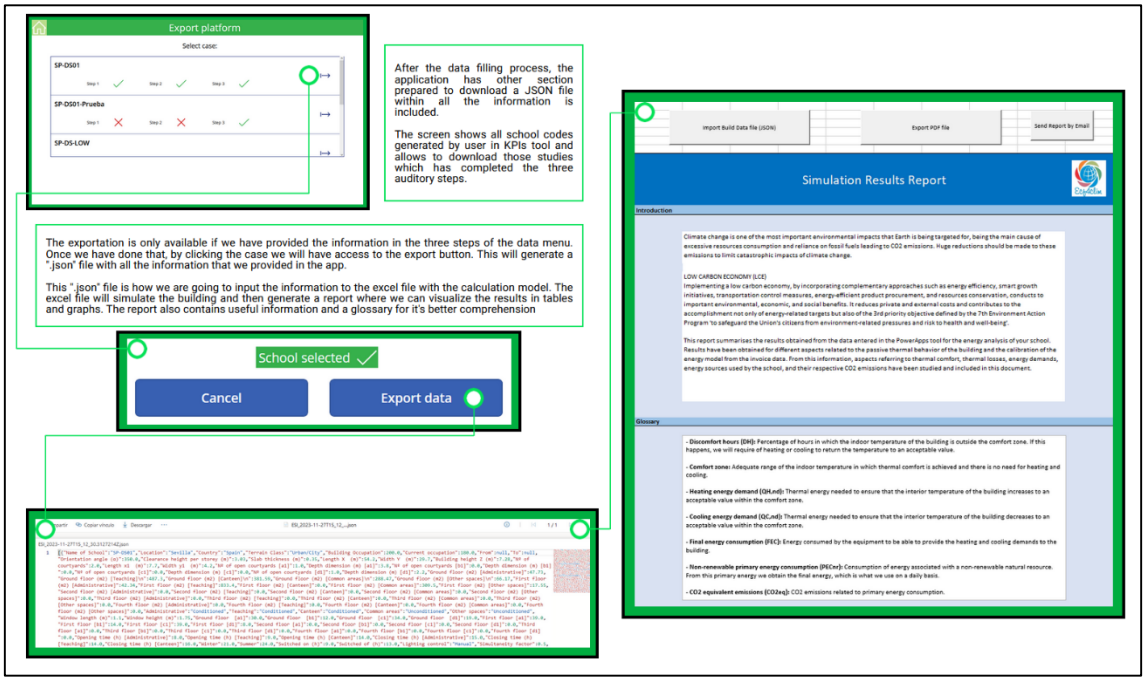

Illustration 9.- Data exportation platform.

Due to the interconnection of the data, the application does not allow downloading the JSON file with the audit until the three previous phases are completed. The result of the report is displayed in the tool's user manual, in **¡Error! No se encuentra el origen de la referencia.**.

5. VALIDATION OF TOOLS

A validation process was designed to test whether the tools can enhance the improvement of individual and collective sustainability competences. To this end, the Youth with Researchers programme, held every year in Seville to foster interest in scientific activity among secondary and high school students, collaborated in the testing and validation process. Thus, the tool has been used within research projects to evaluate sustainability interventions in the participating schools and universities, and to provide feedback concerning the interfaces, data introduction, results presentation, design, etc.

As part of the Youth with Researchers programme, the students involved design and carry out research projects in teams, with the support of teachers and university researchers. Students present the results of their research at a conference held each year at a different venue at the University of Seville and Córdoba faculties.

For the validation of the Sustainability Intervention tool, in four sessions, 25 students used the application to elaborate four research projects focused on sustainability. The students used the tool to audit their schools in different areas, according to the theme of each project.

The testing process started on 16/01/2023 and lasted until 19/04/2023. On the first day, the tool's access and mode of use were explained to the students so they could use it in their work. During the following three sessions, held on 30/01/2023, 20/02/2023 and 20/03/2023, the students used the tool and the results it provided as a basis for their research.

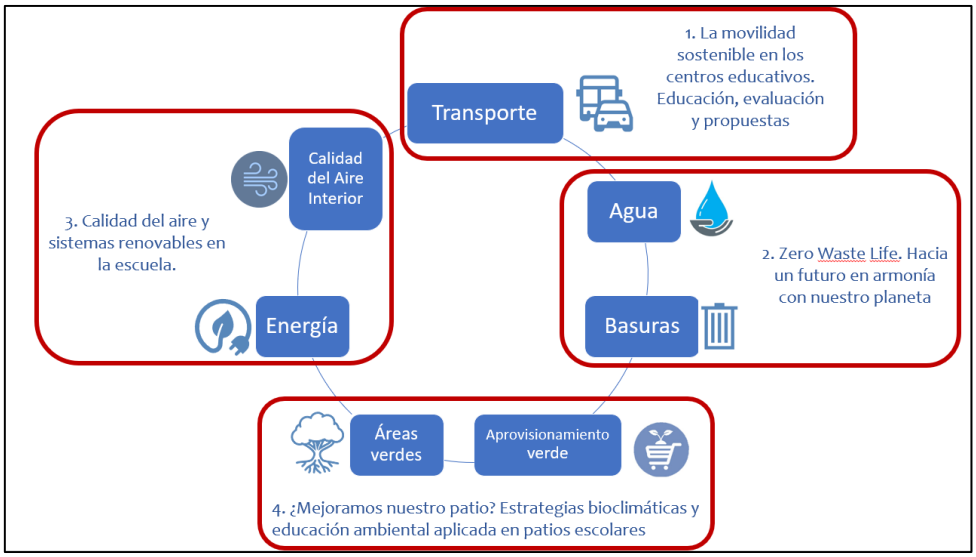

Illustration 10.- Identification of the most related sustainable areas with the projects done by the students.

The projects designed by the students, where they used the different elements of the Sustainability Intervention tool, were:

- 1.- Sustainable mobility in educational establishments. Education, evaluation and proposals.
- 2.- Zero Waste Life. Towards a future in harmony with our planet.
- 3.- Air quality and renewable energy systems at school.

- 4.- Do we improve our playground? Bioclimatic strategies and environmental education applied to school playgrounds.

During the second session, students provided feedback about the tool's use. The information obtained in this session was used when drafting the manuals, including information concerning the data requested in the different parts of the Apps.

Illustration 11.- Young with Researchers students learning about the Apps developed.

The tool was used by the students who presented the results they had obtained in a third session, divided according to the areas of sustainability involved.

Illustration 12.- young with Researchers work session.

Finally, the students drew conclusions concerning the state of their schools and the potential of the sustainability measures they had elaborated. They indicated that the tool helped them to identify areas of sustainability where actions were needed the most. The students commented

on their experience on the use of the tool and how it had helped them design sustainability measures.

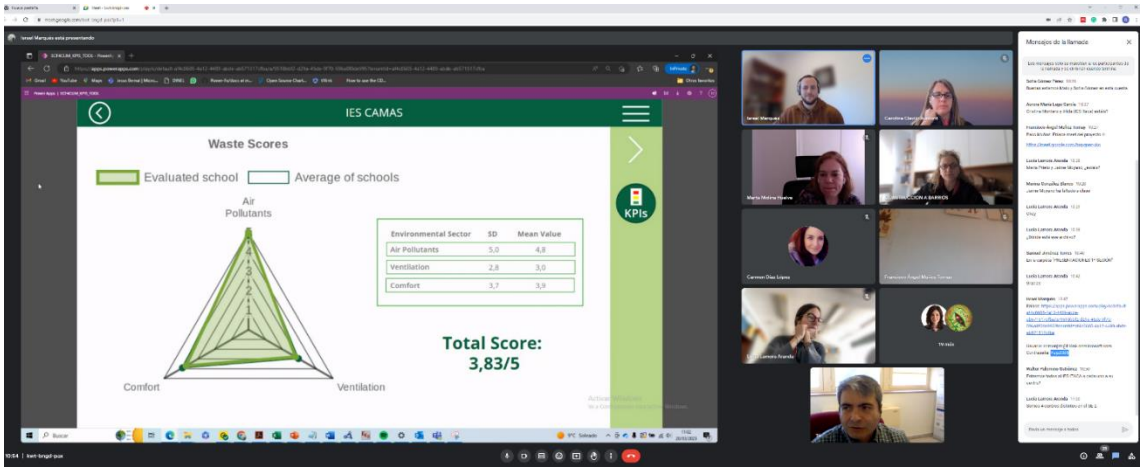

Illustration 13.- Final Young with Researchers session.

This validation process helped to improve the application, the type of content displayed, and the use that the educational community can make of this tool.

Based on this experience, the following improvements were made:

- Improving and extending the user manuals.
- Simplifying the access to the tool.
- Including a screen showing the meaning of the results, as well as adding tips for improving the results in each area.
- Developing and finalising the two sub-levels of the Sustainability Intervention tool, and including the new functionalities in the instructions.
- Elaborating user diagrams to make the user become familiar with the use of the tool more quickly.
- Including a download button for the score's graphs.

In relation to the Energy engine, it was found that the Power Apps environment improves the user experience, as this model was applied in a preliminary way using only Excel. The exclusive use of Excel for this model hindered the understanding and auditing process due to the amount of information required in the audit.

The results are the product of an initial design, followed by a testing process involving different groups of students. Although the applications are now functional, published and tested, they are subject to change.

6. CONCLUSIONS

D 7.10 comprises a Sustainability Intervention tool and, as an auxiliary application, the Energy engine.

The tools are incorporated within our hybrid participatory approach and can be used in the co-design, co-testing, and co-evaluation of sustainability measures. In this way, the tools enhance the development of competences in systemic thinking, future thinking, and critical thinking in evaluating the initial baseline (before the implementation of a measure), the possible impact of its implementation, and its impact on environmental performance.

The tools were validated through the active engagement of high school students during a four-month period, allowing the development of new functionalities and improving the user experience. It also facilitated the development of the two sub-levels of the tool.

At all levels, the aim is the use of the tools by the students to critically reflect upon the challenges and promote changes in various areas of school/university activities relevant for sustainability. The use of the tools provides information and enhances the users' understanding, at different levels, about the impacts of such activities on sustainability, while serving as inspiration for the development of interventions designed to improve sustainability.

These tools are available online from the project's official website and are accompanied by videos and manuals that allow for a quicker adaptation to user needs. The tool is complete and fully operative. However, it may undergo changes throughout the project to adapt to the needs of the users and to facilitate the acquisition of competences by the educational community.

7. REFERENCES

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8. ANNEX 1: SUSTAINABILITY INTERVENTION TOOL MANUAL

Sustainability Intervention Tool Manual

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036505

Table of Contents

Index of Illustrations

1. Introduction

The platform developed in the Microsoft PowerApps environment allows the analysis and understanding of the state of educational centers regarding seven different areas of sustainability, within which Key Performance Indicators (KPIs) are determined. Using the tool will help to evaluate sustainability competencies and define strategies for their improvement. The areas of sustainability that are covered within the App are:

- Green procurement.
- Transports.
- Water.
- Waste.
- Green Areas.
- Indoor Air Quality.
- Energy.

This tool analyzes different aspects of the demonstration sites. Sometimes, the application launches questions not directly related to the calculation of sustainability indicators. Notably, in this document, the issues that are directly related to the calculation of the scores will be **marked in this format**. Other requested information may be useful to draw conclusions about the situation of the demonstration sites, but is not needed to calculate indicators. If there is a lack of information when generating a new study of the educational center, it is possible to edit the entered information.

The application has been translated into 6 different languages to facilitate its use by the students. These languages are:

- English.
- Spanish.
- Finnish.
- Greek.
- Romanian.
- Hungarian.

2. Access to the application

To enter the PowerApps environment where the application is located, it is necessary to access from a Microsoft account that is delivered to the user. For this purpose, a specific account has been generated.

a. Steps to follow

To enter the application, the following link may be used:

https://apps.powerapps.com/play/e/default-af4c0605-4a12-4489-abde-ab571517cfba/a/9518bbf2-d29a-45de-9f70-596a8f0de995?tenantId=af4c0605-4a12-4489-abde-ab571517cfba

Or by scanning the QR code:

Figure 1.- QR code to access the application.

Once the login page is launched, the Microsoft login protocol appears (pop-up page) as follows:

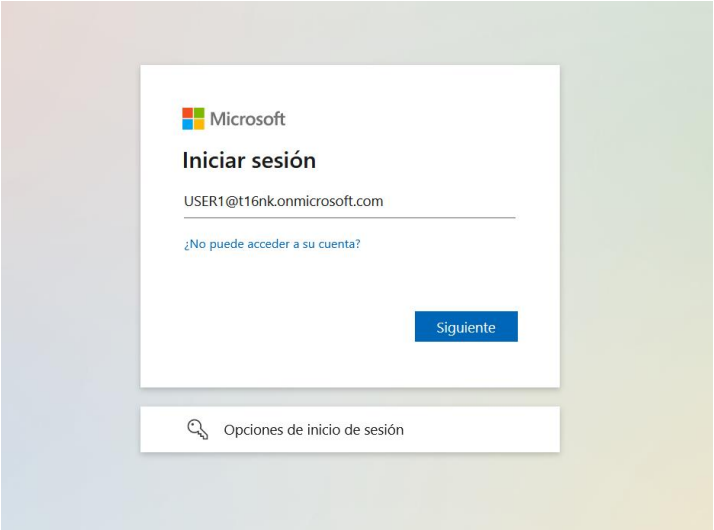


Figure 2.- Microsoft login screen, user. (The user shown was created to display the procedure, it is currently unavailable.)

When the user is entered, the box to enter the password appears:

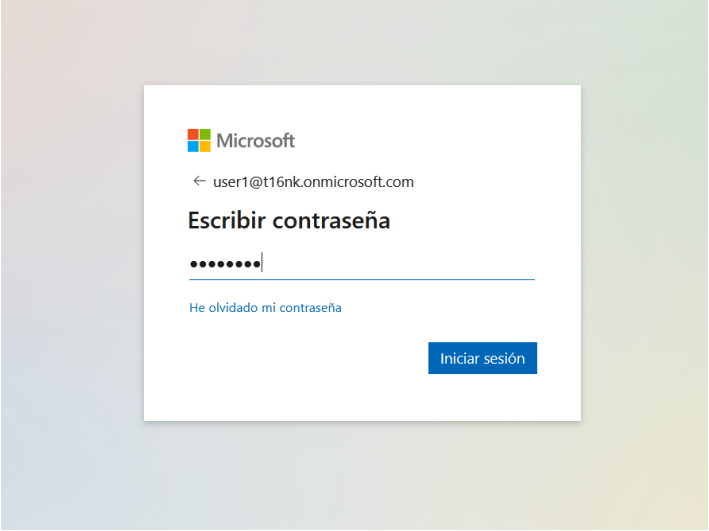


Figure 3.- Microsoft sign-in screen, password. (The user shown was created to display the procedure, it is currently unavailable.)

The user created for the use of this tool is as follows:

USER NAME	PASSWORD
ECF4CLIM_DS@T16NK.ONMICROSOFT.COM	Cozo3509

Table 1.- Microsoft User developed for initializing the app.

The sign-in settings are developed as single-factor authentication, so when Microsoft account is entered, it automatically opens the PowerApps environment where the home screen appears.

Figure 4.- Start screen of the application.

If this is the first time, a **new user** must be generated and all subsequent data will be assigned to such user. To facilitate the management of the App, **it is recommended to create a single user per center.** To create it, the application will ask a name, password, and entity to which the account belongs, that is, to indicate the name of the educational center to which the data will be linked. The application gives the option to generate and remember the password.

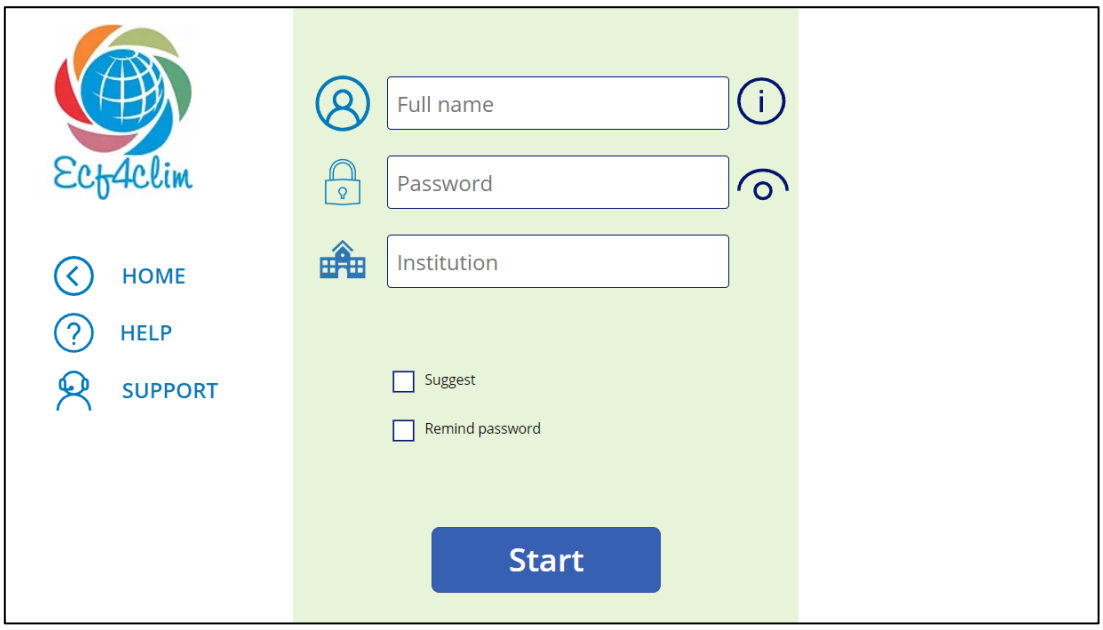


Figure 5.- New User screen.

If for any reason, two or more users are created in the same school, it's important to have the same **Institution** in all users created to preserve and manage the same information inside the app.

When the user has been created, a school code can be created for each center in data menu and all l the information of the seven sustainability areas will be generated.

If a user has already been created, the application access is done by pressing the "Log in" button. It is recommended to have only one user in the application per demonstration site, since each account in PowerApps contains its own information.

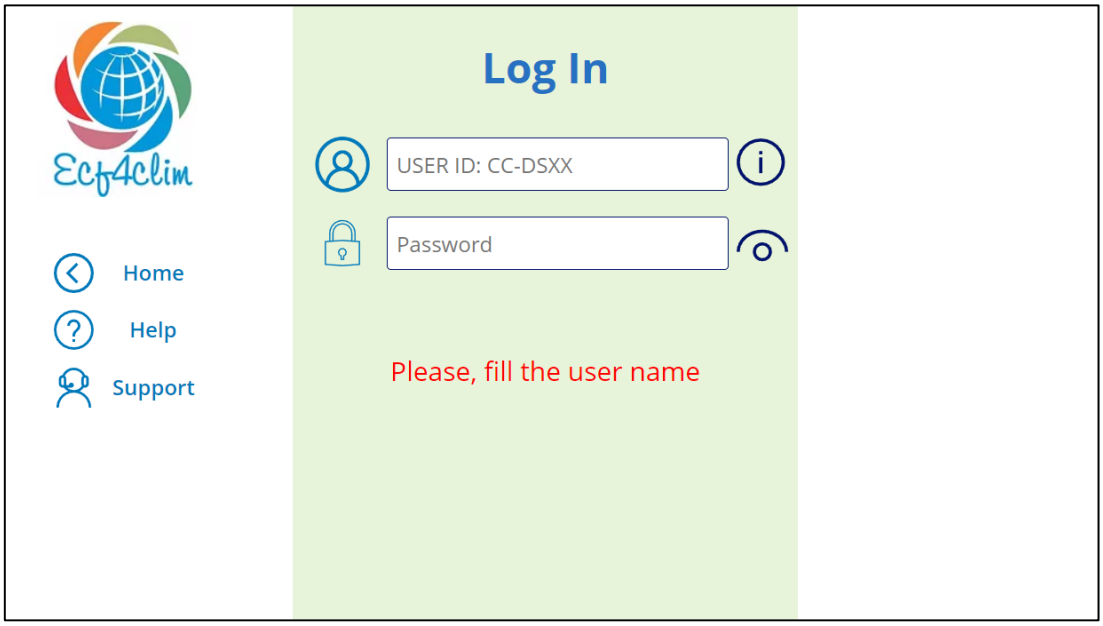


Figure 6.- Login screen.

Once the process of entering the application has been completed, the application shows a screen with two main menus. A button is shown for each sustainability area, added to an extra one whose purpose is the definition of the study center.

General

The development of the application comprises two distinct parts, that can be visualize by colors within the application. The first deals with the data management, including the definition of the case study, as well as the full range of forms that are presented regarding the seven areas of sustainability. The second deals with the results of the performance indicators for each area of sustainability.

Data menu

It is the first screen shown after doing the sign in process in PowerApps. As can be seen, the entire theme of this part of the study has been chosen in blue, to differentiate it from the menu for the sample of results.

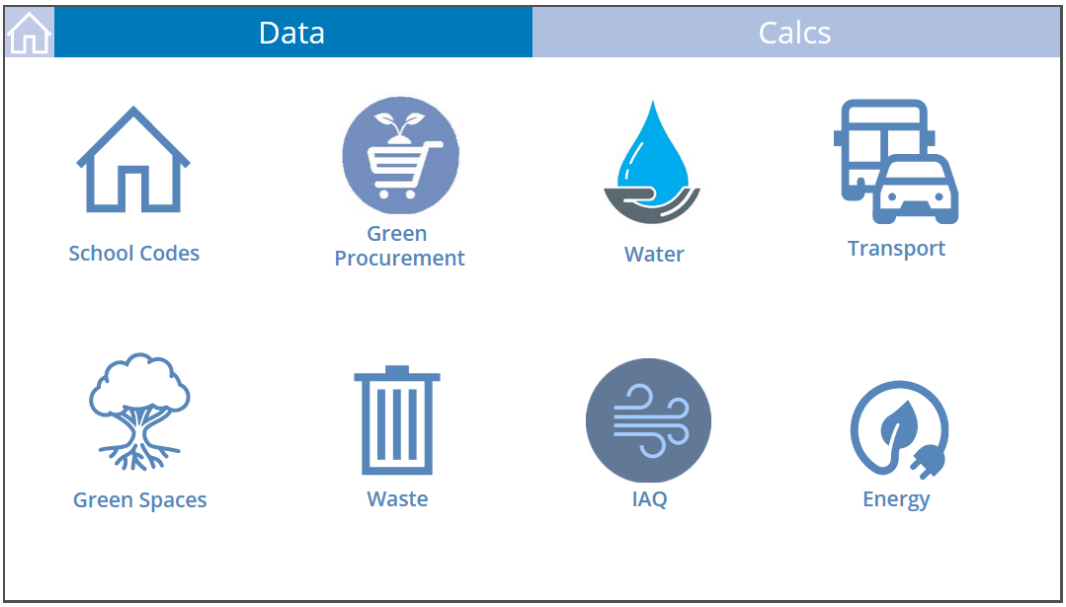


Figure 7.- Visualization of the data menu.

As mentioned in the introduction, this project seeks to obtain sustainability competencies in 7 different areas. In this part of the application, 8 buttons are shown, 7 for the areas of sustainability, and one for the definition of the center.

Calcs Menu

As can be seen in the image below, a green theme has been chosen to differentiate this menu from the data menu. In this way, the user can know where in the application he is browsing only by seeing the color theme of the application. In this menu, the calculations of the scores obtained for each sustainability area are made, considering all the cases studied. Unlike, in the data collection menu, in this case 7 buttons appear, one for each sustainability area.

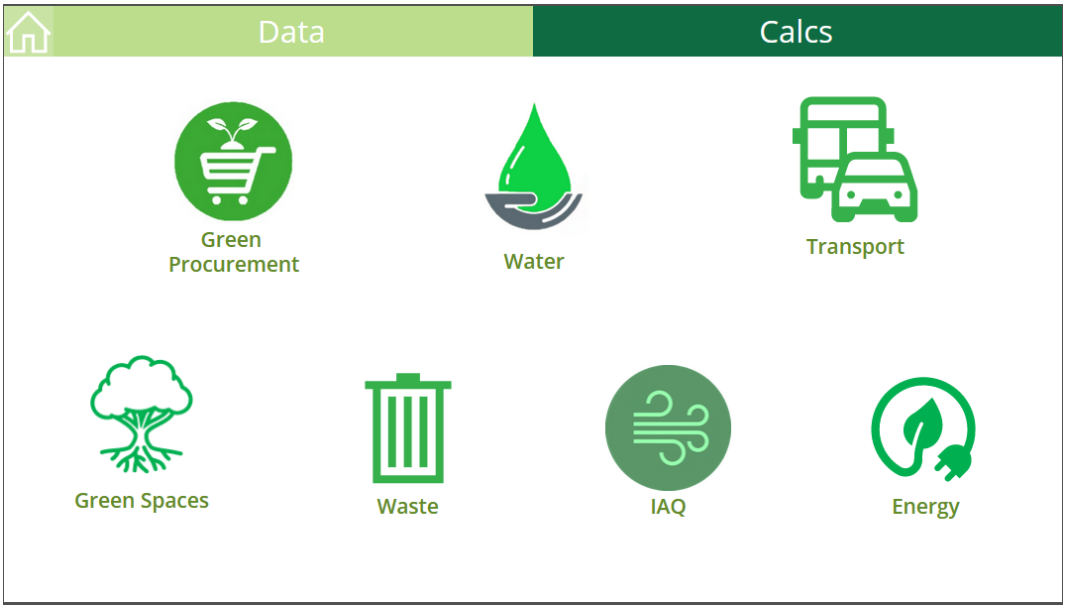


Figure 8.- Visualization of the calculation menu.

It should be noted that this menu performs the operations related to the calculation of indicators within each sustainability area each time the results are going to be displayed. Therefore, the global study evolves continuously each time a center introduces information in the application. This also allows the possibility of monitoring the impact of the measures carried out in an educational center, focusing on the evolution of the values of the scores.

Considerations

When a button is clicked, both in the data menu and in the calculation menu, a screen will appear containing a gallery, that is, a list with all the cases that have been created in a demonstration site. Each PowerApps user has the possibility of creating more than one case study, which can allow different audits to be carried out over time and the results to be contrasted, using this tool to identify and evaluate the impact of measures.

Types of studies based on level of detail.

Three different types of studies have been created according with the level of detail. By doing this the level of detail can be adjusted depending on the amount of data known by the user. These levels are High, Medium, and Low.

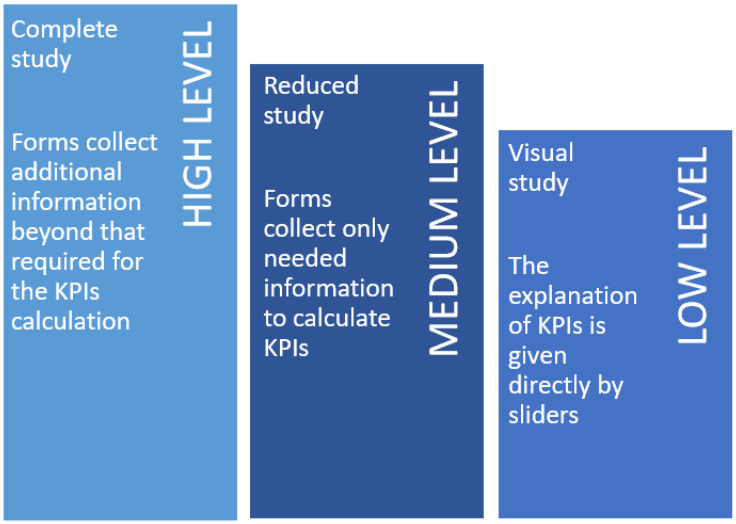


Figure 9.- Different type of studies depending on the level of detail.

High and Medium level studies

In this kind of studies specific values will be asked so that evaluations are more reliable. The difference between them relies on the amount of data available for input. In the high-level type data of many different years are requested, whereas in the medium one the data requested is concerning the last year.

Low level studies

While the first two types only differ in the amount of data to be provided by the user, the low level is focused on providing a simpler and user-friendly use of the tool for students with not much knowledge nor information in these topics. This is ensured with the use of sliders to input the data and explanatory texts that help navigate through the application easily.

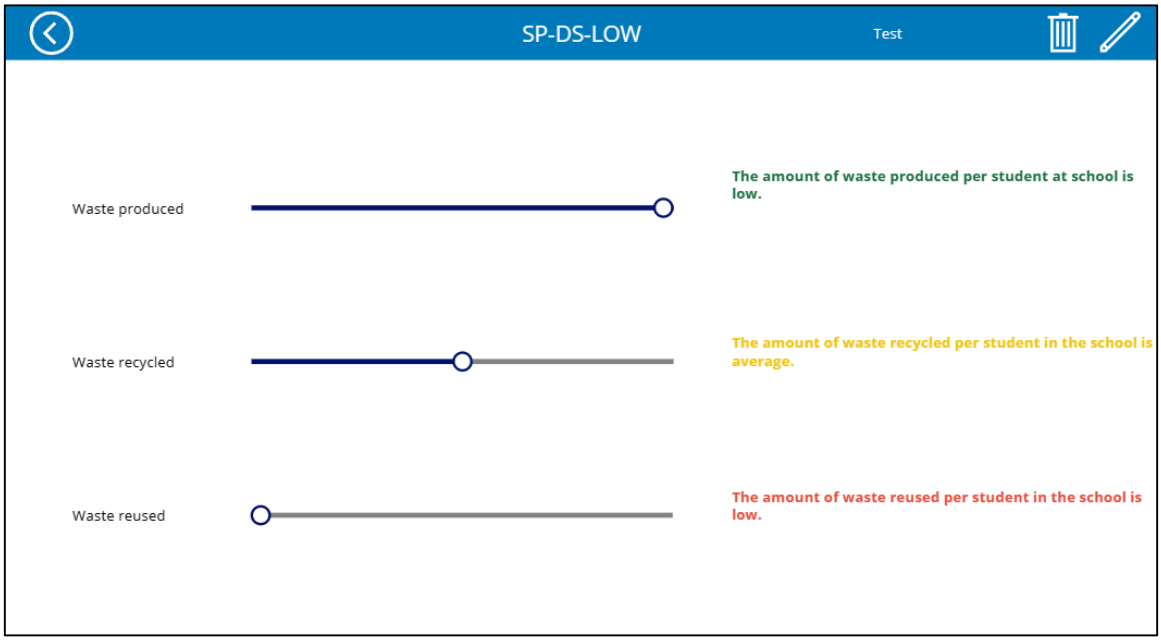


Figure 10.- Low level study window example on the app.

The low-level sliders are designed to facilitate users the data entering. The scores are stored directly evaluating the sustainable performance through some simple and specific questions.

It is also important to know that qualifications through the sliders are provided as:

- Highest score is assigned to the right-side zone of the slider, which presents the results in green.
- The average score is assigned to the middle zone of the slider, which presents the results in yellow.
- Lowest score is assigned to the left-side of the slider, which presents the results in red.

Creating a study

School codes

In this section, general data of the school are requested, which will be used when we study any of the areas of sustainability. When we create a new case, the form asks us to:

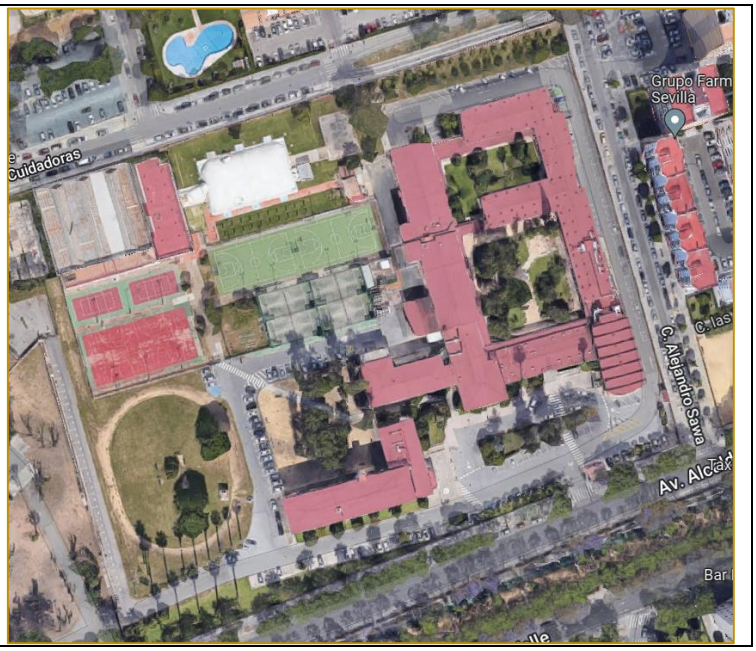
- **Name of the school**: This name will be the main identifier of the study. It will be entered into the forms each time a sustainability area is to be analyzed.
- **Country**
- **City**
- **Type of school**: The different types of schools available are those shown in the table.

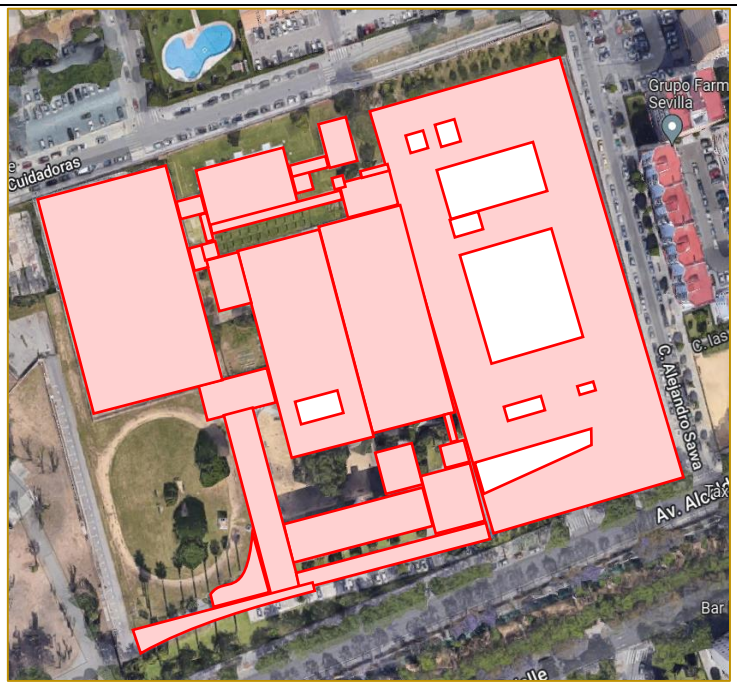
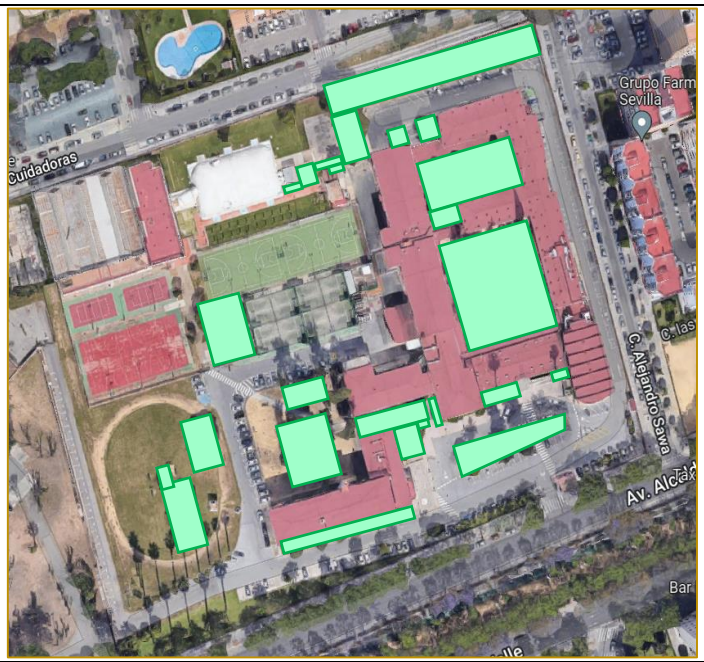
TYPE OF SCHOOL	TYPE OF SCHOOL
BASIC SCHOOL	Basic School
COMPREHESIVE (SECONDARY EDUCATION)	Comprehensive (secondary education)
ELEMENTARY SCHOOL	Elementary School
FIRST SCHOOL (PRIMARY EDUCATION)	First school (primary education)
FURTHER OR ADVANCED EDUCATION	Complementary or advanced education
HIGH SCHOOL	High school
HIGHER EDUCATION	Higher education
MIDDLE SCHOOL (PRIMARY EDUCATION)	Secondary education (primary education)
PRIMARY SCHOOL	Elementary School
SECONDARY AND HIGH SCHOOL	Secondary and Baccalaureate
UNIVERSITY	University

Table 2.- Types of educational centers.

- **Year of construction**
- **Covered area (m2)**
- **Green area (m2)**
- **Grass area (m2)**
- **Students**: Number of students in the center.
- **Teachers**: Number of teachers in the center.
- **Administrative Staff**: Number of people who work as administrative staff in the center.
- **Auxiliary Staff**: Auxiliary personnel working in the center (cleaning, maintenance, security, etc.)

The table below illustrates how to measure the required surfaces:

Image of the school	

Covered area: Covered surfaces, including pavements of sports courts, parking lots, patios, etc. (White area is not covered surface)	
Green Areas: Wooded areas or covered with shrubs.	

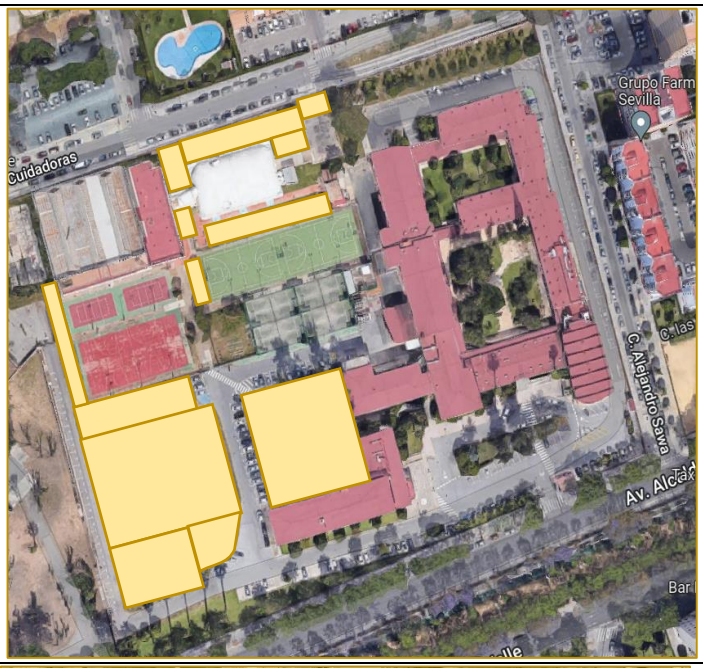
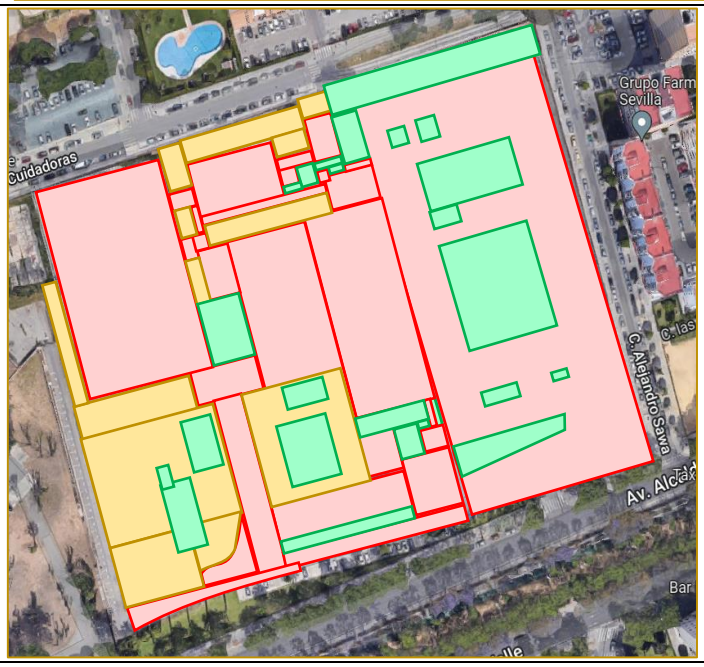
Grass area: Areas covered with grass/albero or unpaved natural soil.	
The sum of all the above areas is the total area of the school.	

Table 3.- Example of determination of areas in an educational center.

Use Tools such as Google Maps allows the determination of the area of polygons from points drawn on the map.

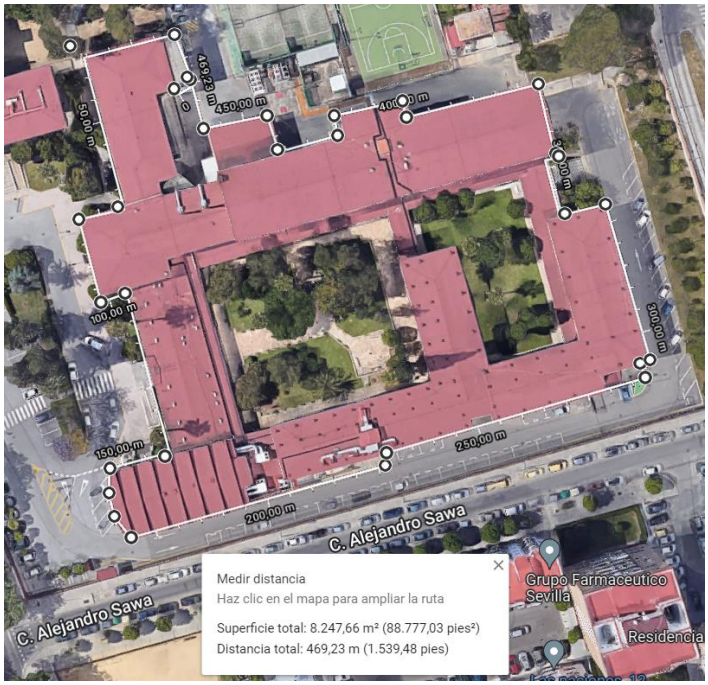


Figure 11.- Example of surface measurement in Google Maps.

The map returns the total area of the generated area. To make measurements easier, it is recommended to start with the smallest surface type. In the example above it would be convenient to start by measuring the Grass Area.

To be able to work with any module in the application (Water, Energy, Waste, Transport, Green Supply, Green Spaces, and Indoor Air Quality) it is **essential** to first have a School Code. Without a defined school code, work with any module will not be possible.

Each demonstration site must have at least 1 school code. All students in the same school will use this school code to work on the different modules.

The first step in the app is to enter the "School Codes" using the button available in "Data" menu. In doing so, a gallery will be shown with the cases raised in my center. if any school code is created yet, it will appear empty, as in the image:

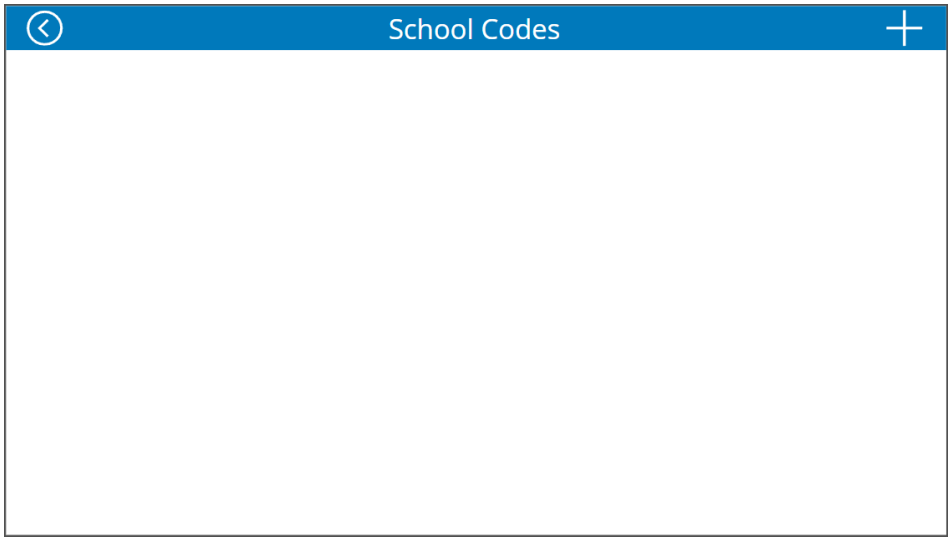


Figure 12.- Image from the School Codes gallery before generating a case.

To create a new code, pressing the (+) button, the following form will appear containing all the questions explained above:

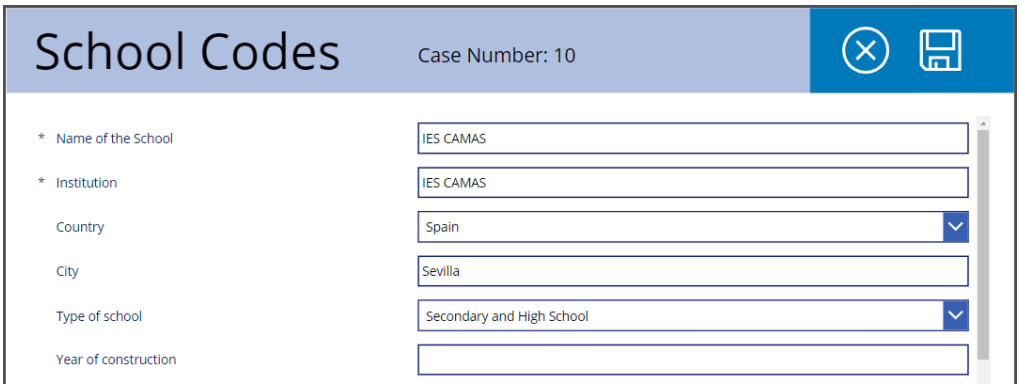


Figure 13.- Extract from the School Codes form.

By hitting the save button, the program returns to the previous gallery, where the new school code will be available to see and edit it.

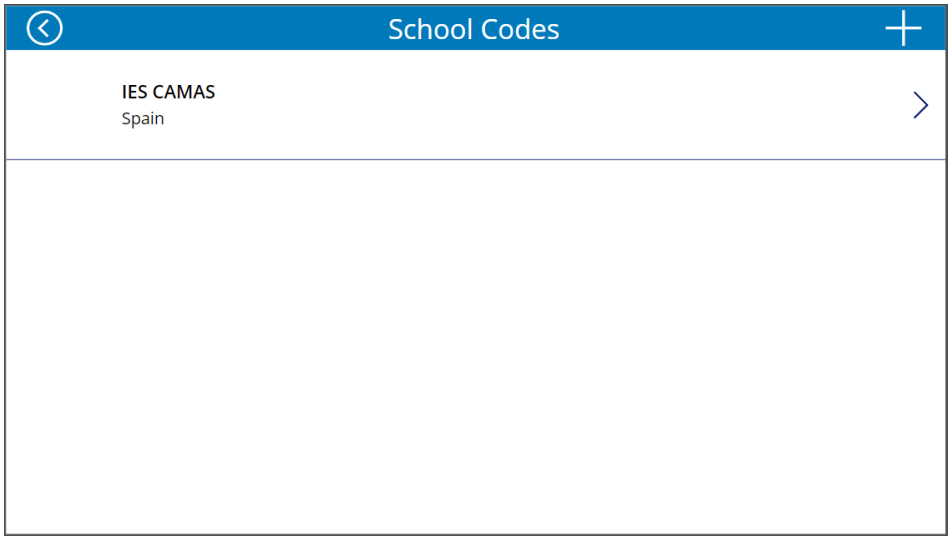


Figure 14.- Image from the School Codes gallery after generating a case.

The data inserted at the beginning can be modified by first pressing the button  , and then the button  inside each school code.

Finally, this is the **only** module of the application that once created **cannot be deleted**. The reason is because the rest of the studies **depend on** this form, if this information is lost by mistake all the studies in the modules would have to be redone to recover the lost data. So, it is important to be **careful** at this step.

Creating the case

After creating a school code, the user will be able to work with the sustainable areas. First, as an example, for the collection of the data, "we select the Waste" button:

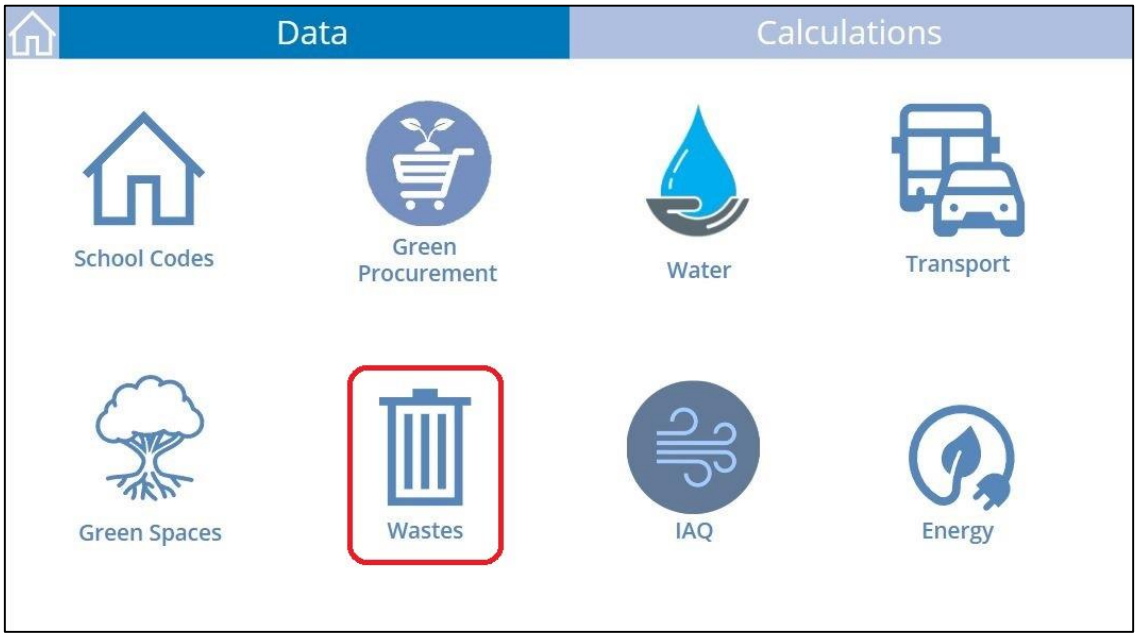


Figure 15.- Navigation in the data menu for access to Waste.

Once inside the menu, the studies of waste carried out will appear in a screen. **Each study is associated with a** school code**. That is, only one waste study can be done for each school code.** If more studies are needed, a newschool code will be generated with **a different name**. For example, if the original school code is named “School_Name”, the new school code can be named as “School_Name_2” or “School_Name_Test” or whatever different to the original school code name.

Figure 16.- Gallery of the Waste menu before adding a case.

Pressing the (+) button the new form is shown. The first data that is requested is the school code associated. (As an example, "IES GRAN CAPITAN" the school code).

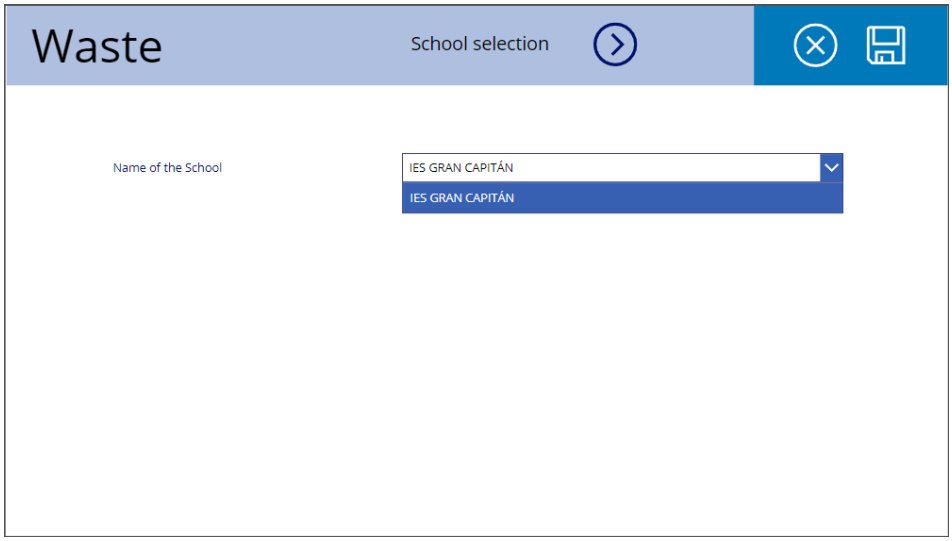


Figure 17.- Start of the Waste form.

In the drop-down list, **all school codes** created by the institution will appear. In principle, in this case, **it only appears 1**.

Pressing the button  , in the form advances displaying different questions. Once all de available information is entered, we save the data by clicking the  button. The information submitted can be seen by pressing the  button in the initial gallery. It is also important to remark that each study is associated with a school code, that is**, only one study can be done for each school code**. If more studies are needed, new school codes will be created to cover them.

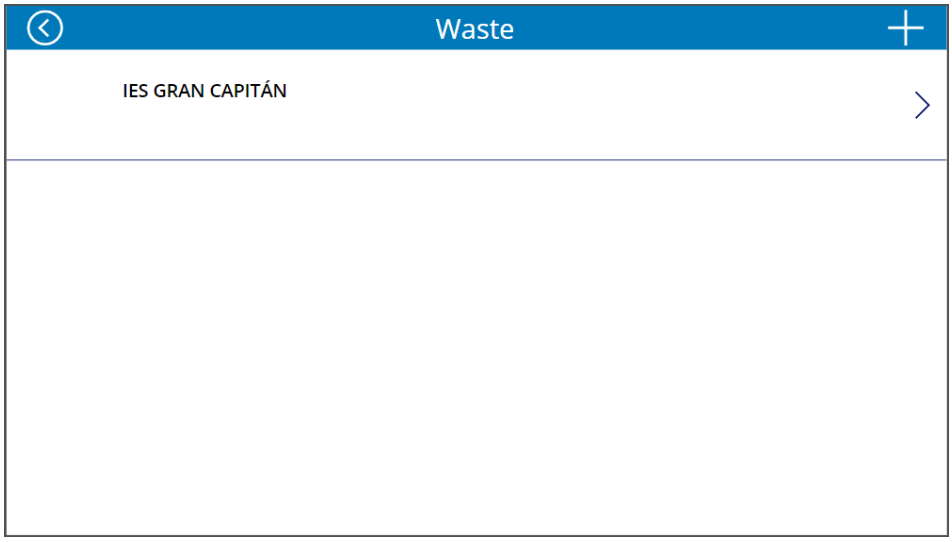


Figure 18.- Gallery of the Waste menu after making a case.

Once inside the study,  button can be pressed to modify the information previously entered. .

Figure 19.- Editing button localisation example.

The general structure of all sustainability areas is the same. First, a gallery with the visualization of the existing studies. Then, the screens regarding the visualization and edition of the data.

Sustainability areas

Next, the different areas of sustainability that are covered in the application are analyzed one by one. To do this, the most decisive aspects in each of the studies will be explained, as well as how to reach the results.

The information required for the app in each category will also be displayed. In this case information displayed with **this font** will mean that the information required is used in indicators calculation. Also, there will be a showcase of the low-level study for each topic.

Transport

To access the transport module, press the "Transport" button in the data menu.

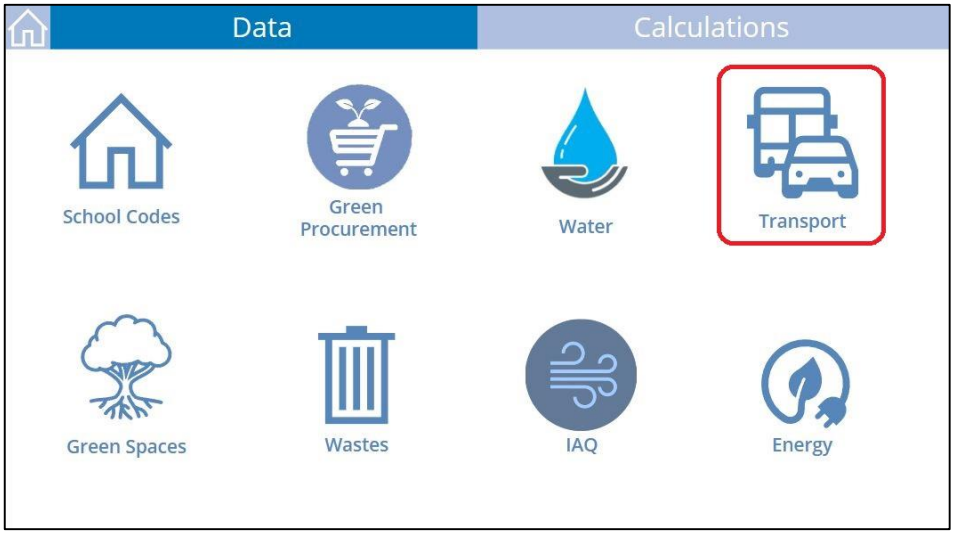


Figure 20.- Navigation in the data menu for access to Transport.

When the Transport button is pressed, the transport menu will be accessed as shown below:

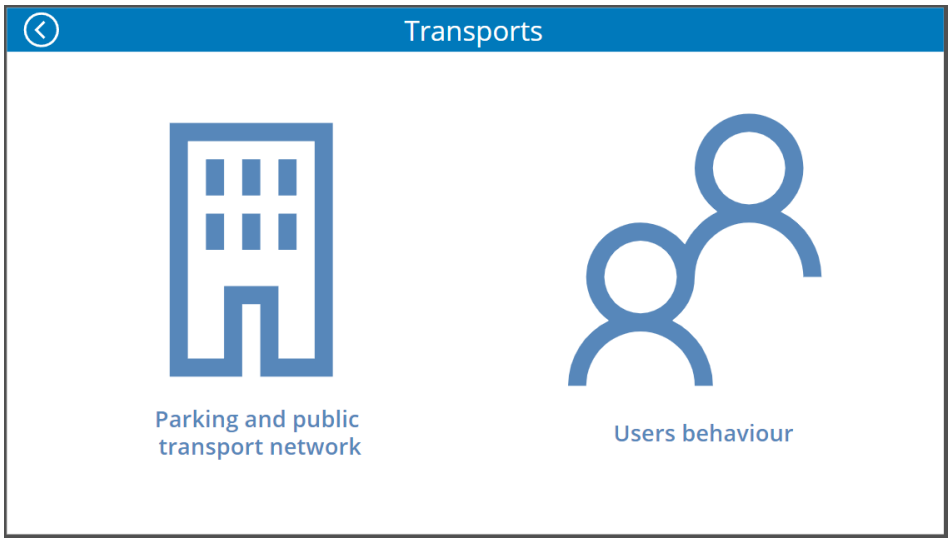


Figure 21.- Visualization of the Transport menu.

Next, two different studies. can be seen The first entitled "Parking and public transport network" and a second called "Users behavior".

Parking and public transport network

This part of the study will address issues related to parking spaces and public transport network. In many of the questions will be necessary to look on a map for elements located within a radius of 100, 500 and 1000m from the study school.

To get this information, a map will be prepared, in which aspects requested in the study will be visualized. Google Earth Pro is proposed to do so as it allows to create circles from a point, and then export this information to Google Maps. The use of another type of program is perfectly valid for this purpose.

Below is an example in Google Earth, in which the circumferences of the different radius ordered on the map have been plotted.

Figure 22.- Circumferences of 100, 500 and 1000m radius on an example school.

In this way, the required information can be searched. To have a map in which elements can be identified will be useful to answer the questions done in the form.

Questions about parking.

- **No. of parking spaces at school or periphery (up to a 100m radius)**
- **No. of parking spaces for disabled at school or periphery (up to a 100m radius)**
- **No. of parking spaces for electric cars at school or periphery (up to a 100m radius)**
- **No. of parking spaces for bicycles at school or periphery (up to a 100m radius)**

To accommodate the number of disabled parking spaces, number of spaces for electric cars and number of bicycle parking spaces, field exploration may be required.

Questions about the public transport network

- **No. of stops in a 500m radius**
- **No. of stops in a 1000m radius**
- **Number of Bus passing daily (1000m radius)**
- **Total number of hours analyzed**
- **Number of Bus passing daily during rushing hour (1000m radius)**
- **Total number of rushing hours analyzed**
- **Distance between the nearest Bus stop and school (m)**

Low-level study

Data estimations will be required on the following topics to make the evaluation of the school:

- Number of electric car parking spaces, or existence of, in the school or near it.
- Number of bicycle parking spaces, or existence of, in the school or near it.
- Availability of public transportation to access the school and its pass frequency.

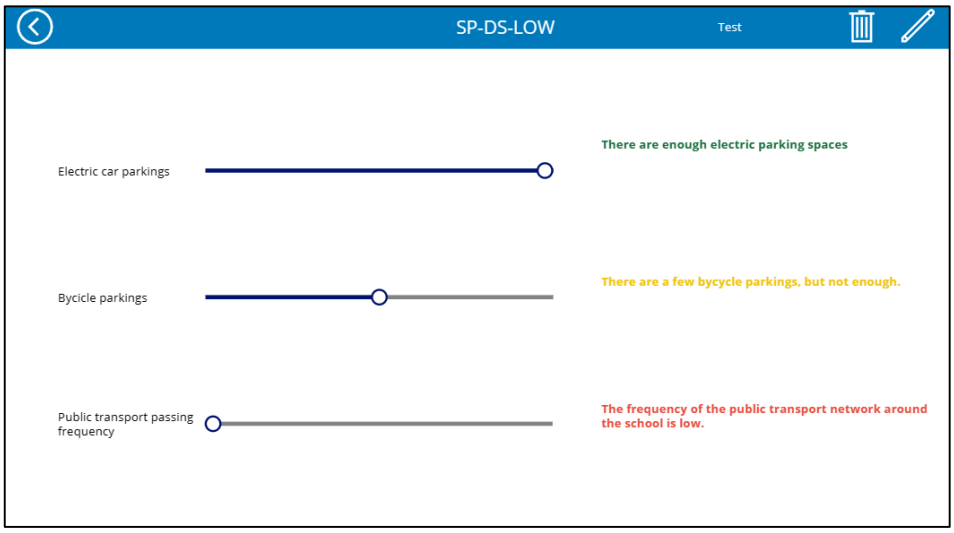


Figure 23.- Low-level study transport data window.

User's Behavior

The questions asked in this form are personal. Each student will answer the questions individually and as consistently as possible:

- **Users practicing car sharing**: Users who share a car.
- **Average number of passengers on car sharing**: In this section, you ask if you share the car to go to school and with how many students you share.
- **Users that use public transport when they go out with their families on the weekends.**
- **Average distance between user's school and home**
- **Average time spent during the trip from home to school.**

- **Average money spent on home-school trips monthly**: If it is not known, an estimate is valid.
- **Habits of transfer to school**. After answering the first questions, it wonders how often the means of transport are used to go to school (Walking, Bicycle, Bus, Metro, Train, Boat, Car, Motorcycle). For each of the transport options, the options "Never", "Sometimes", "Almost always", "Always" appear.
- **Users that if there was a bike path, they would use it.**
- **Users that go back home and return to school more than once per day.**

To answer all these questions, a user has been created in Microsoft Forms for the workgroup **to distribute to as many students in the school as possible**. This form contains a first question, where the name of the school is asked. Options are given to choose a list containing the names of the centers involved in the project.

Access to the form for students

The form can be opened by scanning the QR code or copying the link that appears in the application.

- Link: https://forms.office.com/pages/responsepage.aspx?id=BQZMrxJKiUSr3qtXFRfPuv7y8Eh9Y-NEsCMIKdH5IHZUM1hWNzlWUk0wQ0NGSTlPWlFRVlNJV0ozRi4u
- QR code:

Figure 24.- QR code for access to the user behaviour form in Microsoft Forms.

Regarding data protection, all answers are anonymous, any personal information like name, age, or profile are not requested.

Displaying results

When all the necessary data has been collected, it is displayed by entering the Transport menu within the "Calcs" window.

The results regarding the two transport studies are available in Calcs menu, as illustrated below:

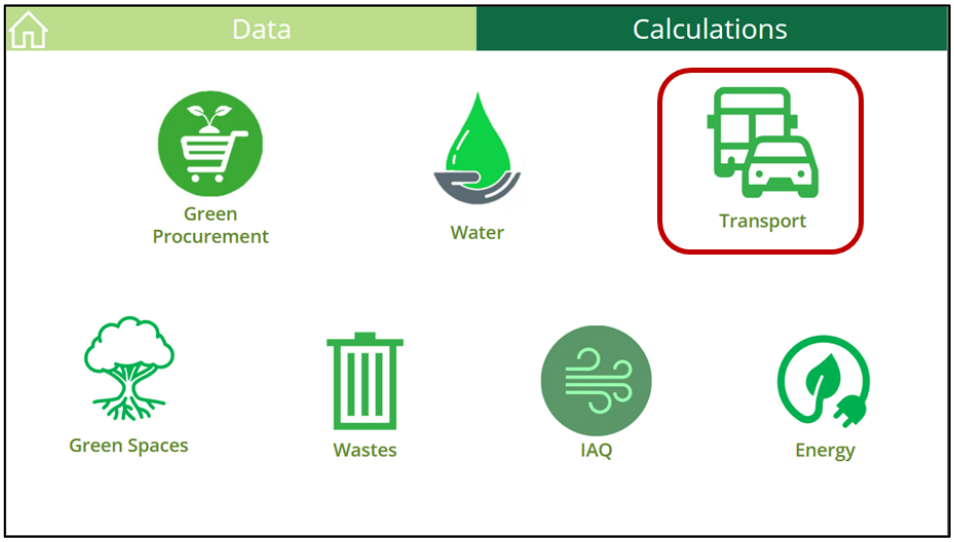
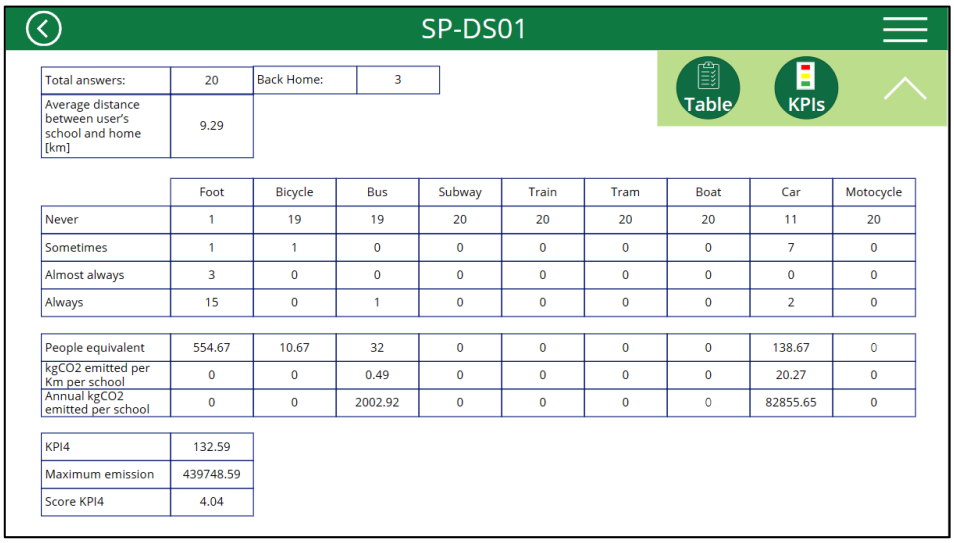


Figure 25.- Navigation in the Calcs menu for the visualization of transports results.

Once transport button is clicked, and also in the initial gallery, a table with the results is shown. Also, clicking the KPIs button, the calculation of the scores is done and results can be seen.



Total answers:	20	Back Home:	3
Average distance between user's school and home [km]	9.29		

	Foot	Bicycle	Bus	Subway	Train	Tram	Boat	Car	Motocycle
Never	1	19	19	20	20	20	20	11	20
Sometimes	1	1	0	0	0	0	0	7	0
Almost always	3	0	0	0	0	0	0	0	0
Always	15	0	1	0	0	0	0	2	0
People equivalent	554.67	10.67	32	0	0	0	0	138.67	0
kgCO2 emitted per Km per school	0	0	0.49	0	0	0	0	20.27	0
Annual kgCO2 emitted per school	0	0	2002.92	0	0	0	0	82855.65	0

KPI4	132.59
Maximum emission	439748.59
Score KPI4	4.04

Figure 26.- Example of a table of mobility results obtained for a center.

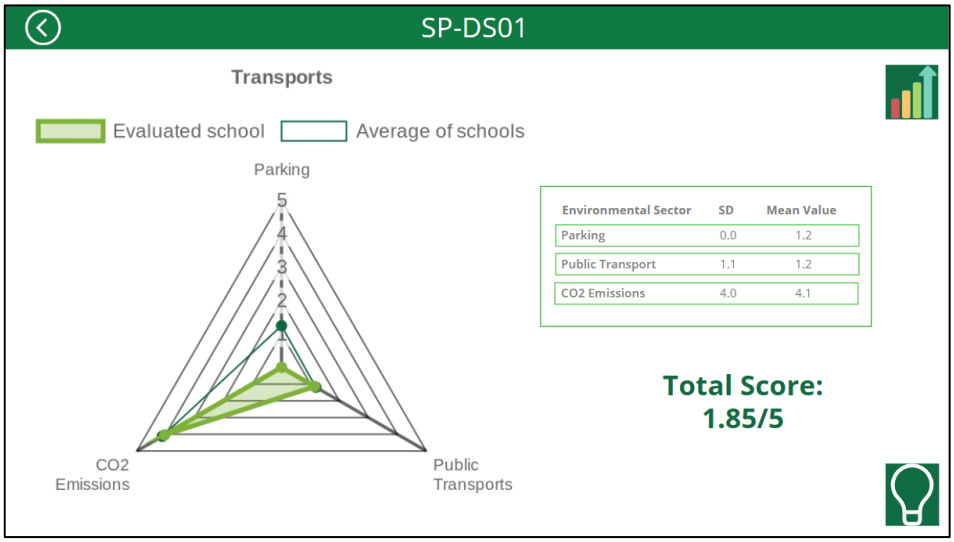


Figure 27.- Example of a resulting graph for transport study.

What do you get from the results?

Seeing the results, you can make an analysis of the emissions that we cause as a school due to our need for transport, seeing which means of transport are those with higher emissions, and evaluating the general behavior of students in relation to transport. From here we can think of proposals that help improve sustainability in our transport habits to the center. An analysis of the results and some recommendations can be seen by pressing the bulb button.

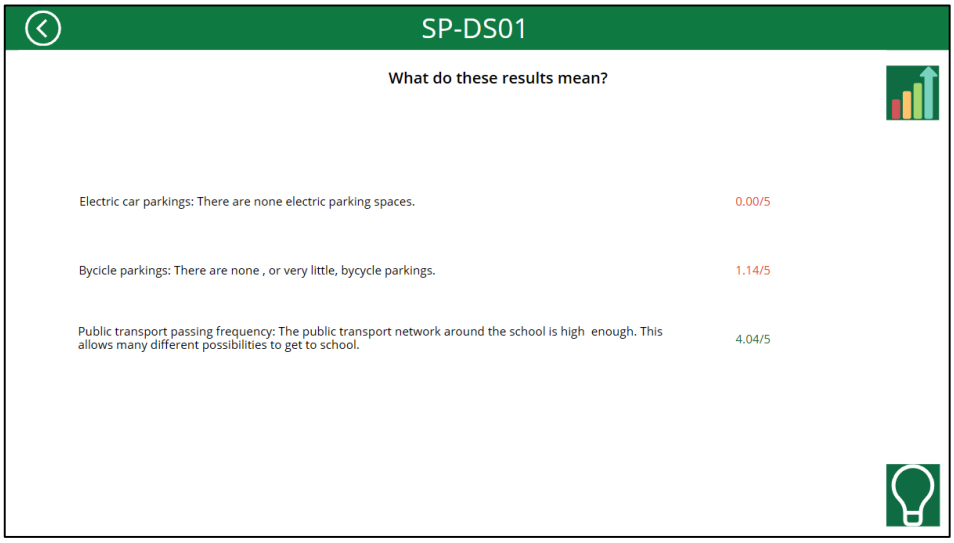


Figure 28.- Interpretation and recommendations based on results.

Wastes

Obtaining information

The questions to be answered for this area of sustainability are:

- **Volume container type X** (up to 5 different types)
- **Volume bag type X** (up to 5 different types)
- **Waste production**: Production of waste. In this section of the questionnaire, we ask about the number of bags or containers generated in a week (full or half full).
- **Recycled**: Recycled. Amount of waste (bags/containers) recycled in a week.
- **Reused**: Amount of waste (bags/containers) reused in a week. In this case, the generation of compost is considered as reuse of waste.

To answer these questions, it is advisable to be aware of waste management for at least 1 week. So, to get more out of the tool, answers will be estimated first. When the measurements have been done, the data collected will be edited to estimate and compare the results obtained.

We will take two measurements:

- The first will be an estimate of what we think about waste management in our centers. Each student will answer these questions by entering the application from their center. When responding to the requested information, screenshots will be taken where the information is included to be able to compare with the second measurement.
- The second will be done one week after the first measurement. Where the student will have been helped by his classmates to have better information about the questions. To edit the study data, we will do the following:

Low-level study

Data estimations will be required on the following topics to make the evaluation of the school:

- Waste production in the school.
- How much of that waste produced is recycled?
- How much of that waste produced is reused?

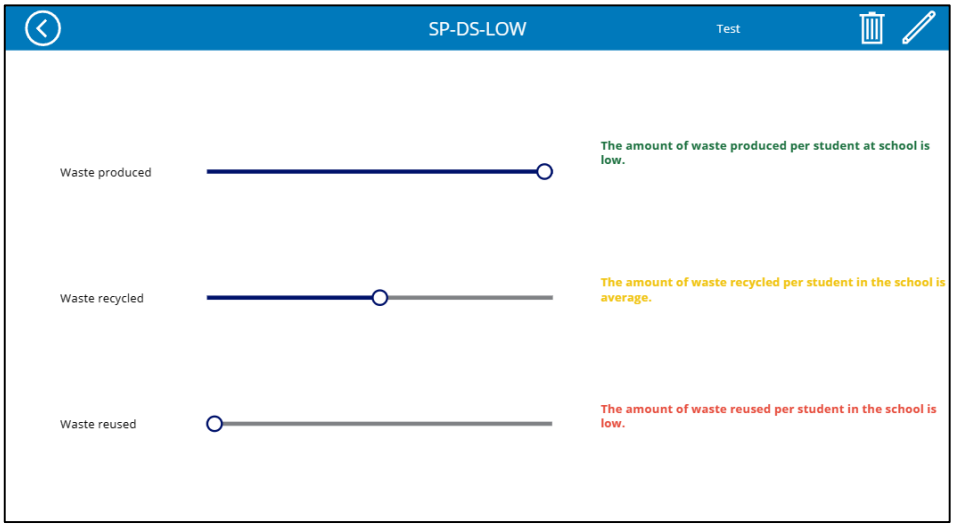


Figure 29.- Low-level study waste data window.

Displaying results

As mentioned, two different measurements will be made. Results obtained are available in "Waste" menu within the "Calcs" screen.

Figure 30.- Menu gallery calculations with the study entered.

After accessing the results screen, a menu can be displayed clicking on the button in the top right corner, and then, clicking the "KPIs" button.

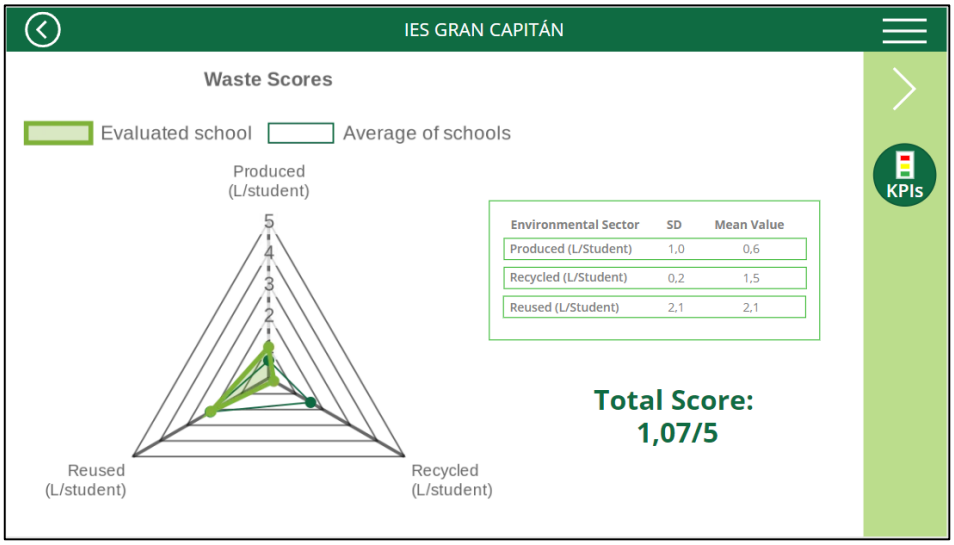


Figure 31.- Example of a resulting graph for the study of Waste.

What do you get from the results?

Seeing the results, a comparison of how the production and management of waste in the center can be made, and also compared with the previous idea that the students had. Considering the results, proposals can be made to help improve waste management in the center.

After showing the operation in two of the areas of sustainability, below, the rest of the studies will be discussed, which follow an operation in the application identical to that shown in the case of Waste.

Energy

Obtaining information

In this module, data will be requested to be able to analyze the overall consumption of the center, the breakdown by types of consumption and, in addition, the associated costs through invoices. The questions that are intended to be answered in this area of sustainability are:

- **Annual consumption values by invoices**
  - Grid Electricity in year X [kWh]
  - Diesel in year X [m3]
  - LPG in year X [kg]
  - Natural Gas in year X [m3]
  - Biomass in year X [kg]
  - Biomass (pellets) in year X [kg]
  - On-site Renewables (electric) in year X [kWh]
  - On-site Renewables (thermal) in year X [kWh]
  - On-site Renewables sold to grid in year 1+2+3 [kWh]
- **Annual cost values by invoices**
  - Grid Electricity year X [€]
  - Diesel in year X [€]
  - LPG in year X [€]
  - Natural Gas in year X [€]
  - Biomass in year X [€]
  - Biomass (pellets) in year X [€]

Low-level study

Data estimations will be required on the following topics to make the evaluation of the school:

- The annual energy consumption of the school.
- The annual energy costs of the school.
- The amount of renewable energy used in the school.
- The amount of CO2 emissions in relation to the type and amounts of energy consumed in the school.

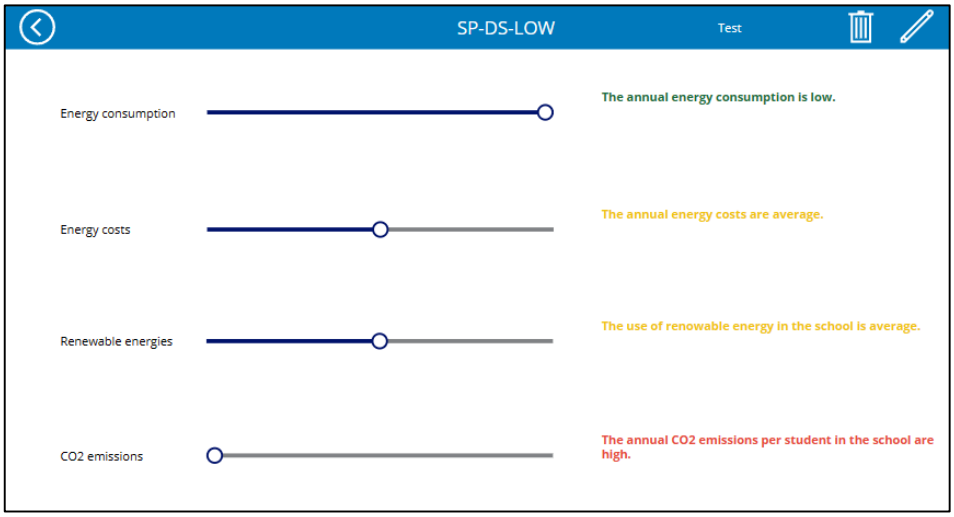


Figure 32.- Low-level study energy data window.

Visualization of results

Once the form in the application have filled out, scores result can be seen in energy section of calculations menu.

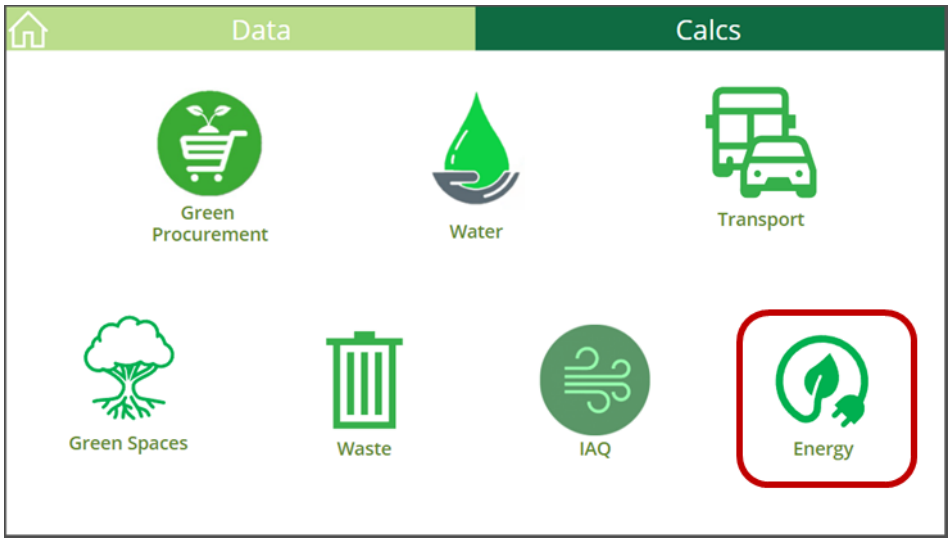


Figure 33.- Navigation in the Calcs menu for the visualization of energy results.

When accessing the module, a gallery will appear with all the energy studies done. (As an example, a study "Escola Secundária Abel Salazar" has been created).

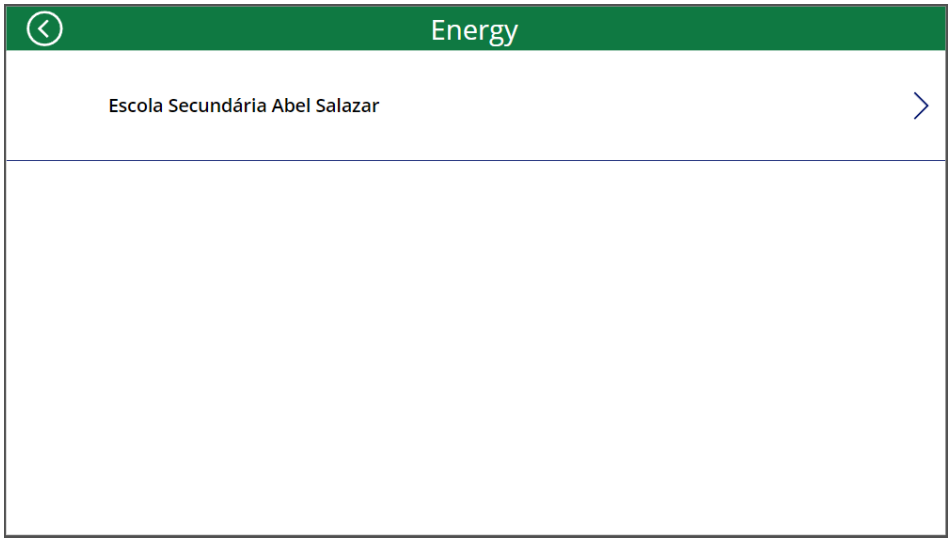


Figure 34.- Gallery of the calculations menu with the study entered.

The navigation is as in the previously explained wastes' study.

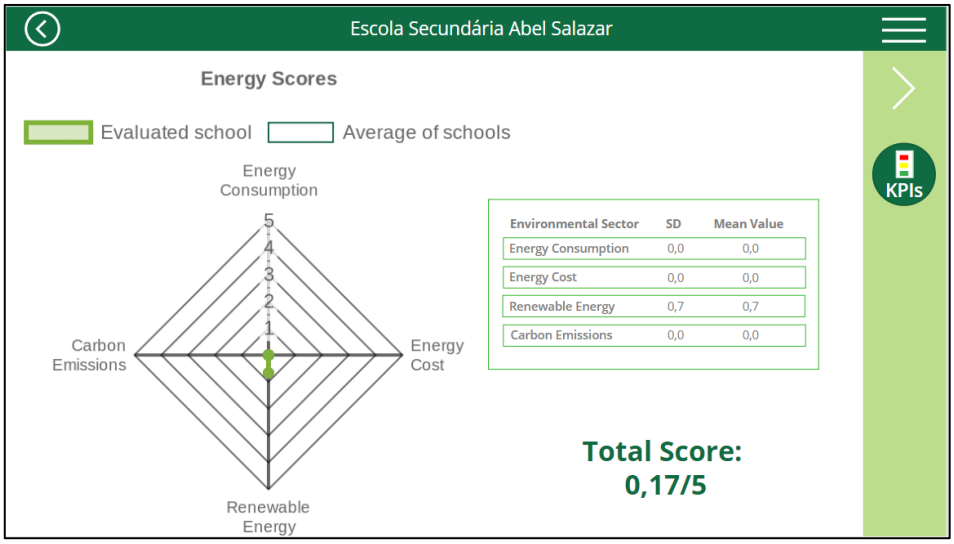


Figure 35.- Example of a resulting graph for Energy study.

In this way, we will have another source of information to analyze the educational center at energy management levels.

Indoor Air Quality (IAQ)

Obtaining information

In order to complete this study in the application, first we need to check if our equipment can measure at least part of the requested information. This is:

- **PM10 Room 1 mg/m3**
- **PM10 Room 2 mg/m3**
- **PM2.5 Room 1 mg/m3**

- **PM2.5 Room 2 mg/m3**
- **CO2 Room 1 ppm**
- **CO2 Room 2 ppm**
- **CO Room 1 ppm**
- **CO Room 2 ppm**
- **TVOC Room 1 mg/m3**
- **TVOC Room 2 mg/m3**
- **Formaldehyde Room 1 mg/m3**
- **Formaldehyde Room 2 mg/m3**
- **Acetaldehyde Room 1 mg/m3**
- **Acetaldehyde Room 2 mg/m3**
- **Acrolein Room 1 mg/m3**
- **Acrolein Room 2 mg/m3**
- **Benzene Room 1 mg/m3**
- **Benzene Room 2 mg/m3**
- **Toluene Room 1 mg/m3**
- **Toluene Room 2 mg/m3**
- **m+p-xylene Room 1 mg/m3**
- **m+p-xylene Room 2 mg/m3**
- **o-xylene Room 1 mg/m3**
- **o-xylene Room 2 mg/m3**
- **Ethylbenzene Room 1 mg/m3**
- **Ethylbenzene Room 2 mg/m3**
- **Trichloroethylene Room 1 mg/m3**
- **Trichloroethylene Room 2 mg/m3**
- **Tetrachloroethylene Room 1 mg/m3**
- **Tetrachloroethylene Room 2 mg/m3**
- **Styrene Room 1 mg/m3**
- **Styrene Room 2 mg/m3**
- **1,4-Dichlorobenzene Room 1 mg/m3**
- **1,4-Dichlorobenzene Room 2 mg/m3**
- **Alpha-pinene Room 1 mg/m3**
- **Alpha-pinene Room 2 mg/m3**
- **Propanal Room 1 mg/m3**
- **Propanal Room 2 mg/m3**
- **Butanal Room 1 mg/m3**
- **Butanal Room 2 mg/m3**
- **Pentanal Room 1 mg/m3**
- **Pentanal Room 2 mg/m3**
- **Isopentanal Room 1 mg/m3**
- **Isopentanal Room 2 mg/m3**
- **Hexanal Room 1 mg/m3**
- **Hexanal Room 2 mg/m3**

- **Benzaldehyde Room 1 mg/m3**
- **Benzaldehyde Room 2 mg/m3**

Although two rooms are included, we only need to make measurements in one room. If two rooms are studied, the result will be the mean of the data.

In addition, we need results in ventilation (distribution of CO2 concentration). To do this, it is requested:

- **Percentage of CO2 concentrations between 1000 and 1700 ppm during the occupancy period Room 1**
- **Percentage of CO2 concentrations between 1000 and 1700 ppm during the occupancy period Room 2**
- **Percentage of CO2 concentrations over 1700 ppm during the occupancy period Room 1**
- **Percentage of CO2 concentrations over 1700 ppm during the occupancy period Room 2**
- **Percentage of T between 20°C and 26°C during the occupancy period Room 1**
- **Percentage of T between 20°C and 26°C during the occupancy period Room 2**

To obtain better results, measurements in two classrooms are recommended. It is possible that the measuring equipment used is not capable to measure all the information requested. So, only information given by the measure device will be filled.

Low-level study

Data estimations will be required on the following topics to make the evaluation of the school:

- The amount of air contamination that can be found in the classrooms.
- The ventilation quality of the classrooms.
- The thermal comfort in the classrooms.

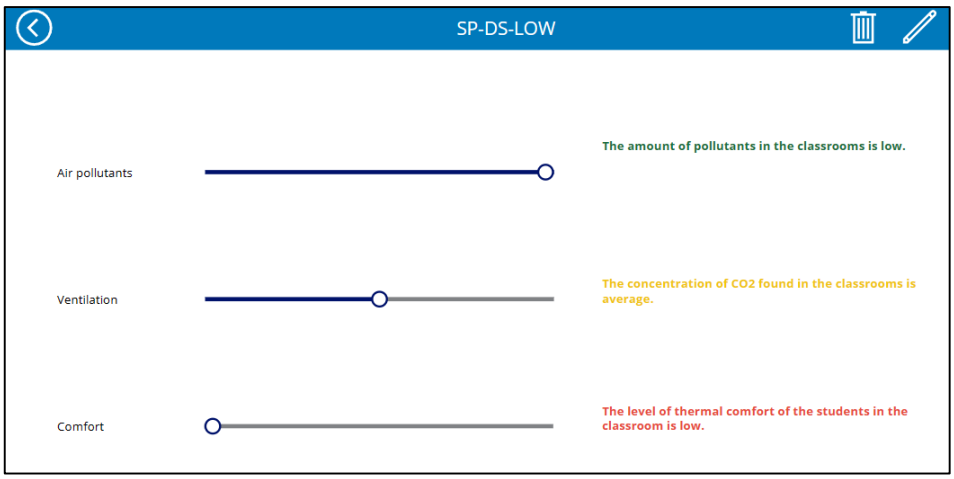


Figure 36.- Low-level study indoor air quality data window.

Viewing the results

As in previous cases, in the Indoor Air Quality section, in the calculations menu scores results will be available, as shown in the example:

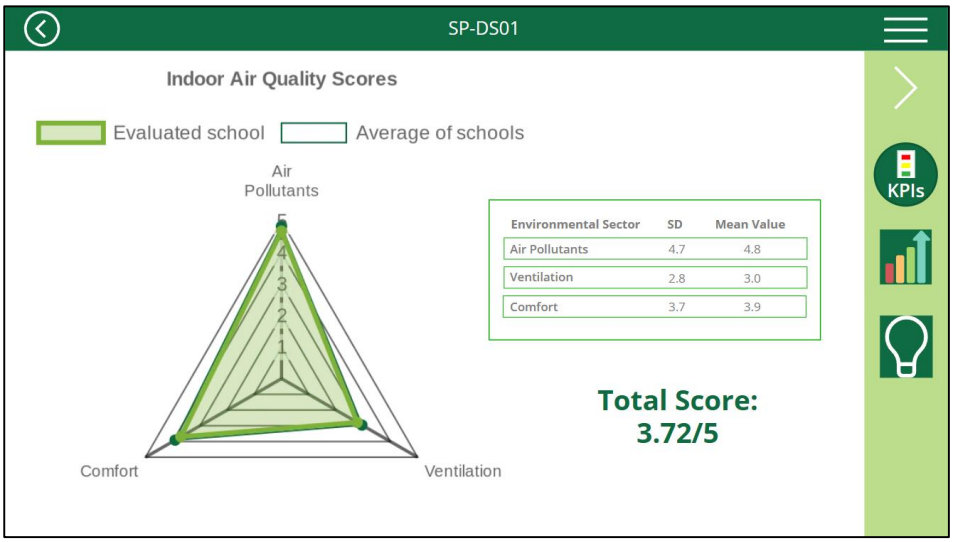


Figure 37.- Example of a resulting graph for IAQ study.

Water

Obtaining information

This study is limited to evaluating annual water consumption and costs. The questions are:

- **Consumption (m3)**: Water consumption in the center for 1 full year.
- **Cost (€)**: How much was paid for water consumption for 1 full year.

As in the "Energy" study, when is not possible to obtain a full year's f data, the available information considering the data period time.

This study allows up to 10 measurements in high level of study. So, instead of performing 10 annual measurements, it can be filled by days/weeks.

Low-level study

Data estimations will be required on the following topics to make the evaluation of the school:

- The amount of water used in relation to the area of the school.
- The amount of water used in relation to the number of students at the school.
- The water costs in relation to the area of the school.
- The water costs in relation to the number of students at the school.

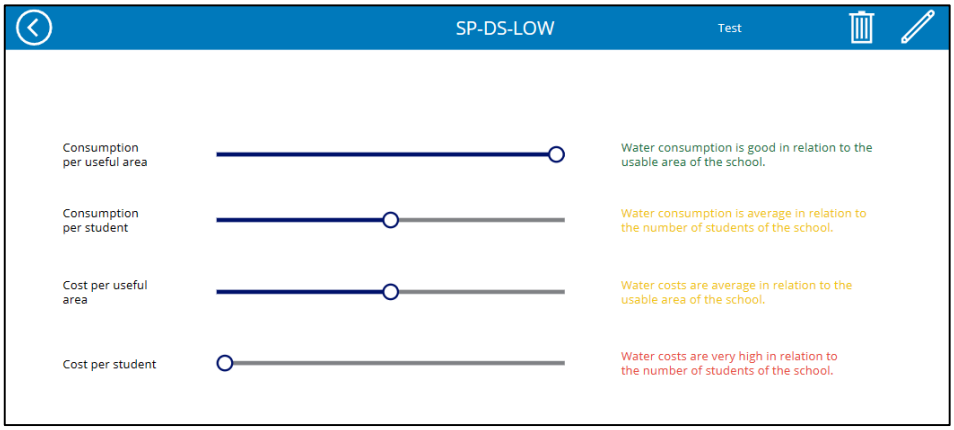


Figure 38.- Low-level study water data window.

Viewing the results

The steps to visualize the scores are **identical** that in the previous modules.

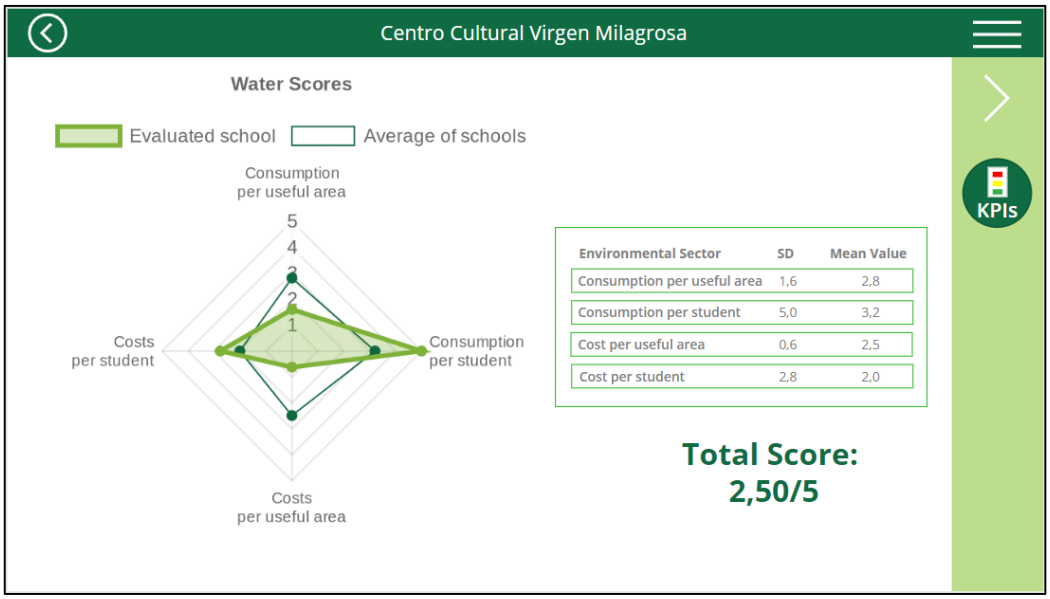


Figure 39.- Example of a resulting graph for a water study.

Green spaces

Obtaining information

For this area of sustainability, the following questions are addressed:

- Type of fuel used in gardening activities.
- **Annual diesel consumption in gardening activities (l/year)**
- **Annual gasoline consumption in gardening activities (l/year)**
- **Annual heavy fuel oil consumption in gardening activities (l/year)**
- **Annual electricity consumption in gardening activities (kWh/year)**

- Chain saw power (kW)
- Mower Power (kW)
- Operation hours chainsaw
- Operation hours mower
- Type of irrigation system
- **Tap water consumption in irrigation (m3/year)**
- **Rainwater consumption in irrigation (m3/year)**
- **Well water consumption in irrigation (m3/year)**
- **Number of trees**
- **Predominant tree specie**
- **Estimated sequestration rate of the predominant tree species (kgCO2/tree and year) (See sheet "CO2 emission factors")**): This data is automatically populated when choosing the predominant tree species.
- **Average age of trees (years)**
- **Amount of fertilizer used (kg/year)**
- **Amount of pesticide used (kg/year)**

To find out the predominant tree species, it is recommended to use the "Google Lens" tool that allows to search the internet from photos. First the predominant tree species is found out, then via Google Lens a photograph of a specimen is taken. Within the search results Google will provide the scientific name of the species. Within the application a list with the available species is given. These are:

Abies alba	**Celtis occidentalis**	**Ginkgo biloba**	**Pinus halepensis**	**Rosmarinus officinalis**
Acacia dealbata	Ceratonia siliqua	Gleditsia triacanthos	Pinus pinaster	Salix alba
Acacia retinodes	Cercis siliquastrum	Jacaranda mimosifolia	Pinus pinea	Sambucus nigra
Acacia saligna	Chamaerops humilis	Juglans nigra	Pinus radiata	Schinus molle
Acer negundo	Cistus albidus	Juniperus communis	Pistacia lentiscus	Schinus polygamus
Acer platanoides	Citrus aurantium	Juniperus oxycedrus	Pittosporum tobira	Sophora japonica
Acer pseudoplatanus	Citrus limon	Juniperus phoenica	Platanus acerifolia	Spartium junceum
Ailanthus altissima	Cocculus laurifolius	Koelreuteria paniculata	Platanus hispanica	Tamarix gallica
Albizia julibrissin	Cordyline sp	Laurus nobilis	Populus alba	Taxus baccata
Alnus glutinosa	Coriaria myrtifolia	Ligustrum japonicum	Populus canadensis	Thuja occidentalis
Aloe arborescens	Corynocarpus laevigatus	Ligustrum lucidum	Populus simonii	Tilia euchlora
Arbutus unedo	Crataegus laevigata	Ligustrum ovalifolium	Prunus americana	Tilia europaea
Bauhinia forficata	Crataegus monogyna	Ligustrum vulgare	Prunus avium	Tilia platyphyllos
Bougainvillea glabra	Cupressus macrocarpa	Maclura pomifera	Prunus cerasifera	Tilia tomentosa
Brachychiton populneum	Elaeagnus angustifolia	Magnolia grandiflora	Prunus cerasifera	Tipuana tipu
Broussonetia papyrifera	Erica arborea	Magnolia macrophylla	Prunus domestica	Turfgrass/lawn 1
Brugmansia Spp	Eriobotrya japonica	Melia azedarach	Prunus dulcis	Ulmus glabra
Bupleurum fruticosum	Erythrina crista-galli	Mespilus germanica	Punica granatum	Ulmus minor
Butia capitata	Eucalyptus camaldulensis	Morus alba	Pyracantha angustifolia	Ulmus pumila
Buxus sempervirens	Eucalyptus globulus	Paradise muse	Pyrus communis	Viburnum tinus
Calocedrus decurrens	Euonymus japonica	Nerium oleander	Quercus cerrioides	Washingtonia filifera
Casuarina cunninghamiana	Ficus benjamina	Olea europaea	Quercus coccifera	Washingtonia robusta
Casuarina equisetifolia	Ficus carica	Parkinsonia aculeata	Quercus ilex	Wisteria sinensis
Casuarina sp	Ficus elastica	Phillyrea latifolia	Quercus pubescens	Yucca aloifolia
Catalpa bignonioides	Firmiana simplex	Phoenix canariensis	Quercus suber	Yucca guatemalensis
Cedrus atlantica	Fraxinus angustifolia	Phoenix dactylifera	Rhamnus alaternus	
Celtis australis	Fraxinus ornus	Phytolacca dioica	Robinia pseudoacacia	

Table 4.- Tree species included for the selection of dominant species.

Low level

Data estimations will be required on the following topics to make the evaluation of the school:

- Quality of green areas in the school.
- CO2 that those green areas are able to recapture.
- Use of pesticides and fertilizers in the school.
- CO2 emissions in relation to the maintenance tasks of the school.

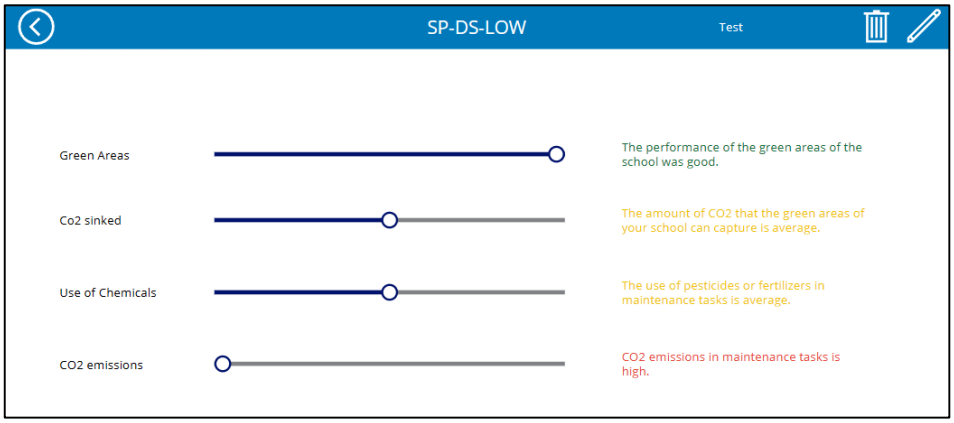


Figure 40.- Low-level study green spaces data window.

Displaying results

Once we have filled in the form in the application, we will capture the results obtained. To do this, access the "Calcs" screen of the application, and press the "Green Spaces" button.

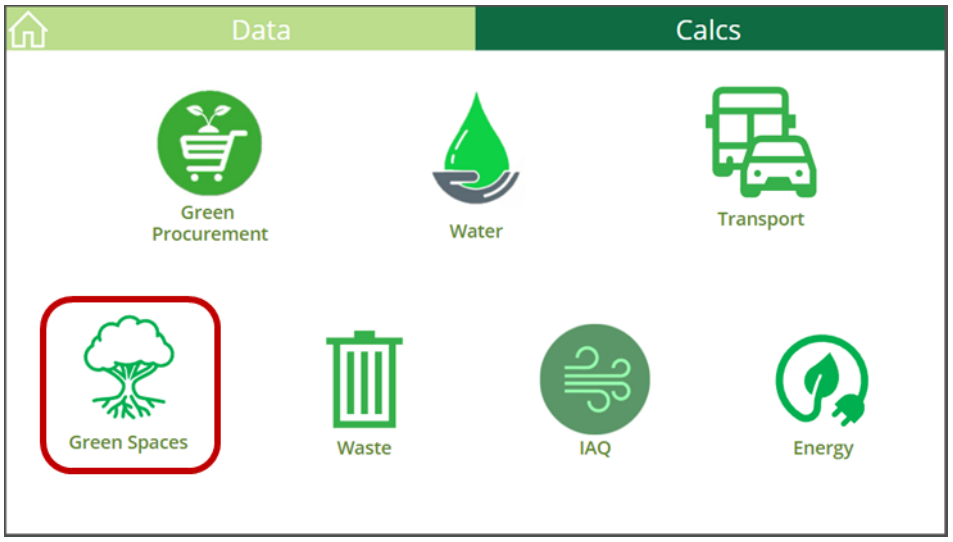


Figure 41.- Navigation in the Calcs menu for the visualization of results.

When accessing the module, we will find a gallery with all the studies we have carried out. (As an example, a study "Escola Secundária Abel Salazar" has been created).

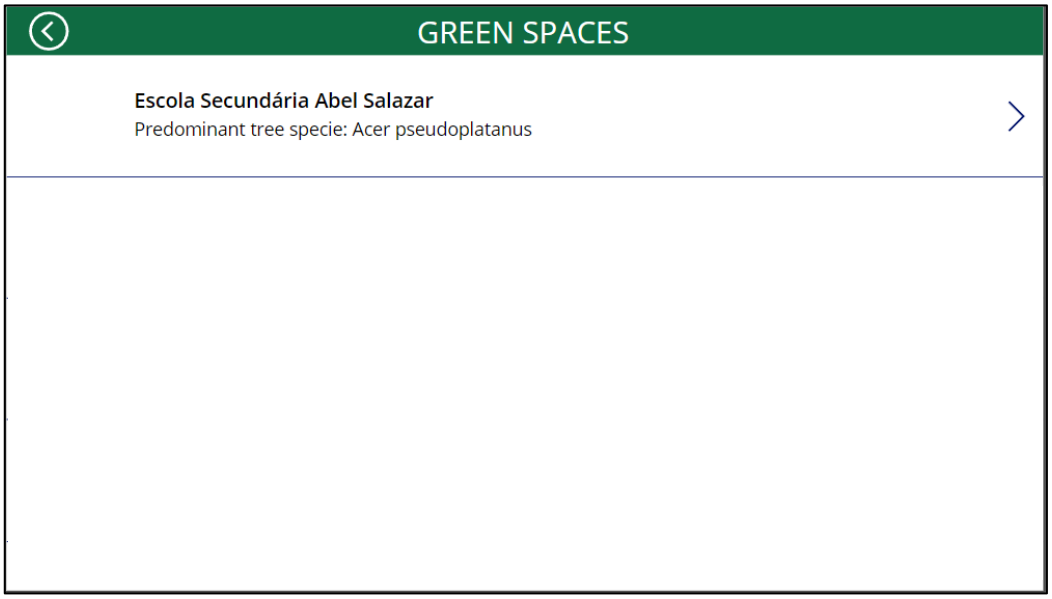


Figure 42.- Selection of the case study for the visualization of results.

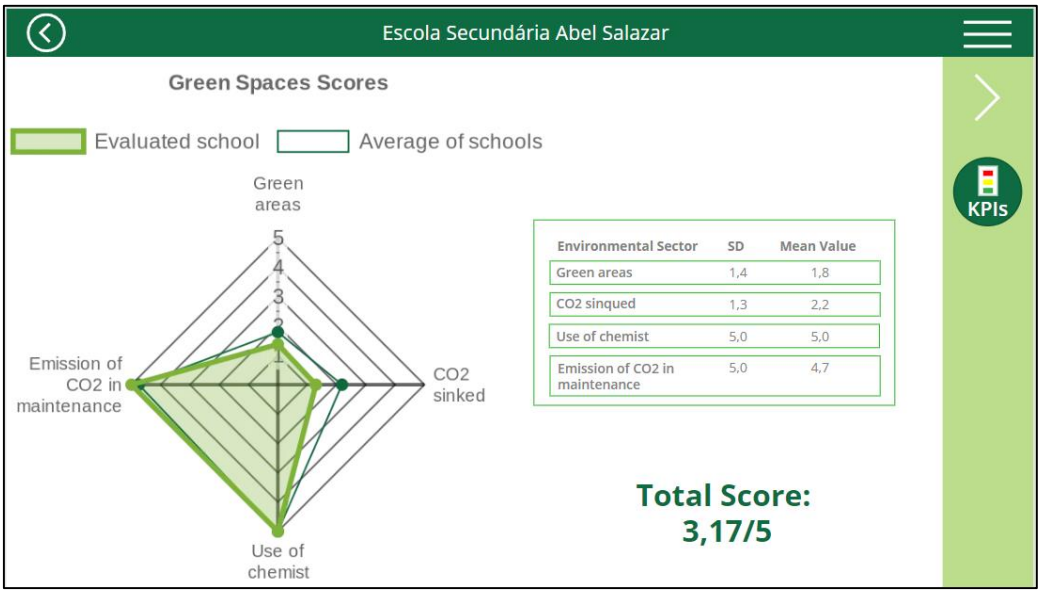


Figure 43.- Example of a resulting graph for Energy study.

In this way, we will have another source of information to analyze our center at levels of management of green areas.

Green procurement

This study has a variety of questions to assess the performance of the center in relation to its equipment, use of paper, sustainability training, Eco-driving, biological food, and suppliers.

Obtaining information

The questions to answer are as follows:

- "Certificate ISO 14001: 2004 - Environmental Management Systems, taking into consideration environmental protection, pollution prevention, legal compliance and socio-economic needs or any other certification related with environment (Yes/No)": This International Standard specifies the requirements for an environmental management system that allows an organization to develop and implement a policy and objectives that take into account legal requirements and information on environmental requirements. significant environmental aspects.
- Policies, objectives, or a target for conserving the environment: "Yes/No".
- **No. of individuals in school with training in green procurement**
- **No. of individuals with eco-driving certificate**
- **No. of equipments with A+++**
- **No. of equipments with A++**
- **No. of equipments with A+**
- **No. of equipments with A**
- **No. of equipments with B**
- **No. of equipments with C**
- **No. of equipments with D**
- **No. of equipments without star level of efficiency**
- **No. of printers without optimum consumption**
- **No. of printers with optimum consumption**
- **Amount of used paper (Kg/Month)**
- **Amount of paper purchased directly to National producers (Kg/Month):** To know this data, names of the companies from which the center buys the paper are needed.
- **Amount of recycled paper used (Kg/Month)**
- Use of chlorine-free paper (Yes/No)
- Concern about chemical information in the labels of detergents (Yes/No)
- Concern about chemical information in the labels of Lab. chemical products (Yes/No)
- **Total amount of purchased food per month (Kg/Month)**
- Total amount of purchased food with biological certificate per month (Kg/Month)
- **No. of county providers**
- **No. of district providers**
- **No. of country providers**
- **No. of international providers**

Low level study

Data estimations will be required on the following topics to make the evaluation of the school:

- The quality of the school's energy equipment.

- Use and recycle of paper in the school.
- Green procurement training level of the staff of the school.
- Number of staff with eco-driving certificate.
- Quality of food used in the school's canteen.
- Where are located the school's main suppliers.

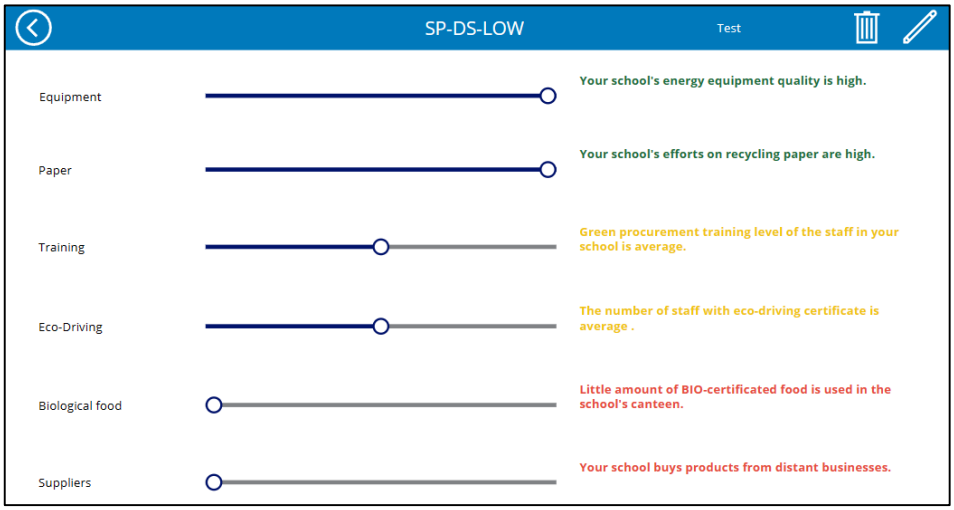


Figure 44.- Low-level study green procurement data window.

Displaying results

At the end of collecting the information, the results are collected by entering the study from the "Calcs" menu.

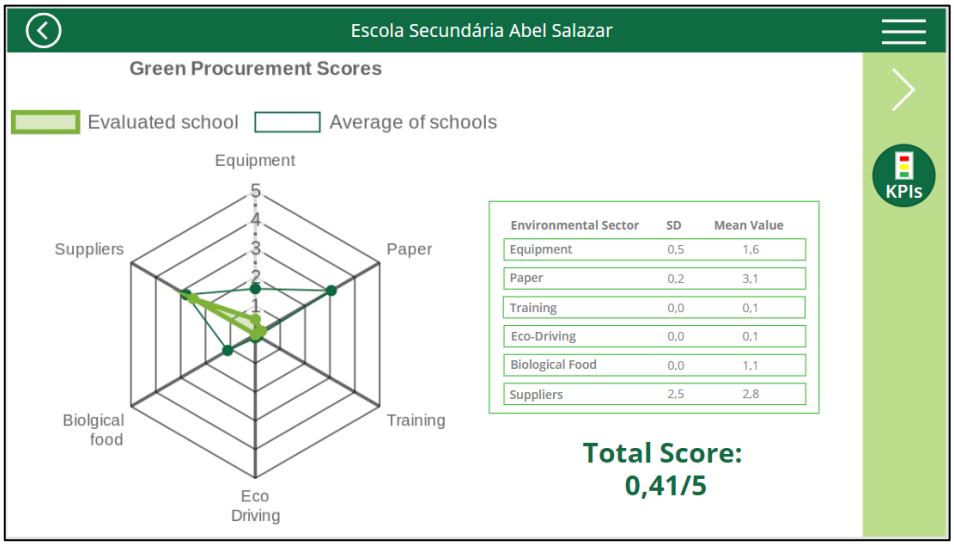


Figure 45.- Example of a resulting graph for the Green Procurement study.

In this way, we will obtain data of interest in relation to the sustainability of the center in terms of supply of material, equipment, food, etc.

KPIs Table

In the following table, the indicators that are going to be calculated from the data provided to the application are summarized. Understanding how indicators are calculated helps us justify the results we get. It can also inspire us to propose measures to improve them.

Environmental pillars	Key Performance Indicators	Scores
Transport		
Car park	KPI-T1. No. of parking spaces for electric cars at school or periphery per student (up to a 100m radius)	Transport score (0-5)
	KPI-T2. No. of parking spaces for bicycles at school or periphery per student (up to a 100m radius)	
Public transport network	KPI-T3. No. of public transports passing daily per hour (1000 m radius)	
CO2 emissions	KPI-T4. Annual CO_2 Emissions per student (kgCO2/student)	
Green procurement		
Equipment efficiency	KPI-GP1. No. of equipment A+ or higher EU Energy Label per total no. of equipment	Green procurement score (0-5)
Paper usage	KPI-GP2. Annual paper usage in school per student (kg/student)	
	KPI-GP3. Recycled paper usage in school (kg recycled /kg consumed)	
Training in green procurement	KPI-GP4. No. of staff with training in green procurement per total no. of staff	
Organic food	KPI-GP6. Food with biological certificate (kg food with biological certificate/kg total food)	
Suppliers	KPI-GP7. Local suppliers (No. local suppliers /total suppliers)	
Green spaces		
Green areas	KPI-GS1. Number of trees per non-covered area (m^2)	Green spaces score (0-5)
	KPI-GS2. Number of trees per student (student[1])	
	KPI-GS3. Green area per non-covered area (%)	
	KPI-GS4. Green area per student (m^2/ student[1])	
CO_2 sequestration	KPI-GS5. Annual CO 2 sank per non-covered area (kgCO 2/m^2)	
Use of chemicals	KPI-GS6. Total kg of chemicals used for green area maintenance (kg/m^2)	
CO2 emissions in maintenance	KPI-GS7. Annual CO 2 emissions for the space maintenance of non-covered area (kgCO 2/year.m^2))	
Energy		
Energy consumption	KPI-E1. Annual final energy consumption per area (kWh/m^2)	Energy score (0-5)
	KPI-E2. Annual final energy consumption per student (kWh/student)	
Use of renewable energy	KPI-E3. Renewable energy production (%)	
Energy cost	KPI-E4. Annual energy cost per m 2 (€/m^2)	
	KPI-E5. Annual energy cost per student (€/student)	
CO2 emissions	KPI-E6. Annual carbon footprint per student (kgCO_2/student)	
Water		
Water consumption	KPI-H2O1. Water consumption (m^3/m^2)	Water score (0-5)
	KPI-H2O2. Water consumption (m^3/student)	
Water cost	KPI-H2O3. Water cost (€/m^2)	
	KPI-H2O4. Water cost (€/student)	
Waste		
Waste produced	KPI-W1. Volume of waste produced (non-recyclables and reusables (m^3/student)	Waste score (0-5)
Waste recycled	KPI-W2. Volume of waste recycled (m^3/student)	
Waste reused	KPI-W3. Volume of waste reused (m^3/student)	
Final school Sustainability Index		ECF4CLIM score (0-5)

Did something go wrong?

The assessment and communication of the experience in the use of the application is essential to detect possible errors and ways of improvement in the development of the tool. We aim to

strengthen a platform that can support the centers in decision-making for the implementation of measures that improve the sustainability skills of the educational community.

That is why, on the login screen, a button has been added for the feedback **"Support".** By clicking on it, a Microsoft form is displayed where comments can be made about things that are not understood, or possible errors that have been detected.

For the development team it is important to have references of the user experience! So, please make use of the form every time you detect something that does not work as expected, or every time you do not understand a specific point of the application. Form responses are made anonymously.

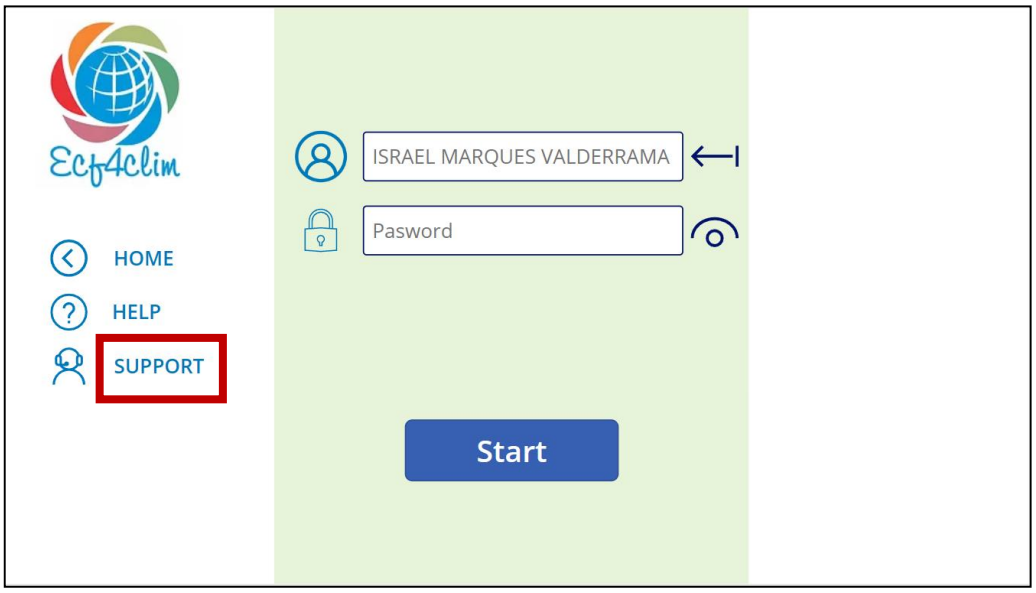


Figure 46.- Access to the feedback form.

9. ANNEX 2: ENERGY ENGINE MANUAL

Energy Engine Manual

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036505

Table of Contents

Index of Illustrations

1. Introduction

The platform developed in the Microsoft PowerApps environment allows the analysis and understanding of the state of educational centers regarding **energy performance**, covering aspects such as climate systems, lighting specifications, or occupation profile of the building using forms. This environment supports the data collection and allows to stablish different cases, to have data traceability.

The tool includes three different parts, to facilitate a sequential and easier study:

1. Definition and characterization of building.
2. Definition and characterization of heat, ventilation, and air conditioning (HVAC) systems.
3. Definition and characterization of lighting, water facilities and energy consumption.

Through the data gathering process in each part, the user will do an energy auditory of the school, that will be analyzed using the report of auditory. The report is a document in where practical information, graphs, and annotations are done basis on the auditory data. An example is given at the end of the manual.

The application has been translated in six languages, those are English, Spanish, Finnish Greek, Romanian, and Hungarian.

2. Access to the application

To enter the PowerApps environment where the application is located, it is necessary to access from a Microsoft account that is delivered to the user. For this purpose an specific account have been generated.

b. Steps to follow

The environment of the application can be accessed through the following link:

https://apps.powerapps.com/play/e/default-af4c0605-4a12-4489-abde-ab571517cfba/a/9518bbf2-d29a-45de-9f70-596a8f0de995?tenantId=af4c0605-4a12-4489-abde-ab571517cfba

Or by scanning the QR code:

Figure 47.- QR code to access the application.

Once the login page is launched, the first thing that appears is the Microsoft login protocol, the appearance of the pop-up page is as follows:

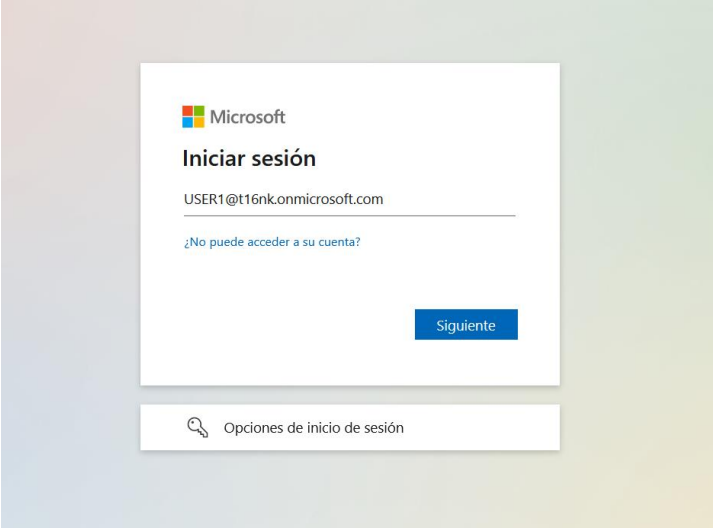


Figure 48.- Microsoft login screen, user. (The user shown was created to display the procedure, it is currently unavailable.)

When the user is entered, the following box to introduce the password appears:

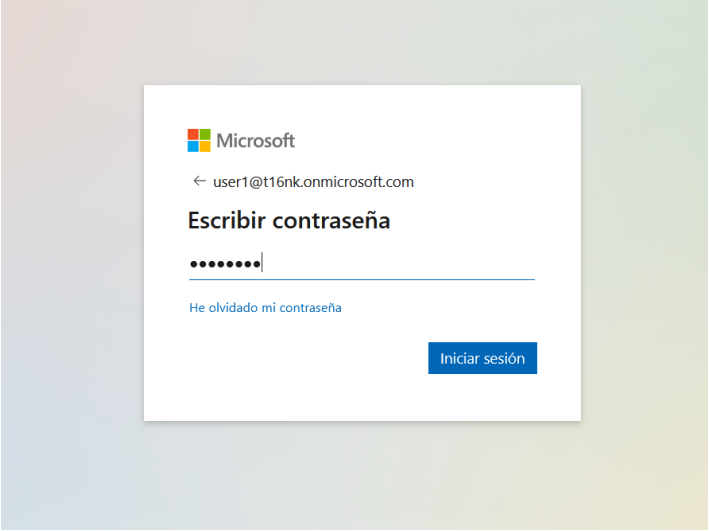


Figure 49.- Microsoft sign-in screen, password. (The user shown was created to display the procedure, it is currently unavailable.)

The user created to use this tool is as follows:

USER NAME	PASSWORD
ECF4CLIM_DS@T16NK.ONMICROSOFT.COM	Cozo3509

Table 3.- Microsoft User developed for initializing the app.

The sign-in settings are developed as single-factor authentication, so when Microsoft account is entered, it automatically opens the PowerApps environment where the home screen appears.

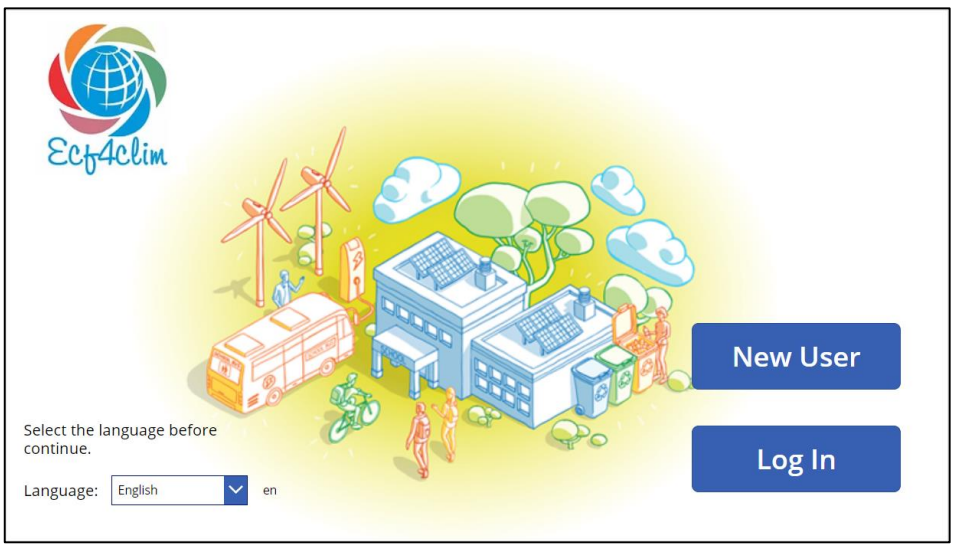


Figure 50.- Start screen of the application.

If this is the first time, a **new user** must be generated and all subsequent data will be assigned to such user. To facilitate the management of the App, **it is recommended to create a single**

user per center. To create it, the application will ask a name, password, and entity to which the account belongs, that is, to indicate the name of the educational center to which the data will be linked. The application gives the option to generate and remember the password.

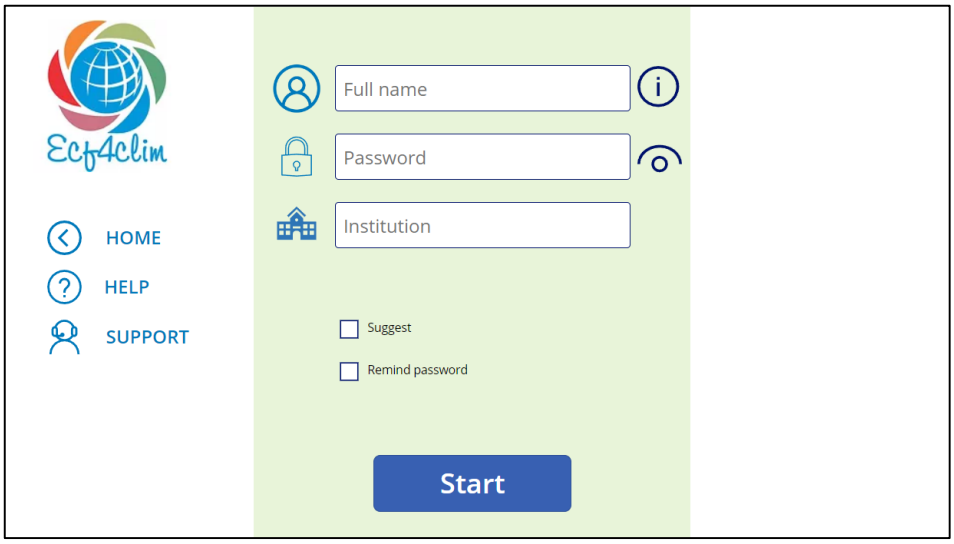


Figure 51.- New User screen.

If for any reason, two or more users are created in the same school, it's important to have the same **Institution** in all users created to preserve and manage the same information inside the app.

When the user has been created, a school code can be created for each center in data menu and all I the information of the seven sustainability areas will be generated.

If a user has already been created, the application access is done by pressing the "Log in" button. It is recommended to have only one user in the application per demonstration site, since each account in PowerApps contains its own information.

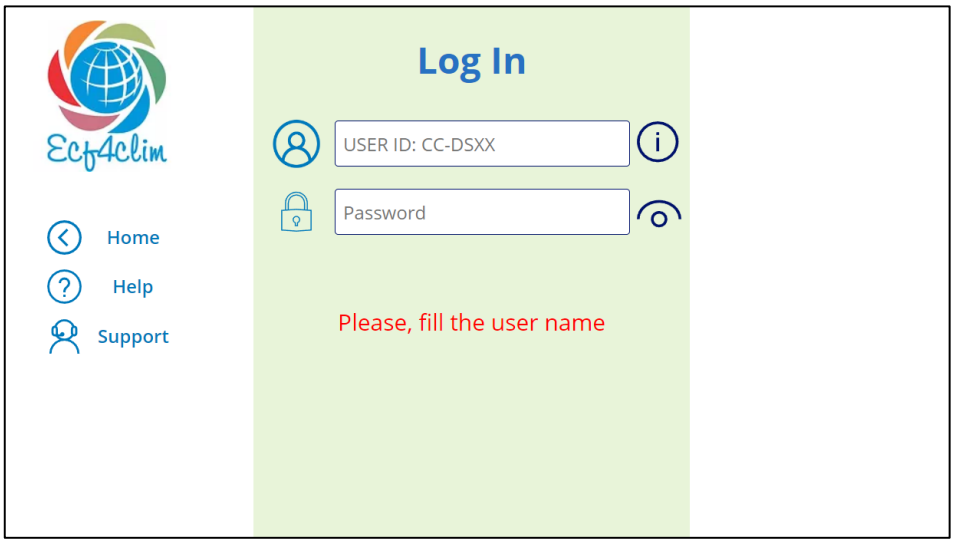


Figure 52.- Login screen.

Note: This app is an evolution of Sustainability Interventions Tool designed for the sustainability areas indicators calculation. So, the user created on this environment will be the same than on this app.

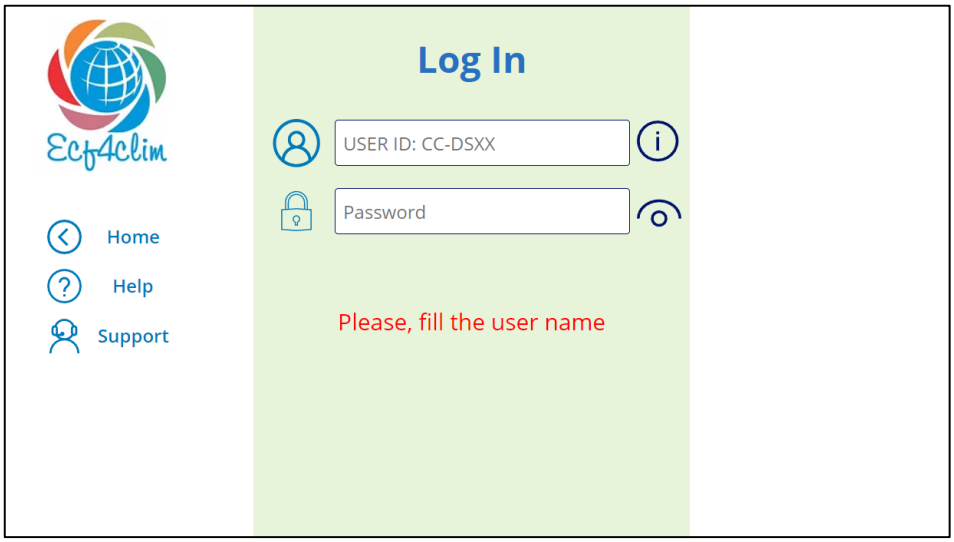


Figure 53.- Login screen.

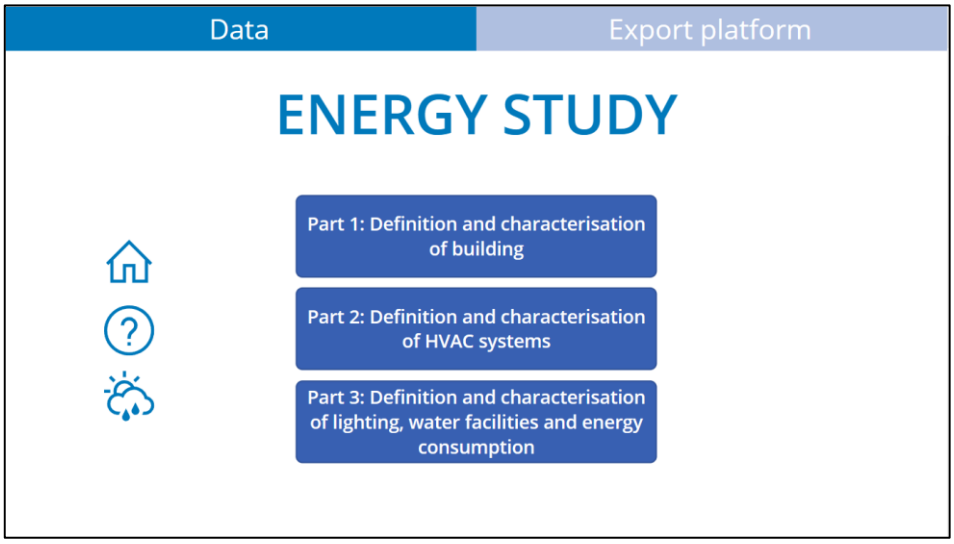
Once the process of entering the application has been completed, the application shows a screen where two main menus appear. Thea first is a screen designed to guide the user through the energetic auditory, added to an extra one whose purpose is the exportation of the gathered data.

General

The application has two parts to facilitate data acquisition. First, the user includes all the available information corresponding to the three auditory steps defined. Then an export platform has been developed to cluster and obtain all the auditory data.

Data menu

After the login process, the data menu prepared to collect the information is shown, with the three different parties of the study:



54.- Visualization of the data menu.

Each step of the auditory is comprised by the same structure:

1. Gallery menu: On this first screen the user has the possibility to create a new study (pressing button), or view and modify information previously entered.
2. View screen: After select an existing case, or after creating a new one, the user can see the information in each part.
3. Edit screen: Inside the screen, by selecting the pencil button the information can be modified.

Weather data

As part of the information to be collected for the energy audit in the building, meteorological information is to be considered. It is useful to estimate demands and requirements of the building along the year, among other things.

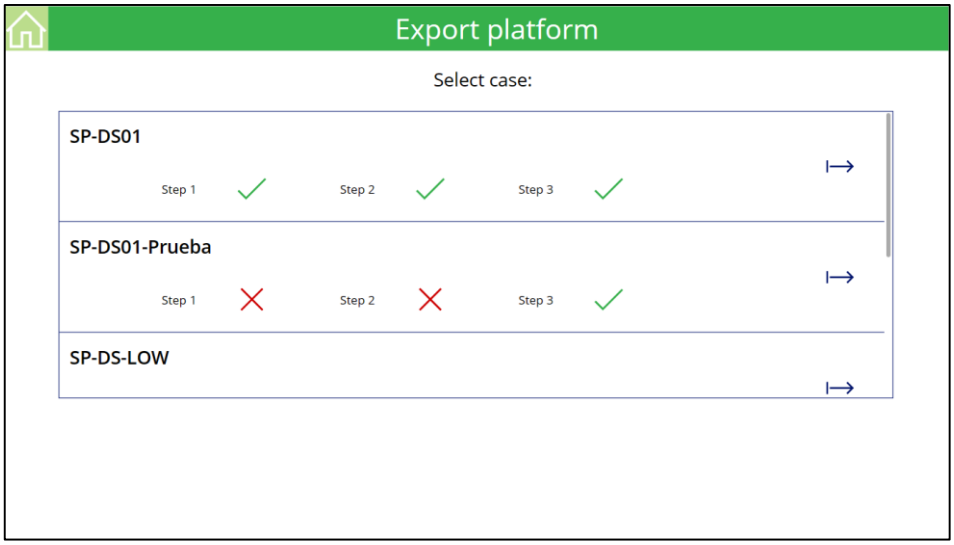
Within the data management menu, it is possible to see the locations of the available, weather data corresponding to the demonstration sites involved in the project. This data also allows users to compare the performance of the building if it would be sited in other place with different clime.

Regarding the weather files, the information was obtained through the Repository of free climate data for building performance simulation (https://climate.onebuilding.org/). The locations selected are nearest locations to demonstration sites involved. The files can be found pressing the button .

Exportation platform

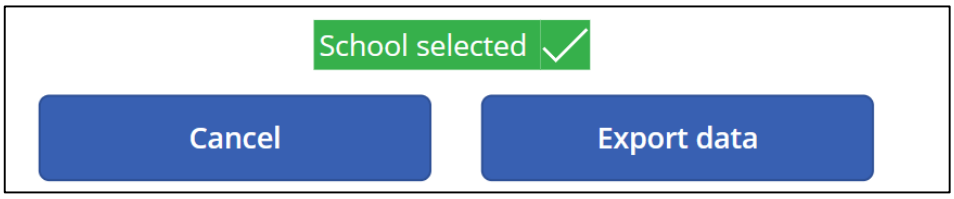
After the data filling process, the application has other section prepared to download a file in a JSON extension within all the information is included. The screen shows all school codes

generated by user in Sustainable Intervention tool and allows to download those studies which has completed the three auditory steps.



55.- Visualization of the calculation menu.

The download is only available to those school codes which have ✓ in all steps. Getting a ✗ in one of the steps means that the information does not exist. Once all data requested is filled, after pressing export button ⟼, a new button will appear to download the file in the bottom of the screen:



56.- Data export button.

After pressing "Export data", a new tab appears in the navigator with the structure of the document generated, as is shown below:

57.- Visualization of the exported data document.

The last step regarding PowerApps is to press the download button of this document, and all auditory information will be available in local.

Report Creation

To finish with the auditory process, the Excel file with the calculation model and the two data files (PowerApps JSON file and weather data file) will be executed to run the developed model. Once the data are included, the template of the report visible in the excel document will be auto filled. Also, a button has been added to send the auditory report by email.

Considerations

When a button is clicked, both in the data menu and in the exportation menu, a screen will appear containing a gallery, that is, a list with all the cases that have been created by the user. That is, each PowerApps user has the possibility of creating more than one case study, which can allow different audits to be carried out over time and the results to be contrasted, using this tool to identify and evaluate the impact of measures.

The information related to School Codes must be settled previously using the Sustainability Intervention Tool.

Study parts

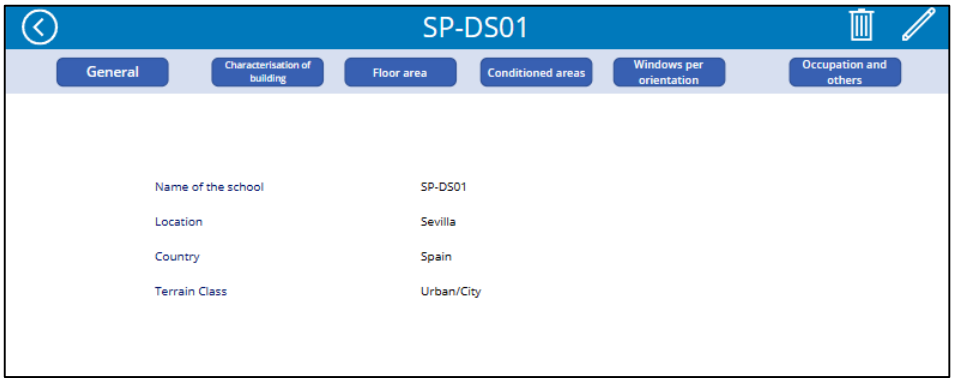
In this section, the three different areas covered in the application are explained, highlighting the most decisive aspects and the ways to reach the results.

Part 1: Definition and characterization of the building

General

On this preliminary section, some general aspects are asked to identify the building:

- Name of the school.
- School's location, Country and city.
- Type of terrain of the school and its environment.

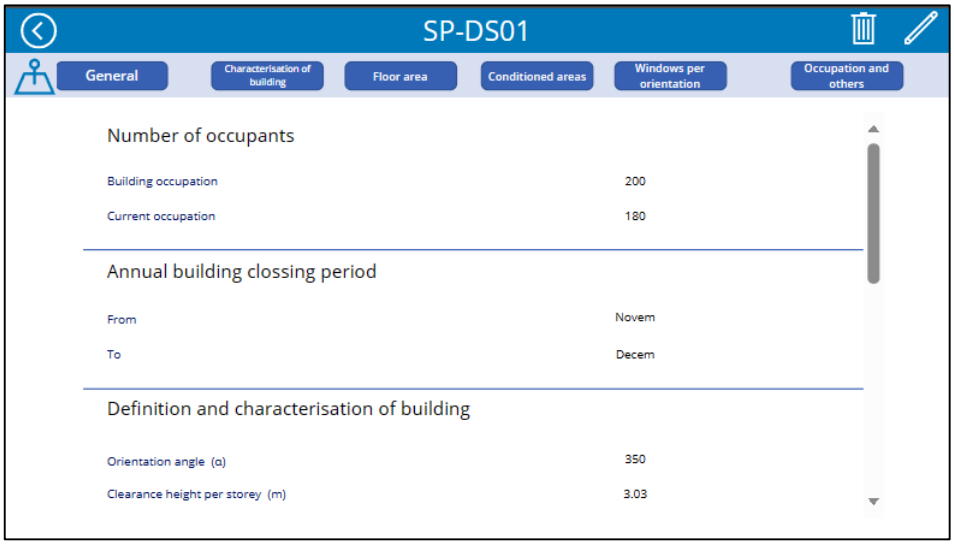


58.- General information about the building.

Characterization of the building

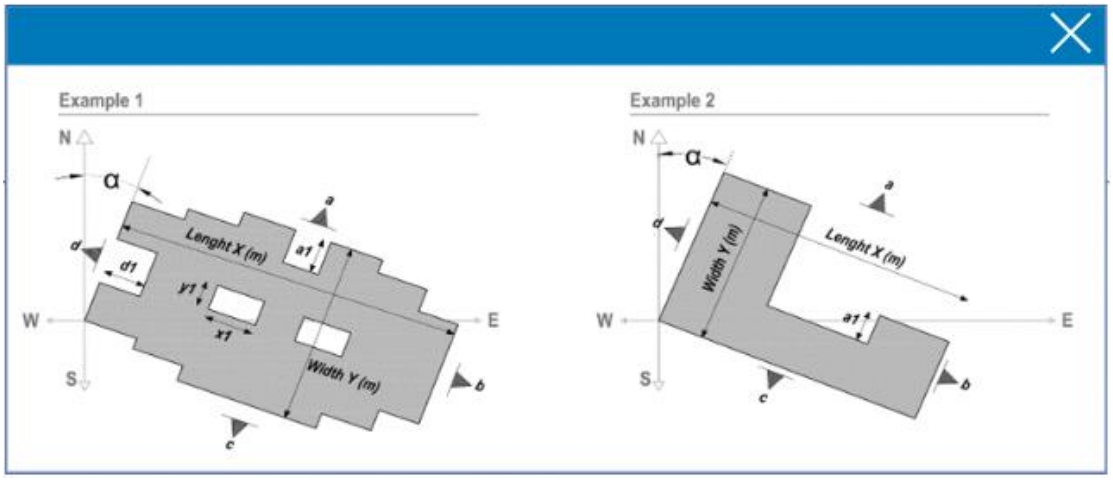
Some measurements of the building are requested. Mainly lengths and heights, but also some occupation data to estimate building's usage:

- Building's maximum and usual occupation.
- Annual building's closing period.
- Orientation angle of the building.
- Length, width, and height of the building.
- Number, length, and width of courtyards.



59.- Characterisation of the building.

. The pop-up window that appears pressing  button serves as a guide to identify some of the measures requested on the building. This button is in the upper corner of the left side of the window. Although each school has own construction design, these general variables have been set to standardize the building characterization.



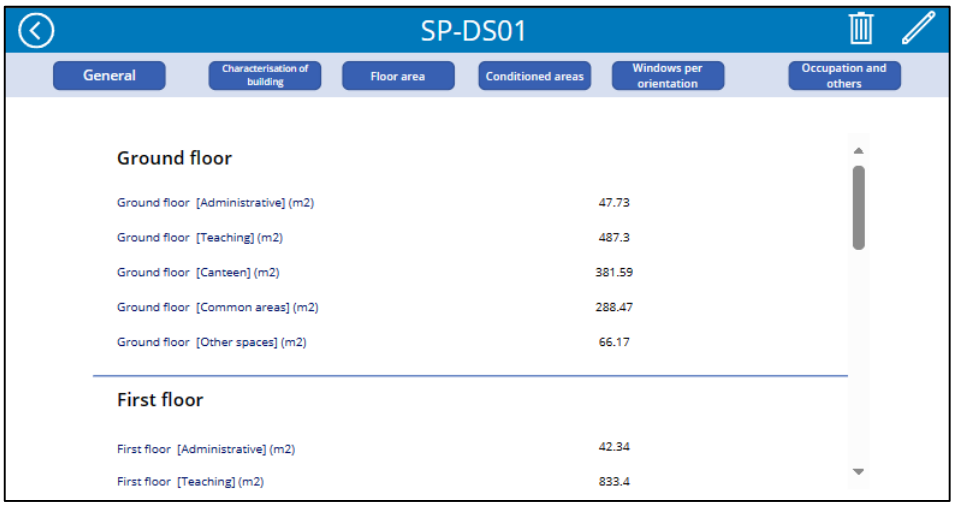
60.- Building's variables legend map

Floor Area

This section describes the area per usage type in each floor of the building. The information is adjusted to the number of floors of each school (from 1 to 4). The different types of usage considered were:

- Administrative.
- Teaching.
- Canteen.
- Common areas.

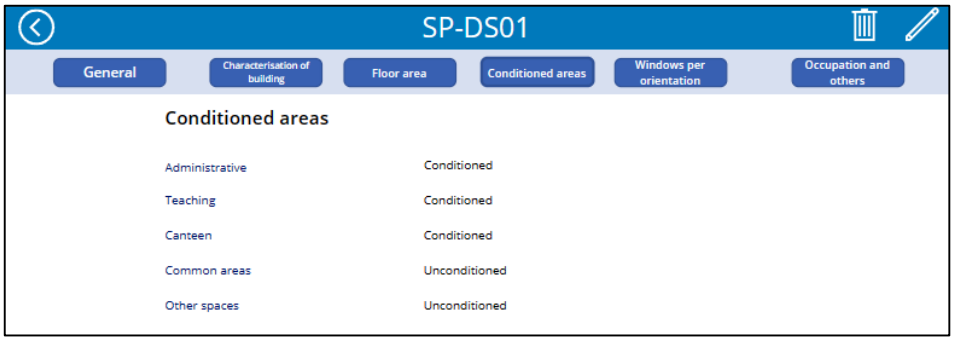
- Other spaces.



61.- Floor Areas per usage type.

Conditioned areas

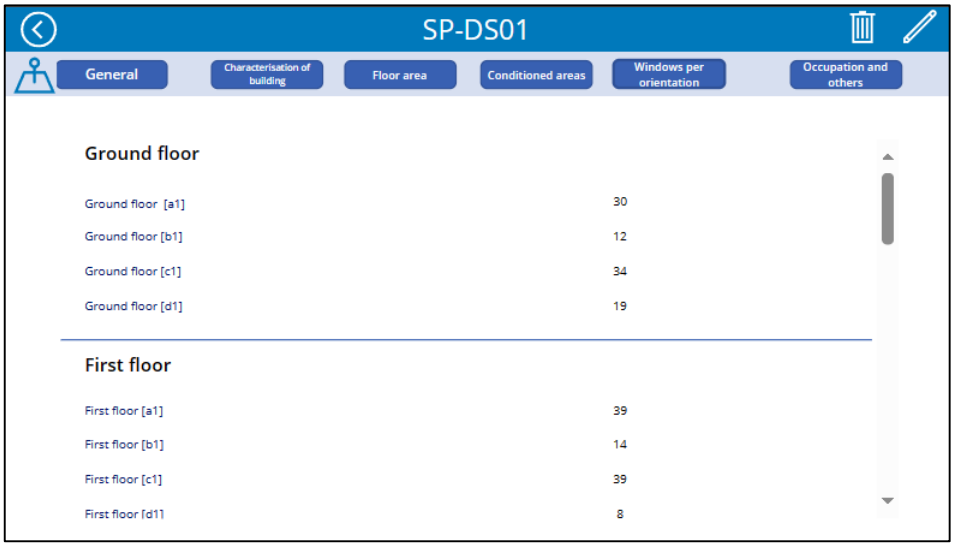
in a general way, this section is orientated to indicate whether the area types defined earlier are conditioned or not.



62.- Indication of which area usage type is conditioned or not.

Windows per orientation

For each orientation and floor the number and orientation of windows are requested, using to this purpose, the same king of geometrical variables shown previously:

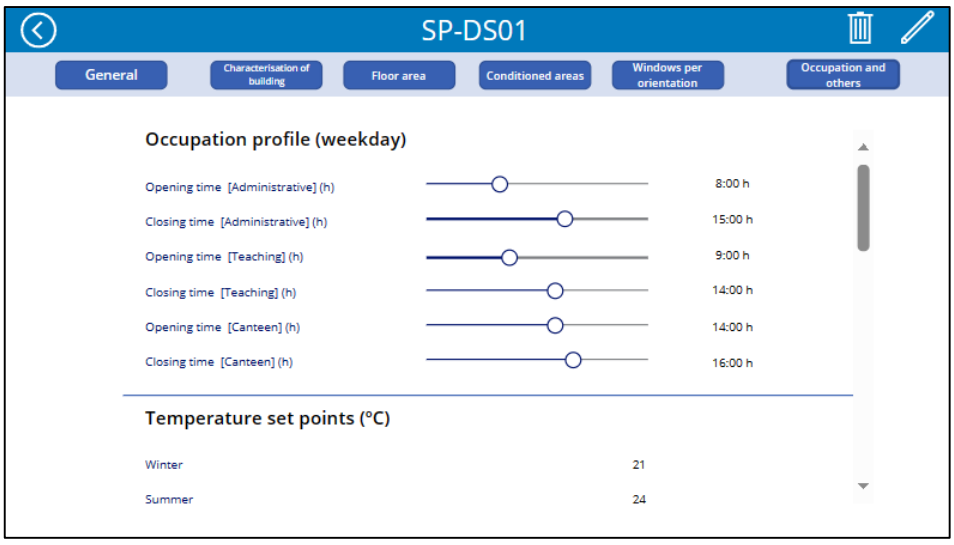


63.- Window information.

Occupation and others

This module is programmed to register the occupation profile in the building. The following information is requested:

- Opening and closing time for each type of use in the building.
- Temperature set points for heating and cooling.



64.- Building occupation profile information.

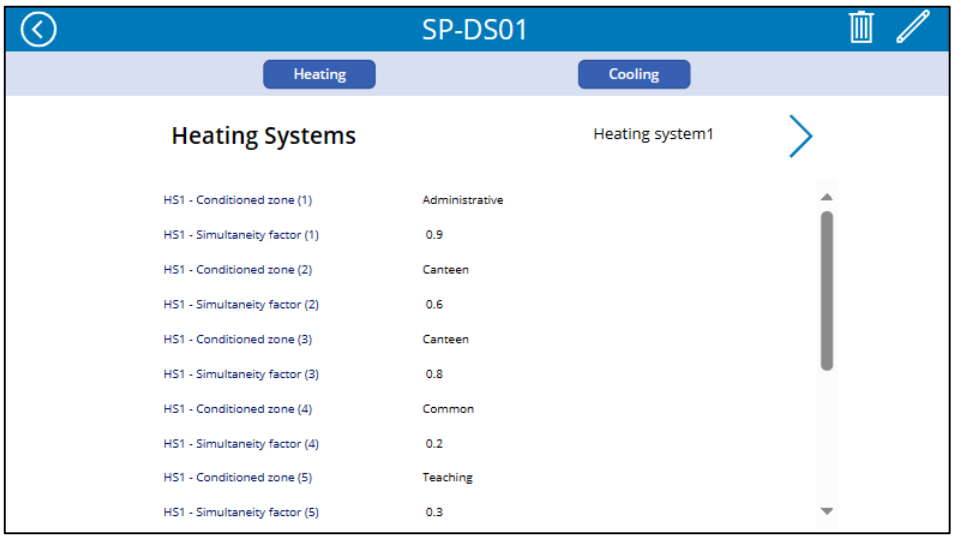
Part 2: Definition and characterization of HVAC systems

On this second step in the audit, the user will be asked for data regarding the heat, ventilation, and air conditioning systems available in the school.

Heating

Regarding the heating systems, the following information is required:

- Simultaneity factor for each conditioned zone of the building.
- Heating system type. You can select between:
    - Electric heating (radiators).
    - Electric boiler.
    - Conventional boiler.
    - Low temperature boiler.
    - Condensing boiler.
    - Biomass boiler.
    - Heat pump.
- Energy source. You can select between:
    - Electricity.
    - Diesel oil.
    - GLP.
    - Natural gas.
    - Biomass.
    - Biomass (pellets).
- Number of systems.
- Nominal capacity of the system.
- Efficiency or COP (%) of the system.
- Hours switched on and off in a day.
- Minimum operation demand.



65.- Heating system definition.

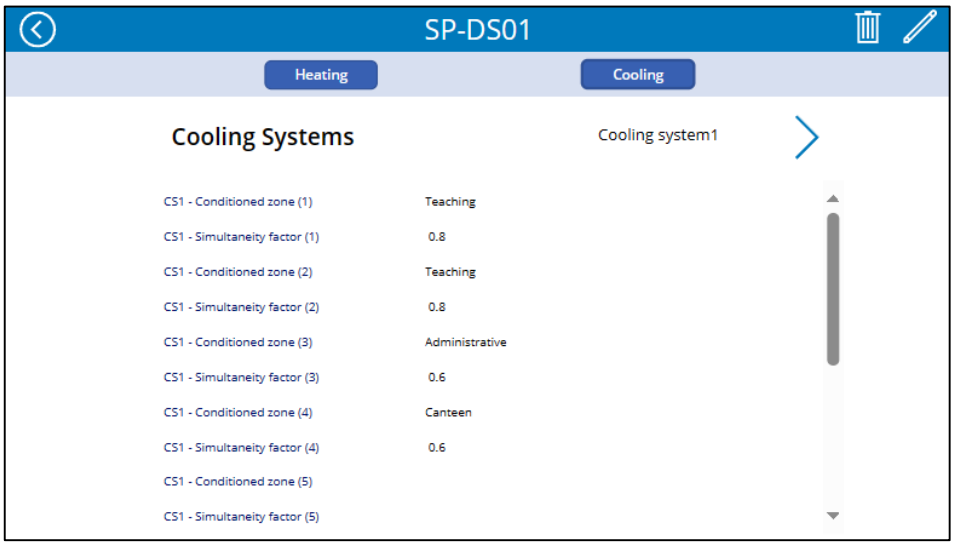
Two different heating systems can be defined. To change between the systems, press > button.

Cooling

Regarding the heating systems, the following information is required:

- Simultaneity factor for each conditioned zone of the building.

- Cooling system type. You can select:
  - Heat pump.
- Energy source. You can select between:
  - Electricity.
  - Diesel oil.
  - GLP.
  - Natural gas.
  - Biomass.
  - Biomass (pellets).
- Number of systems.
- Nominal capacity of the system.
- Sensible nominal capacity of the system.
- Efficiency or EER (%) of the system.
- Hours switched on and off in a day.
- Minimum operation demand.



66.- Cooling system definition.

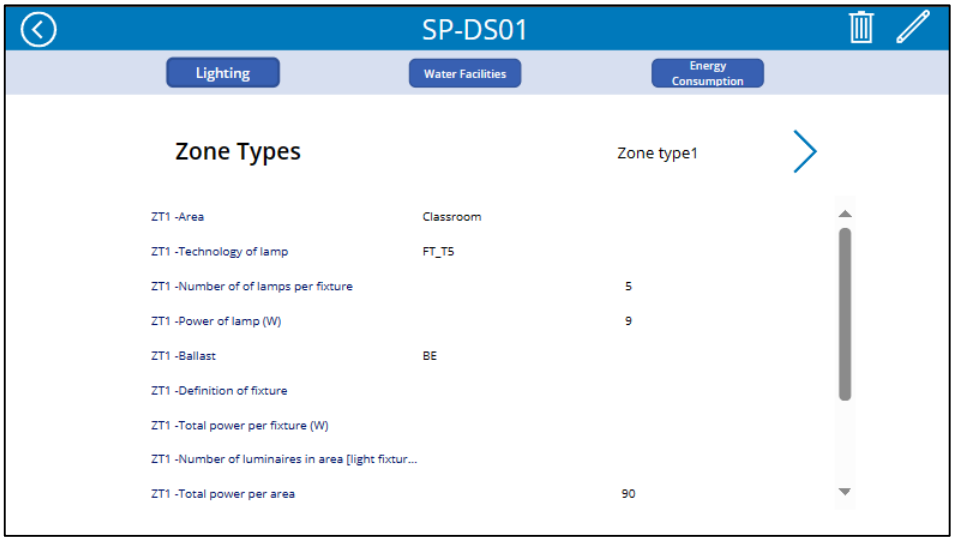
Two different cooling systems can be defined. To change between the systems, press button.

Part 3: Definition and characterization of lighting, water facilities and energy consumption

Lighting

The information regarding lighting is requested for the different zones defined in the building. It is possible to create up to 6 different zone types that will be used in the study. The information is:

- Type of zone. To choose from:
    - Classroom.
    - Corridors.
    - Teacher's office.
    - Bathrooms.
    - Others.
- Technology of the lamp. To choose from:
    - FT-T8.
    - FT-T5.
    - FC.
    - IC.
    - HAL.
    - VM.
    - VS.
    - IM.
    - IND.
    - LED.
- Number of lamps per fixture.
- Power of lamp.
- Lamp's ballast type. To choose from:
    - BE.
    - BF.
- Definition of fixture.
- Total power por fixture.
- Number of luminaires in area (light fixtures).
- Total power per area.
- Number of zones.
- Operating hours per day.
- Simultaneity factor.
- kWh per day.

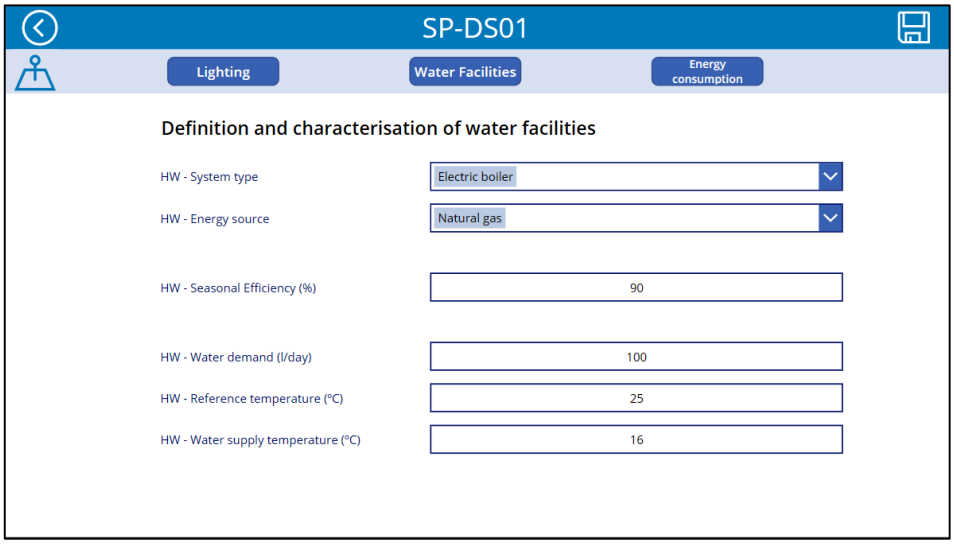


67.- Lighting zone definition.

Water facilities

This section is oriented to provide information about water heating facilities in the building.

- System type. We can select between:
  - Electric heating.
  - Electric boiler.
  - Conventional boiler.
  - Low temperature boiler.
  - Condensing boiler.
  - Biomass boiler.
  - Heat pump.
- Energy source. You can select between:
  - Electricity.
  - Diesel oil.
  - GLP.
  - Natural gas.
  - Biomass.
  - Biomass (pellets).
- Seasonal efficiency (%).
- Water demand in liters per day.
- Reference temperature.
- Water supply temperature.

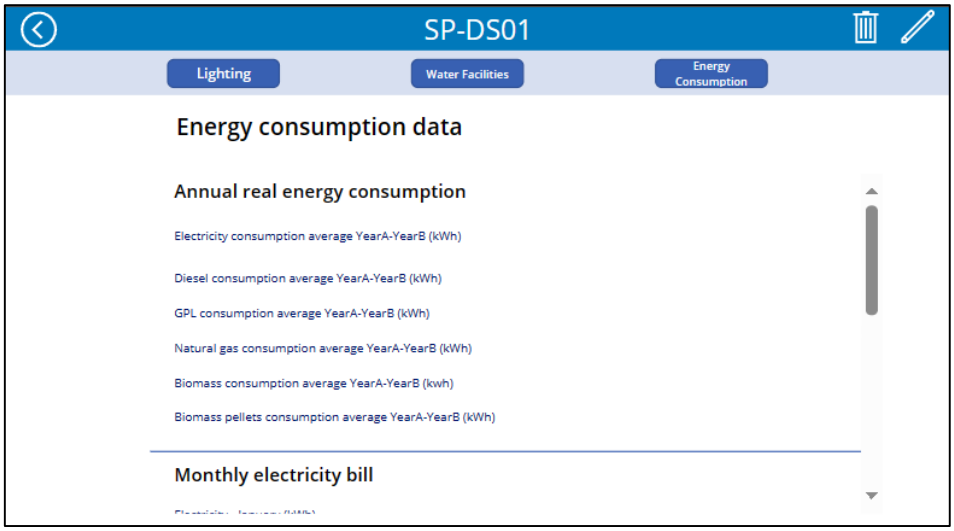


68.- Water heating facilities definition and characterisation.

Energy consumption

We are asked to provide real data about the annual energy consumption and monthly electricity bill to compare with the simulation results. The data needed is:

- Electricity consumption average.
- Diesel consumption average.
- GLP consumption average.
- Natural gas consumption average.
- Biomass consumption average.
- Biomass average consumption average.
- Electricity consumption for each month (from the electricity bill).
- Monthly baseline of electricity (not simulated).



69.- Real energy consumption data input.

Results

To visualize the results of the study, the model calculates in an Excel file the energy demands and energy consumptions and assesses all the information collected in the study (occupation, type of devices, building characteristics, etc.). Once the model is run, the Excel app returns a pdf file with a report with the main results. This document includes explanations about the results obtained. The visualization of this report is in Annex: Report of building performance.

Did something go wrong?

The assessment and communication of the experience in the use of the application is essential to detect possible errors and ways of improvement in the development of the tool. We aim to strengthen a platform that can support the centers in decision-making for the implementation of measures that improve the sustainability skills of the educational community.

That is why, on the login screen, a button has been added for the feedback **"Support".** By clicking on it, a Microsoft form is displayed where comments can be made about things that are not understood, or possible errors that have been detected.

For the development team it is important to have references of the user experience! So, please make use of the form every time you detect something that does not work as expected, or every time you do not understand a specific point of the application. Form responses are made anonymously.

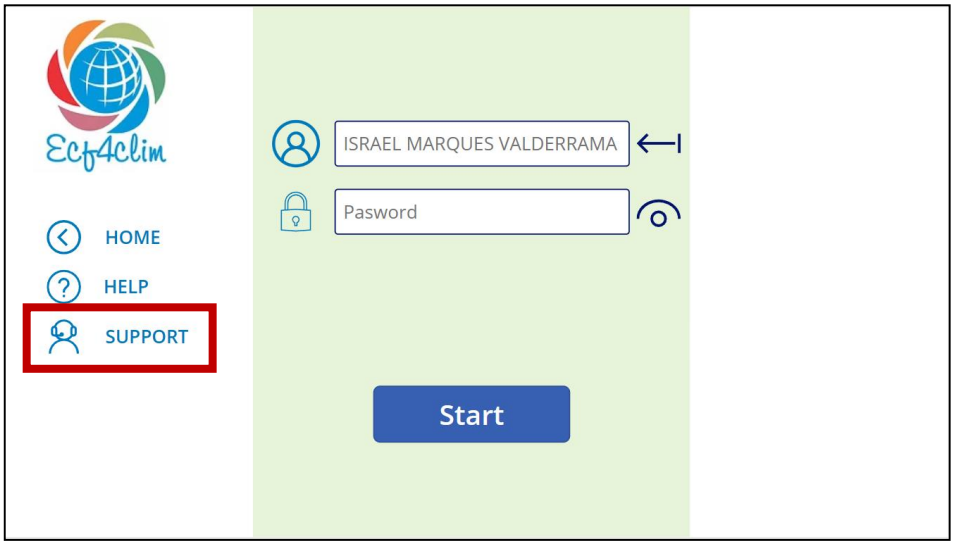


Figure 70.- Access to the feedback form.

Annex: Report of building performance

Simulation Results Report

Introduction

Climate change is one of the most important environmental impacts that Earth is being targeted for, being the main cause of excessive resources consumption and reliance on fossil fuels leading to CO2 emissions. Huge reductions should be made to these emissions to limit catastrophic impacts of climate change.

LOW CARBON ECONOMY (LCE)
Implementing a low carbon economy, by incorporating complementary approaches such as energy efficiency, smart growth initiatives, transportation control measures, energy-efficient product procurement, and resources conservation, conducts to important environmental, economic, and social benefits. It reduces private and external costs and contributes to the accomplishment not only of energy-related targets but also of the 3rd priority objective defined by the 7th Environment Action Program 'to safeguard the Union's citizens from environment-related pressures and risk to health and well-being'.

This report summarises the results obtained from the data entered in the PowerApps tool for the energy analysis of your school. Results have been obtained for different aspects related to the passive thermal behavior of the building and the calibration of the energy model from the invoice data. From this information, aspects referring to thermal comfort, thermal losses, energy demands, energy sources used by the school, and their respective CO2 emissions have been studied and included in this document.

Glossary

- **Discomfort hours (DH):** Percentage of hours in which the indoor temperature of the building is outside the comfort zone. If this happens, we will require of heating or cooling to return the temperature to an acceptable value.

- **Comfort zone:** Adequate range of the indoor temperature in which thermal comfort is achieved and there is no need for heating and cooling.

- **Heating energy demand (QH,nd):** Thermal energy needed to ensure that the interior temperature of the building increases to an acceptable value within the comfort zone.

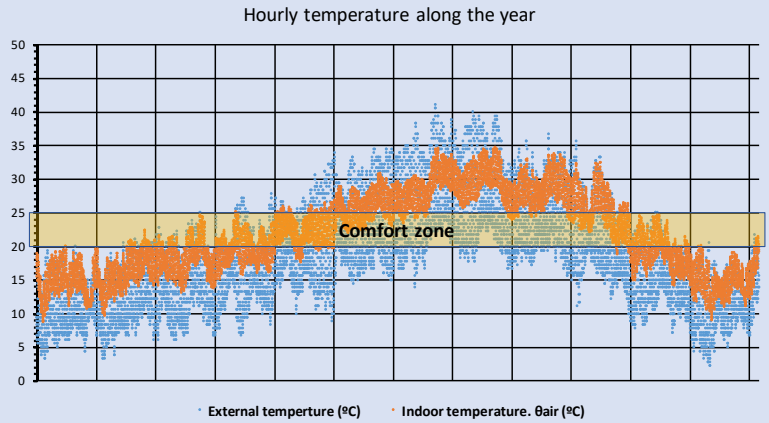
- **Cooling energy demand (QC,nd):** Thermal energy needed to ensure that the interior temperature of the building decreases to an acceptable value within the comfort zone.

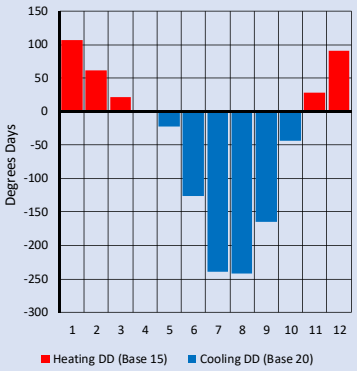
- **Final energy consumption (FEC):** Energy consumed by the equipment to be able to provide the heating and cooling demands to the building.

- **Non-renewable primary energy consumption (PECnr):** Consumption of energy associated with a non-renewable natural resource. From this primary energy we obtain the final energy, which is what we use on a daily basis.

- **CO2 equivalent emissions (CO2eq):** CO2 emissions related to primary energy consumption.

Passive thermal performance of building





		Max. Outdoor T (ºC)	41,1	Max. Indoor T (ºC)	34,73
Conditioned area Af (m2)	1523,51	Min. Outdoor T (ºC)	2,2	Min. Indoor T (ºC)	8,69

Evolution of the outside air temperature and the inside temperature in the building throughout the year, without cooling or heating.

When the temperature inside the building is higher than the comfort zone, cooling will be necessary. When the temperature inside the building is lower than the comfort zone, heating will be necessary. If the building temperature is within the comfort range, nothing will need to be done.

Degree days for each month of the year.

They are measured to know the needs of both heating and cooling.

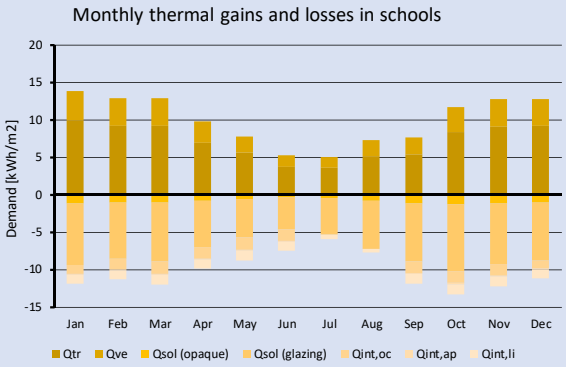
The greater the difference between the temperature inside the building and that of the comfort zone, and the longer this difference occurs, the greater the heating and cooling requirements.

SCHOOL BUILDING (Results)

	DH (%)	QH,nd (kWh/m2 a)	QC,nd (kWh/m2 a)
	66%	23,95	10,87
Max.	90%	30,00	20,00

	FEC (kWh/m2 a)	PECnr (kWh/m2 a)	CO2eq emissions (kg CO2eq/m2 a)
	23,26	51,94	8,95
Max.	20,00	25,00	5,00

	Scores (0 to 5)
Thermal comfort	0,3
Energy consumption	-
CO2 emissions	-
Energy demand	1,5

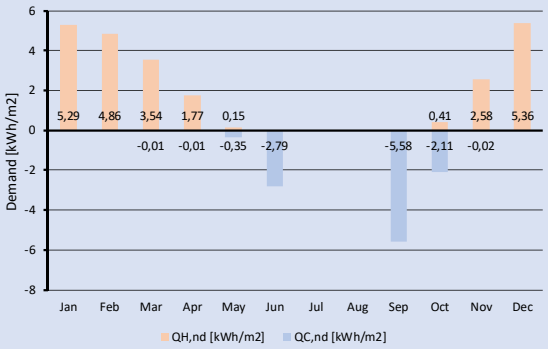


Building simulation results.

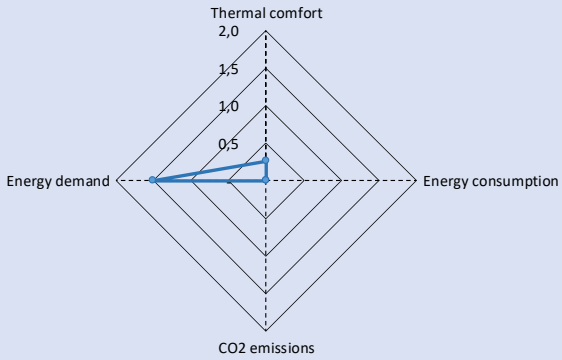
The calculated values are the discomfort hours (DH), heating demand (QH,nd), cooling demand (QC,nd), final energy consumption (FEC) , non-renewable primary energy consumption (PECnr), CO2 emissions associated with non-renewable

Breakdown of the different types of gains and losses in the building and how they affect demand.

Heat losses occur due to ventilation (Qve) and heat transmission through walls and windows (Qtr). Heat gains are due to solar gains through walls (Qsol opaque), solar gains through windows (Qsol glazing), gains from building occupants (Qint oc), gains from



Final heating (QH,nd) and cooling (QC,nd) demands per month.



Building final scores.

Applying an energy rating method, we attribute final scores to the building, from 1 to 5, in 4 different areas:

- **Thermal comfort:** It is evaluated considering the percentage of discomfort hours during the period of occupation of the building. It represents the amount of time, during the period of occupation, that the building will need air conditioning.

- **Energy demand:** It is evaluated based on the annual energy demand for both heating and cooling (kWh/m2 a). It represents the amount of thermal energy that we need to provide in other to maintain the building in thermal comfort conditions.

- **Energy consumption:** It is evaluated considering the final energy consumption of all energy uses (kWh/m2 a). It represents the amount of energy that we end up spending in order to make the building be in thermal comfort conditions.

- **CO2 emissions:** It is evaluated considering the amount of CO2 emitted into the

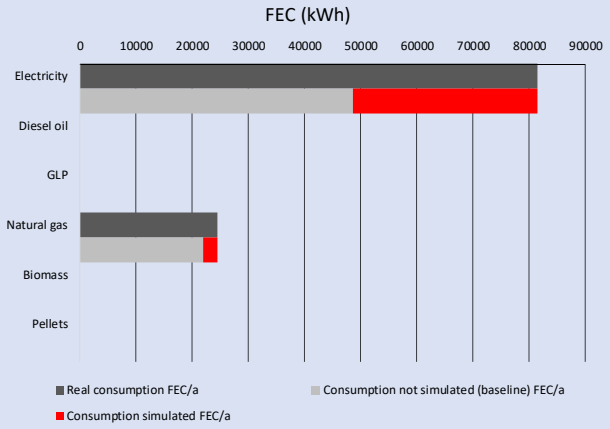
Simulation Results Report

Calibration of energy model through energy bill data

CALIBRATION BY ENERGY SOURCE (kWh)

	Baseline FEC/a	Simulated FEC/a	Real FEC/a*	Simulated (%)
Electricity	48.568,7	32.897,9	81.466,7	40%
Diesel oil	-	-	-	-
GLP	-	-	-	-
Natural gas	21.959,1	2.536,8	24.495,9	10%
Biomass	-	-	-	-
Biomass (pellets)	-	-	-	-
Total	70527,9	35434,8	105962,6	33%

*Energy not simulated *Energy simulated *Energy bill data



Breakdown of final energy consumption according to the energy source.

The simulated values are compared with the real values obtained through energy bill data. Depending on the size of the study, the simulated part of the energy consumption will be higher or lower.

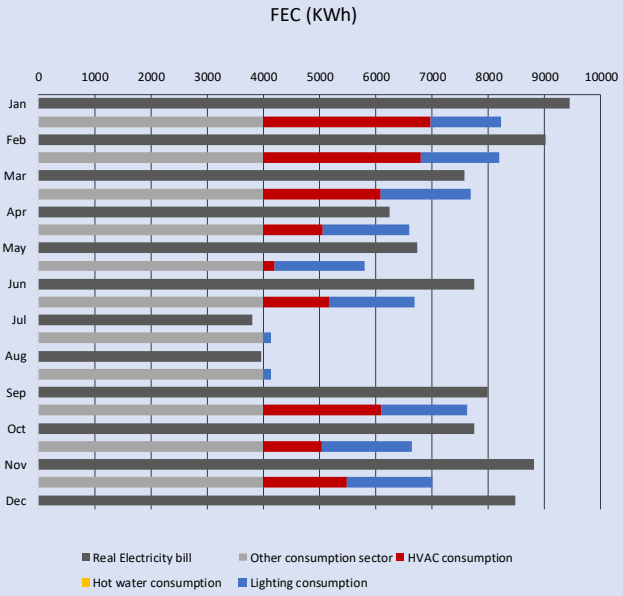
The consumption of the non-simulated part is also taken into account to be able to make comparisons with the real values of the

CALIBRATION OF MONTHLY ELECTRICITY CONSUMPTION BY SECTOR

	Baseline FEC/a	Simulated FEC/a	Real FEC/a*
Jan	4.000,0	4228	9449
Feb	4.000,0	4192	9015
Mar	4.000,0	3692	7580
Apr	4.000,0	2590	6242
May	4.000,0	1795	6736
Jun	4.000,0	2693	7746
Jul	4.000,0	139	3800
Aug	4.000,0	139	3968
Sep	4.000,0	3629	7995
Oct	4.000,0	2633	7756
Nov	4.000,0	3013	8817
Dec	4.000,0	4156	8483
Total	48000,0	32898	87587

*Energy not simulated *Energy simulated *Energy bill data

	Monthly baseline
Other consumption sector (kWh)	4000

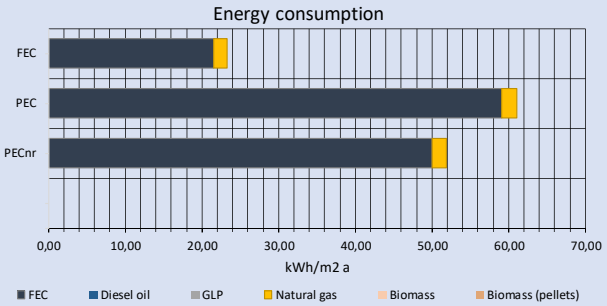


Breakdown of final energy consumption according to its uses.

These are air conditioning and ventilation, domestic hot water, and lighting. The simulated values are compared with the real values obtained through energy bill data, as in the previous case.

Total (kWh a)

	FEC (kWh a)	PEC (kWh a)	PECnr (kWh a)	CO2eq emissions (kg CO2eq a)
Electricity	32.897,93	90.008,75	76.191,62	13.027,58
Diesel oil	-	-	-	-
GLP	-	-	-	-
Natural gas	2.536,83	2.945,26	2.940,18	606,30
Biomass	-	-	-	-
Biomass (pellets)	-	-	-	-
	35.434,76	92.954,01	79.131,80	13.633,88



Breakdown of final energy consumption and CO2 emissions according to the energy source.

The data is expressed in terms of energy (kWh) in the first table and in terms of energy per area (kWh/m2) both in the second table and in the graphs.

Ratio (kWh/m2 a)

	FEC	PEC	PECnr	CO2
Electricity	21,59	59,08	50,01	8,55
Diesel oil	-	-	-	-
GLP	-	-	-	-
Natural gas	1,67	1,93	1,93	0,40
Biomass	-	-	-	-
Biomass (pellets)	-	-	-	-
	23,26	61,01	51,94	8,95