D4.3
Baseline assessment of the environmental performance

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1. EXECUTIVE SUMMARY

The ECF4CLIM project aims to co-design and test a European Competence Framework (ECF) for climate change and sustainable development that will enable and empower the citizens to act towards sustainability. In its framework, students, teachers, parents, and the wider educational community are engaged, contributing to the climate action and to foster transformational changes towards sustainable development in the spirit of 'citizen science'.

The present deliverable – "D4.3: Baseline assessment of the environmental performance", was produced in the context of task 4.3 of the WP 4 – "Testing the ECF – Baseline assessment". The WP4 has as its main purpose to assess the baseline of the individual and collective competences of the educational community and to evaluate the impact of the organisational structures, options and attitudes on the environmental performance of the pilot schools and universities. This WP promotes the co-design of measures to improve the knowledge, skills, attitudes, and social practices relating to sustainable development through a participatory hybrid approach, including elements from citizen science and citizen engagement.

This document reports the achievements obtained in work developed in the pilot schools through four working phases, namely:

a. Pre-audit phase
b. Site audit phase
c. Site assessment
d. Data analysis

These actions involved the school community, making schools aware of their environmental performance for a sustainable community, and helping them set goals and implement measures (in the structural and social axes).

This deliverable includes the following information:

- Executive summary;
- The ECF4CLIM project: team and methodology;
- Environmental audits: Results and discussion of the Key Performance Indicators (KPIs) and Scores;
- IoT solutions for real-time monitoring of selected parameters: methodology, results and discussion.

2. LEGAL NOTICE

3. About the project

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

This project intends to apply a novel hybrid participatory approach, rooted in participatory action research and citizen science, and to co-design the ECF in pilot 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 (Science, Technology, Engineering, and Mathematics) -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.

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 small and medium enterprises (SMEs) in the consortium maximises the broad adoption and applicability of the ECF for the required transformational change towards sustainability.

3.1. Who we are

The ECF consortium consists of ten partners (Table *1*). The project is coordinated by Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas - CIEMAT.

Table 1- ECF4CLIM partners.

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 (**REBAG**)	HU	
Smartwatt Energy Sercuces SA (**Smartwatt**)	PT	
Que Technologies Kefalaiouchiki Etaireia (**QUE**)	GR	

3.2. ECF4CLIM Methodology

The ECF4CLIM methodology is based on an innovative hybrid conceptual and methodological participatory approach combining and integrating elements from participatory action research, citizen engagement, deliberative formation, crowdsourcing, and theory-based stakeholder evaluation. This hybrid methodology approach will guarantee that, for each group within the educational community, the most suitable participatory strategies and tools are implemented.

The project methodology is divided into five main sections, namely:

1. The identification of 12 pilot educational institutions in Portugal, Spain, Romania, and Finland to apply the methodology;
2. The detail of the materials and methods used for data collection;
3. The development of a multi-criteria environment assessment to characterise the environmental performance of schools and their community through sustainability indicators;
4. The description of the structural procedure to engage and encourage students, teachers, and families towards an energy efficient and a Low-Carbon Economy (LCE) pathway;
5. The report of the data collection campaigns for methodology validation.

3.2.1. Pilot schools

A set of 13 pilot schools located in Portugal, Spain, Romania, and Finland was selected to test and validate the ECF4CLIM methodology. The list of the demonstration sites and respective characteristics are shown in Table 2, while their location is depicted in Figure 1. There are three Portuguese schools located in Lisbon's district (two in the municipality of Loures and one in the municipality of Lisbon). Three schools are located in Spain, from which one is in Madrid, one in Sevilla, and one in Barcelona. The four Romanian schools[1] are located in Dragasani, Mioveni, Sercaia and Pitesti. Two of the Finnish schools are located in Tampere, one University in Jyväskylä.

The 13 ECF4CLIM pilot schools cover the complete educational cycle, including pre-school, primary school, lower and upper secondary schools, higher education, and universities.

[1] The project's proposal only defined three pilot schools in Romania. However, an additional school was interested to participate in the project and therefore the results obtained in the environment audit performed in this fourth school were considered in the analyse of the global environmental performance and included in this deliverable.

Table 2- List of the ECF4CLIM demonstration sites.

Code	Country	City	Type of school*	School area (m²)	No. Students
S1	Portugal	Loures	Primary, Lower and upper secondary school	35270	741
S2		Loures	Primary and Lower secondary school	25888	792
S3		Lisbon	Higher education**	80824	9602
S4	Spain	Seville	Lower and upper secondary school	14823	498
S5		Madrid	Pre-school and Primary school	11039	675
S6		Barcelona	Higher education	2625000	1193
S7	Romania	Dragasani	Primary and secondary school	4873	976
S8		Mioveni	primary and secondary school	5800	1431
S9		Sercaia	Primary and Lower secondary school	4189	203
S10		Pitesti	Higher education	10659	1943
S11	Finland	Tampere	Upper secondary school	15000	1200
S12		Tampere	Lower secondary school	4725	550
S13		Jyväskylä	Higher education**	10245	400

*International Standard Classification of Education
**In these universities it was only considered for analysis one building.

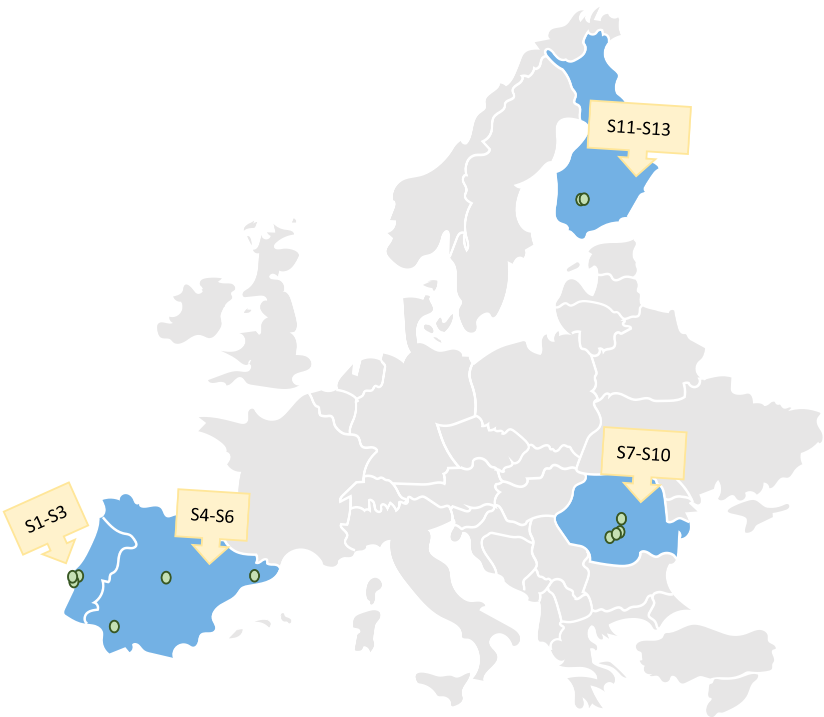


Figure 1- Location of the ECF4CLIM pilot schools.

3.2.1.1. Multi-criteria environment assessment through sustainable indicators

The multi-criteria environment assessment focuses on six environmental sectors: transport, green procurement, green spaces, energy, water, and waste, assessed by Key Performance Indicators (KPIs), obtained through technical assessment and behaviour surveys applied at the selected educational establishments, as illustrated in Figure 2. Technical assessments were based on technical audits, that used a checklist, to collect information about building characteristics, equipment, activities, behaviours, occupation profiles and resource consumption of the educational buildings. The on-line surveys were carried out to monitor the performance of the selected educational communities in terms of individual and collective behaviour, such as transport patterns, daily habits, and practices in the environment sectors.

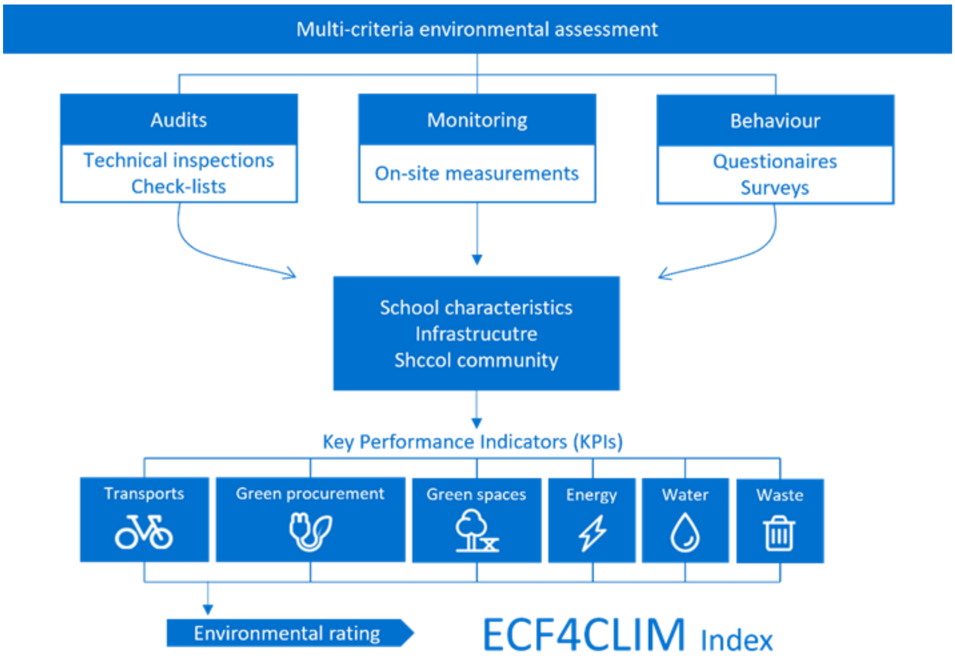


Figure 2 - ECF4CLIM methodology.

The environmental sectors and KPIs were selected according to the objectives of the European Green Deal (European Commission, 2019), the European Climate Pact launched by the European Commission (European Commission, 2020), and the European Biodiversity Strategy (European Commission, 2020). All targets, applied to the boundary conditions and scope of the educational communities, allowed identifying the six environmental pillars where schools can play an essential role towards a LCE and sustainability: transports, green procurement, green spaces, energy, water, and waste (Table 3). The KPIs per environmental sections are defined in Table 4. Further details about their calculation are provided in each environmental sector section of this document. These KPIs can be adapted to other contexts and requirements.

Table 3: Environmental and energy sectors characterisation.

TRANSPORTS	Analysis of the users' behaviour questionnaire to quantify the CO_2 emissions associated with the home to school commute, quantification of parking spaces for electric vehicles and bicycles in schools, and assessment of the transports network availability nearby schools.
GREEN PROCUREMENT	Evaluation of schools procedures related to the procurement of services and goods. This analysis focuses on electric and electronic equipment labelling, consumption of recycled paper, training in green procurement, and acquisition of biological food from local suppliers.
GREEN SPACES	Assessment of the schools area reserved for green spaces, CO_2 sequestration potential through the quantification and characterisation of the green species, and CO_2 emissions associated with the use of chemists and resources consumption in the maintenance of the green spaces.
ENERGY	Quantification of the schools' energy consumption for the last five years (2017 to 2021) and the associated CO_2 emissions.
WATER	Quantification of the schools' water consumption for the last five years (2017 to 2021) and the associated CO_2 emissions.
WASTE	Quantifications of the volume of waste produced in schools, including recycled and reused waste.

Table 4: Multi-criteria environmental assessment of schools: environmental pillars, KPIs and scores range.

Environmental pillars	Key Performance Indicators	Scores
Transport		
Parking	KPI-T1. No. of parking spaces for bicycles at school or periphery per student (up to a 100m radius) KPI-T2. No. of parking spaces for electric cars at school or periphery per student (up to a 100 m radius)	Transport score (0-5)
Public transport network	KPI-T3. No. of public transports passing daily per hour (1000 m radius)	
CO_2 emissions	KPI-T4. Annual CO_2 Emissions per student ($kgCO_2$/student)	
Green procurement		
Equipment efficiency	KPI-GP1. No. of equipment A 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 a biological certificate/Kg total food)	
Suppliers	KPI-GP7. Local suppliers (No. local suppliers /total suppliers)	
Green spaces		
Green areas	KPI-GS1. No. of trees per non-covered area (m^2) KPI-GS2. No. of trees per student (trees/student) KPI-GS3. Green area per non-covered area (%) KPI-GS4. Green area per student (m^2/ student)	Green spaces score (0-5)
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)	
CO_2 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) KPI-E2. Annual final energy consumption per student (kWh/student)	Energy score (0-5)
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)	
CO_2 emissions	KPI-E6. Annual carbon footprint per student ($kgCO_2$/student)	
Water		
Water consumption	KPI-Wr1. Water consumption (m^3/m^2) KPI-Wr2. Water consumption (m^3/student)	Water score (0-5)
Water cost	KPI-Wr3. Water cost (€/m^2) KPI-Wr4. Water cost (€/student)	
Waste		
Waste produced	KPI-W1. Volume of urban solid waste produced (non-recyclables and non-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)

In addition to the KPIs evaluation, the schools environmental performance is assessed based in scores, per each environmental sector. For a better analysis of the results, these scores varies between 0 to 5, where 0 is the worst performance, indicating the need of improvement of the school, and 5 the best performance. The score's formulas are shown along the results and discussion chapter (chapter 4), in each environmental section analysis.

To understand the environmental performance of the schools and their potential environmental improvement, a final score (ECF4CLIMscore) is calculated through the mean value among all environmental scores, according to equation 1 (Eq. 1).

$$ECF4CLIM_{score} = \frac{T_S+GP_S+GS_S+E_S+Wr_S+Ws_S}{6} \quad \text{(Eq. 1)}$$

where T_S: transport score, GP_S: green procurement score, GS_S: green spaces score, E_S: energy score, Wr_S: water score, Ws_S: waste score.

This final score allows a comparative evaluation of the schools (benchmark) accordingly to their environmental performance, but mainly an evaluation of each school's performance over time.

3.2.1.2. Environmental and behavioural data collection

The environmental performance of the pilot schools and surroundings was evaluated in the academic year 2021/2022 through:

(1) a **technical audit** performed by the project team and school community to assess the physical conditions of each school and their performance, considering six environmental sectors: transport, green procurement, green spaces, energy, water, and waste. The audit used a standardised checklist as a support tool. The technical audits were assessed in the 13 schools, representing a participation rate of 100% of the pilot schools.

(2) an **online questionnaire** applied to the scholar population, focusing on their commuting behaviour. The questionnaire, composed mainly of multiple-choice questions, was common to all educational establishments and was translated into the four languages of the pilot schools. In the pre-schools and primary schools, the online questionnaire was answered with the support of the teachers or parents. The anonymity of the participants was guaranteed throughout the entire process. The questionnaire was applied successfully in 8 schools (participation rate of 62% of the pilot schools). Schools S1, S3, S6, S8, and S9 have not answered the questionnaire.

The standardised checklist for the technical audit and the behavioural questionnaire is available in the Appendices Section (Appendix I, and Appendix II) to support other schools in assessing their environmental performance.

4. Environmental performance: results and discussion

4.1. Waste management

The schools' performance regarding waste management was assessed based on the KPIs and scores presented in Table 5 and Table 6.

Table 5: KPIs calculation for the waste management sector.

Sector	KPI designation	KPI calculation
Waste	Weekly production of urban solid waste (USW) per student	$\text{KPI}_{W1} = \frac{\text{weekly production of USW}}{\text{no. of students}}$
	Weekly production of recyclables per student	$\text{KPI}_{W2} = \frac{\text{weekly production of recyclable waste}}{\text{no. of students}}$
	Weekly production of reusables per student	$\text{KPI}_{W3} = \frac{\text{weekly production of reusable waste}}{\text{no. of students}}$

Table 6: Methodology for the calculation of the waste management scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
Waste	Urban Solid Waste	$S_{W1} = \frac{(\max(KPI_{W1}) - KPI_{W1}) \times 5}{max(KPI_{W1}) - \min(KPI_{W1}) * 0.95}$	Highest KPI_{W1} found	Min(KPI_{W1}-(KPI_{W2}+KPI_{W3})) less 5%	2
	Waste recycled	$S_{W2} = \frac{KPI_{W2} \times 5}{1.05 \times max(KPI_{W2})}$	Without recyclable waste	Highest KPI_{W2} found plus 5%	1
	Waste reused	$S_{W3} = \frac{KPI_{W3} \times 5}{1.05 \times max(KPI_{W3})}$	Without reusable waste	Highest KPI_{W3} found plus 5%	1

Parameters assessed:

- Urban Solid Waste produced;
- Waste recycled;
- Waste reused.

Figure 3 shows the results for KPI-W1 and KPI-W2, which assess the weekly urban solid waste production (non-recyclable and non-reused) and the recyclable waste production per student, respectively. The S4 did not perform the waste monitoring campaign. The data from S13 was not included in the data analysis once the values obtained were representative from the entire university, and not exclusively of the building in analysis.

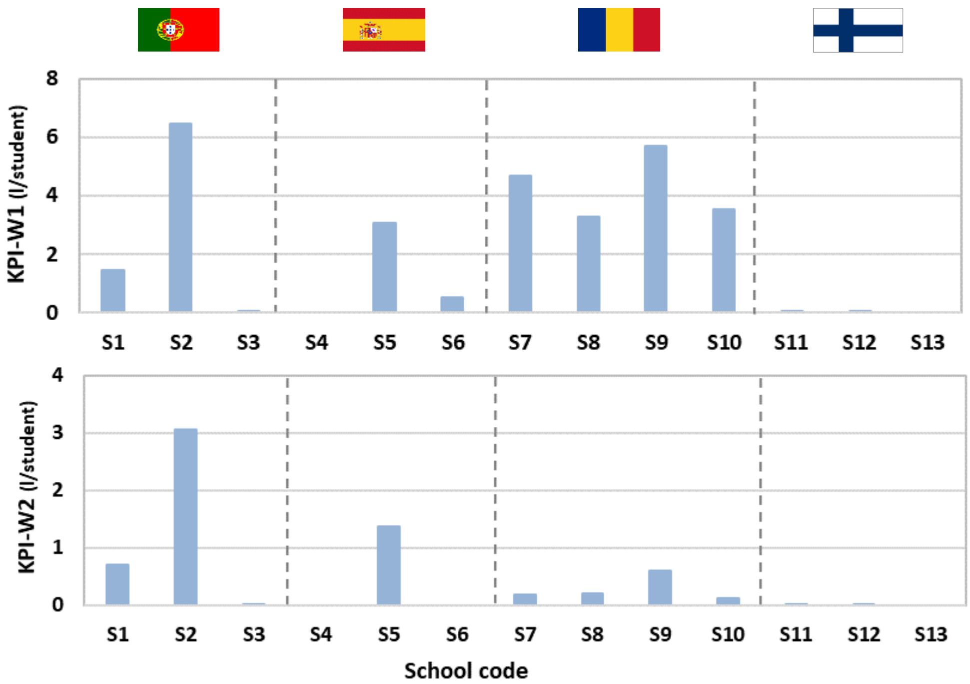


Figure 3 - Weekly urban solid waste (non-recyclable and non-reused) (KPI-W1) and recyclable waste (KPI-W2) produced in each school per student.

The total school waste is the sum of the urban solid waste, recyclable waste and reused waste. However, the KPI-W3, which assesses the reused waste production, was zero or was not accounted for in all the schools.

On average, the ECF4CLIM schools produce 3 litters of urban solid waste per student and per week, while the average production of recyclable waste is 0.6 litters per student per week. These results show that besides the efforts to increase the awareness of the school's community for the importance of the separation of waste, the amount of recyclable waste produced is still very low compared with the total amount of waste produced. It should be mentioned that waste is the environmental topic more explored in the awareness campaigns performed in the schools.

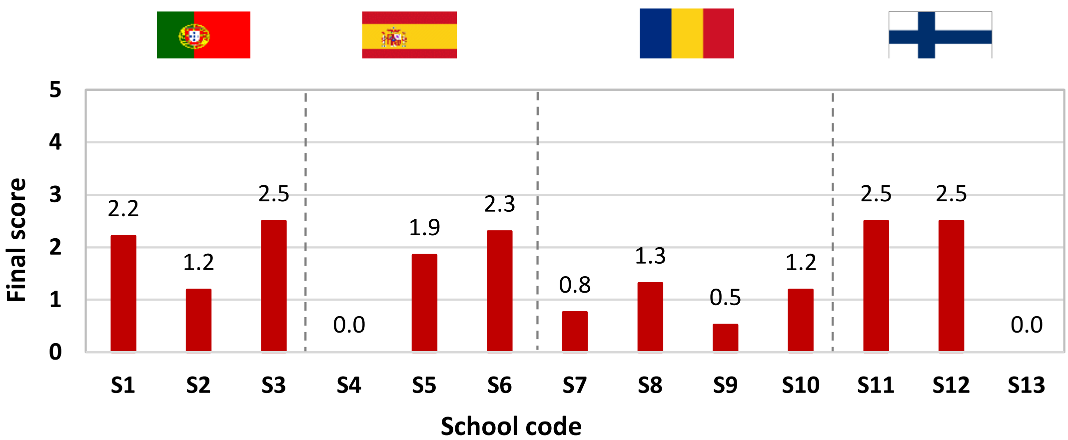


Figure 4 - Final score for the waste sector.

Figure 4 shows the final score for the waste sector, which considers the three sub-scores, related to the production of urban solid waste, recyclable waste and reusable waste. Results show that the performance of the schools is, in general, weak and that there is an important margin for improvement.

An additional observation of the obtained data is the fact that the quantification of the waste from S3, S11 and S12 was in kilograms. This data was converted to litters, the unity used in KPIs. For this conversion was applied the density values attributed to the recyclable material referenced by a Portuguese entity responsible for the recycling in Portugal. This fact may compromise the variability of the data.

The audits and meetings developed in the schools showed that three main conditions contribute to the low performance of the schools regarding waste management:

1) The schools are equipped with bins to make the separation of the waste per typology, but the community is not contributing to the separation of the waste. In these schools, more training and awareness campaigns are needed;
2) The schools are not equipped with bins to make the separation of the waste per typology, or there are a limited number of bins and sometimes not well distributed in the schools. In these schools, it is important to invest in the acquisition of more bins and in the improvement of their management;
3) The schools are equipped with bins, but they are not well identified, and the users are not able to use them adequately, principally for new types of materials that are emerging. In these schools, it is important to focus on training and on signposting.

4.2. Water management

The schools' performance regarding water management was assessed based on the KPIs and scores presented in Table 7Table *6* and

Table *8*. For the water KPIs were used the average of the consumptions and cost values of the last 5 years (2017-2021).

Table 7: KPIs calculation for the water management sector.

Sector	KPI designation	KPI calculation
Water	Water consumption per useful area	$\mathrm{KPI}_{\mathrm{Wr1}} = \frac{\text{annual water consumption}}{\text{useful area}}$
	Water consumption per student	$\mathrm{KPI}_{\mathrm{Wr2}} = \frac{\text{annual water consumption}}{\text{no. of students}}$
	Water costs per useful area	$\mathrm{KPI}_{\mathrm{Wr3}} = \frac{\text{annual water costs}}{\text{useful area}}$
	Water costs per student	$\mathrm{KPI}_{\mathrm{Wr4}} = \frac{\text{annual water costs}}{\text{no. of students}}$

Table 8: Methodology for the calculation of the water management scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
Water	Water consumption per useful area	$S_{Wr1} = \frac{(\max(KPI_{Wr1}) - KPI_{Wr1}) \times 5}{\max(KPI_{Wr1}) - \min(KPI_{Wr1}) \times 0.95}$	Highest KPI_{Wr1} found	Lowest KPI_{Wr1} found less 5%	1
	Water consumption per student	$S_{Wr2} = \frac{(\max(KPI_{Wr2}) - KPI_{Wr2}) \times 5}{\max(KPI_{Wr2}) - \min(KPI_{Wr2}) \times 0.95}$	Highest KPI_{Wr2} found	Lowest KPI_{Wr2} found less 5%	1
	Water costs per useful area	$S_{Wr3} = \frac{(\max(KPI_{Wr3}) - KPI_{Wr3}) \times 5}{\max(KPI_{Wr3}) - \min(KPI_{Wr3}) \times 0.95}$	Highest KPI_{Wr3} found	Lowest KPI_{Wr3} found less 5%	1
	Water costs per student	$S_{Wr4} = \frac{(\max(KPI_{Wr4}) - KPI_{Wr4}) \times 5}{\max(KPI_{Wr4}) - \min(KPI_{Wr4}) \times 0.95}$	Highest KPI_{Wr4} found	Lowest KPI_{Wr4} found less 5%	1

Parameters assessed:

- Water consumption;
- Water cost.

Figure 5 displays the results obtained for each water management KPI and for each school, and Table 9 presents the average KPIs per country. Results show that the Spanish schools presented the highest water consumption per area (1.2 m^3/m^2) and per student (6.8 m^3/student), followed by the Portuguese, Romanian and Finnish schools. However, the cost of water is higher in Portugal, which causes a negative impact on KPIs 3 and 4 from the Portuguese schools that the schools cannot avoid.

Figure 6 shows the final water management score. It is clear that Portuguese schools are highly affected by the cost of water but, in general, the schools had a good performance in this sector.

The audits and meetings developed in the schools showed that there are three main conditions that contribute to the consumption of water in the schools and that should be considered to improve their performance:

1) In some schools, the consumption of water is highly associated with the maintenance of green spaces. These schools should avoid the consumption of tap water for irrigation and give preference to wells.
2) We also identified important leakages in some schools that cause significant losses of water. The identification and reparation of these situations are urgent.
3) The toilets are another area with an import consumption of water. The use of temporised taps and faucet aerators can reduce water consumption.

It is interesting to observe that the countries that presented the highest consumption of water are located in the south of Europe where the water is scarcer. This indicates that the implementation of measures in Portuguese and Spanish schools should be a priority.

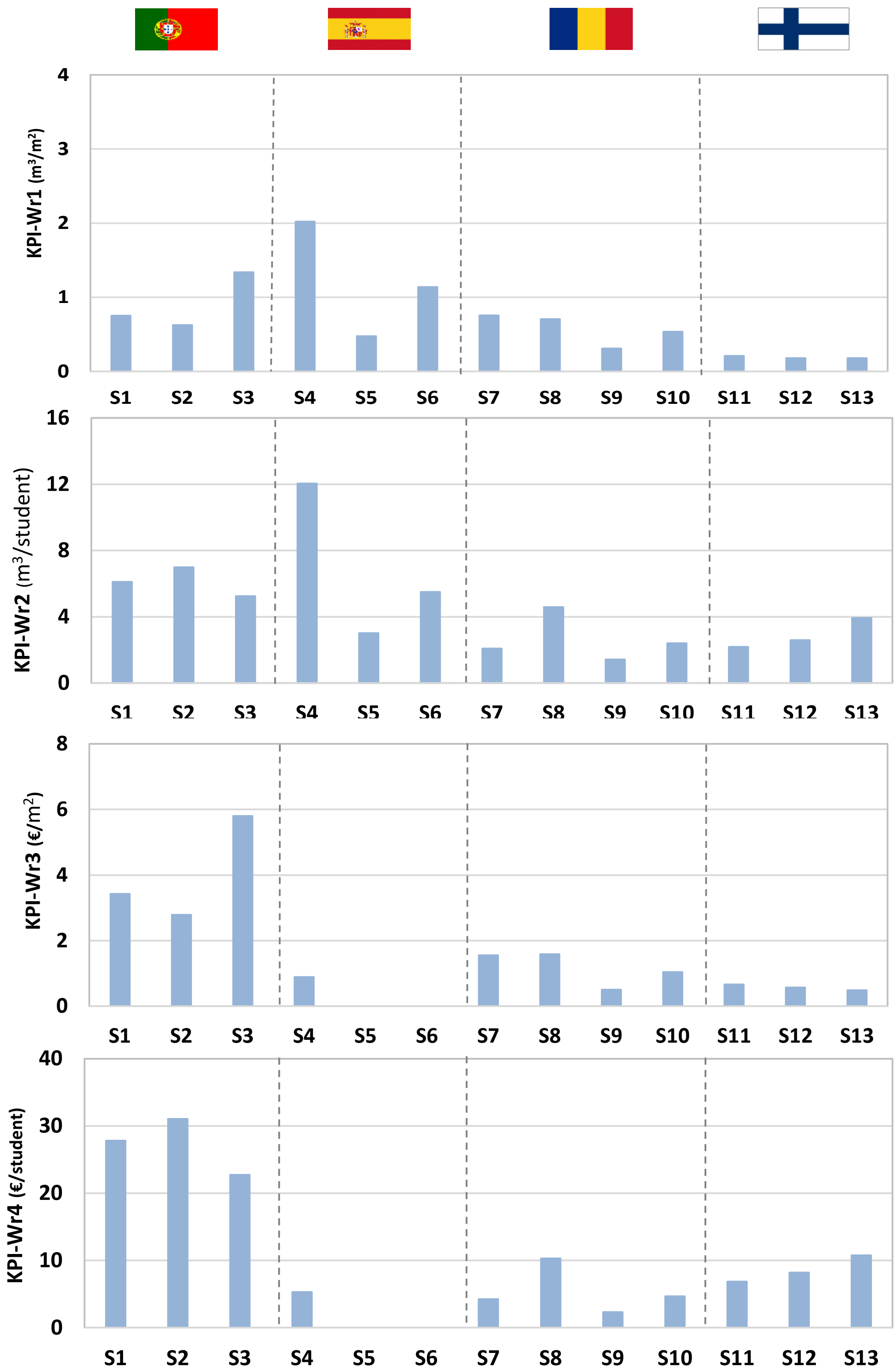


Figure 5 - KPIs results for the water section.

Table 9 - KPIs results (average values) for the water section.

Country	KPIs (Average values)			
	KPI-Wr1 - Water consumption (m^3/m^2)	KPI-Wr2 - Water consumption (m^3/student)	KPI-Wr3 - Water cost (€/m^2)	KPI-Wr4 - Water cost (€/student)
Portugal	0.9	5.8	4	26
Spain	1.2	6.8	0.3	1.8
Romania	0.6	2.6	1.2	5.4
Finland	0.2	2.9	0.6	8.6

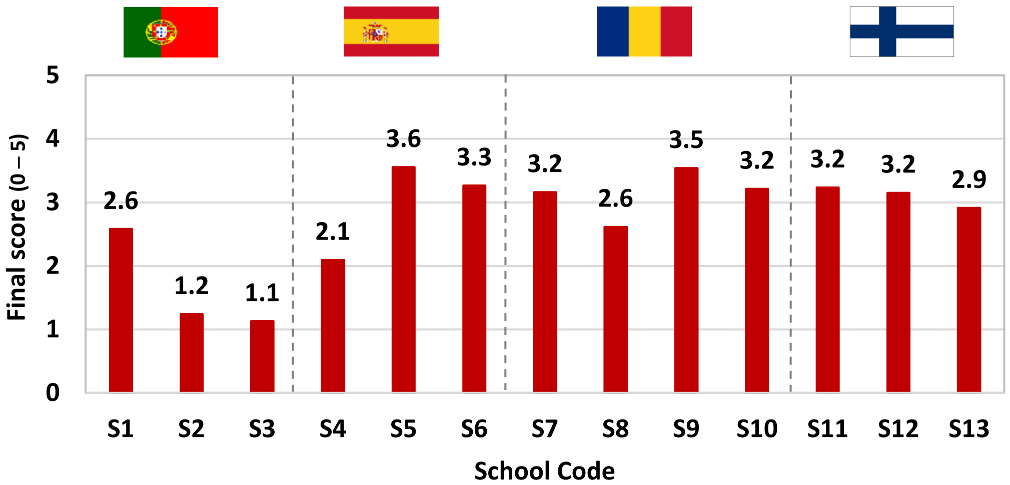


Figure 6 - Water final score (0-5).

4.3. Transports

The schools' performance regarding the transports sector, in what concerns the mobility patterns of the schools' community, the schools' infrastructures for parking, and the offer of public transportation was assessed based on the KPIs and scores presented in **¡Error! No se encuentra el origen de la referencia.** and Table 11.

Table 10: KPIs calculation for the transport sector

Sector	KPI designation	KPI calculation
Transports	Charging stations for electric cars per student	$KPI_{T1} = \frac{\text{no. of charging stations for eletric cars}}{\text{no. of students}}$
	Parking places for bicycle per student	$KPI_{T2} = \frac{\text{no. of parking places for bicycles}}{\text{no. of students}}$
	Public transports per hour	$KPI_{T3} = \text{no. of public transports per hour within a 1000 radius}$
	CO_2 annual emissions per student	$\mathbf{PE_i} = \frac{\left(\#_{\text{never}} \times 0 + \#_{\text{almost never}} \times \frac{1}{3} + \#_{\text{almost always}} \times \frac{2}{3} + \#_{\text{always}} \times 1\right) \times \textbf{no. of people of the school}}{\textbf{no. of people that answered the questionnaire}}$ Where: *i* = transport mean (motorbike; car; boat; tram; train; subway; bus; bicycle; on foot); *PE*PE_i = person equivalent of the transport mean i.

		$$\mathbf{CO_{2\,i}Emissions} = \sum_{i}(\mathbf{FE_i} \times \mathbf{PE_i}) \times \mathbf{daily\ average\ distance} \times \mathbf{22} \times \mathbf{10}$$ Where: $CO_{2\,i}$ Emissions = Annual emissions associated to the transport mean i. **= emission factor of the transport mean i [1].** $$KPI_{T4} = \frac{\sum_i CO_{2\,i}\ \text{Emissions}}{\text{no. of students}}$$

Table 11: Methodology for the calculation of the transport scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
Transports	Parking	$S_{T1} = \frac{(KPI_{T1} + KPI_{T2}) \times 5}{1.05 \times [\max(KPI_{T1}) + \max(KPI_{T2})]}$	Without charging stations	Highest (KPI_{T1} + KPI_{T2}) found plus 5%	2
	Public Transports	$S_{T3} = \frac{KPI_{T3} \times 5}{1.05 \times \max(KPI_{T3})}$	Without public transports	Highest KPI_{T3} found plus 5%	1
	CO_2 annual emissions	$S_{T4} = 5 - \frac{\text{school emissions} \times 5}{\text{maximum emission}}$	100% of the students go by car	100% of the students go on foot or by bicycle	2

Parameters assessed:

- Parking characteristics;
- Public transports network;
- School community behaviour;
- CO_2 emissions from daily commuting to school.

4.3.1. Parking characteristics

The parking characteristics of the ECF4CLIM schools were assessed based on the number of parking spaces for electric cars at the school or periphery (up to a 100m radius) and the number of parking spaces for bicycles at the school or periphery (up to a 100m radius) as it is presented in Figure 7.

Considering the KPI-T1, it is clear that the Finnish schools have the highest number of parking places for bicycles, which shows the commitment of the schools and authorities to provide conditions for the school community to travel by bicycle. The application of the behavioural questionnaires showed that it is also in Finland that the school community use bicycle more frequently. Some schools from Spain and Romania also have a good number of parking places for bicycles. However, the behavioural questionnaire shows that bicycle is not used so frequently in these countries showing that the existence of parking for bicycles is not sufficient to change the behaviours of the community.

The meetings developed in the schools showed that there are three conditions that do not contribute to the use of the bicycle:

1) Lack of paths between schools and homes that guarantee the safety of the commuters, principally in the case of small children. This constraint should be worked with the local

authorities to build cycle paths separated from the street by green barriers that protect people from accidents and air pollutants.

2) Lack of awareness of the community that still prefers using the private car instead of using active transportation or a combination between active transportation and public transport (principally when the distance between home and school is long).
3) The low income of the parents from some schools that do not allow them to buy bicycles for their children. Some schools have shared bicycles available, but they do not have the capacity to maintain them in proper conditions.

Regarding the KPI-T2, from the 13 pilot schools, only two universities, from Portugal (S3) and Spain (S6) have parking spaces with charging stations available for electric cars. This result highlights the necessity of future investment in this field.

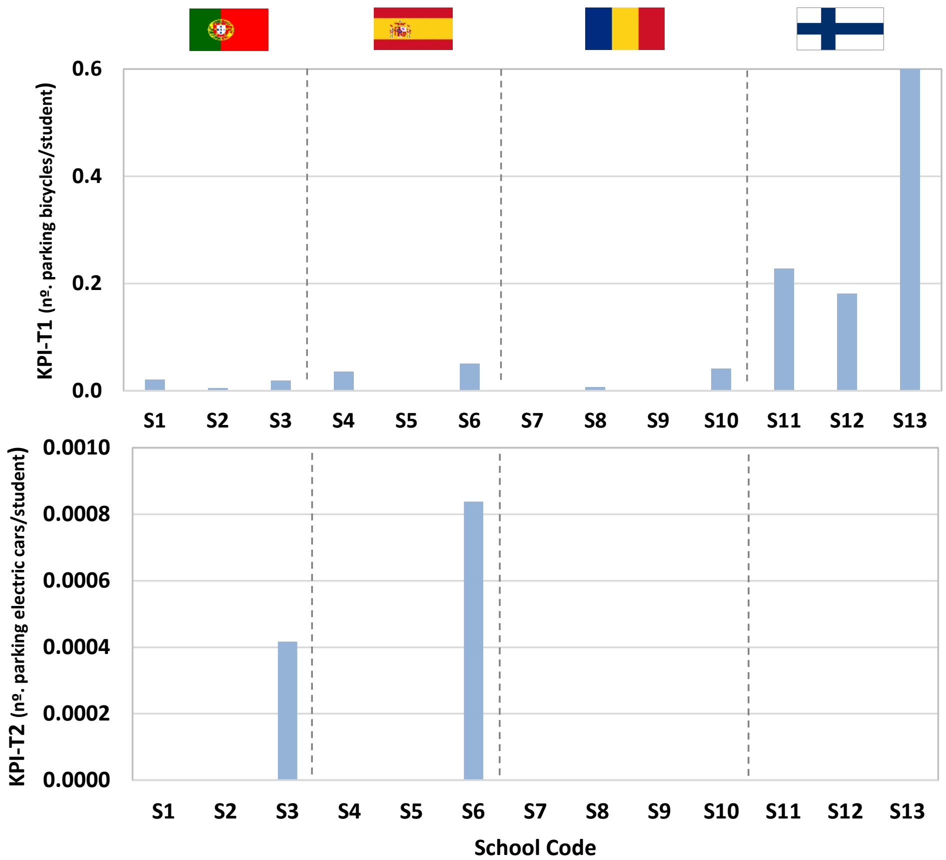


Figure 7- Parking availability for bicycles (KPI-T1) and electric cars (KPI-T2) of the schools.

Figure 8 displays the final score for the parking section. It shows that the Finnish schools have the highest parking scores (between 0.72 and 2.38, with an average of 1.34), but in general the performance of the schools is reduced (average parking score is 0.64) indicating that there is a large space for improvement in the ECF4CLIM schools.

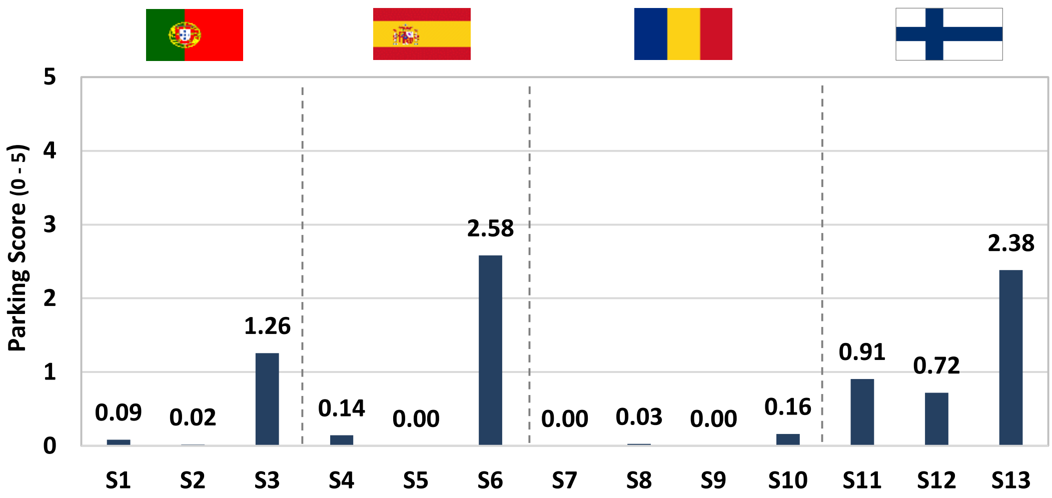


Figure 8 - Parking score (0-5).

4.3.2. Public transport network

The public transport network of the schools was assessed based on the:

- Number of stops in the periphery of the schools.
- Number of transports passing daily (1000m radius).
- Number of transports passing daily during rushing hour (1000m radius).
- Distance between the school and the nearest transport stop (m).

Based on the data obtained in the environmental audit, all the schools have a bus stop within a radius of 1000 m, 3 schools (S5, S6, S12) have a train stop, 2 schools have a tram stop (S11 and S12) and 1 school has a metro stop (S3). Figure 9 shows the frequency of public transport passing by the school per hour within a radius of 1000 m (KPI-T3) and indicates that schools from Finland are very well served by public transports with an average of 79 transports per hour passing near the school.

In the meetings with the schools, the short frequency of public transports, the incoherent connection between transports and the long time needed to make the daily route were identified as the main causes for the use of private cars instead of public transportation.

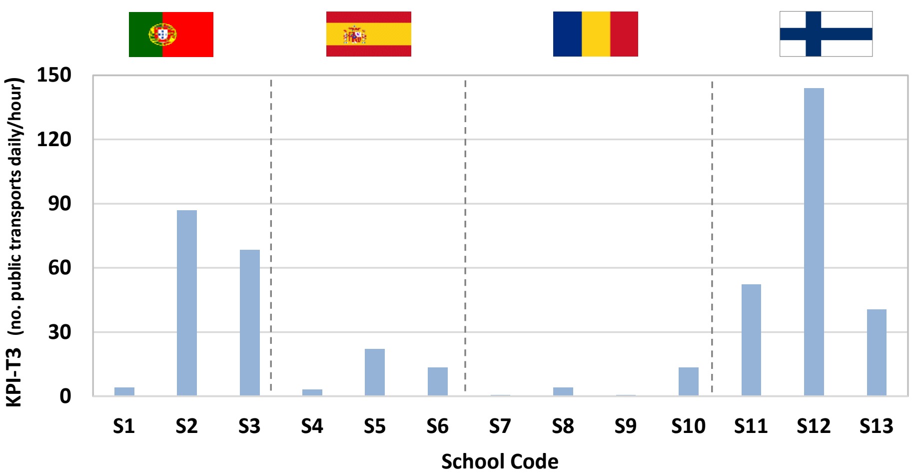


Figure 9 - Results of the KPI-T3 for the public transport network.

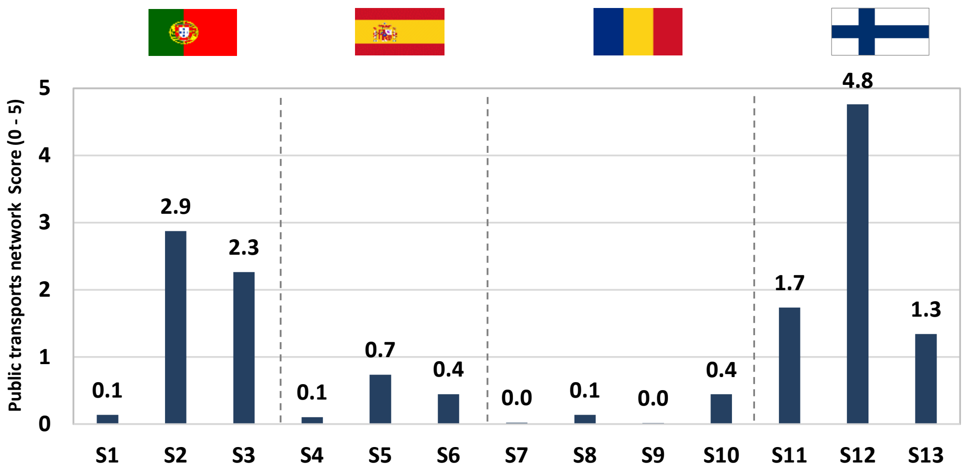


Figure 10- Public transports network score (0-5).

Figure 10 shows the score of the public transports network (S_{T3}). Finland schools presented the best performance in this area (average score: 2.6), far from the Portuguese (average score: 1.8), Spanish (average score: 0.43), and Romanian (average score: 0.15) schools. In general conclusion, we can say that the public transport network of the studied schools is weak, and it will need significant improvement in those schools/locations where the private car is a relevant fraction of the used transport. These low values of the S_{T3}, mainly in Portuguese school S1 and in Spanish and Romanian schools, are a consequence of the low frequency of public transports in the period of hours analysed nearby of each school.

4.3.3. Mobility pattern of the students

The daily commuting pattern of the schools' community of the ECF4CLIM schools was assessed by applying the behavioural questionnaire to the students (Appendix II). They were questioned about the type of transport modes they use, the distance between home and school and if they practice car sharing. Figure 11 and Figure 12 resume the information on the mobility patterns of the students per school and per country. Data is missing for the schools S1, S3 S8, S9, once they did not apply the questionnaire during the defined period. The data considered in the following analysis (Figure 11 and Figure 12) is based on people equivalent (see Table *10*).

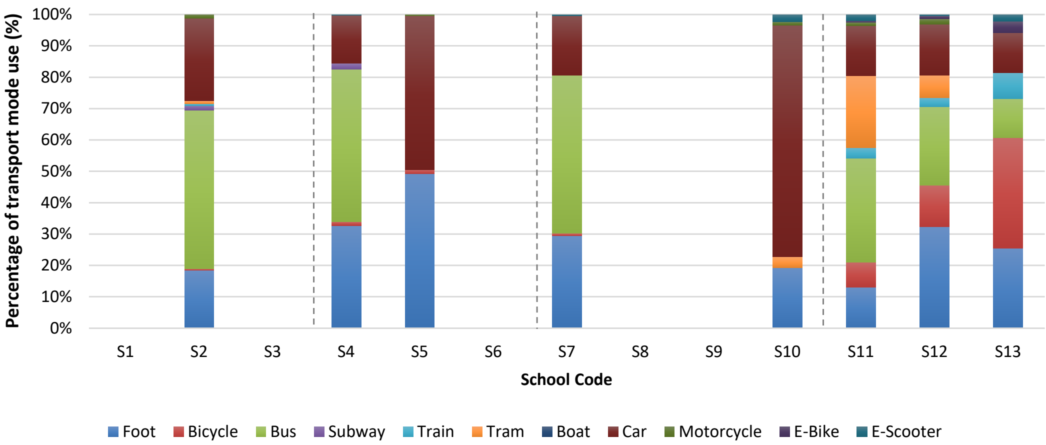


Figure 11 - Mobility pattern of the pilot schools' students.

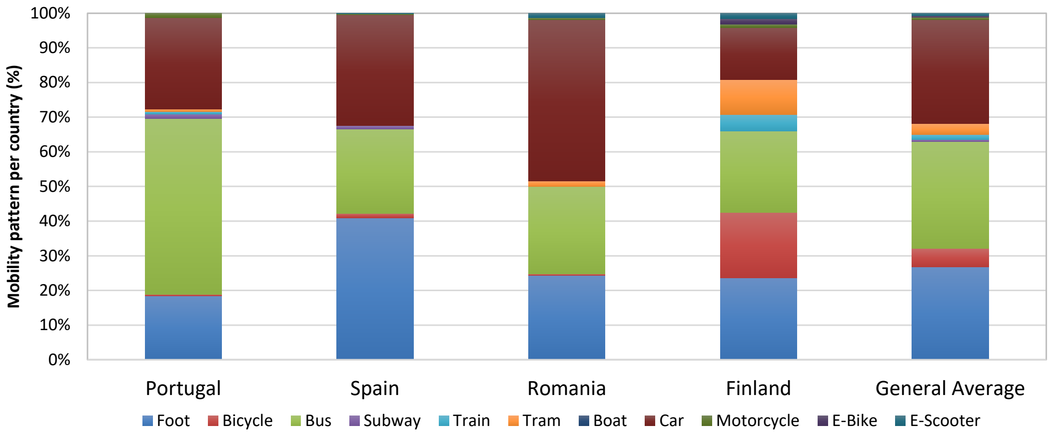


Figure 12 - Mobility pattern per country (%) - Values based on person equivalent.

The previous figures show that Finland schools present a completely different mobility pattern characterised by a big diversity of transports means used to go to school and by a lower use of the private car (with a share of 29%). Instead of using the car, Finnish students go to school principally by foot (24%), by bus (24%), and by bicycle (19%). In Portugal, represented by one school, students go to school mainly by bus (51%), by car (26%), and by foot (18%). In Spain, students chose to do their daily commute by foot (41%), by car (32%), and by bus (24%). In Romania, students go to school mainly by car (46%), by bus (25%), and by foot (24%). Figure 11 also shows that the youngest students (primary and lower secondary schools) tend to go to school by car, followed by walking. The students from the secondary schools use the bus more (S11 and S12). The use of a car by university students from Romania (S10) is 74% which is a very high percentage when compared with university students from Finland (S13), that mostly choose to go to school by bicycle (35%) and walking (25%).

The choice of transport mode is therefore dependent on the school's region (socioeconomic level of the country and infrastructures available), the school's education level (students age and autonomy), and the distance between home and school.

The annual CO_2 emissions per student regarding daily commuting (KPI-T4) was estimated and it is represented in Figure 13.

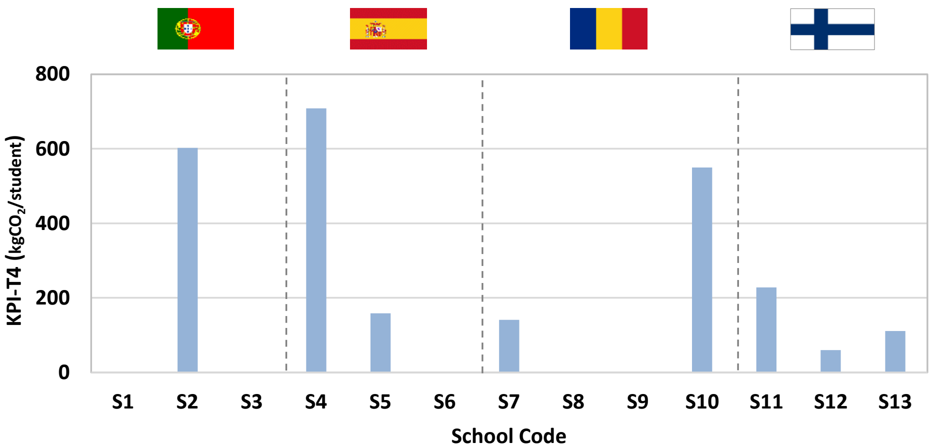


Figure 13 - Annual CO_2 emissions per student ($kgCO_2$/student)

According to the results, the Portuguese school (S2) is the school with the highest annual carbon emissions (average: 201 kgCO_2/student), followed by the Spanish schools (average: 290 kg CO_2/student), and by the Romanian schools (average: 173 kg CO_2/student), and by the Finnish schools (average: 133 kgCO_2/student.

Figure 14 shows that Finnish schools had the highest average CO_2 emissions score (score average: 3.6), followed by Spanish schools (score average: 2.2), Portuguese schools (score average: 1.5), and Romanian schools (average score: 0.9). The average CO_2 transport emission score is 2.

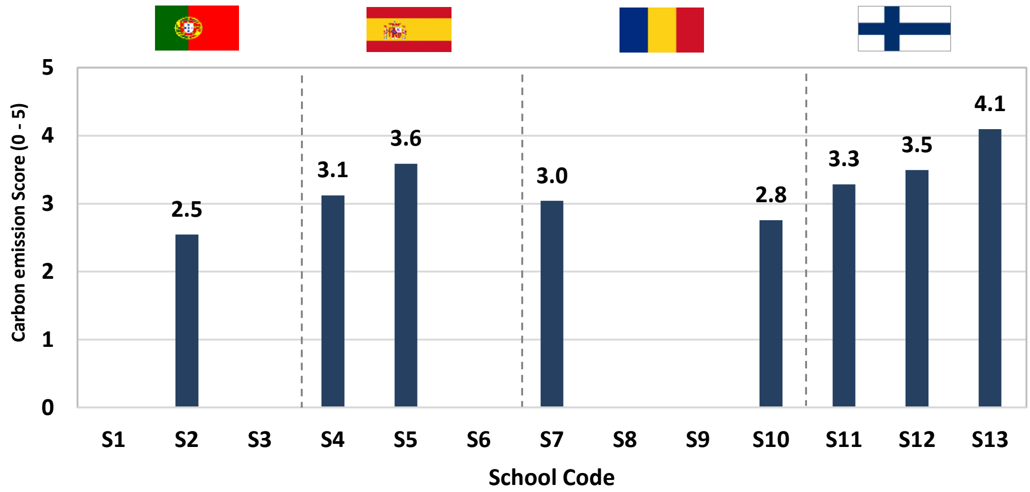


Figure 14 - Annual CO_2 transport emission score for the schools.

The performance of the transport sector (final score) was assessed based on the individual scores of:

- Charging stations for electric cars.
- Parking places for bicycles.
- Public transports.
- CO_2 annual emission.

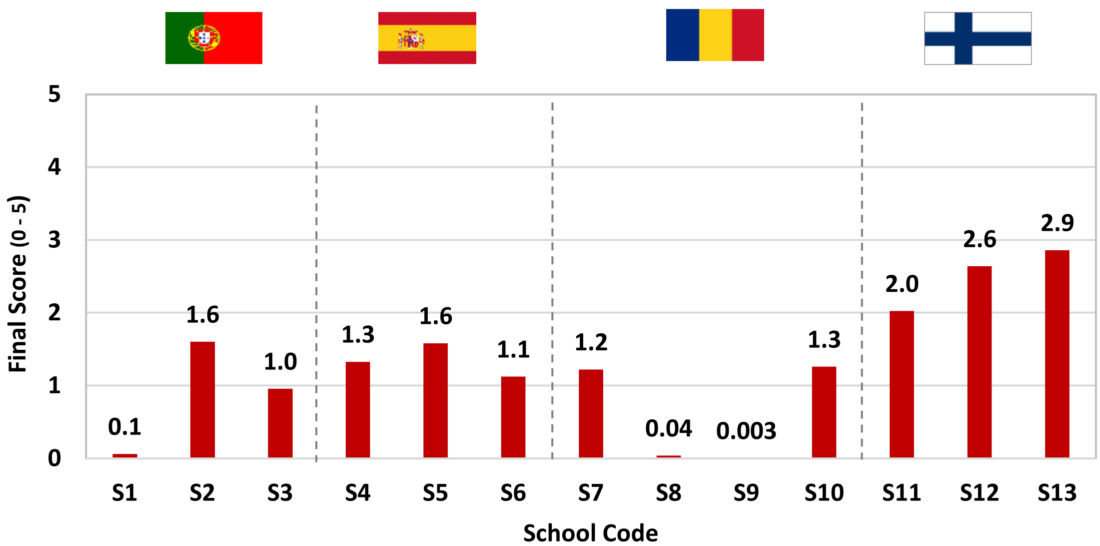


Figure 15 - Final score of the transport sector.

Figure 15 presents the final scores for the transports. The improvement of the schools' performance should focus on the improvement of the mobility infrastructures surrounding the schools and on the change of the schools' community behaviours. Some of these measures require close collaboration between the schools, the local, regional and national authorities and the public transport entities, such as the increase of cycle paths, bicycle parking, places to charge electric cars and the improvement of public transports.

4.4. Green spaces

The schools' performance regarding the green spaces sector was assessed based on the KPIs and scores presented in Table 12 and Table 13.

Table 12: KPIs calculation for the green spaces sector.

Sector	KPI designation	KPI calculation
Green Spaces	Trees per non-covered area	$KPI_{GS1} = \frac{\text{no. of trees}}{\text{non} - \text{covered area}}$
	Trees per student	$KPI_{GS2} = \frac{\text{no. of trees}}{\text{no. of students}}$
	Green area per non-covered area	$KPI_{GS3} = \frac{\text{green area}}{\text{non} - \text{covered area}} \times 100$
	Green area per student	$KPI_{GS4} = \frac{\text{green area}}{\text{no. of students}}$
	Annual CO_2 sequestration per non-covered area	$KPI_{GS5} = \frac{\text{no. of trees} \times SR_{\text{dominant species}} + \text{lawn area} \times SR_{\text{lawn}}}{\text{non} - \text{covered area}}$ Where: SR = sequestration rate.
	Annual usage of chemicals per green area	$KPI_{GS6} = \frac{\text{quantity of fertilisers and pesticides}}{\text{green area}}$
	Annual CO_2 emissions for maintenance per non-covered area	$KPI_{GS7} = \frac{\text{Fuel} \times FE_{\text{fuel}} + \text{water} \times FE_{\text{water}} + \text{electricity} \times FE_{\text{electricity}}}{\text{non} - \text{covered area}}$ Where: FE = factor emission.

Table 13: Methodology for the calculation of the green spaces scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
Green Spaces	Green areas	$S_{GS1} = \frac{(KPI_{GS1} + KPI_{GS3}) \times 5}{1.05 \times [max(KPI_{GS1}) + max(KPI_{GS3})]}$	Without green areas	Highest (KPI_{GS1}+ KPI_{GS2}) found plus 5%	1
	Annual CO_2 sequestration	$S_{GS2} = \frac{KPI_{GS5} \times 5}{1.05 \times max(KPI_{GS5})}$	Without green area	Highest KPI_{GS5} found plus 5%	1
	Annual usage of chemicals	$S_{GS3} = 5 - \frac{KPI_{GS6} \times 5}{max(KPI_{GS6})}$	Highest KPI_{GS6} found	Without chemicals	1
	Annual CO_2 emissions in maintenance	$S_{GS4} = 5 - \frac{KPI_{GS7} \times 5}{max(KPI_{GS7})}$	Highest KPI_{GS7} found	Without emissions	1

Parameters assessed:

- Green areas;
- Use of chemicals, water, and energy in green areas maintenance;
- CO_2 sequestration and emission.

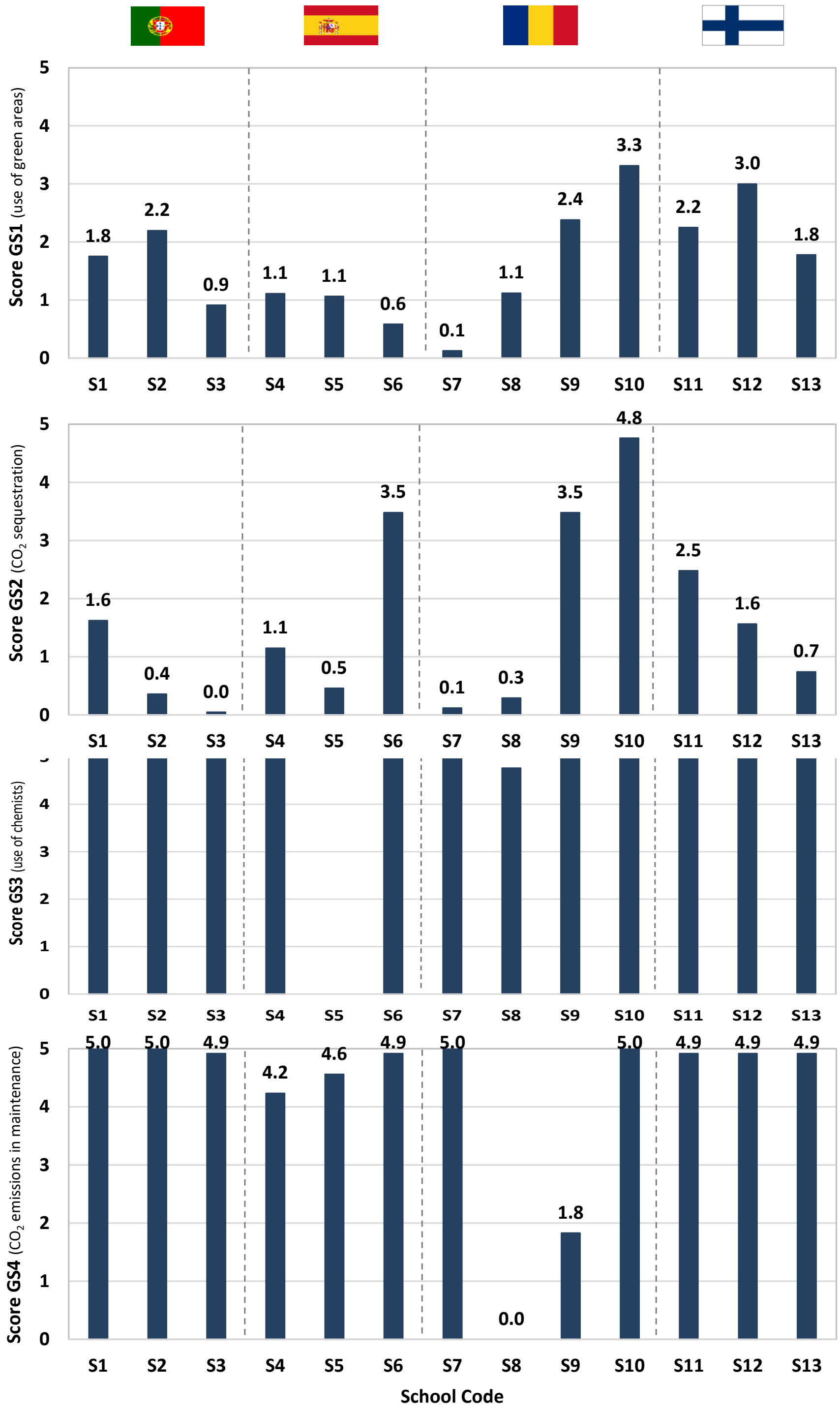


Figure 16 - Green spaces scores (0-5) of the pilot schools.

Figure 16 shows the green spaces score assessed for the ECF4CLIM schools that integrated the green spaces KPIs, whose country results are presented in Table 14.

Table 14: KPIs results of the green spaces.

Country	KPIs (Average values)						
	KPI-GS1	KPI-GS2	KPI-GS3	KPI-GS4	KPI-GS5	KPI-GS6	KPI-GS7
Portugal	0.005	0.127	30	7	0.1	0.000	0.0002
Spain	0.003	1.062	17	45	0.3	0.005	0.0024
Romania	0.003	0.004	61	5	0.4	0.000	0.0113
Finland	0.008	0.071	40	4	0.3	0.000	0.0005

Analysing the score 1 (S_{GS1}), which evaluates the green areas and the number of trees (KPI-GS1 and KPI-GS3), it is possible to conclude that the Finnish schools have the best performance, with an average score of 2.34, followed by the Romanian (score average: 1.74), Portuguese (score average: 1.62), and Spanish (score average: 0.92) schools.

In what concerns the annual CO_2 sequestration score (S_{GS2}), calculated based on the KPI-GS5, the Romanian schools are the ones with the best performance (score average: 2.16), followed by the Spanish schools (score average: 1.70), by the Finnish schools (score average: 1.60), and by the Portuguese schools (score average: 0.68). The variability of the S_{GS2} results is due to the differences between the predominant trees species, and, consequently, the carbon sequestration factor (SF) of the species. The Spanish university (S6) has a higher number of planted trees in comparison with the other schools. However, the SF of the main specie is low (*Pinus halepensis*, SF 2.74 $kgCO_2$/tree and year) in comparison with other tree species present in S10, such as *Populus alba* (SF 21.81 $kgCO_2$/tree and year) and in S13 such as *Picea abies* (SF 24.8 $kgCO_2$/tree and year).

The use of chemicals in green spaces' maintenance (KPI-GS6) also contributes to carbon emissions. In general, the pilot schools do not use chemicals for the maintenance of green areas. Only the Romanian school S8 uses chemicals, which causes an increase in the KPI.

The performance of the schools in what concerns the carbon emissions associated with the maintenance of the green spaces (S_{GS4}) is very good. These results mean that the schools' emissions from fuel, water and electricity consumption are very low and almost non-existent.

Figure 17 shows that Finnish schools have the best performance in the green spaces sector (average: 3.5), followed by Portuguese schools (average: 3.0), Romanian schools (average: 2.9), and Spanish schools (average: 2.6).

In the meetings with the schools, the community expressed a high interest in creating and maintaining vegetable gardens and green halls. They stated that green spaces have a huge impact not only on the environment but also on the connection between the students living in urban areas and nature, which is essential to respect it. Schools also referred to the importance of community work on the green spaces for the mental health of the staff and also to bring the parents to the school. The vegetables produced in these gardens are frequently donated, which also stimulates the social skills of the students.

In order to enhance the improvement of this sector, some measures should be considered, acting predominantly in increasing schools' CO_2 sequestration capability but also in reducing CO_2 emissions from green area maintenance.

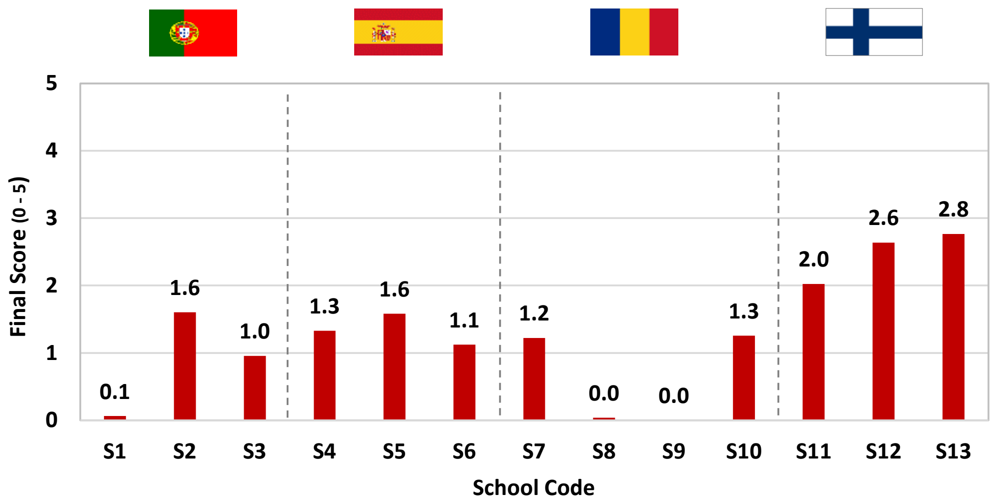


Figure 17 - Final score (0-5) for the green space sector.

4.5. Green procurement

The schools' performance regarding the green procurement was assessed based on the KPIs and scores presented in Table 15 and Table 16.

Table 15: KPIs calculation for the green procurement sector.

Sector	KPI designation	KPI calculation
Green Procurement	Equipment efficiency	$KPI_{GP1} = \frac{\text{no. of equipment A+ or higher EU energy label}}{\text{total no. of equipments}}$
	Paper used per student per year	$KPI_{GP2} = \frac{\text{quantity of used paper} \times 10}{\text{no. of students}}$
	Recycled paper used	$KPI_{GP3} = \frac{\text{quantity of recycled paper}}{\text{total quantity of paper}}$
	Training in green procurement	$KPI_{GP4} = \frac{\text{no. of employees with training in green procurement}}{\text{total no. of employees}}$
	Biological food	$KPI_{GP5} = \frac{\text{quantity of food with biological certificate}}{\text{total quantity of food}}$
	Local suppliers	$KPI_{GP6} = \frac{\text{no. of local suppliers}}{\text{total no. of suppliers}}$

Table 16: Methodology for the calculation of the green procurement scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
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
	Biological food	$S_{GP4} = KPI_{GP5} \times 5$	Without food with biological certificate	100% certified food	0.25
	Local suppliers	$S_{GP5} = KPI_{GP6} \times 5$	Without local suppliers	100% local suppliers	0.25

Parameters assessed:

- Equipment efficiency.
- Paper used.
- Recycled paper used.
- Training in green procurement.
- Biological food.
- Local suppliers.

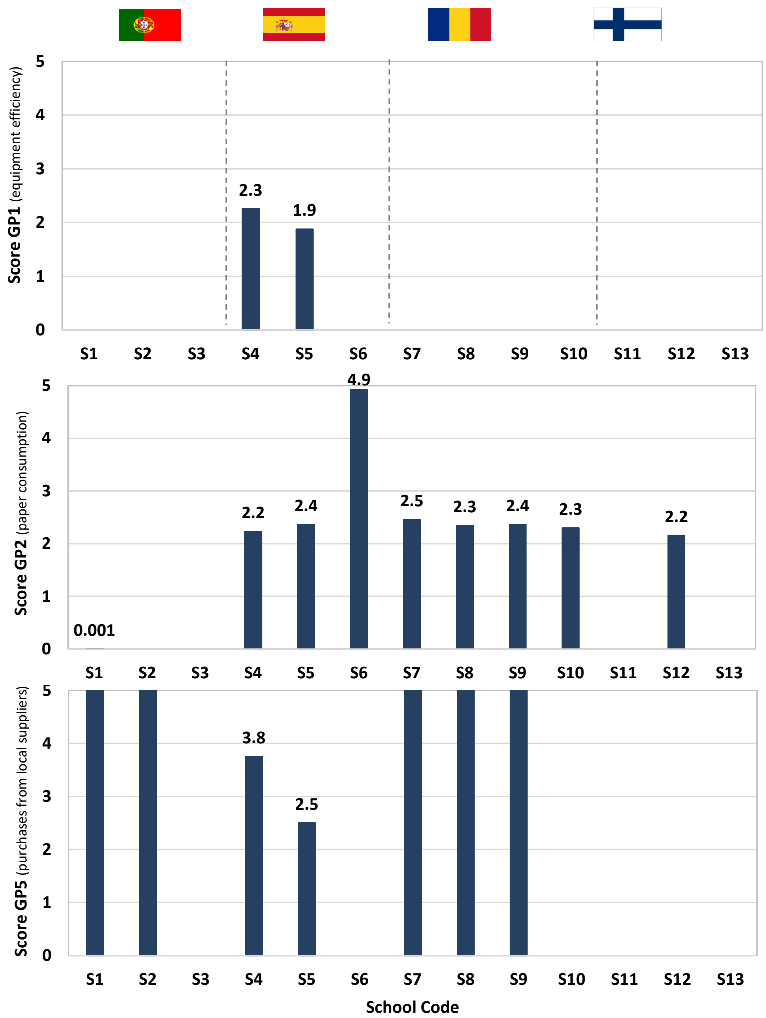


Figure 18- Green procurement scores (0-5).

Figure 18 shows only the scores results for the scores S_{GP1}, S_{GP2} and S_{GP5}, once Scores S_{GP3} and S_{GP4} are devoid of data.

Considering the S_{GP1}, which assesses the efficiency of the new equipment acquired by the schools, only the Spanish schools, S4 and S5, acquired new electronic equipment since 2021, and both of them purchased equipment with high efficiency levels (classification level A).

The S_{GP2} makes a balance between the amount of paper used in the schools (KPI-GP2) and the consumption of recycled paper (KPI-GP3). Figure *18* to the results, the schools tend to not use recycled paper.

The scores S_{GP3} and S_{GP4} highlighted the low or non-existent investment of the schools in training in green procurement and biological certification of food. These areas should be targeting areas in the future.

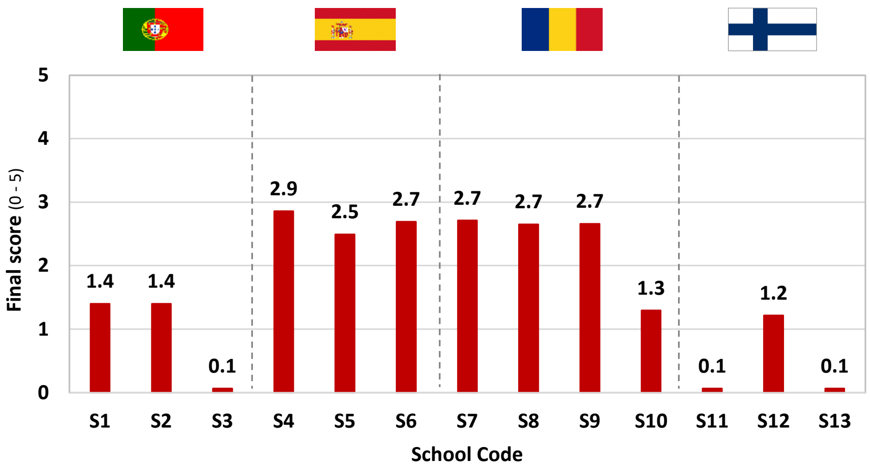


Figure 19 - Final score of the green procurement sector

The final score of the green procurement sector is presented in Figure 19. Results show that schools have a great potential for improvement, in special the Portuguese and Finnish schools. Solutions can focus on the acquisition of recycled paper instead of white paper; investment in training about green procurement to empower the school staff so they can make sustainable decisions for the sake of the school; purchase of biological products from local suppliers, contributing to the increase of the local economy and for the decrease of the carbon footprint.

In the meetings performed with the schools, it was mentioned that frequently the schools do not have the autonomy to select the suppliers and products. So, highlighting once again, the existence of a close collaboration between the schools and authorities is important to implement measurements.

4.6. Energy management

The schools' performance regarding energy management was assessed based on the KPIs and scores presented in Table 17 and Table 18.

Table 17: KPIs calculation for the energy management sector.

Sector	KPI designation	KPI calculation
Energy	Energy consumption per useful area	$KPI_{E1} = \frac{\sum_i \text{annual consumption of electricity}_i + \sum_j(\text{annual consumption of fuel}_j \times \text{density}_j \times \text{FC}_j)}{\text{useful area}}$ Where: *i* = type of electricity (provide by the grid; onsite produced); *j* = type of fuel (diesel; LPG; natural gas); FC_j = conversion factor to kWh of fuel *j*
	Energy consumption per student	$\text{KPI}_{E2} = \frac{\sum_i \text{annual consumption of electricity}_i + \sum_j(\text{annual consumption of fuel}_j \times \text{density}_j \times \text{FC}_j)}{\text{no. of students}}$ Where: *i* = type of electricity (provide by the grid; onsite produced); *j* = type of fuel (diesel; LPG; natural gas); FC_j = conversion factor to kWh of fuel *j*
	Percentage of renewable energy production	$KPI_{E3} = \frac{\text{Renewable energy produced for onsite consumption} + \text{renewable energy production sold to grid}}{3 \times \left[\sum_i \text{annual consumption of electricity}_i + \sum_j(\text{annual consumption of fuel}_j \times \text{density}_j \times \text{FC}_j)\right]}$ Where: *i* = type of electricity (provide by the grid; onsite produced); *j* = type of fuel (diesel; LPG; natural gas); FC_j = conversion factor to kWh of fuel *j*

	Energy costs per useful area	$KPI_{E4} = \frac{\text{energy annual costs}}{\text{useful area}}$
	Energy costs per student	$KPI_{E5} = \frac{\text{energy annual costs}}{\text{no. of students}}$
	CO_2 annual emissions	$KPI_{E6} = \frac{(\text{electricity consumption} - REP \times GL) \times FE_e + \sum_i (\text{annual consumption of fuel}_i \times \text{density}_i \times FC_i) \times FE_i}{\text{no. of students}}$ Where: *i* = type of fuel (diesel; LPG; natural gas); FC_i = conversion factor to kWh of fuel *i* FC_e = emission factor associated to electrical energy consumption. FE_i = emission factor associated to fuel *i*. REP = renewable electrical production GL = grid losses

Table 18: Methodology for the calculation of the energy management scores.

Sector	Score designation	Score calculation	Less favourable scenario	More favourable scenario	Weighting for final score
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
	CO_2 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

Parameters assessed:

- Energy consumption
- Energy cost
- Renewable energy
- Carbon emissions

4.6.1. Energy consumption

The assessment of the energy consumption in schools considered all the available energy sources: electricity, diesel, GPL, natural gas, biomass, biomass pellets, electric renewable and thermal renewable. The main sources of energy in the schools are electricity (S1-S13) and natural gas (S1, S3-S13), although some schools also use diesel (S9), GPL (S3), biomass pellets(S12), and renewable energy (S3,S13) to produce energy.

The energy KPI-E1 and KPI-E2 consider the energy consumed in the previous 5 years of the audit (2017-2021), the number of students, and the area of the school. According to Figure 20, the universities (S3, S6, S10 and S13) have the highest consumption per area and per student. This fact reflects the higher complexity of the university buildings that join spaces with very specific requirements, such as laboratories with high consuming instruments that are operating continuously. Furthermore, these type of establishments are in operation for a long period of time, sometimes 14h, including classes and students activities, increasing the energy consumption.

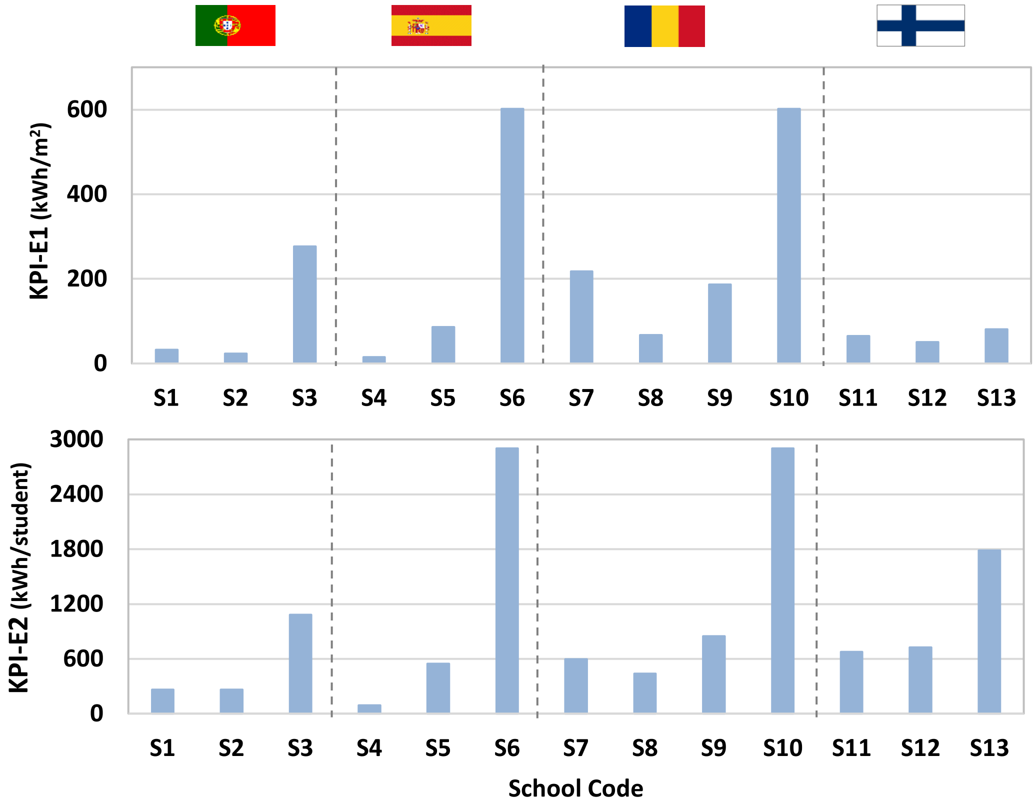


Figure 20 - KPIs results of the energy sector.

Figure *20* - KPIs results of the energy sector.Figure 21 shows that the schools of Portugal and Spain have a higher energy consumption score (average score ≈ 4 and 3, respectively).

In the Portuguese schools, most of the primary and secondary schools (S1 and S2), have natural ventilation and do not have an air conditioning system. Consequently, the comfort of the students and staff is frequently compromised. In the meetings with these schools, it was mentioned that the students in the winter are frequently dressed with coats and gloves during classes. In order to solve this problem, the school used to distribute some heaters in the classrooms, but due to the high costs of the energy, they are rarely turned on. Consequently, the indoor air quality is also compromised during cold and rainy days because the windows are not opened to promote ventilation due to the meteorological conditions.

In the coldest countries the energy consumption is higher. One reason for these results is because the schools are equipped with mechanical ventilation, which can increase the energy consumption.

The improvement of these KPIs relies on adequate management of energy efficiency, on the selection of more efficient equipment and, whenever possible, on the production of renewable energy.

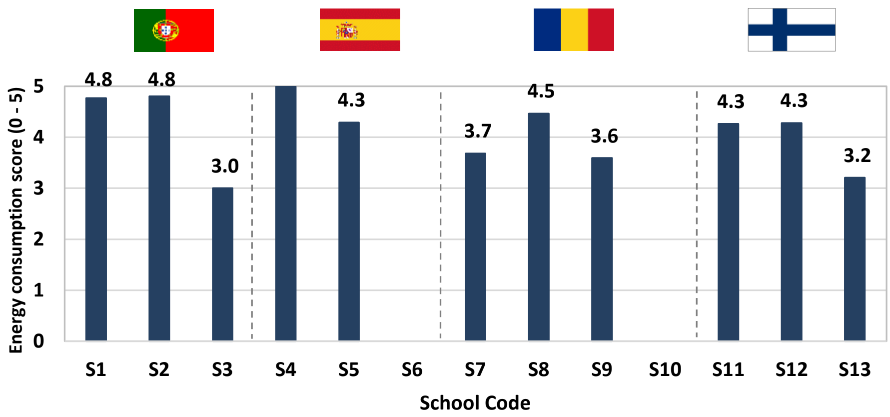


Figure 21 - Energy consumption score (0-5).

4.6.2. Energy cost

The KPIs related to the energy cost (KPI-E4 and KPI-E5) and the respective score are presented in Figure 22 and Figure 23. The total energy cost depends on the energy consumption, energy mix and energy price in each country. Therefore, to reduce energy costs, the schools need to reduce energy consumption and, if possible, increase the contribution of renewables to their energy mix.

However, schools do not have the autonomy and budget to invest in producing renewable energies on-site. Besides the non autonomy of the schools, the municipalities can have an important role in making a political decision in the schools' use of renewable energy, being an example of that Finnish secondary schools. Energy companies can be an interesting solution to the implementation of energy efficiency measures and renewable solutions in schools. These companies can make the initial investment in the schools and are later paid with the savings resulting from the implementation of the measures.

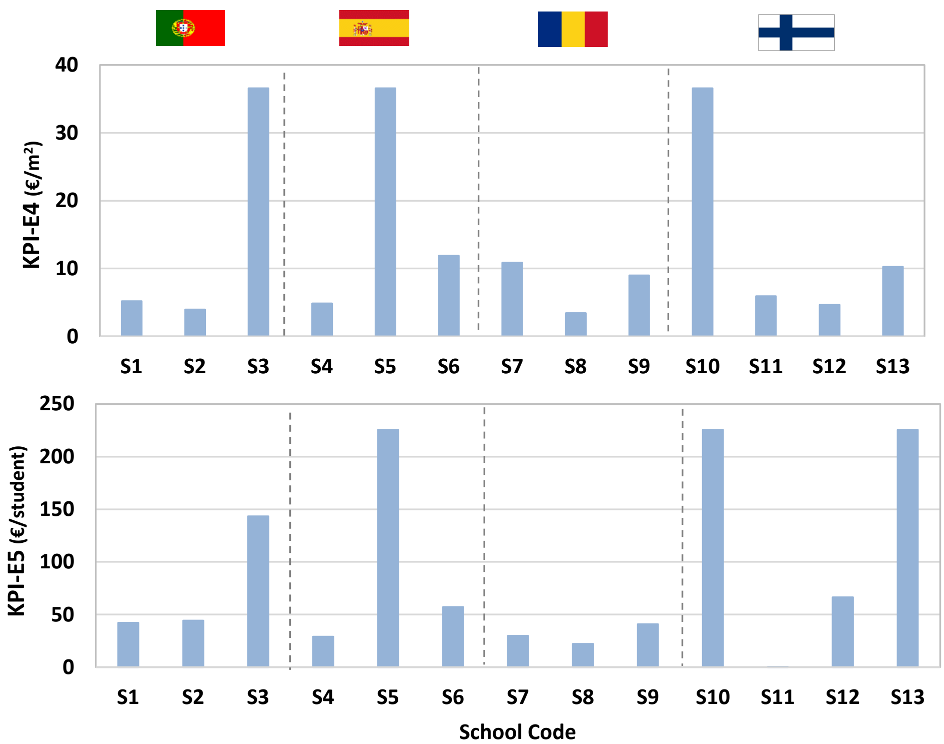


Figure 22 - KPIs results of the energy cost per student and per m^2.

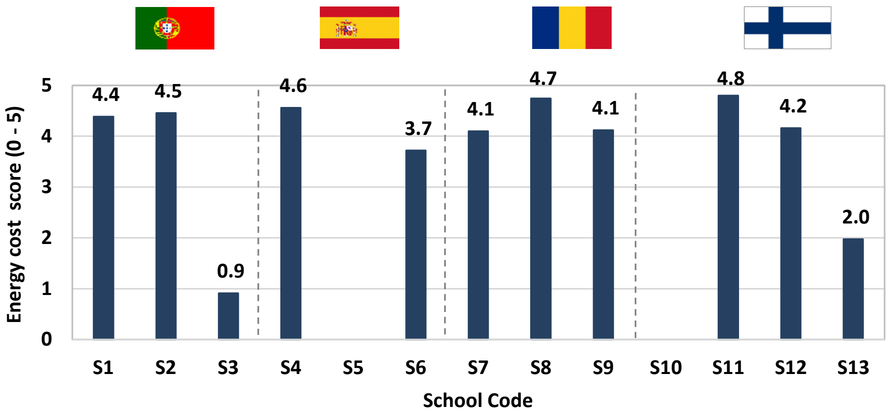


Figure 23 - Energy cost score (0-5).

4.6.3. Renewable energy

The renewable energy KPI (KPI-E3) assesses the contribution of the renewable energy produced by each school and sold to the grid. In the ECF4CLIM pilot schools, there are two schools with on-site renewable energy consumption (electrical and thermal) which are S3 and S13, both universities. The production of renewable energy for own consume is an important measure to decrease the electrical consumption, in special in buildings with more demanding in operation.

4.6.4. Annual carbon emissions

Carbon emissions associated with energy consumption can be seen as an important KPI to assess the environmental impact of energy consumption in schools. However, we should consider that the same electricity consumption in schools from different countries can cause different emissions of CO_2 due to the different national energy mixes.

As expected, the highest CO_2 emissions were associated with buildings with more energy needs (universities and schools from Finland and Romania). The carbon emission from schools can be reduced by implementing energy efficiency measures and increasing renewable energy use. Biomass burning is often considered a carbon-neutral energy source, however, the IPCC considers that in terms of equivalent carbon dioxide, biomass burning is not totally neutral. In addition, the impact of biomass burning on indoor and outdoor air quality should not be neglected.

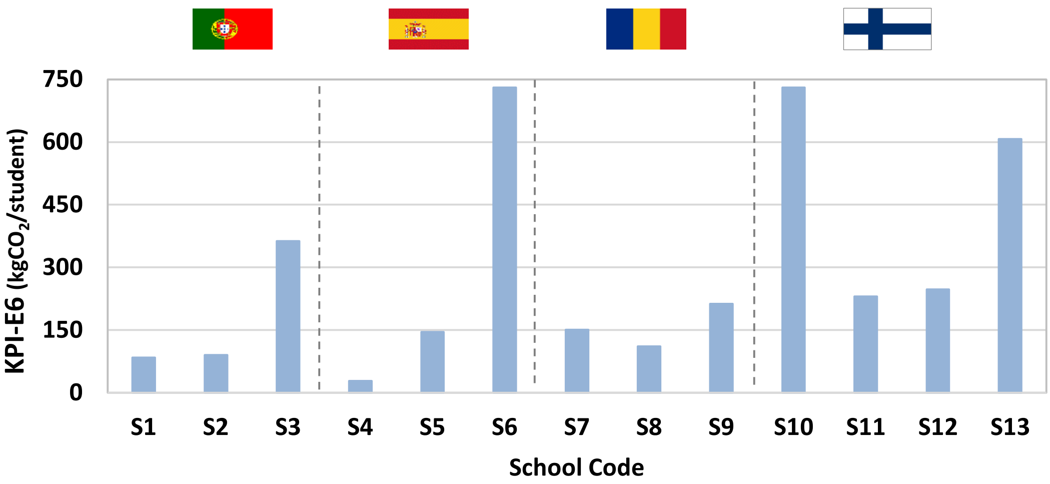


Figure 24- KPI results for the carbon emissions by the energy consumption.

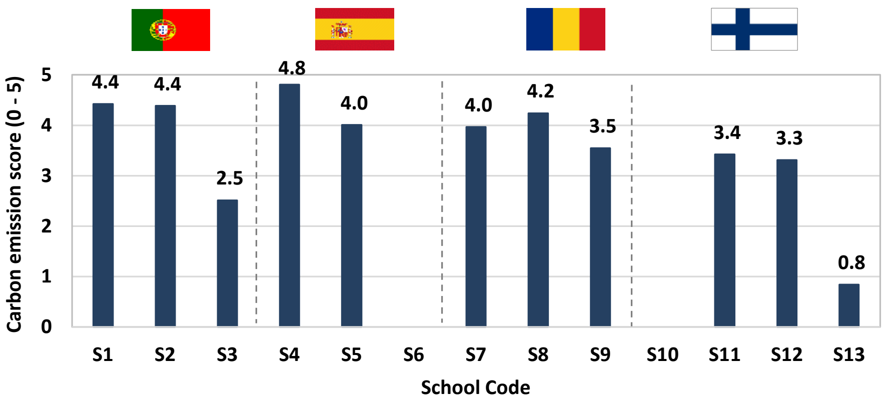


Figure 25 - Carbon emissions score (0-5).

The final energy score can be observed in Figure 26.

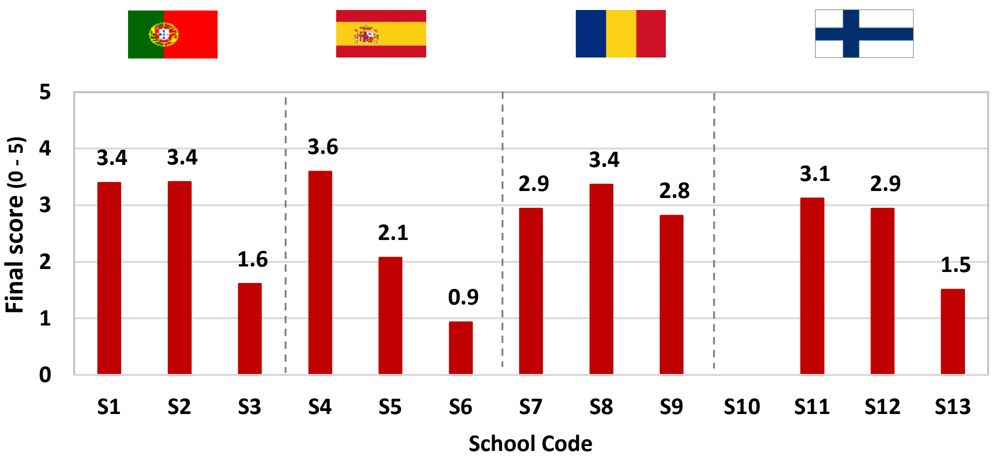


Figure 26 - Final score of the energy sector.

4.7. General environmental performance overview

The baseline assessment of environmental performance carried out at the pilot schools is geared towards ECF definition, analysis, and support within the framework of GreenComp.

The data presented results from a preliminary analysis and inserted in a participatory hybrid approach, where it is expected that throughout the project, through internal and external actions, the values presented will improve and evolve to a more sustainable scenario.

The methodology was defined and applied before the application of project measures and will be applied and evaluated in the next stages of the project. This continuous evaluation in a living procedure format, where the entire school community is involved in all stages of the process, serves as a tool to monitor progress and evaluate the improvement of ECF competences.

5. IoT installations for the Baseline assessment

5.1. Scope of installations within ECF4CLIM

The purpose of the IoT ecosystem deployment is to provide accurate and real-time data analytics of the selected pilot sites. These analytics will include metrics regarding the indoor air quality of the pilot site's classrooms, for example, temperature, humidity and CO_2 concentrations. Through this approach, the educational community will be able to examine the quality of their classrooms since the covid 19 pandemic has raised awareness towards a clearer and healthier environment in the academic society.

In addition, the IoT ecosystem solution gives the opportunity to pilot sites to have an accurate view of the energy consumption of the selected intervention spaces. Utilising the solution, the pilot sites could correlate the behavioural routine of the students to the impact that they deliver to the environment. Therefore, they could associate the carbon footprint that educational institutions deliver to the environment.

Finally, the IoT equipment will provide the ECF4CLIM platform with real-time extraction of data from the selected pilot sites. In addition, it will offer the capability to distribute these extracted data to the ECF4CLIM database platform for the calculation of the respective dynamic Key Performance Indicators, to examine and validate the impact that the sustainability activities offer to the selected educational institutions.

5.2. Roles and responsibilities

For the proper deployment of the IoT ecosystem to the respective academic pilot sites, a procedure must be executed to apply the solution to each premise accordingly. Each building has its unique building infrastructure, which must be considered before installing any IoT device. Therefore, all the respective partners must follow a plan for successful implementation. Finally, important is the assignment of the roles and responsibilities of the people participating in the installation procedure.

5.2.1. Pilot Director

The demo site coordination is the responsibility assigned to the pilot director. This role has been assigned to the pilot partners: CIEMAT, JYU, US, IST, MEDARESEARCH and UAB.

Pilot Director's primary responsibility is the design and orchestration of the IoT ecosystem deployment in the respective pilot sites. The role description is very wide and includes all non-technical issues, along with managing the technical teams and communicating with academic institutions. Each pilot director will delegate the roles of the Commissioner and the Technician, who are key persons for installing and commissioning the IoT equipment in the pilot sites.

The pilot director should comply with legal and ethical issues for data collection based on EU and national legislation and comply with the GDPR regulation. S/he is in charge of the administrative procedures of their organisation, for example, the procurement of the proposed IoT equipment. In addition, the pilot directors in all pilot sites are responsible for the anonymization of the pilots' site information as they act as an interface between the end users and the consortium. Consequently, no information regarding user names and addresses is communicated to the technical directors. Similar considerations for GDPR compliance will be considered for all associated components that process data collected from pilots' site data. These considerations will be described in the Deliverables reporting the individual components.

Apart from the non-technical responsibilities, the pilot director is in charge of the proper completion of the audit templates, which were provided by the Technical Director. The audit templates describe the building infrastructure of the selected pilot sites in detail. To provide adequate information, they received dedicated workshops and guidance from the Technical Director, and in conjunction with inputs from the buildings' facility managers, they were able to fulfil this task successfully.

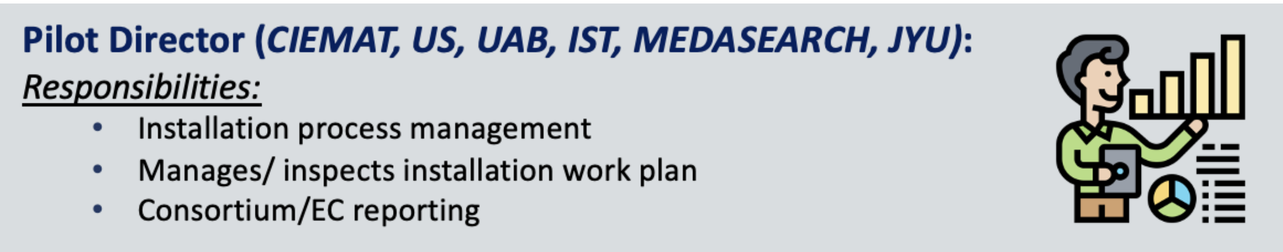


Figure 27- Pilot Director

5.2.2. Technical Director

The Technical Director is behind in designing the IoT ecosystem that will be deployed in the ECF4CLIM project.

Except for the design of the solution, the Technical Director trains the pilot partners, as described above, about which information to include in the audits and how to properly complete them.

By providing workshops and guidelines to explain the appropriate information collection regarding the buildings' assets' characteristics, the Technical Director will minimise the error in the process and ensure that the building information corresponds to reality.

The training activities address the commissioners as well. In order to become familiar with the solution and understand the steps that need to be carried out, the Technical Director tutors the commissioners about how to instal and commission the IoT equipment and finally overtake the maintenance of the IoT Ecosystem.

After examining all the provided information from the audits, the technical director creates a list of proposed IoT equipment that must be deployed in the pilot sites addressing the project's requirements.

In case the commissioners aren't able to solve an issue that appears during the maintenance procedure, they communicate with the Technical Director to receive guidelines to restore the system to its prior operational status.

Technical Director (QUE):

Responsibilities:

- Training activities
- Creation of BOMs
- Awareness of Installation guidelines/instructions
- 2nd level technical support

Figure 28 - Technical Director

5.2.3. Commissioner

The Commissioner is a person which is chosen from the pilot director. Her/ his role's responsibilities include the installation and commissioning of the suggested IoT equipment in the selected pilot sites. Apart from the installation of the IoT equipment s/he is responsible for the health monitoring of the system and its troubleshooting when it's needed. Establishing a seamless extraction of data of the intervention spaces. To tackle these tasks efficiently, the commissioners attend the dedicated workshops provided by the Technical Director.

The profile of the commissioner is based on technical knowledge and strong communicational skills since s/he acts as an interface between the Technical Director, the Pilot Director, the technician and the end users. Therefore, to communicate with the different parties and to understand the manuals of the IoT equipment, that person, or the involved groups, will guarantee an adequate communication capacity in the installation process with all the involved parties.

Commissioner (selected by the pilot director):

Responsibilities:

- Commissioning and System configuration
- End-user orientation regarding the installed system
- 1st level technical support

Figure 29 - Commissioner

5.2.4. Technician(s)

Lastly, the technicians are the personnel in charge of connecting the energy metering devices, which are hard-wired, to the electric circuit panels. They handle cases where the commissioner is not allowed to intervene, for example, installing an IoT device to the electrical circuit panel of a building. They are certified electricians, and they have been selected by the pilot director.

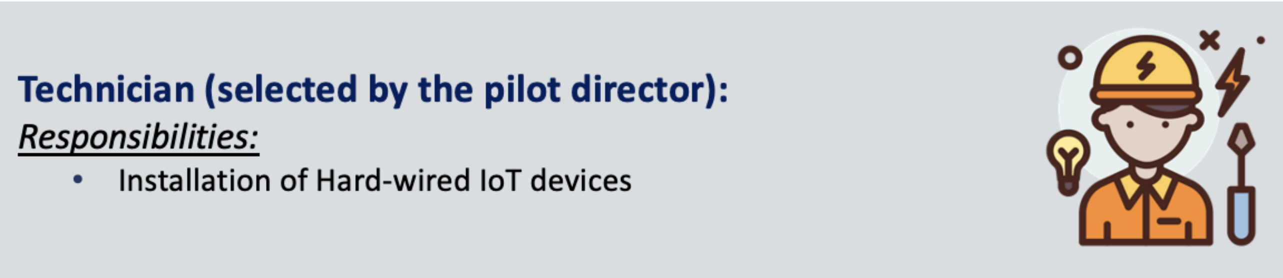


Figure 30 - Technician

5.3. Installation procedure

For the proper fulfilment of the task, an installation road map has been designed and has been separated into three phases: pre-installation, installation and post installation.

5.3.1. Pre-Installation

The first phase comprises of the preparation that needs to be organised before the installation of the IoT equipment. During the pre-installation phase, the auditing procedure takes place. The pilot director distributes to the pilot partners two auditing templates. Both of the audit templates are vital for understanding the pilot's existing building infrastructure. In order to propose the appropriate IoT equipment and provide a tailored made technical solution, the Technical Director should have a detailed overview of the aspects of the buildings.

The first audit template includes a high-level view of the building aspects of the pilot site, like how many intervention spaces will participate in the project, if there is an internet connection or what kind of devices within a pilot site maybe will be monitored for the scope of the project. Its purpose is to identify the eligibility of the proposed pilot sites based on the requirements of the project. An indicative audit template is illustrated below in Figure 31.

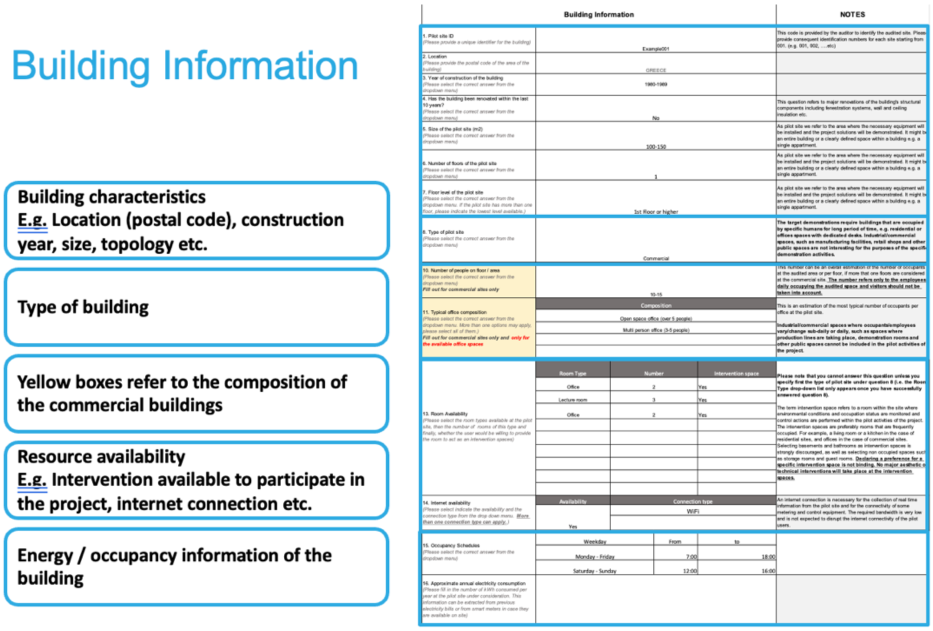


Figure 31- Level 1 Audit

The purpose of the second level audit, presented in Figure 32, is to convey a clear view of the onsite conditions, electrical infrastructure and device availability. In the second level audit, the Pilot Director, with the help of the building facility managers, writes in high detail the characteristics of the building's infrastructure. According to this information, the Technical Director, in agreement with the involved parties on each local site, will understand and agree on which spaces are eligible for the project and the equipment requirements every building has to install the appropriate equipment.

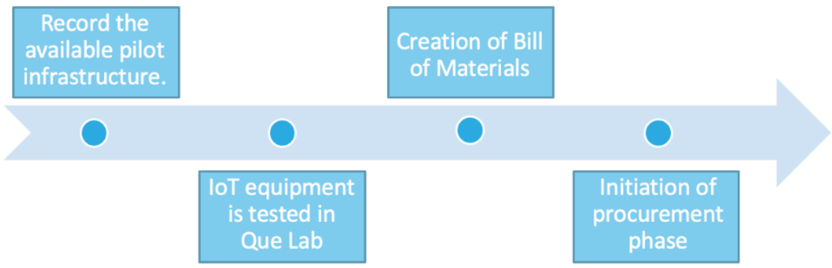


Figure 32 - Scope of the Audits

To minimise the errors in the auditing process, the Technical Director conducts with the respective partners dedicated workshops to demonstrate the procedure and to answer any concerns that might be risen in the process.

After auditing the pilot sites, the Technical Director examines the templates and searches in the market for appropriate IoT equipment to tackle the project requirements, the respective pilot sites, and the IoT system.

Following this, the Technical director tests and validates the equipment in the lab premises to be sure that it will work smoothly with the pilot sites and the IoT system. Finalising the IoT list that will participate in the project, the Technical Director delivers to each Pilot Director the suitable IoT list to be procured to initiate the procurement phase.

Finally, after receiving all the aforementioned IoT equipment, the selected Commissioners attend extra workshops to understand the steps to follow to configure the IoT gateway and commission the IoT devices to it. Except for the workshops, deployment plans are distributed to them to minimise the error and better understand the IoT ecosystem's commissioning procedure.

5.3.2. Installation

In the installation phase, the Pilot Director organises the technical teams (Commissioner, Technician, Technical Director) and the pilot sites in order to schedule the necessary on-site appointments to deploy the IoT ecosystem in the pilot sites.

On the on-site visit, the Technician is connecting the din rail energy metering devices to the relevant electric circuit board according to the manufacturer's manual. The commissioner using the manufacturer's and Que's manuals, deploys the solution in conjunction with the aid of the technical director.

After implementing the installation and commissioning procedure, the commissioner validates the gathered data to be sure that everything runs smoothly in the system accordingly to the plan.

5.3.3. Post Installation

Establishing the constant and seamless data extraction of the pilot sites is the final obligation of the commissioner. By utilising the health monitor tool, they are able to view the statuses of the installed IoT devices in their respective building without the need to attend physically. Therefore, in case of a device malfunction or disconnection from the power supply, the commissioner would be notified immediately and, through communication with the pilot site to identify the issue, will arrange an on-site visit to solve it.

In addition, the data streamed to the IoT Cloud will be monitored by the Technical Director in case anomalies are identified in the system. When this situation occurs, the Technical Director communicates with the commissioner in order to solve the issue and restore the system to its prior state.

5.4. Deployment of equipment

The IoT equipment proposed list selection and the validation procedure of each equipment will be explained in detail in deliverable *D.711 ECF4CLIM IoT Platform v.1 (tested at QUE Lab premises).*

5.4.1. IoT Equipment topology

Since each pilot site has its unique building characteristics, each IoT solution is tailor-made and different from the other proposed IoT solutions in the other pilot site in order to adapt to different infrastructures and be able to gather data successfully without harming the existing building systems.

Concerning their installation topology, the IoT devices that will be installed are divided into two main categories: the plugged and the hard-wired IoT devices.

The IoT gateway and the Indoor Air Quality multi-sensors are included in the first category. These devices need to be plugged into the energy power supply for the whole duration of the project to stream data without interruptions.

The IoT gateway is a small industrial computer, no larger than the dimensions of a credit card. Acts as a bridge between the installed IoT ecosystem hardware devices and the IoT Cloud. Establishing secure and constant streaming of data, the IoT gateway is an essential part of the IoT ecosystem. It is comprised of a raspberry Pi 4 computer, its case, an SD card with its firmware and a Z-Wave antenna, allowing the communication of the IoT gateway with Z-Wave IoT devices.

The Indoor Air Quality multi-sensor is proposed to be located indoors, a place around 1,5m height above the floor. It should be placed away from direct sunlight, any cover, or any heat source to avoid false signals for temperature control.

The hard-wired energy meters comprise devices that are powered through cables attached to the electric circuit board. This equipment is being installed in the selected circuit board, capturing the energy consumption of the chosen intervention space.

5.4.2. Deployment plan

As described above, by providing the commissioners with the deployment plans, the errors during the installation phase are minimised. Each deployment plan is designed by the Technical Director, associating the procured equipment with the existing building's infrastructure, that will participate in the project. They are pilot site-specific and cannot be used for the deployment of another pilot site.

For every device, step-by-step guidance is provided demonstrating which options the commissioner should select from each dropdown list and where s/he could input labels. An example is shown below in Figure 33.

Installation Order	Device	Installation	Commissioning guidance	
			Information registration	Load Registration step
1	***Raspberry Pi***	**Plug n' Play** **Where?:** At an area with good Wi-Fi connection at a close distance to where individual devices will be installed. **How?:** Set up the device following the manual provided by Que	**Country:** **** **Zone Type:** Commercial **Zone Names:** ECExmple1	
2	***Energy metering Device***	**A certified electrician is required** **Where?:** Electric Circuit board **How?:** Connect each clamp of the device to a phase of the main power supply on the circuit breaker board. Installation details in manufacturer's manual	**Device Name:** *To be provided by the commissioner	**Energy Consumption Load** **For the whole building** **Load NameI:** *To be provided by the commissioner
3	***Indoor Air Quality Sensor***	**Plug n' Play** **Where?:** ECExmple1 **How?:**Connect to power through the the power supply and place it away from any heat sources, with the front area of the device facing the work station.	**Device Name:** **To be provided by the commissioner	**Ambient Sensing Load** **For the selected intervention space** **Load NameI: *To be provided by the commissioner**

Figure 33- Deployment plan

The left column presents the order that the devices should be commissioned. The second from left column includes the devices, and the middle column indicates the position that the device should be installed. Finally, the two right columns demonstrate in detail the inputs the commissioner should select in Que's commissioning application to link them to the IoT ecosystem database correctly.

5.4.3. Next steps

After producing the Bill of Materials to the respective partners, as presented above in the installation road map, the pilot directors initiate the procurement phase. There were drawbacks in the installation timeline since the schools were closed due to summer and Christmas holidays. In addition, every organisation in the ECF4CLIM project has different administrative procedures, therefore the procurement phase might take longer due to the organisation's regulations. Since the examination process of the auditing templates and the distribution of the Bill of Materials has been fulfilled, the installation procedure is expected to start in the following months.

6. CONCLUSION

The work developed in the scope of the task 4.3 assessed the environmental performance of the pilot schools involved in the ECF4CLIM. This evaluation methodology intended to share with the schools the knowledge about their sustainable situation, thereby giving them knowledge of the real problem and the complexity of the sustainability in schools. It is important to highlight that, due to a wide variety of factors, as the variability of the climate conditions of the countries, the student's ages, the socioeconomic level of these students' families, and also the economic potential of the local and national authorities to invest in their schools, the present analysis intend to show to the schools how they can improve their performance, rather than compare them. This fact can be evidenced by the very distinct results previously analysed.

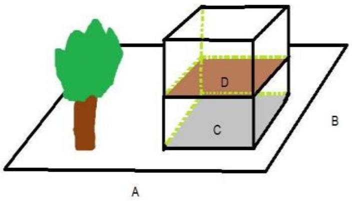
Once the ECF4CLIM project is a living process, where the scholar community, authorities and other stakeholders are involved to the continuous development of an ECF, the data obtained in the task 4.3 activity will be considered for the next steps of the project, namely on WP5 and WP6. On WP5, it will contribute to the definition of adequate interventions to enhance individual and collective competences, and to improve the performance of the schools. On WP6, a new environmental assessment will be performed, and compared to this baseline data, to assess the efficiency of the implemented interventions in schools.

Regarding the IoT ecosystem deployment, it is presented the scope of the installation of the solution as well as the functionalities that can offer to the project. Additionally, the installation road map procedure with the roles and responsibilities of the people that participate in the process are demonstrated. Specifications concerning the topology of the proposed IoT devices are documented in conjunction with the deployment plan that will be provided by the technical director in order to facilitate the process. Finally, the next steps towards the implementation of the solution deployment are described and the deviations that occurred in the time plan due to the aforementioned reasons.

7. APPENDICES

7.1. Appendix I

A) Administrative area	
A1. Name of the school	
A2. Type of school	
A3. Age-range of students	
A4. Country	
A5. City	
A6. Address	
A7. Contact person for the ECF4CLIM	
A8. General photo of the school	

B) Physical characteristics		Data to request
B1. Year of construction		1 - Architecture Project (Building's blueprints)
B2. Total school Area (m^2) (A x B) - See figure		
B3. Gross Floor Area (m^2) (C) - See figure		
B4. Usable Floor Area (m^2) (C + D) - See figure		
B5. Number of floors		
B6. Number of classrooms		
B7. Canteen (Y/N)		
B8. Gymnasium (Y/N)		
B8.1. Gymnasium's covered area (m^2)		
B9. Provide the description (year, type) of any recent renovations. e.g. Heating, cooling, ventilation andair conditioning & refrigeration (HVAC&R) systems:		

C) Use of the classroom building	
C1. Number of occupants	
C1.1. Students	
C1.2. Teachers	
C1.3. Administrative Staff	
C1.4. Auxiliary Staff	
C2. Number of occupants per classroom	
C3. Number of canteen users/day	
C4. Classroom building utilisation period (open and close time)	
C4.1. Week	
C4.2. Weekend	
C5. Yearly closure periods	
C5.1. Which energy-using equipment are in operation during the closure period?	

D) Use of the gymnasium	
D1. Gymnasium utilisation period (open and close time)	
D1.1. Week	
D1.2. Weekend	
D2. Yearly closure periods	
D2.1. Which energy-using equipment are in operation during the closure period?	
D3. Observations/comments on the use of the gymnasium (e.g. definition of extra-curricular schoolactivities, gymnasium usage during the weekend for non scholar activities):	

E) Energy consumption		Data to request
E1. Is electricity consumed? (Y/N)		2 - Monthly bills of the last 5 years (2017, 2018, 2019, 2020, 2021) for all types of energy consumption
E1.1. Annual average bill (kWh, €)		
E1.2. What are the main uses of electricity (e.g. air conditioning, ventilation, lighting, ...)?		
E2. Is natural gas consumed? (Y/N)		
E2.1. Annual average bill (kWh, m^3, €)		
E2.2. What are the main uses of natural gas (e.g. hot water, heating, ...)?		
E3. Is propane/LPG consumed? (Y/N)		
E3.1. Annual average bill (kg, €)		
E3.2. What are the main uses of propane/LPG (e.g. hot water, heating, ...)?		
E4. Is oil/diesel consumed? (Y/N)		**Data to request**
E4.1. Annual average bill (kg, €)		

	E4.2. What are the main uses of oil/diesel (e.g. hot water, heating, ...)?		2 - Monthly bills of the last 5 years (2017, 2018, 2019, 2020, 2021) for all types of energy consumption
	E5. Are other fuel/energy sources consumed? (Y/N) Specify which sources are consumed: (e.g. natural gas, propane, oil/diesel biomass, …)		
	E5.1. Annual average bill (energy units, €)		
	E5.2. What are the main uses of other fuels or energy sources (e.g. hot water, heating, ...)?		
	E6. Observations/comments on energy consumption:		

	F) Energy production	
	F1. Is there renewable energy production (e.g. photovoltaic panels, solar water heaters)?	
	F1.1. What portion of this energy is consumed in the building?	
	F2. Observations/comments on energy production:	

	G) Lighting		Data to request
	Gi. Interior Lighting		3 - Lighting Project
	Gi1. What type of lighting is predominantly used in the building (e.g. fluorescent, incandescent, halogen, LED, ...)?		
	Gi1.1. Definition of available technical data. Characterisation (e.g. power (W), luminous flux (lumen), ...)		
	Gi1.2. In what year was the system approximately installed?		
	Gi1.3. Brand and model of the system (most common system)		
	Gi2. What is the lighting schedule?		
	Gi3. Are there systems for automatic control (e.g. motion sensor, time clock, photocell, ...)? Which and where?		
	Ge. Exterior Lighting		
	Ge1. What type of lighting is predominantly used (e.g. fluorescent, incandescent, halogen, LED, metal halide...)?		

	Ge1.1. Definition of available technical data. Characterisation (e.g. power (W), luminous flux (lumen), ...)		
	Ge1.2. In what year was the system approximately installed?		
	Ge1.3. Brand and model of the system (most common system)		
	Ge2. What is the lighting schedule?		
	Ge3. Are there systems for automatic control (e.g. motion sensor, time clock, photocell,...)? Which and where?		
	G4. Observations/comments on lighting (internal or/and external):		

	H) Heating		Data to request
	H1. Are there heating systems in the building?		4 - HVAC projectand HVAC descriptive documents
	H2. Equipment used for heating in the building:		
	H2.1. Type of system (centralised system, single units, ...)?		
	H2.2. Which is the temperature set point for heating?		
	H2.3. Type of equipment (e.g. heat pump, boiler, radiators, ...)		
	H2.4. Type of energy/fuel consumed (e.g. electricity, natural gas, propane, ...)		
	H2.5. Definition of available technical data. Characterisation (e.g. Power, yield, EER, COP, ...)		
	H2.6. In what year was the system approximately installed?		
	H2.7. Brand and model of the system (most common system)		
	H3. Utilisation schedules		
	H3.1. In which months of the year is the heating system used?		
	H3.2. How many hours a day is the heating on during those months?		
	H4. Is there regular maintenance work?		
	H4.1. Definition of maintenance frequency		
	H4.2. Definition of annual maintenance cost		

	H5. Observations/comments on heating:

	I) Cooling		Data to request
	I1. Are there cooling systems in the building?		4 - HVAC projectand HVAC descriptive documents
	I2. Equipment used for cooling in the building:		
	I2.1. Type of system (centralised system, single units, …)?		
	I2.2. Which is the temperature set point for cooling?		
	I2.3. Type of equipment (e.g. chiller, monosplits, …)		
	I2.4. Type of energy/fuel consumed (e.g. electricity, natural gas, propane, ...)		
	I2.5. Definition of available technical data. Characterisation (e.g. Power, yield, EER, COP, ...)		
	I2.6. In what year was the system approximately installed?		
	I2.7. Brand and model of the system (most common system)		
	I3. Utilisation schedules		

	J) Ventilation		Data to request
	J1. Is there mechanical ventilation in classrooms?		4 - HVAC projectand HVAC descriptive documents
	J1.1. Type of system/equipment of ventilation		
	J1.2. In what year was the system approximately installed?		
	J1.3. Definition of available technical data. Characterisation (e.g. ventilation rate, electric power, ...)		
	J1.4. How many hours per day is the mechanical ventilation in classroom on?		
	J2. Is there natural ventilation in classrooms?		
	J2.1. Type of system/equipment of natural ventilation (e.g. windows, free-cooling system, ...)		
	J2.2. Is ventilation operating at night?		
	J3. Is there mechanical ventilation in other zones? Where? (e.g. kitchen, toilets, parking, ...)		
	J3.1. Type of system/equipment of ventilation		

J3.2. In what year was the system approximately installed?		
J3.3. Definition of available technical data. Characterisation (e.g. ventilation rate, electric power, ...)		
J3.4. How many hours a day is the ventilation on?		
J4. Is there natural ventilation in other zones (e.g. kitchen, toilets, ...)? Where?		
J5. Is there regular maintenance work of mechanical ventilation systems?		
J5.1. Definition of maintenance frequency per system		
J5.2. Definition of annual maintenance cost per system		
J6. Observations/comments on ventilation:		

K) Other equipment	
K1. Are there digital whiteboards in classrooms?	
K1.1. Are shading devices and lighting used when the digital whiteboard is on?	
K2. Are there digital projectors in classrooms?	
K2.1. Are shading devices and lighting used when the digital projector is on?	
K3. Observations/comments about other equipment:	

L) Energy metering		Data to request
L1. Electricity metering (Y/N and where)		5 - Electric installations project
L1.1. General distribution board?		
L1.2. Partial distribution boards?		
L2. Natural gas metering (Y/N and where)		

	L2.1. General meter?		6 - Gas installations project
	L2.2. Partial meters?		
	L3. Propane/LPG metering (Y/N and where)		
	L3.1. General meter?		
	L3.2. Partial meters?		
	L4. Observations/comments on energy metering:		

	M) Energy Management	
	M1. Identification of the entity/person responsible for the energy management	
	M1.1. Function, tasks and main responsibilities	
	M1.2. Are the heating, cooling and ventilation systems controlled manually or automatically?	
	M2. Is there an energy management system?	
	M3. Observations/comments on energy management:	

	N) Energy Audits	
	N1. Were there any previous energy audits?	
	N1.1. Date of the audit	
	N2. Observations/comments on energy audits:	

	O) Building envelope		**Data to request**
	O1. How do you rate the quality of the facade and roof of the building (good/acceptable/bad)? Good: high insulation Acceptable: moderate insulation Bad: without insulation		7 - Construction details of the building envelope 8 - Map of glazed areas 9 - Characteristics of glasses and windows' frames
	O1.1. Definition of facade and roof layers (if data is available)		
	O1.2. Average thickness of facade and roof (e.g. wall thickness, measured through a window or opening)		
	O1.3. Are there infiltrations in the building facade? Where?		
	O1.4. Are there any visible cracks on the walls? Where?		

	O2. How do you rate the quality of the building's windows (good/acceptable/bad)? Good: double glazing with high tightness Acceptable: moderate insulation Bad: single glazing without tightness		
	O2.1. Definition of windows (e.g. sliding or hinged)		
	O2.2. Are there infiltrations through the windows? Where?		
	O2.3. Characterisation of the glazing and window frame		
	O3. Shading devices		
	O3.1. Are there outdoor shading elements (e.g. blinds, shutters, ...)?		
	O3.2. Are there indoor shading elements (e.g. blinds, curtains, ...)?		
	O3.3. Are there natural shading elements or from the building architecture (trees, building elements, ...)?		
	O4. Observations/comments on the building envelope		

	P) Comfort	
	P1. How do you rate the thermal comfort felt in the building (too hot/acceptable/too cold)?	
	P1.1. Is there any particular aspect that should be improved (e.g. there are building zones very cold in the winter or too hot in the summer, ...)?	
	P2. How do you rate the visual comfort felt in the building (good looking/acceptable/bad looking)?	
	P2.1. Is there any particular aspect that should be improved (e.g. there are building zones with poor lighting or too bright)?	
	P3. How do you rate the noise from outdoor in the building (quiet/moderately quiet/too noisy)?	
	P3.1. Is there any particular aspect that should be improved?	
	P4. Observations/comments on comfort:	

	Q) Indoor Air Quality (IAQ)

Q1. In this section, you will characterise the generalbuilding and 4 different classrooms with different characteristics (e.g. types of occupancy, activities, exterior influences on IAQ, others...)	Classroom 1	Classroom 2	Classroom 3	Classroom 4	General Building
Q1.1. How do you rate the indoor air quality? (good/acceptable/bad)					
Q1.2. Is there any particular aspect regarding the air quality that should be improved upon? (eg Poorlyventilated areas)					
Q1.3. Are there any recent complaints related to poorindoor air quality? (e.g. headaches, dry nose, other symptoms, ...)					
Q1.4. Is dust deposition (or other particulate deposition) visible on surfaces?					
Q1.5. Is fungi growth (mould growth) visible on the walls or ceilings?					
Q1.6. How do you rate the hygienic conditions of spaces? (rate both in a scale from: 1 - "very bad" to 5 - "excellent")					
Q2. Classroom characteristics					
Q2.1. Localisation					
Q2.2. Area (m2)					
Q2.3. Height (m)					
Q2.4. Type of flooring					
Q2.5. Type of windows					
Q2.6. Electricity power available (Y/N). Number and location of the electric sockets.					
Q2.7. Number of students in the classroom					
Q2.8. Number of chalk blackboards, white boards or digital board					
Q2.9. Classroom identification (number, name, etc)					
Q2.10. Are there any spaces where chemicals are handled nearby the selected classrooms (e.g. detergents)?					

	Q2.11. Is there a printer inside the classroom?					
	Q2.12. Are there any windows that open directly to a nearby busy road in either classrooms?					
	Q2.13. Are the air intakes (HVAC/AC units) for the classrooms located near the floor level?					
	Q2.14. Are the air intakes (HVAC/AC units) for the classrooms located near exhausts from other buildings (or its own building)?					
	Q2.15. How often are the chalk blackboards used? (Rate the usage: 1 - Almost never to 5 - Daily usage)					
	Q2.16. How often are the whiteboards used? (Rate the usage: 1 - Almost never to 5 - Daily usage)					
	Q2.17. How often are the digital boards used? (Rate the usage: 1 - Almost never to 5 - Daily usage)					
	Q3. Photo of the classrooms					
	Q4. Observations/comments on IAQ:					

	R) Waste management	
	R1. Do you keep tracks on how much total waste is produced?	
	R2. Is there separation of waste for recycling (paper, glass, plastic)?	
	R2.1. Is there any recycling activity at the school?	
	R2.2. Is there any accounting for the amount of waste sent for recycling?	
	R2.3. Specify the volume per week produced for the following waste types:	
	R2.3.1. Total waste (Recyclable + Non Recyclable - L/week)	
	R2.3.2. Waste sent for recycling (L/week)	

	R2.3.3. Paper sent for recycling (L/week)	
	R2.3.4. Plastic sent for recycling (L/week)	
	R2.3.5. Glass sent for recycling (L/week)	
	R2.3.6. Other waste types sent for recycling (L/week)	
	R3. Is there any dedicated used food oil depositing container nearby?	
	R3.1. How much oil is deposited per week in the container (L/week)?	
	R4. Is composting practiced in school?	
	R4.1. What's the origin of the waste (e.g. kitchen) in the composting process?	
	R4.2. Do you keep tracks on how much waste is composted?	
	R4.3. What's the volume of waste sent off for composting? (L/week)	
	R5. Is there any dedicated container for electronic waste nearby?	
	R5.1. Is electronic waste deposited in those containers?	
	R5.2. Do you keep tracks on how much electronic waste is deposited?	
	R6. Is there re-use of paper?	

	R7. Observations/comments on waste management:
	Note:. this information will be obtained in the waste assessment campaign

	S) Water		**Data to request**
	S1. Monthly average bill (m³, €)		10 - Monthly waterbills of the last 5 years (2017, 2018, 2019, 2020, 2021)
	S2. Water metering (Y/N and where)		
	S2.1. General meter?		
	S2.2. Partial meters?		
	S3. Are there any devices for water saving (e.g. flow controller taps, dual system of sanitary discharge, ...)? Which ones?		
	S4. Is there consumption of hot water in the building? (Y/N)		
	S4.1. What kind of equipment is used for hot water production (e.g. heat pump, boiler, water heater, ...)?		
	S4.2. What is the temperature setpoint for hot water (e.g. in the storage tank)		

	S4.3. What type of energy/fuel source is consumed to produce the hot water (electricity, natural gas, propane, ...)?	
	S4.4. Approximate year of the system installation	
	S4.5. Brand and model of the system (most common system)	
	S4.6. Are there solar thermal collectors installed and in operation? How many collectors?	
	S4.7. Definition of available technical data. Characterisation of solar collectors	
	S5. Utilisation schedules of hot water	
	S5.1. Hot water is used in which months of the year?	
	S5.2. Where is hot water used (kitchen, toilets, baths, ...)?	
	S6. Sources of water available (e.g. public supply, well, ...)	
	S7. Observations/comments on the use of water:	

	T) Transports	
	T1. Parking area	
	T1.1. # of parking spaces at school or periphery within a 100 m radius	
	T1.2. # of parking spaces for disabled at school or periphery within a 100 m radius	
	T1.3. # of parking spaces for electric cars at school or periphery within a 100 m radius	
	T1.4. # of parking spaces for bicycles at school or periphery within a 100 m radius	
	T1.5. Photo of the parking area	
	T2. Characterisation of the transport network	
	T2.1. Bus	
	T2.1.1. # of bus stops within a 500m radius	
	T2.1.2. # of bus stops within a 1000m radius	
	T2.1.3. Daily average frequency of passing buses per hour	
	T2.1.4. Daily average frequency of passing buses per rush hour	
	T2.1.5. Distance between the nearest stop and school	
	T2.1.6. Define rush hour period and duration for bus usage	
	T2.1.7. What is the opening and closure time for bus service?	

	T2.2. Subway	
	T2.2.1. # of subway stops in a 500m radius	
	T2.2.2. # of subway stops in a 1000m radius	
	T2.2.3. Daily average frequency of passing trains passing per hour	
	T2.2.4. Daily average frequency of passing trains per rush hour	
	T2.2.5. Distance between the nearest stop and school	
	T2.2.6. Define rush hour period and duration for subway usage	
	T2.2.7. What's the opening and closure time for subway service?	
	T2.3. Train	
	T2.3.1. # of train stops in a 500m radius	
	T2.3.2. # of train stops in a 1000m radius	
	T2.3.3. Daily average frequency of passing trains passing per hour	
	T2.3.4. Daily average frequency of passing trains per rush hour	
	T2.3.5. Distance between the nearest stop and school	
	T2.3.6. Define rush hour period and duration for train usage	
	T2.3.7. What is the opening and closure time for train service?	
	T2.4. Tram	
	T2.4.1. # of tram stops in a 500m radius	
	T2.4.2. # of tram stops in a 1000m radius	
	T2.4.3. Daily average frequency of passing trams passing per hour	
	T2.4.4. Daily average frequency of passing trams per rush hour	
	T2.4.5. Distance between the nearest stop and school	
	T2.4.6. Define rush hour period and duration for tram usage	
	T2.4.7. What is the opening and closure time for tram service?	
	T2.5. Boat	
	T2.5.1. # of boat stops in a 500m radius	
	T2.5.2. # of boat stops in a 1000m radius	
	T2.5.3. Daily average frequency of passing boats per hour	
	T2.5.4. Daily average frequency of passing boats per rush hour	
	T2.5.5. Distance between the nearest stop and school	
	T2.5.6. Define rush hour period and duration for boat usage	
	T2.5.7. What is the opening and closure time for boat service?	

T3. Observations/comments on transports:

U) Green Spaces		
U1. General Information		
U1.1. Total garden area (m^2)		
U1.2. Type of green spaces (garden/kitchen garden/trees)		
U1.3. Total grassland area (m^2)		
U1.4. Photo of the green spaces		
U1.5. Total covered area (m^2)		**Types of areas**
U1.6. Total waterproofed area (m^2)		
U1.7. Total green area (m^2)		
U1.7.1. Grass Area (m^2)		
U1.7.2. Vegetable growth area (m^2)		
U1.8. Is there any street furniture in the school grounds (e.g. benches, tables, etc)		
U1.9. Does leisure equipment exist in the school grounds? (e.g. swings, etc)		
U2. Energy		
U2.1. Type of fuel in gardening activities		
U2.2. Annual diesel consumption in gardening activities (L/year)		
U2.3. Annual gasoline consumption in gardening activities (L/year)		
U2.4. Annual heavy fuel oil consumption in gardening activities (L/year)		
U2.5. Annual electricity consumption in gardening activities (kWh/year)		
U2.6. Chain saw power (kW)		
U2.7. Mower Power (kW)		
U2.8. Operation hours chainsaw		
U2.9. Operation hours mower		
U3. Water		
U3.1. Type of irrigation system		
U3.2. Origin of irrigation water		
U3.3. Water consumption in irrigation (m^3/year)		
U4. Gardening treatments		
U4.1. Name of pesticide used		
U4.2. Amount of each pesticide used (Kg/year)		

	U4.3. % of active ingredient of each pesticide	
	U4.4. Name of each fertiliser used	
	U4.5. Amount of each fertiliser used (Kg/year)	
	U4.6. % of N of each fertiliser	
	U4.7. % of P_2O_5 of each fertiliser	
	U4.8. % of K_2O of fertilizer	
	U4.9. Type of compost used	
	U4.10. Amount of each compost used	
	U5. Biome information	
	U5.1. Number of trees	
	U5.2. Predominant tree species (See table in the end)	
	U5.3. Average age of the identified trees	
	U6. Comments on green spaces:	

	V) Green Procurement	
	V1. Certifications Information	
	V1.1. 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 (Y/N)	
	V1.2. Policies, objectives or a target for conserving the environment (Y/N)	
	V2. Electronic equipment information	
	V2.1. # of equipment without star level of efficiency	
	V2.2. Did you purchase new equipment after February 21st 2021?	
	V2.2.1. # of equipment with A rating	
	V2.2.2. # of equipment with B	
	V2.2.3. # of equipment with C	
	V2.2.4. # of equipment with D	
	V2.2.5. # of equipment with E	
	V2.2.6. # of equipment with F	
	V2.2.7. # of equipment with G	
	V2.3. Printers	
	V2.3.1. # of printers	
	V2.3.2. # of printers with optimum consumption	
	V2.3.3. Amount of used paper (Kg/Month)	

	V2.3.4. Amount of paper purchased directly to National producers (Kg/Month)	
	V2.3.5. Amount of recycled paper used (Kg/Month)	
	V2.3.6. Use of chlorine-free paper (Y/N)	
	V3. Chemicals	
	V3.1. Concern about chemical information in the labels of detergents (Y/N)	
	V4. Food products information	
	V4.1. Total amount of purchased food per month (Kg/Month)	
	V4.2. Purchase site of food products	
	V4.2.1. # of county providers	
	V4.2.2. # of district providers	
	V4.2.3. # of country providers	
	V4.2.4. # of international providers	
	V5. Comments on green procurement:	

	W) Other Comments:

	Sequestration Factor per green species		
	Turfgrass/lawn	0,78	kg CO^2 seq/m2 . year
T	*Butia capitata*	0,02	kg CO^2 seq/tree . year
	Cordyline sp,	0,02	kg CO^2 seq/tree . year
	Musa paradisiaca	0,02	kg CO^2 seq/tree . year
	Yucca aloifolia	0,09	kg CO^2 seq/tree . year
	Chamaerops humilis	0,10	kg CO^2 seq/tree . year
	Phoenix reclinata	0,18	kg CO^2 seq/tree . year
	Phoenix canariensis	0,19	kg CO^2 seq/tree . year
	Washingtonia robusta	0,23	kg CO^2 seq/tree . year
	Washingtonia filifera	0,28	kg CO^2 seq/tree . year
	Bupleurum fruticosum	0,39	kg CO^2 seq/tree . year
	Magnolia macrophylla	0,50	kg CO^2 seq/tree . year
	Juniperus communis	0,56	kg CO^2 seq/tree . year
	Crataegus monogyna	0,58	kg CO^2 seq/tree . year
	Juniperus oxycedrus	0,60	kg CO^2 seq/tree . year

	Juglans nigra	0,78	kg CO^2 seq/tree . year
	Bougainvillea glabra	0,81	kg CO^2 seq/tree . year
	Juniperus phoenica	0,81	kg CO^2 seq/tree . year
	Schinus polygamus	0,81	kg CO^2 seq/tree . year
	Ligustrum japonicum	0,84	kg CO^2 seq/tree . year
	Albizia julibrissin	0,87	kg CO^2 seq/tree . year
	Viburnum tinus	0,92	kg CO^2 seq/tree . year
	Spartium junceum	0,97	kg CO^2 seq/tree . year
	Prunus americana	0,98	kg CO^2 seq/tree . year
	Rosmarinus officinalis	1,15	kg CO^2 seq/tree . year
	Rhamnus sp,	1,31	kg CO^2 seq/tree . year
	Buxus sempervirens	1,36	kg CO^2 seq/tree . year
	Ligustrum ovalifolium	1,43	kg CO^2 seq/tree . year
	Ficus benjamina	1,44	kg CO^2 seq/tree . year

7.2. Appendix II

- ECF4CLIM Behavioural questionnaire about mobility patter and resources consumption:

1. **School identification**
2. **Class**
3. **Eco-Schools member**
    a. Yes
    b. No
4. **If yes, do you participate in the Eco-schools' programme activities?**
    a. Yes
    b. No
5. **Classification/Role in the school**
    a. Student
    b. Teacher
    c. Staff
6. **Gender**
    a. Female
    b. Male
    c. Other
7. **Age**

PART A: Transports

1. **Do you go to school by foot?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
2. **If yes, indicate the time, in minutes you spend going from your home to school'**
3. **Do you go to school by bicycle?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
4. **If yes, indicate the time, in minutes you spend going from your home to school**
5. **Do you go to school by bus?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
6. **If yes, indicate the time, in minutes you spend going from your home to school**
7. **Do you go to school by subway?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
8. **If yes, indicate the time, in minutes you spend going from your home to school**

9. **Do you go to school by train?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
10. **If yes, indicate the time, in minutes you spend going from your home to school**
11. **Do you go to school by tram?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
12. **If yes, indicate the time, in minutes you spend going from your home to school**
13. **Do you go to school by car?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
14. **If yes, indicate the time, in minutes you spend going from your home to school**
15. **Type of car:**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
16. **If yes, indicate the time, in minutes you spend going from your home to school**
    a. Type of car
    b. Gasoline
    c. Diesel
    d. Electric vehicle
    e. Hybrid - Gasoline
    f. Hybrid - Diesel
    g. Other
    h. I do not know
17. **Do you go to school by motorcycle?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
18. **If yes, indicate the time, in minutes you spend going from your home to school**
19. **Do you go to school by public electric transports?**
    a. Never
    b. Sometimes
    c. Almost Always
    d. Always
    e. Other
20. **If yes, which transport do you use?**
    a. Public electric bicycle

b. Public electric scooter/motorcycle

21. On the way to school, do you use more than one transport or way of mobility?

a. Yes
b. No

22. If yes, select the ones that you use

a. Walking
b. Bicycle
c. Bus
d. Subway
e. Tram
f. Car
g. Motorcycle
h. Electric bicycle
i. Electric scooter/motorcycle

23. Do you practice car sharing when you go to school?

a. Yes
b. No

24. If yes, how many passengers go to your school with you?

25. Do you go back to your home and return to school more than once per day?

a. Yes
b. No

26. What is the distance between your home and school?

27. How much do you spend, in EUROS, on your trips home – school, using car or motorcycle each month?

a. I don't know it
b. I know it (Please, fill the amount in EUROS in the Comment)

28. How much do you spend, in EUROS, on your trips home – school, using public transports each month?

a. I don't know it
b. I know it (Please, fill the amount in EUROS in the Comment)

29. If there was a bike path between your home and the school, would you rather the bike?

a. Yes
b. No

30. Do you use the public transport when you go out with your family on the weekend?

a. Never
b. Sometimes
c. Almost Always
d. Always

PART B: Students consumption

1. Could you estimate the amount of each of the following materials that you consume in school each year?

a. I am not able to estimate my material consumptions (Question not applicable to this level)
b. In class, I use my own stationery material, and the electronic devices provided by the school
c. In class, I use the stationery material and the electronic devices provided by the school

2. **If you use your own material, could you estimate the amount of each of the following materials that you consume in school each year?**
    a. Paper (sheets)
    b. Recycled paper (sheets)
    c. Large size notebooks or notepads (DinA4)
    d. Small size notebooks or notepads (DinA5)
    e. Large size notebooks (DinA4) made of RECYCLED PAPER
    f. Large size notebooks (DinA5) made of RECYCLED PAPER
    g. Cardboard sheets (50x65)
3. **Do you use books in class?**
    a. Yes, I use my own printed books
    b. Yes, I use the printed books provided by my school
    c. No, I do not use printed books
4. **If yes, could you tell us how many books you bought in the last school year? Include new books, second-hand books and books you borrowed**
    a. New books
    b. Second-hand/Reused books
5. **SC3. Some of the materials and supplies used in class may last more than one school year. Below, we ask you to estimate which and how many of these materials you purchased in the last school year:**
    a. Cardboard folders
    b. Plastic folders
    c. Erasers
    d. Pens
    e. Markers
    f. Pencils
    g. Colour pencils
    h. CDs
    i. DVDs
    j. Glue sticks
    k. Scissors
    l. Plastic rulers
    m. Plastic cases (approx. 20x10x2 cm)
6. **Frequently computers and other devices are used in class. You could estimate the, HOURS PER DAY in average, you use the computer or tablet in class, whether it is a computer available at the school or if it is yours.**
    a. School computer
    b. Student computer
    c. School tablet
    d. Student tablet

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7. **Previous questions include the materials that are often used. If there are other materials or stuff you purchased or acquired, please include up to three additional ones. To do so, please indicate the weight (kg) and material (s) which it is made of:**
    a. Wood
    b. Glass

c. Aluminium
d. Steel
e. Metal (other)
f. Plastic PET*
g. Plastic PVC*
h. Plastic HPDE*
i. Plastic PP*
j. Plastic ABS*

8. Please, include below any information or comment you can share with us: