D7.8 Environmental footprint calculator version I and II.

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Who We Are

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

Name	Country	Logo
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas CIEMAT	ES	
Instituto Superior Técnico. University of Lisbon. IST	PT	
Universidad de Sevilla USE	ES	
University of Jyväskylä JYU	FI	
Universitat Autònoma de Barcelona UAB	ES	
Meda Research Ltd MedaResearch	RO	
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Smartwatt Energy Services SA Smartwatt	PT	
Que Technologies Kefalaiouchiki Etaireia QUE	GR	

About the Project

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

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

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

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

LEGAL NOTICE

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1. EXECUTIVE SUMMARY

This document describes the Environmental footprint calculator simulation tool. The Footprint calculator will be based on Life Cycle Assessment (LCA) methodology. The tool will connect the LCA baseline data and will allow users to update and simulate improvements for self-assessment. A preliminary excel-based version of the tool is released as a downloadable file. This will be independent and usable by school from the beginning, before LCA baseline development, in order to facilitate the use.

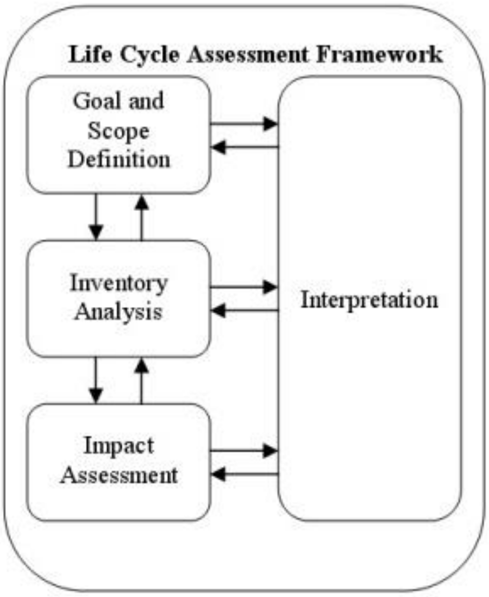
CIEMAT has designed the ECF4LCIM environmental footprint calculator to quantify the environmental impacts of a student in a school based on the Life Cycle Assessment methodology. This deliverable 7.8 is included as an exploitation result of part of the work developed Task 7.3, and it contributes towards the objectives of the products of the WP7. Digital Platforms/Applications/Devices for Active Learning.

The aims of WP7.3 task is the development of tools to support the transition to a more sustainable performance in schools by monitoring and benchmarking environment and energy performance, identifying sustainable and cost efficient solutions, based on procurement related and behavioral-related measures. Within task WP7.3, the Environmental footprint calculator aims at creating a tool that enable the schools and students to self-assess their performance by identifying hotspots and environmental potential of improvement. Two versions are developed, one for schools evaluation (School) and one for the individuals of the community (School Users).

Inputs data such as amount and type of fuel consumed for heating purposes, electricity consumption for different purposes, water consumption, paper and other materials consumption in “the School” are considered in the tool. Besides, the version for School user can calculate their household environmental footprint and the total.

2. METHODOLOGY AND STRUCTURE

The work carried out makes use of the multi-criteria and holistic approach offered by LCA following the guidelines of ISO 14040 and ISO 14044 standards. LCA is a methodology that allows the evaluation of the environmental impacts associated to all the stages of a product's life cycle and encompasses extracting raw materials, processing, manufacturing, transportation and distribution, use, reuse and recycle and final disposal.



ISO 14040:2006

Figure 1. LCA Methodology Framework

The framework of the development and LCA encompassess four phases: i) Definition of objective and scope; ii) Inventory Analysis; iii) Impact Assessment and iv) Interpretation of results.

Environmental footprint calculator design plan according to LCA methodology

The first step was the identification of the school system according to the goal, scope and key components of the School system. Then, a template to collect input data from schools was designed in order to build the inventory (inputs and outputs of material and energy related to each component of the system). Considering the inventory data and main inputs and outputs, a BBDD of factors of environmental impacts was developed linked to them allowing the characterization of the impact by a method including several environmental impact categories. Finally, results are showed graphically allowing interpretation.

Thus, The LCA database contains two types of information:

- calculations and relationship between inputs and outputs, and between process of different activities, connecting inflows and outflows, in suitable units to be connected with Impact factors
- factors calculated per unit processes to be related with impact factors

Goal and scope definition

The goal of this LCA is the quantification of the environmental impacts associated to the consumption of energy, materials and water of EC/schools located in Europe, and specifically in the regions of Spain, Finland, Romania and Portugal.

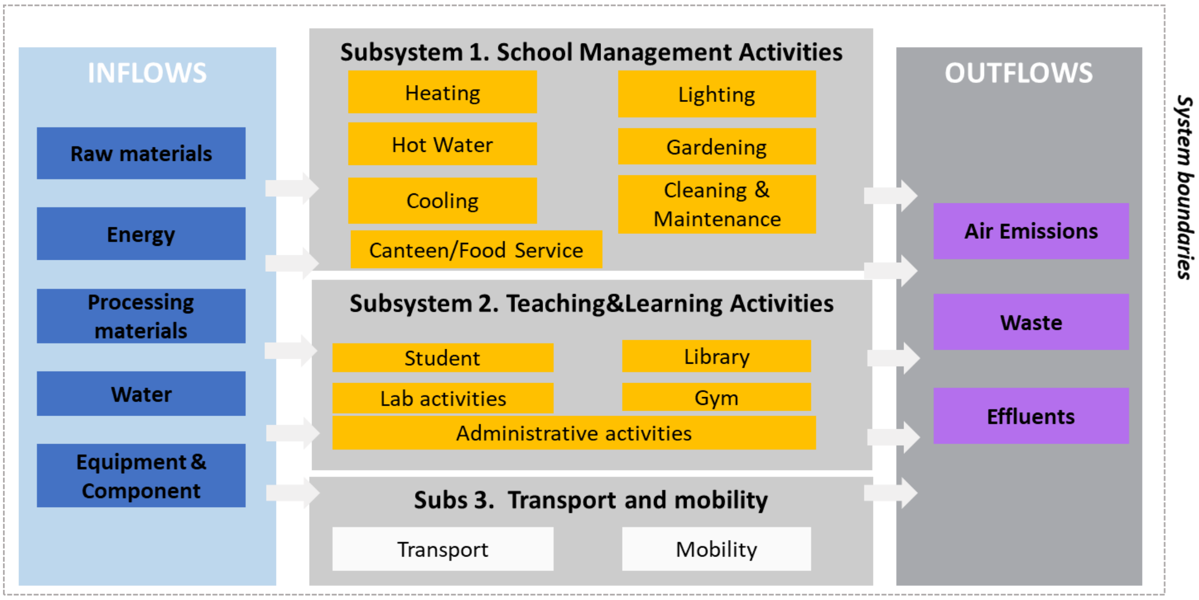
Functional unit. The function considered in this LCA is the provision of education to a student activity for an annual season. The inventory of the whole energy, materials and water consumption will be referred to this period and will be calculated per school. Results will be the expressed per year and per student.

Scope and system boundaries. The work is focused on the quantification of the environmental impacts for educational activities per student (or school users). Two scopes, named version School and School User, have been proposed:

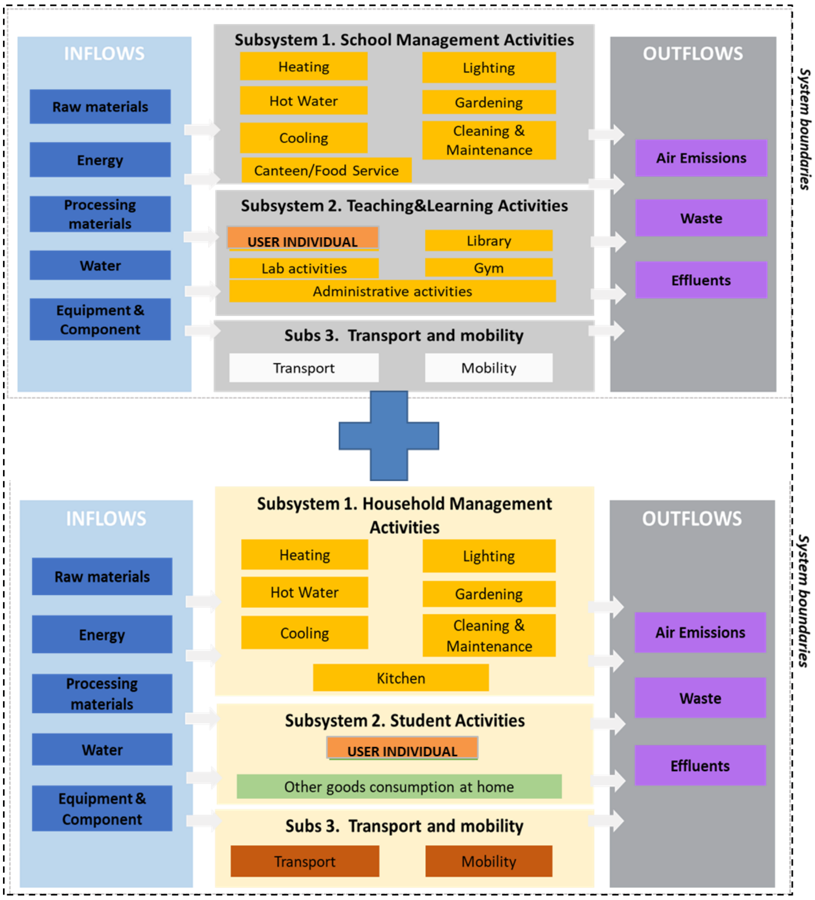
- A. School: consider the School system
- B. School user: includes the household system consumptions, referred to the student or school user.

Figure 2 depicts the total system boundaries considered and the activities included ineach scope (A. School; and B. School User). Important sources of information and consulted databases have been selected. Processes whose contribution to mass and energy flows are known to be important and whose emissions are relevant to the environment were selected and investigated. Ecoinvent database has been used for the most common processes such as transport, fuels and basic materials and chemicals. The LCA software used to modelled processes has been SIMAPRO™.

A) School system



B) School and household system



All the inputs and information on the system "School" used in this tool correspond to the following activities grouped by the three subsystems:

A. Subsystem EC/Building and School Management

- General data
- Electricity
- Water
- Heating
- Hot water
- Cooling
- Ventilation
- Lighting
- Gardening
- Cleaning & Maintenance
- Food Service
- Wastes

B. Subsystem Educational Activities in the EC/School (Teaching and Learning)

- Students' activities - classroom
- Laboratory activities
- Gym activities
- Library
- Administrative and support activities

C. Subsystem Transport and Mobility

- Outings/excursions transport
- Mobility

At home, similar structure was applied. Except for teaching and learning the kind of inputs are very similar. Thus, forms have been designed and adapted to the scopes.

Some considerations have to be taken into account by users when use the B scope tool.

- It will be required a previous data collection at home on consumptions (water, energy, etc.), and data on the characteristics of your house building.

- They can include the charges on the environmental footprint associated to the activities in your School to achieve a more complete assessment of your footprint. This data should be collected from the PREVIOUS CALCULATION OF THE SCHOOL ENVIRONMENTAL FOOTPRINT OF YOUR SCHOOL WITH THE ECF4CLIM TOOL FOR THAT. If these are not available, they can use DEFAULT DATA (from Climact Project).

3. Integration in Digital Platform/ Simulator Space

For the further development foreseen based on the present downloadable Excel-based tools, all the necessary calculations and simulations will be integrated by Smartwatt on the backend layer using technologies such as Python. The calculations will be mainly based on the excel tool and database defined by CIEMAT (excel).

Smartwatt will be responsible for displaying all the necessary data and information, using adequate visualization tools in the platform, using technologies such as HTML5 and JavaScript.

Within the Simulators Space of the Digital platform the simulation tools is linked with the WP4 (Figure 2).

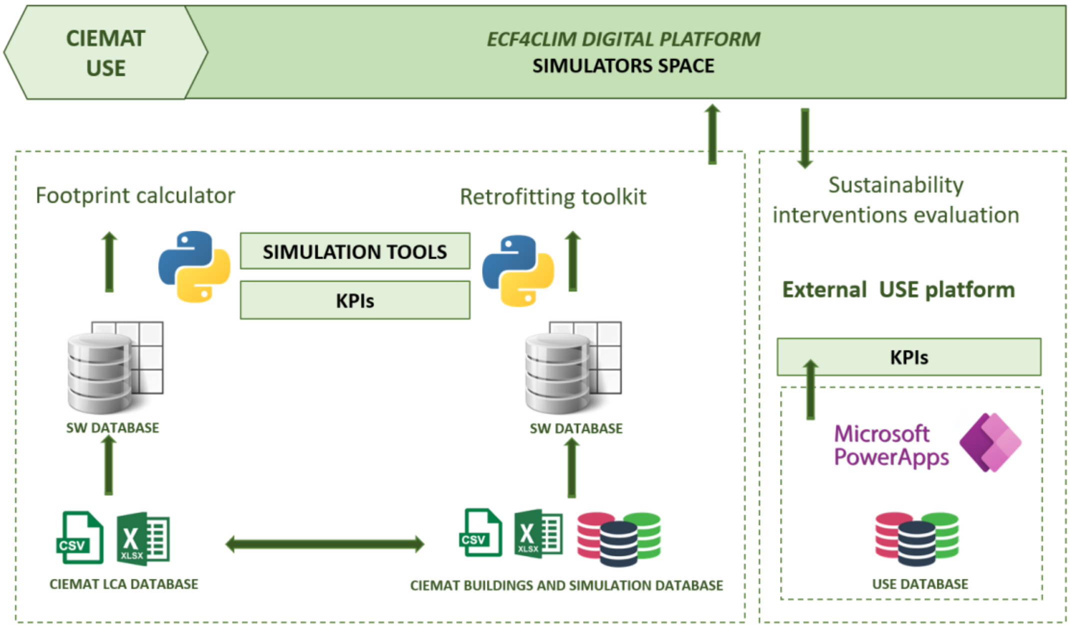


Figure 2 - Overview of the Simulators Space

2. Inventory Database: inputs and calculations

The inventory describes the inputs and information analysis which is needed to obtain flows of the system, as well as how the impact factors are calculated. In other words, it describes required inputs, FDB and IFDB per activity in the system.

Specific tasks of the subsystem 1. School Management

Table 1. Activities included in the System, per subsystem.

Subsystem	*Activity (Tab)*
1 EC/School Management	**General data**
	Electricity
	Water
	Heating
	Hot water
	Cooling
	Ventilation
	Lighting
	Gardening
	Cleaning & Maintenance
	Food Service
	Wastes
2 Educational Activities in the EC/School	Students activities - classroom
	Laboratory activities
	Gym activities
	Library
	Administrative and support activities
3 Transport and Mobility	Outings/excursions transport
	Mobility

Each tab in the LCA module excel file corresponds to each activity, in which inputs can be complete. As a result the EF tool calculations of impact per school, per School user (and per m2 of usable area in some cases) are provided.

General data

This part collects info about school (name, country, days of curricular activity, courses, and number of and staff, etc.) which is needed to the rest of calculations.

Electricity

Electricity is one of the main factors to take into account. Electricity is used as input in a multitude of activities and processes developed in schools. The potential environmental emissions linked to electricity consumption are strongly dependent on the electricity sources used in each country.

Two types of sources have been considered, electricity from the national grid, produced out of the school, which comes from outside the school (info from invoices), and electricity production *in site* (Photovoltaics Solar Panel).

Electricity grid impact factor

The diversity of technologies and the contribution from each one to the "mix" in each country is a determinant factor which must be characterized in order to create an updated scenario of electricity which schools use to supply their requirements. Table 2 shows the electricity grid considered per each country/region.

Table 2. Electricity mix percentages per Country/Region grid and technology.

	ES	PT	FI	RO	EUR
Coal	2.3%	4.4%	8.0%	17.1%	17.7%
Oil	4.2%	2.2%	0.4%	0.3%	1.4%
Natural gas	26.5%	33.5%	5.4%	17.9%	21.0%
Nuclear	22.3%	6.4%	33.9%	20.4%	22.6%
Hydro	12.9%	26.0%	23.1%	28.0%	15.9%
Biofuels	1.9%	0.0%	16.0%	0.8%	4.4%
Waste	0.7%	1.1%	1.3%	0.0%	1.3%
Geothermal	0.0%	0.4%	0.0%	0.0%	0.5%
Wind	21.5%	22.8%	11.6%	12.4%	11.3%
Solar PV	5.9%	3.1%	0.4%	3.1%	3.7%
Other sources					
Tide	0.0%	0.0%	0.0%	0.0%	0.0%
Solar thermal	1.9%	0.0%	0.0%	0.0%	0.1%
	100.0%	100.0%	100.0%	100.0%	100.0
ren	44.8%	53.4%	52.3%	44.3%	37.2%
non-ren	55.2%	46.6%	47.7%	55.7%	62.7%

The scenarios of electricity were created using information of electricity generation per each country/region, and adding transport and distribution process of electricity until “low tension grid electricity distribution”. The results are impact factors per kWh of electricity consumed in the school.

Data of electricity mixes have been obtained from IEA (2020). Source: IEA Electricity Information https://www.iea.org/data-and-statistics/data-product/electricity-information

In site electricity alternatives and impact factors

Photovoltaic (PV) solar panels and wind energies are real renewable options to produce power in buildings. To simplify the scenario, standard ratios of production have been used to calculated electricity production using bibliography and commercial information.

PV solar panel electricity production has been calculated considered LCA inventories of the active panel area with different types of solar cells and efficiencies provided by the Ecoinvent database. PV electricity impact results have been calculated considering the surface of panels with different efficiency in the different regions.

References:

- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230.

On one hand, with the results of calculation of country/regional electricity grid scenario (generation, transport and distribution), a factor per country and impact category has been calculated. On the other hand, the results of the scenarios of the *in site* electricity production depending on data from schools are used by the tool to calculate a specific factor. Finally, the tool calculates a global electricity impact factor in terms of the impact per kWh (for each impact). Electricity global factor is used as a factor to the electricity which is associated in each activity in the different activities (tabs).

The questionnaire asks the user for data about technical characteristics (machinery, appliances, etc.) used to develop the different activities (tabs in the tool), to calculate the electricity consumption by process (included in the activities), since one objective of the LCA module is to be able to allocate environmental impact to activities and find hotspots. To guarantee that whole electricity which schools consume is included in calculation to obtain global environmental LCA results each part of consumption by activities is subtracted from the invoice total consumption, and the difference represents the electricity from "other electricity consumption", being considered in life cycle assessment of the system.

Electricity Credit

The module includes the possibility of the school supplies electricity to the grid if the school produces electricity in site but school does not consume all the production. In this case, the electricity which is provided by the school facilities is considered as avoided electricity to be produced by the national grid. Consequently, this fact has a positive environmental impact, decreasing the impact due to the electricity consumption.

Water

Usually, tap water quantities are obtained from invoices (monthly or annual), being a unique total consumption value for the school (or the household in the School User EF tool). As the same as electricity, water is also a factor data consumption which is part of a several range of activities or process such as toilet use, drinking, gardening, etc. A *priori*, main consumption could be toilet use, but the designed system do not consider toilet activity as separated activity , due to the strong influence of behavior of students and users in general what makes difficult the estimation. In the case of gardening, it would be possible to estimate the amount of water by school staff *(see gardening)* if there are other sources (rainfall collection or water well) or individual metering.

References:

- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230.

Specific tasks of the subsystem 1. School Management

This subsystem is referred to activities in the building use phase, operation and maintenance.

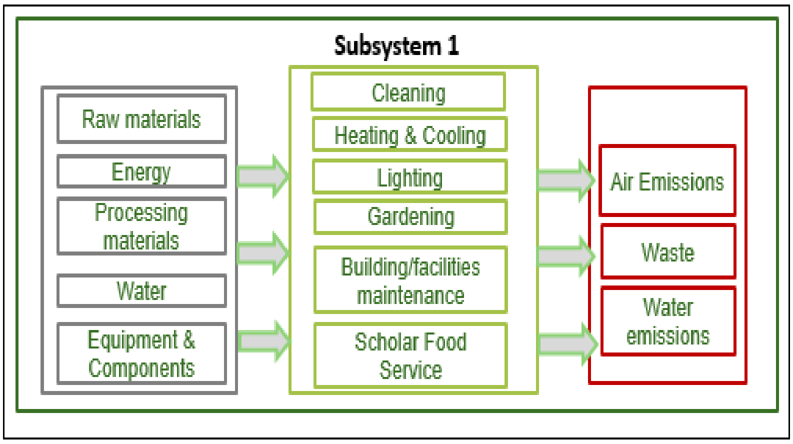


Figure 1. Subsysistem 1.

Heating

Heating of the school building requires the use of fuels and electricity. The manufacturing of the heating and cooling system itself is excluded from the analysis. Consumption was evaluated by considering the type of heating system (or systems), fuel and the technical characteristics of the equipment (power and yield). Twelve systems have been selected:

- Solar heating
- Electric resistance
- Portable heater
- Heat pump
- Geothermal heat pump
- Boiler (>100 kW) which use:
    - Natural Gas
    - Fuel oil
    - Diesel
    - Coal
    - Biomass (pellets)
    - Biofuel

Solar heating: due to the variability of influential factors the user must know the power and yield of the system in the location. And the production is obtained using the information about time utilization per year. The factor provided calculates the impact to produce heat, in terms of kWh by a solar heating system.

Electric resistance: power and utilization time is considered to calculate the electricity consumption.

Portable heater: power and utilization time are the required data. The scenario is referred to a little appliance which provides hot air, and consumes electricity.

Heat pump and geothermal heat pump: depends on COP[1], power and utilization time.

The boilers use fuel in a combustion process. The scenario has been calculated using a standard process for a "heat produced in a more than 100 kW boiler". To conversion and factor calculations LHV of IDAE and emission rates from IPCC and EEA have been used.

References:

- IDAE, poderes caloríficos http://www.idae.es/uploads/documentos/documentos_PCI_Combustibles_Carburantes_final_valores_Update_2014_0830376a.xlsx
- IPCC
- EMEP/EEA air pollutant emission inventory guidebook 2016. www.eea.europa.eu/publications/...eea...combustion/1-a-4-small-combustion-2016

Hot Water System

It is possible that hot water was produced apart from the heating system, allowing the estimation of the energy and resources consumption associated to the hot water system to supply the hot water demand. Estimated demand per School user have been calculated using standard consumption criteria for design of hot water demand in different type of buildings using a technical guide of IDAE. The following assumptions have been taken:

- School without shower: 3 l/day*student, which corresponds with 57 kWh/year*student
- School with shower:15 l/day*student, which corresponds with 285 kWh/year*student

For household

- Single family home 30 l/day*person and 573 kWh/year*person
- Multi-family home building (centralised system) 22 l/day*person and 420 kWh/year*person

The created scenarios have been the following:

- Hot water produced with a heat pump: EER[2] is a necessary data to electricity demand calculation.
- Electric water heater: power, yield and operation time are the data to electricity demand calculation.
- Boiler which use:
  - Natural gas
  - Fuel oil
  - Diesel

[1] Coefficient of performance of the equipment.
[2] EER: Energy Efficiency Ratio

  - Coal
  - Biomass
  - Biofuel
- Solar Water Heating, can be combined with different options to support the hot water demand:
  - SWH + electricity
  - SWH + natural gas
  - SWH + biomass

Boiler is referred to a combustion process in a boiler, and the impact factor has been calculated using LHV of IDAE and using emission rates of IPCC and EEA. Thermosolar energy contribution for solar water heating has been calculated with a factor of heating value of 899 kW/m2, provided as reference value similar to a LHV for fuels by IDAE. The scenario used to calculate impacts is referred to a heat from thermal solar energy. Auxiliary/Hybrid system could be electricity or natural gas and biomass.

References:

- IDAE. Guía Técnica Agua Caliente Sanitaria Central (2010) http://www.idae.es/uploads/documentos/documentos_08_Guia_tecnica_agua_caliente_sanitaria_central_906c75b2.pdf
- IDAE. Poderes caloríficos http://www.idae.es/uploads/documentos/documentos_PCI_Combustibles_Carburantes_final_valores_Update_2014_0830376a.xlsx

Cooling

Cooling system and appliance to alleviate warm temperatures requires energy consumption, and there are several types. The most common ones have been created:

- Chiller (central equipment per buildings, long lifetime): scenario considered the electricity consumption, thought EER.
- Splits appliances (with different refrigerant: fluorinated compounds, CO2 and water). Refrigerant presents leakages, more number of loads, etc.
- Fun: power
- Heat/cool pump: EER
- Geothermal heat/cool pump: EER

The calculated consumptions and emissions are the emissions from equipment electricity consumption and refrigerant leakages. For splits, inventories are based in the report from AC-Sun, a commercial study of cooling appliances, which analyses the carbon footprint of provision of cooling equipment during one year in Spain through LCA methodology. This work provides data about annual refrigerant leakages ratios for most common refrigerants. An average of these values was used, resulting a 13.2% of total refrigerant per year. The operation time corresponds to the hours per day and months in which the cooling system is used. The assumption is that the equipment works 80% of the operation time in active mode, 20% stand-by, and 10% in off-mode.

Ventilation

Ventilation moves outdoor air into a building or a room, and distributes the air within the building or room. The general purpose of ventilation in buildings is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it. There are different methods that may be used to ventilate a building: natural and mechanical. Building ventilation has a main ratio to calculate the electricity consumption – the ventilation rate- which is the amount of outdoor air that is provided into the space.

According to the requirements to keep a good quality air (offices, residences, reading rooms, museums, courtrooms, teaching and assailable classrooms and swimming pools) minimum values per flow (in case the school has mechanical ventilation) have been considered depending on the country:

m^3/*STUDENT	COUNTRY
45	Spain
15[3]	France
18	Gibraltar
24	Portugal
21.6	Finlandia
14.4	**Romania**
23	EUR27

Taking the number of students, the required flow is calculated. Two scenarios of mechanical ventilation have been created in order to calculate electricity consumption, using mean value for specific ventilators power (SPF): Only ventilation and not only ventilation (is used in cooling/heating). With flow, SPF and operation time, electricity consumption is calculated depending on the number of students.

For households: 14.4 m3/h.

References:

- RITE: Reglamento de Instalaciones Térmicas de Edificios. Spanish Thermal Building Regulations (Royal Decree 1027/2007 and updated in the Royal Decree 238/2013)
- Guía técnica. Instalaciones de climatización con equipos autónomos. IDAE, 2012. http://www.idae.es/uploads/documentos/documentos_17_Guia_tecnica_instalaciones_de_climatizacion_con_equipos_autonomos_5bd3407b.pdf
- Guidance Building Bulletin 101: ventilation for school buildings. March, 2014 https://www.gov.uk/government/publications/building-bulletin-101-ventilation-for-school-buildings
- Dias Pereira, L. M. Modernised Portuguese Schools - From IAQ and Thermal Comfort towards Energy Efficiency Plans. PhD Thesis in Sustainable Energy Systems. Department of Mechanical Engineering, FCTUC. February/2016

[3] Requirement for nursery, primary and secondary schools.

https://estudogeral.sib.uc.pt/bitstream/10316/29419/1/Modernised%20Portuguese%20Schools.pdf
- Reglement Sanitaire Departemental. Titre Iii Dispositions Applicables Aux Batiments Autres Que Ceux A Usage D'habitation Et Assimiles http://www.lot.gouv.fr/IMG/pdf/04_RSDtitreIII46.pdf

- Rate for Finland : Ventilation guidelines for those responsible for the use of ECEC, school and higher education facilities. Finish institute for health and welfare. https://thl.fi/en/web/environmental-health/indoor-air/coronavirus-and-safety-of-indoor-air/ventilation-guidelines-for-those-responsible-for-the-use-of-ecec-school-and-higher-education-facilities#Physical_activity
- Rate for Romania : VENTILATION RATES AND IAQ IN EUROPEAN STANDARDS AND NATIONAL REGULATIONS Nejc Brelih*1, Olli Seppänen1 1 REHVA – Federation of European heating, ventilation and air conditioning associations Rue Washington 40, B-1050 Brussels, Belgium *Corresponding author: nb@rehva.eu. https://www.aivc.org/sites/default/files/1a5.pdf
- Rate for EUR 27 was calculated as the average value of the individual values for countries. AVERAGE
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: http://link.springer.com/10.1007/s11367-016-1087-8> [Accessed 20/03/2017]

Lighting

Lighting involves the use of electricity and the impact of fabrication referred to the use (lamp*h). Electricity consumption is estimated taking to account a previous info collected by school (manager, LCC, LCB...), choosing representative space sper type (classroom, toilet, corridors, labs, etc) as sample, which characteristics are representative of the diversity of classrooms in the building. For example, the user can select one big classroom, and one little using the size as a criteria; or one class where the predominant lamp is 55 w fluorescent tube lamp and other where the predominant lamp type was 36 fluorescent tube lamp using the power as a criteria. Selecting the predominant type of lighting system, and completing the power, the number of lamps in the room and the number of room similar to the each one, a simplified calculation of the electricity consumption is made.

Three scenarios have been presented to calculate the impact of replaced lamp:

- Fluorescent tube lamp
- Compact fluorescent lamps
- LEDs downlight

Similarly, the user can complete the form for its house building.

References:

- Tähkämö, L. Life cycle assessment of light sources - Case studies and review of the analyses. Aalto University publications series - Doctoral Dissertations 111/2013, 2013.

- ETH dababase
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: <http://link.springer.com/10.1007/s11367-016-1087-8> [Accessed 20 03 2017].

Gardening

Gardening activities are those related to green areas care. As well as carbon sequestration, it includes machinery and equipment's use, watering, pesticides treatment and fertilization.

Carbon dioxide sequestration by vegetation

Required inputs to characterize green area are the surface of turf grass (m2), trees species and number of each one. Users have to complete info about predominant species (a maximum of three) choosing between 136 species.

Terrestrial vegetation can be a carbon dioxide sink. Vegetation captures CO_2 from the air by photosynthesis process during the growth of the plant. This CO_2 is stored in the structure of plants and soil and therefore it is removed from the atmosphere. However, at the same time losses of CO_2 can occur by mineralization of organic matter by autotrophic respiration of plants and when vegetation is removed. The sequestration and storage of carbon depends on several factors: type and age of species, climatic conditions and management of vegetation, among others. The factor considers that the existing vegetation in school is not going to be cut, but remains during the life cycle of the specie.

Data of CO_2 absorption by forest species values has been taken from Spanish National Forest Inventory, since many forest species are also planted in urban gardens and schools. This national level information is a very valuable date, due to the fact that it is updated periodically, collecting the variability of the carbon sequestration in different climates existing at Iberian Peninsula. For species planted in the schools' gardens which do not grow naturally in the territory, the study on urban vegetation in the city of Barcelona has been applied. When data on CO_2 fixation rate is available in the National Forest Inventory this is the figure used in the tool. Otherwise, have to be considered data from Barcelona study is applied. It has been considered data for both types of vegetation (natural and urban) can be extrapolated to the other regions included in the project: Portugal, Finland and Romania.

Carbon dioxide sequestered by vegetation is subtracted for the global emissions of CO2 in the gardening activities.

References:

- Ex ante Carbon Dioxide Absorption Calculator. MAPAMA. 2015.
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Gardening machinery/equipment's use

The nature and scope of school green spaces varies strongly. Schools could have recreational lawn areas, gardens and some trees, different types of flora and scholar orchard. The area dedicated to "green spaces" is also highly variable.

The scenario considered supposes that not heavy machinery is needed. The tool asks about petrol consumption, and emissions are calculated according to that consumption. Equipment selected to be used in "green areas" of the schools is categorized as non- road equipment. Machinery commonly used in gardening is mainly fueled by petrol. The type of gardening equipment selected includes garden trimmers, lawn mowers, chain saws, garden shredders, wood cutters, suction machines and shrub clearers among others.

Relevant emissions from gasoline combustion in 2 or 4 stroke engines from 1 to 3 kW are CH_4, CO_2, N_2O, SO_2, NO_X, NMVOC, CO and NH_3 (Winter. 2012). Data from hydrocarbons (HC) and small particles (PM) have been collected from EPA-420 (2010).

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Watering

As have been explained before, water consumption is a critical factor in some regions due to the presence of water scarcity areas in Europe. Therefore, the impact on water scarcity produced by irrigation of green areas can be relevant. However, in order to be able to assess water consumption in watering, school must to know the amount of water which is spent in watering and differentiate it from other water uses.

Three options are presented as source of water per origin:

- Tap water: only if that consumption is apart from the amount of water considered in water consumption (different invoices, for example).
- Rain water: if school collect water from rain in covers, or store tanks. It is not consider electricity to impulse water.
- Well water: depends on the country. Well is not included for Gibraltar, since water in Gibraltar is mainly desalinated water. Electricity consumption for pump the water is also considered.

Pesticides

Pesticides have great variability in composition, characteristics and function. There are three main categories of pesticides: herbicides, insecticides and fungicides. It has been selected two of them for each class to be included in the tool.

Two steps have been followed to select them. First, the Community List of Approved and Excluded Active Substances has been consulted to ensure included pesticides are approved by the European Union. And second, products included in the “Parks and Gardens" scope of the Register of

Phytosanitary Products of the Ministry of Agriculture and Fisheries, Food and Environment of Spain (MAPAMA) have been consulted. is a summary of options presented in the tool, with main characteristic of the pesticide, and which is the pesticide of each type (herbicide, insecticide and fungicide) used as representative of the group.

Technical data of representative pesticide have been collected from Pesticide Properties DataBase (PPDB) from the University of Hertfordshire. However, in the absence of several parameters, the data have been supplemented by other sources (AP-42 (1995) Hazardous Substances Data Bank (HSDB) and Nageswara Rao (2016)).

Table 3 is a summary of options presented in the tool, with main characteristic of the pesticide, and which is the pesticide of each type (herbicide, insecticide and fungicide) used as representative of the group.

Technical data of representative pesticide have been collected from Pesticide Properties DataBase (PPDB) from the University of Hertfordshire. However, in the absence of several parameters, the data have been supplemented by other sources (AP-42 (1995) Hazardous Substances Data Bank (HSDB) and Nageswara Rao (2016)).

Table 3. Pesticides scenarios summary.

Type of pesticide	Option in the TOOL	Main characteristic	Representative pesticide
Herbicide	**Herbicide 1**	Preventive herbicide	Diflufenican 50%
Herbicide	**Herbicide 2**	Pre and post -emergence herbicide	Oxyfluorfen 48%
Insecticide	**insectcide 1**	Pyrethroide family	Cypermethrin 10%
Insecticide	**insectcide 2**	Other	Dimethoate 40%
Fungicide	**Fungicide 1**	Foliar and soil	80% Fosetil-AL
Fungicide	**Fungicide 2**	Foliar and soil Cu based	Cu 50% oxychloride

Application of pesticides in the field releases emissions to the different environmental compartments. A part of the applied pesticide is volatilized to air, both the active component of pesticide and the associated inert part (which that does not act against the pest but facilitates its dosage and application). These losses can be very important in some pesticides. Another part is spread on the soil. For the calculation of these emissions the EPA AP-42 methodology has been used.

Pesticides can also be incorporated into water by two ways, through runoff water or by leaching into groundwater. Surface water runoff calculations have been made following methodology by Wauchoupe (1978), which provides the transfer factors to the surface waters according to the type of pesticide and the type of formulation. Transfer factors for the selected pesticides fluctuate between 1% of the applied pesticide dose for copper Oxychloride and 0.5% for the rest of them. Potential groundwater contamination has been evaluated using Groundwater Ubiquity Score (GUS) combined with Organic Carbon-Water partition coefficient (Koc). Results show low leaching potential for the six selected pesticides.

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Fertilizers application

Gardening activities could include fertilizers application in order to improve soil characteristic of the school green areas. Extended commercial used fertilizers have been selected as input to gardening activities. The user will be able to choose and insert the amount per year which is applied. In case of NPK or PK compounds the user must provide info about % on Nitrogen, Phosphorous and Potassium.

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Table 4. Inorganic fertilizers.

Ammonium nitrate
Ammonium sulphate
Calcium ammonium nitrate (CAN)
Di ammonium phosphate (DAP)
Liquid urea-ammonium nitrate solution

NPK compound (Insert %N,%P,%K)
PK compound (Insert %N,%P,%K)
Triple superphosphate
Potassium sulfate
Unknown NPK

In case of organic fertilization, scenarios of production of compost have been obtained from bibliography, depending on the origin of organic material to produce compost, and each one is characterized by N content.

Table 5. Organic fertilization scenarios.

Organic fertilization 2: Organic materials of residues of municipal waste	N	1,015%
Organic fertilization1: Organic materials of residues of foods with green waste	N	1,230%

Fertilizers application on green areas results in emissions to air, water and soil. Direct and indirect emissions have been included both for nitrogen and phosphate fertilization. Emissions to the air are produced by NH3 volatilization, NOx and N2O emissions, which have been calculated following Nemecek and Kägi (2007) methodology. . Organic fertilization data is provided by grass cultivation scenario.

Outputs to water, in form of NO3 (nitrogen fertilization) and phosphorous (phosphate fertilization) are produced by three different ways: leaching, surface runoff and soil erosion with water participating as erosive factor. Nemecek & Kägi (2007) and Ausley (1999) have been applied to calculate them.

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Cleaning and maintenance

Cleaning activities refer to the daily cleaning of classrooms, offices, corridors and other dependencies of the school building. Maintenance activities include the annual painting, repairing and other required maintenance of the building elements. They involve the use of cleaning, substances, chemical products, stuff and machines.

Several selected stuff has been presented in the tool. Some consumption is expressed as number of units of objects (gloves, keys, etc.), for which scenarios have been created, considering the amount of the main materials which it is made, basing on commercial information. Furthermore, there are also common materials such as plastics HPDE, PE, PP, ABS, PVC, PS, steel, wood, aluminum, etc., for which the user has to input the amount used in mass units. Electricity consumption of appliances and machinery are calculated with power and operation time per year.

Table 6. Consumptions of materials in cleaning (a) and maintenance activities considered (inputs per activity).

a) Cleaning material consumption

INPUT (MATERIAL/STUFF)	UNIT
Cotton	kg
Cotton cloth	units
Polyester	kg
Cleaning paper	kg
Cleaning paper - Toilet paper (roll)	units
Cleaning paper (big roll)	units
Ammonia	l
Detergent	l
Bleach	l
Wax	l
Soap	l
Plastic bags	units
Plastic HPDE	kg
Plastic PE	kg
Plastic PP	kg
Plastic ABS	kg
Plastic PVC	kg
Plastic PS	kg
Plastic PET	kg
Latex gloves	units

b) Maintenance material consumption.

INPUT (MATERIAL/STUFF)	UNIT	INPUT (MATERIAL/STUFF)	UNIT
Adhesive	kg	Key	units
Sealant	cm^3	Metal ns	kg
Paint (Water solvent)	l	Lubricant	kg
Paint (Acrylic solvent)	l	Cement Portland	kg
Barnes	l	Gravel	kg
Wood	kg	Plaster	kg
Glass (flat)	m^2	Sand	kg
Glass	kg	Rubber	kg
Iron (kg)	kg	Leather	kg
Iron (m^3)	m^3	HPDE	kg
Aluminum (kg)	kg	PE	kg
Aluminum (m^3)	cm^3	ABS	kg
Aluminum doorknob/handle	units	PVC	kg
Steel sheet	kg	Plastic PS	kg
Steel (kg)	kg	Pipe PVC	m
Steel fence	m	Ceiling Panel (PS)	cm^2
Steel locked	units		

Data sources to commercial products:

- http://www.reactiva.com.ar/php/producto.php?action=info_product&id=196
- http://limpiezaycelulosa.com/Papel-higienico
- http://www.ecosmep.com/cabecera/upload/fichas/7182.pdf
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- file:///C:/Users/acvase/Downloads/descargas-catalogos-Catalogo%20PVC%20(baja%20resolucion).pdf
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- http://www.visever.com/descargas/ficha_horizontal.pdf
- http://www.duracero.com/Catalogo_DURACERO_2014.pdf
- https://www.interempresas.net/FeriaVirtual/Catalogos_y_documentos/188785/Cerraduras-y-empun--771-aduras.pdf

Food Services/Kitchen

Scholar food service considers the equipment and operation time. The electricity consumption was calculated considering a working period in hours per day for discontinuous working appliances (Dishwasher, oven, kitchen/plate, microwave, coffeemaker) and the whole day for continuous working appliances (freezer and fridge) in the scholar period.

Wastes

Schools produce waste which is a mix between typical waste from offices activities and houses. Two groups of wastes have been presented depending on the subsystem which they are produced from. All wastes have been allocated as an activity into subsystem 1, school management. Some wastes have been characterized in unit values, considering commercial information, but most of the wastes are asked in the tool in mass value, due to heterogeneity of wastes. Impact factor per wastes have been calculated with general processes of waste treatment and end of life scenarios obtained from Ecoinvent. For some materials two possibilities are included: disposal and recycling. Wastewater treatment has been estimated considering a 75% ratio between water consumption and wastewater production based on bibliography (Marín Galvín, R. (2015)).

References:

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Table 7.Wastes produced in the system, divided in a) from subsystem 1, and b) from subsystem .

a) Wastes from subsystem 1

Input (Material/staff)	Unit
WEEE[4]	kg
Fluorescent tube	Units
Compact fluorescent lamps	Units
Incandescent bulbs	units
Halogen lamps	units
LEDs	units
Waste oil	Kg
Dirty cleaning paper	Kg
Dirty cleaning textile	Kg
Plastics mixed	kg
Iron disposed off	kg
aluminum disposed off	kg
Metal ns disposed off	kg
Glass disposed off	kg
Wasted mixed	kg
Paint disposed off	kg
Wood disposed off	kg
Debris mixed	kg
Water treatment	m3

b) Wastes from subsystem 2

Input (Material/staff)	Unit
Disposal cardboard	Kg
Disposal glass	Kg
Disposal mixed plastics	Kg
Disposal metal	Kg
Recycling textiles	Kg
Recycling cardboard	Kg
Recycling glass	Kg
Recycling mixed plastics	Kg
Recycling steel and iron	Kg
Recycling textiles	Kg
Used toner module, laser printer	Kg
Computers disposed off to WEEE treatment	Kg
Laptop disposed off to WEEE treatment	Kg
CRT flat screen to WEEE treatment	Kg
LCD flat screen to WEEE treatment	Kg
WEEE different to computers, scanners,…to treatment	Kg

[4] WEEE: waste electrical and electronic equipment.

Subsystem 2. Activities in the School to educational activities.

Other activities strictly linked to the education performance in the schools such as the resources related to teaching such as pens, books, paper and other several materials and staff, and the use of computers and other electronic equipment are included within the scope of this subsystem. The subsystem is divided according to Figure 2.

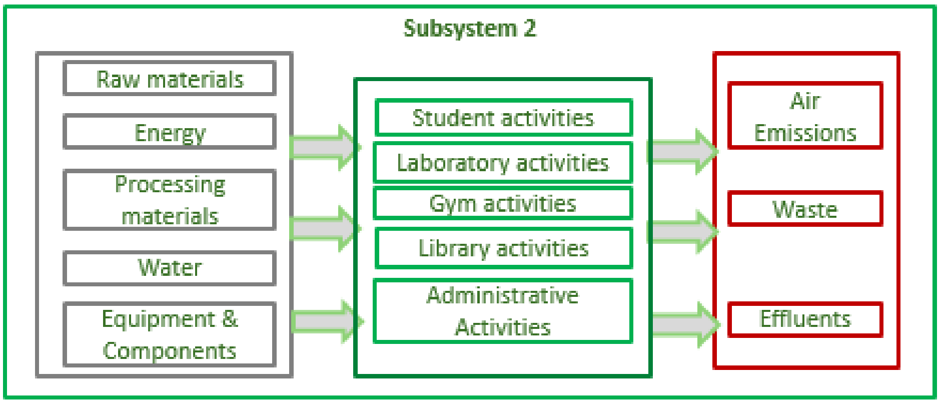

Figure 2. Subsystem 2. Activities in the School required to teaching and learning,pure Educational Activities.

Student activities

Student activities are referred to learning activities, considering consumption of the student, when students support own education buying some resources to use in class. Previous work is required per school, since for this part an average of consumption of materials and products per student is needed. For example, school could collect data of a survey of materials and products which are spent by each student in a sample class or group of classes.

In addition, student activities could include other non-specific materials, such as paint, wood, plastic, rubber, ….). Therefore, a section dedicated to insert other consumption in material terms have been included. To calculate impact factor of the products, commercial information has been consulted, considering the production of material which makes up each product.

Other relevant consumption in this activity takes into account the average of number of books per course (book which student have to supply), to calculate a weighted average of total supplied books per student. Book could be bought or be reused (cero emissions considered in production of product). A percentage of secondhand book is obtained from Behavior Questionnaire. To calculate impact factor an average of literature have been used as to calculate weight per unit (Arberola Lopez et al, 2010).

Finally, student activity includes the student utilization of appliances and equipment. Educational centers are starting to use technological package as alternative to books, providing contents in electronical format. Electricity consumption determines the impact factor, so impact it is calculated thought the time of use of own laptops or tablets in class. Other electricity spent by "other appliances/equipment" has been covered, and it is calculated using power and operation time.

Table 8. List of student activity material consumptions.

Material/Product	Unit

Paper (kg)	kg
Recycled paper (kg)	kg
Paper (sheets, A4)	unit
Recycled paper (sheets, A4)	unit
Notebooks (little size)	unit
Notebooks (big size)	unit
Recycled paper notebook (little)	unit
Recycled paper notebook (big size)	unit
Cardboard folder	unit
Plastic folder	unit
Eraser	unit
Pen	unit
Marker pen	unit
Pencils	unit
Colour pencil	unit
CDs	unit
DVDs	unit
Glue stick	unit
Paperboard	kg
Corrector	unit
Scissors	unit
Rule (30 cm)	unit
Compass	unit

Laboratory Activities

Most typical substances in basic laboratory activities are include, and some stuff (gloves, glasses, etc.) as well.

Microscopes and Autoclave have been identified as typical laboratory appliances in schools in order to calculate electricity consumption. Other lab devices could be considered if school knows operation time and power.

Two options of typical lab waste, separated of the common "Waste activity" (Subsystem 1 included a part for Wastes), could be completed in that activity information. Lab activity could produce hazardous liquid effluents and hazardous solid effluents, considering the type of waste that will be managed. Density of the liquid hazardous wasted is based on density conversion factors developed by the UK Environment Agency for the commercial and industrial waste survey in UK. There is a factor for each of the European Wastes Codes in the List of Wastes. An average of density has been used.

In addition, lab activities could include other non-specific materials, as paint, wood, plastic, rubber,….), so a section to insert other consumption in material terms have been included. To calculate impact factors of the products commercial information of densities has been consulted, considering the production of simple material which makes up the product or substance.

Table 9. Laboratory consumptions.

Substance	Unit
Alcohol 96º.	l
Hcl	l
Nitric Acid	l
Acetic Acid	l
Hydrogen Peroxide	l
Formic Aldehyde	l
Potassium Hydroxide	kg
Eter Petroleum	kg
Potassium Permanganate	kg
Iron(Iii) Sulfate, Without Water, In 12.5% Iron Solution State	kg
Calcium Chloride, Cacl2	kg
Chemicals Organic	kg
Chemicals Inorganic	kg
Gloves	unit
Gloves Latex	unit
Security Glasses	unit

Gym activities

Due to the diversity of stuff used in gym activities a short list of consumptions has been proposed: Balls, Mats, Hurdles, Frisbi, Lockers, Foam/mattress). Additionally, gym activities could be include other non-specific products different to the proposed stuff, including a section where the user can insert products, by simple material composition in weight (plastic, rubber, etc.). To calculate impact factors of the products commercial information of weight has been considered.

Library Activities

Library activities consider the books bought by the school per year, as well as multimedia resources (CD/DVD). Moreover, library activities could include other non-specific materials, so a section to insert other consumption in material terms has been included. To calculate impact factors of the products commercial information of densities has been consulted.

Administrative Activities

Administrative activities include all consumption of materials, products and energy, necessary to develop the educational activity and that has been purchased by school. Consumptions are divided in three groups: material/products, devices used and new devices (**Table 10. Administrative activity consumptions.**Table 10).

Impact factor of materials/products have been calculated using commercial info about weight, and considering the production of materials which compound each product. For "devices used" the impact is referred to electricity consumption, so depends on operational time. As in other activities, other section have been included in which the user can be complete information about non-specific materials, as paint, wood, plastic, rubber, etc. To calculate impact factors of the products commercial information of densities has been consulted.

Table 10. Administrative activity consumptions.

Material/ products				**Devices used**		**New devices**	
Toner Cartridge (Black)	Units	Pencils	Units	Computer Desktop+CRT Screen	Units	Desktop Computer, Without Screen	Units
Ink Cartridges (Colour)	Units	Colour Pencils	Units	Computer Desktop+LCD Screen	Units	Laptop Computer	Units
Printed Paper A4	Units	CD	Units	Laptop	Units	LCD Flat Screen	Units
Printed Paper A3	Units	DVD	Units	Notebook	Units	CRT Screen	Units
Paper	Kg	Glue Stick	Units	Printer - Inject	Units	Printer, Laser Jet, B/W	Units
Cardboard Folder	Units	Pins	Units	Photocopier	Units	Printer, Laser Jet, Colour	Units
Plastic Folder	Units	Art Paper	Units	Printer Multifunction	Units	Keyboard	Units
Pen	Units	Art Paint	Units	3d Printer	Units	Mouse Device, Optical, With Cable, At Plant/GLO U	Units
Marker Pen	Units	Desk Teacher	Units	Speakers (10 W, Aux Desktop Computer)	Units	Tablet	Units
Tape	Units	Chairs	Units	Tablet	Units	Other Office Machinery (New)	Kg
Paper Envelope	Units	Bookcase	Units	Speakers (Big System)	Units		
Plastic Sleeve PP	Units	Desk Kid	Units	Overhead Projector	Units		
Clamp	Units	Chairs Kid	Units	Multimedia Projector	Units		
Elastic Rubber	Units	Battery Ion Li (Rechargeable)	Units	Scanner	Units		
Eraser	Units	Battery Ion Li	Units	Plasticiser Machine	Units		
Chalk handle	Units	Battery Nimh (Rechargeable)	Units	E-Boards	Units		
Clips	Units	Battery Nicd (1300mah)	Units	Cd Player	Units		
Pad (Mouse)	Units	Battery Nicd (2000mah)	Units	DVD/VCR	Units		
Chalks	Units			Network Access	Hours		

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Subsystem 3. Activities out of the school: Transport and mobility

Subsystem 3 is related to activities outside the center. Figure 3 present the subsystem 3 scheme, where two types of activities could be defined: transport of the students and school staff to official outings, and the mobility of the whole educational community to the center.

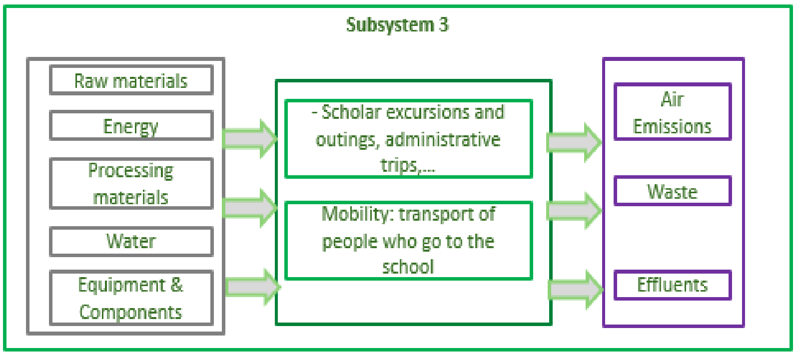

Figure 3. Subsystem 3. Activities out of the school. Transport and mobility.

Transport

Required data is number of passengers, type of vehicle and distance of trip (km). The impact factor depends on the vehicle and it has been calculated in terms of personkm.

Possible vehicles included in LCA module: Bus, van, public bus, metro, tram, car petrol and car diesel, train, bicycle, motorcycle, e-bike, e-car, plane and boat. Non vehicle (On foot, walking)

Mobility

Mobility could be a complex activity due to variability of scenarios considering the big range of territories, cities, village, etc. LCA module included 2 options:

- Private collective route: special route mobility to pick students up. It used to be hired by Parents Association, City Hall or School. Vehicle can be a private bus or a van. The LCA tool allows the introduction of up to 5 routes.
- Independent mobility: each person of the community provides his/her mobility. Means of transport can be: Walking, bicycle, public bus, metro, train, tram, boat, car and motorbike.

The calculations are made using the results of Behavior questionnaire:

- Info about means of transports: using Behavior Questionnaire results school must calculate a % of use of each modes of transport by community people to go to school.

% mobility by $X= ((1*a+0.8\cdot a_1+0.4\cdot a_2)/ b) \cdot 100$

Where,

X: mean of transport

a_x: % of surveyed who answered “always” in question “Do you travel to the school by X?"

$a_{x1:}$ % of surveyed who answered “almost always” in question “Do you travel to the school by X?"

$a_{x2:}$ % of surveyed who answered “sometimes” in question “Do you travel to the school by X?"

b: 2.2 (weight of 100% of answers).

- Info about data of number of trips per day: direct result of the questionnaire, % Community people who come back to home per vehicle (4 trips to school per day).

- Info about people who share the car: direct result of the questionnaire, % community people who share car

- Info about passengers in sharing cars:

Average of the number of passengers in sharing cars= g/ h

Where,

g: sum of all answers (numerical values) to question to the question “how many passengers go to your school with you?”

h: number of answers.

Note that, it is need sum the passenger who has fill the answer, because that the total of passengers, needed to calculate transports in personkm, corresponds to *g* (rest of passengers) plus *h* (people how answer the questionnaire).

- Info about distance between home and to school

Average of the distance between home and to school = i/ j

Where:

i: sum of all answers (numerical values) to the question “What is the distance between your home and school?"

j: number of answers.

The impact factor depends on the vehicle and it has been calculated in terms of personkm. Percentages are assumed as a representative sample of the whole school, since they are multiplied by whole school people (total number of students plus teachers and staff who work in the school) and by the average of distance, to get a result in personkm per type of vehicle.

Regarding to calculations of the allocation of weight of impact in case of sharing car, a factor of relationship has been calculated to decrease the weight of impact per student when car is shared with more people. That means, the impact is distributed between people who travel in the car.

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5. Environmental Impact Factors Database

LCA module is oriented to obtain impact results referred to different impact categories. ILCD handbook proposed methods have been used to analyze the impacts. As a result, the impact factors included in the LCA module correspond to the assortment of impact methodologies and impact categories which ILCD includes. Information was developed by the Institute for Environment and Sustainability in the European Commission Joint Research Centre (JRC), in co-operation with the Environment DG. It is part of the Commission's promotion of sustainable consumption and production patterns.

Table 11. Impact Categories.

Impact category	Recommended method	Indicator
Climate change	Baseline model of 100 years of the IPCC	**kg CO2 eq**
Ozone depletion	Steady-state ODPs 1999 as in WMO assessment	**kg CFC-11 eq**
Human toxicity, non-cancer effects	USEtox model (Rosenbaum et al, 2008)	**CTUh**
Human toxicity, cancer effects	USEtox model (Rosenbaum et al, 2008)	**CTUh**
Particulate matter	RiskPoll model (Rabl and Spadaro, 2004) and Greco et al 2007	**kg PM2.5 eq**
Photochemical ozone formation	LOTOS-EUROS (Van Zelm et al, 2008) as applied in ReCiPe	**kg NMVOC eq**
Acidification	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	**molc H+ eq**
Freshwater eutrophication	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	**kg P eq**
Freshwater ecotoxicity	USEtox model, (Rosenbaum et al, 2008)	**CTUe**
Land use	Model based on Soil Organic Matter (SOM) (Milà i Canals et al, 2007)	**kg C deficit**
Water resource depletion	Model for water consumption as in Swiss Ecoscarcity (Frischknecht et al, 2008)	**m3 water eq**
Mineral, fossil & renovable resource depletion	CML 2002 (Guinée et al., 2002)	**kg Sb eq**

ILCD Method was developed by the Institute for Environment and Sustainability in the European Commission Joint Research Centre (JRC), in co-operation with the Environment DG. It is part of the Commission's promotion of sustainable consumption and production patterns.

The environmental impact characterization allows to link all emissions, effluent and wastes production as consequence of the consumption of material and energy in the School, with the environmental impacts. In this tool the Environmental Footprint includes a set of impact categories:

Impact	**Description**	**Endpoint**
Climate change	This impact quantifies the global warming potential and is expressed in unit of kg of CO2 equivalents. Substances such as CO2, methane or N2O are the main, but narture and human activities emmit many other which also contribute to the global warming, and therefore, to the CLimate Change.	Global impact
Ozone depletion	This impact measures the destructive effects on the stratospheric ozone layer (stratophere) which protects the plant of damaging radiation and preserves the life on the Earth. Unit: kg CFC-11 eq.	
Human toxicity, non-cancer effects	This impact expresses the estimated increase in morbidity (non-cancer) in the total human population. Unit: Comparative Toxic Unit for humans (CTUh)	Human Health
Human toxicity, cancer effects	This impact expresses the estimated increase in cancer-related morbidity in the total human population per unit mass of a chemical emitted (cases per kilogramme). Unit: Comparative Toxic Unit for humans (CTUh)	
Particulate matter	This impact provides the quantification of the patrticular matter emmited. This impacts on human health increasing the disease incidence (respiratory, Cardiovascular, etc.). It is expressed in kg PM2.5 eq.	

Photochemical ozone formation	This impact quantifies the contribution to photochemical ozone formation in the tropospshere wherre the human live. Ozone is toxic for human (and other beings). It is expressed in kg NMVOC eq (Non-methane volatile organic compounds)	
Acidification	This impact quantifies the acidifying potential of the substances released, whic change the ph affecting ecosystems. It expressed in mol H+ eq	Ecosystems damage
Freshwater eutrophication	This impact quantifies the degree to which the emitted nutrients reach the freshwater end compartment (phosphorus considered as limiting factor in freshwater). Freshwater ecosystem equilibrium is fragile and the unbalanced nutrients cycle can has catastrophic consequences, specially in lakes and lagoons. Unit: kg P eq	
Freshwater ecotoxicity	The impact estimates the fraction of potentially affected species. Unit: Comparative Toxic Unit for ecosystems (CTUe)	
Land use	The impacts measures the land use activities impact on soil properties considering the mass deficit of soil organic carbon. Unit kg de deficit de C	Resources depletion
Water resource depletion	The water use related to local scarcity of water (m3)	
Mineral, fossil & ren resource depletion	The impact quantifies the depletion of abiotic resources as comparison with one of the most scarce minerals (Antimony). Unit: kg of Sb. Eq.	

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3. ENVIRONMENTAL FOOTPRINT RESULTS

The module presents the results per impact category in terms total of the school, per student considering the contribution of different elements of the system to compare the influence of subsystems in the impact of the total system impact, and the activities in each subsystem impact.

An environmental foot print covering most of relevant environmental impacts is calculated:

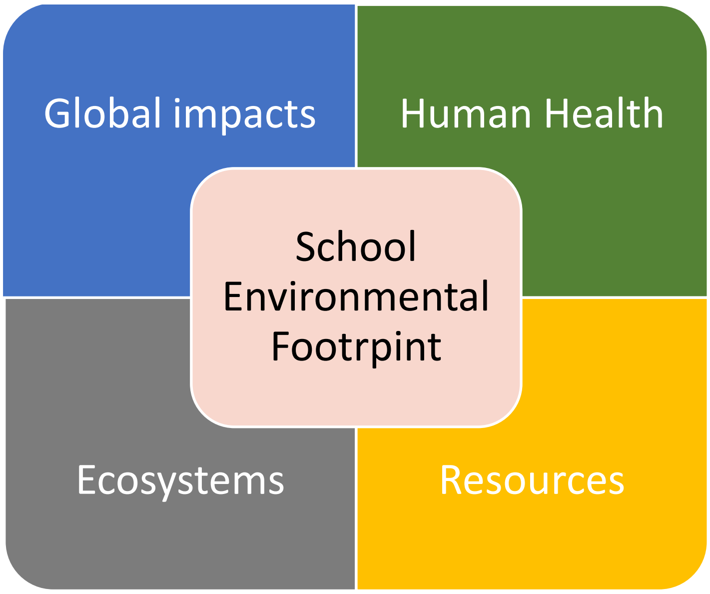

Table 12. Summary of result presentation in V1 – School System and School User

	Tables	Charts
Results by subsystem: values and contribution per subsystem	- Impacts per school - Impacts per student	Contribution per subsystem
Subsystem 1 School Management Activities: values per activity and graphical activities comparison **+ Other consumptions of electricity** **+ Water**	- Impacts per school - Impacts per student - Impacts per usable m^2	Contribution per activity
Subsystem 2 Educational Activities: values per activity and graphical activities comparison	- Impacts per school - Impacts per student	Contribution per activity

Subsystem 3. Activities out of the school - Transport and mobility: values per activity and graphical activity comparison	- Impacts per school - Impacts per student	Contribution per activity Comparison with the average

Table 13. Summary of result presentation in V1 – School System and School User

	Tables	Charts
Results by subsystem: values and contribution per subsystem	- Impacts per school - Impacts per student	Contribution per subsystem
Subsystem 1 School Management Activities: values per activity and graphical activities comparison **+ Other consumptions of electricity** **+ Water**	- Impacts per school - Impacts per student - Impacts per usable m^2	Contribution per activity
Subsystem 2 Educational Activities: values per activity and graphical activities comparison	- Impacts per school - Impacts per student	Contribution per activity
Subsystem 3. Activities out of the school – Transport and mobility including School and Family trips: values per activity and graphical activity comparison	- Impacts per school - Impacts per student	Contribution per activity Comparison with the average