Project co-financed by the European Regional Development Fund

School Low Carbon Footprint in Mediterranean cities

Deliverable 3.2.1

School Environmental Footprint Guidelines

EDUFOOTPRINT

School Low Carbon Footprint in Mediterranean Cities

PRIORITY AXIS: Fostering Low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas
OBJECTIVE: 2.1 To raise capacity for better management of energy in public buildings at transnational level

DELIVERABLE NUMBER: 3.2.3

TITLE OF DELIVERABLE: School Environmental Footprint Guidelines (SEFGs)

WP n. 3: Testing

ACTIVITY N. 3.2

PARTNER IN CHARGE: Ambiente Italia

PARTNERS INVOLVED: ALL PARTNERS

Date: 05th May 2017

Summary

The general objective of EduFootprint Project is to better manage, plan and monitor the energy consumption in public buildings in the Mediterranean area. Specifically EduFootprint will reach this aim working focused in public school buildings with an innovative Life Cycle Assessment (LCA) approach, considering not just direct energy impacts of buildings (consumption), but also indirect ones (public procurement or general human awareness and behaviour). This deliverables is connected to Work Package n. 3, named Testing, and it is a document for guiding partners in the implementation of EduFootprint model and calculator in the pilot schools.

1. Introduction

The Guideline is one of the main deliverables of EduFootprint project, addressed to owners and managers of public buildings used for activities with educational purposes, that has the following goals:

- To describe the suggested methodology to be used in the calculation of the Environmental Footprint in schools;
- To assure common methodologies used in different pilot areas during the development of project activities;
- To describe the tool EduFootprint Calculator, specifically developed to allow an easy monitoring of energy consumption in buildings and to calculate the Environmental Footprint in schools;
- To help owners and managers to assess the energy efficiency of the public buildings *(direct consumption)* together with other environmental impacts (*community indirect consumption)*;
- To help to improve the environmental performance, broadly speaking, providing a defined package of actions for reducing the footprint; (the suggested actions derive from the activities tested in the past in different previous experiences or are to be tested at transnational level in the project);
- To reduce the current Environmental footprint of the pilot school.

2. Life Cycle Assessment and Environmental Footprint methodologies

WHAT IS EDUFOOTPRINT?

EduFootprint is a project focused on public buildings where the ~~of~~ education and training services take~~s~~ place. The public buildings can be kindergartens, primary and high schools, university campus. Local authorities might use this guideline in order to analyse the environmental impacts and the energy consumption of the educational buildings.

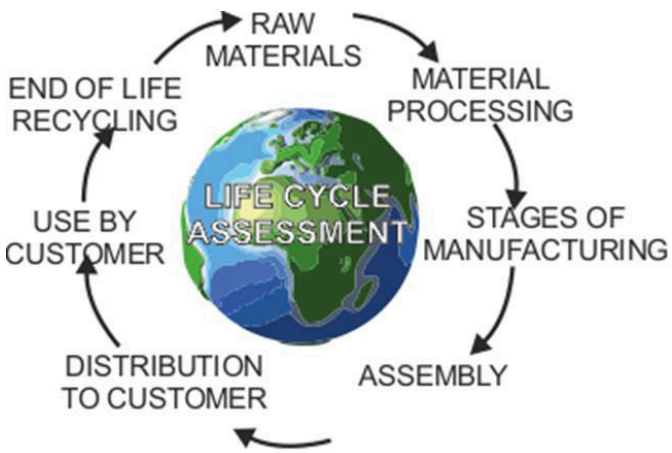
EduFootprint completes this process, helping the owner, manager or people who attend the education in the public buildings to extend their understanding of environmental impacts with a Life Cycle Assessment (LCA) approach. This approach considers not only the direct impacts of buildings, but also the indirect ones such as impacts of resource consumption in public procurement, mobility and transport, human awareness and behaviour, waste management.

EduFootprint contents ~~is~~ are compatible and integrated with the sustainable development education initiatives in schools and university. EduFootprint also extends the capability of local public administration to optimize Sustainable Energy Action Plan (SEAP) in the UE Covenant of Mayors initiative.

WHAT IS THE LCA APPROACH?

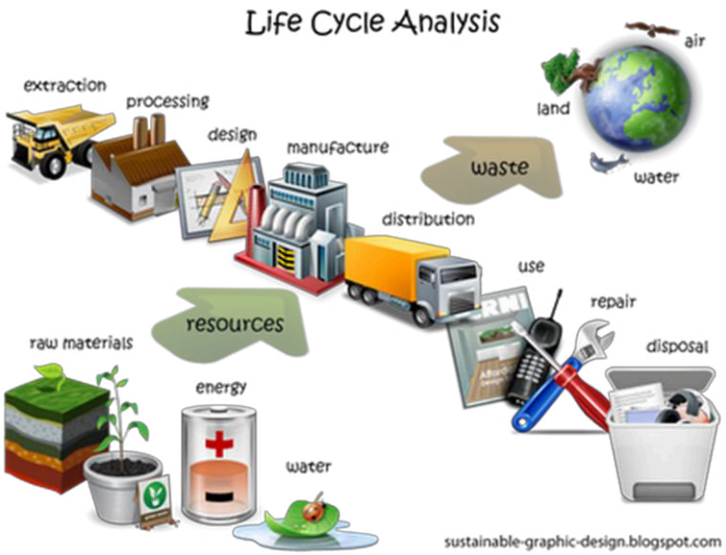
The term “life cycle” refers to the major activities in the course of the product’s life-span from its manufacture, use and maintenance, to its final disposal, including the raw material acquisition required to manufacture the product.

Figure 1 – Life Cycle Assessment visual scheme



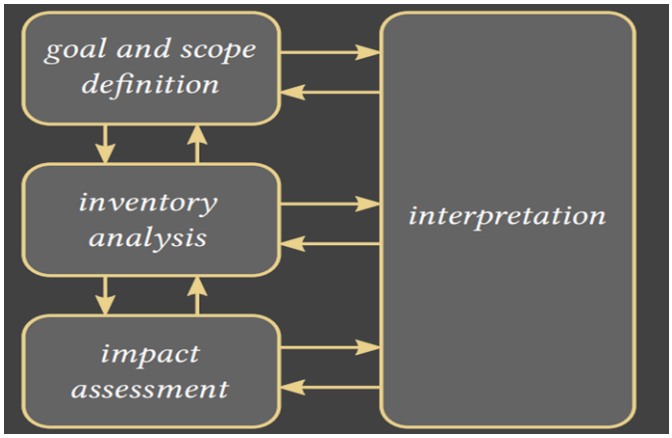
Simply stated, the life cycle of a product or service embraces all of the activities that go into making, transporting, using and disposing of that product or service. The typical life cycle consists of a series of stages starting from extraction of raw materials, through design and formulation, processing, manufacturing, packaging, distribution, use, re-use, recycling and, ultimately, to waste disposal (figure 2).

Figure 2 – Life Cycle Phases



Among the newer concepts about LCA there is the "Life cycle management" (LCM), which is an integrated approach to minimising environmental burdens throughout the life cycle of a product, system (organisation) or service. This approach is provided for EduFooprint project. A typical LCA-study consists of the stages showed in figure 3.

Figure 3 – Stages of LCA study (ISO 14040:2006)

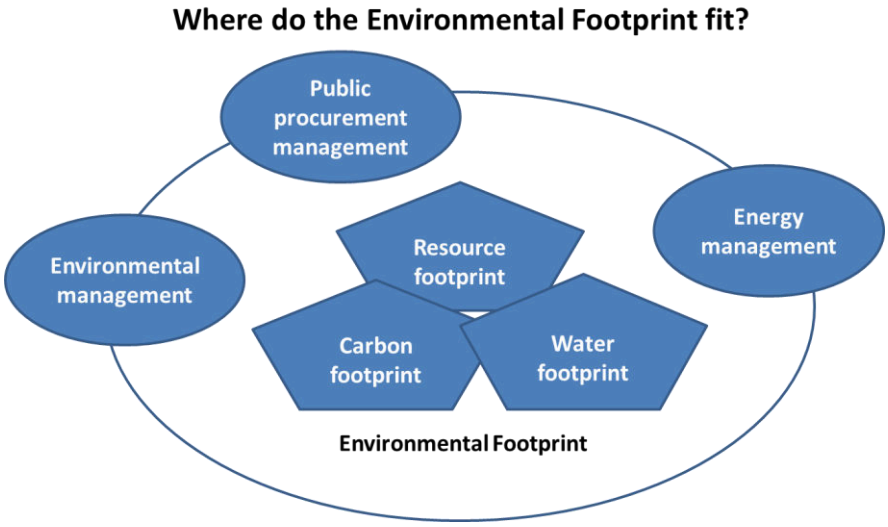


ISO 14040:2006 describes the principles and framework for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements. ISO 14040:2006 covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies. It does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA.LCA is a decision support tool. Used in the right way, it can help to ensure that education building manager's choices are environmentally oriented.

WHAT IS THE ENVIRONMENTAL FOOTPRINT?

The Environmental Footprint (EF) is a multi-criteria measure of the environmental performance of a good/service-providing organisation from a life cycle approach. The design of this measure in EduFootprint project should be based on the Organisation Environmental Footprint (OEF). The OEF is a method for modelling and quantifying the physical environmental impacts of the flows of material/energy, resulting emissions and waste streams associated with the Organisational activities from a supply-chain perspective (from extraction of raw materials, through use, to final waste management).

Figure 4 - Concept of the Environmental Footprint



A life cycle approach takes into consideration the spectrum of resource flows and environmental interventions associated with a service or organisation from a supply-chain perspective. It includes all stages of the product's life cycle, from raw material acquisition through processing, distribution, use, and end-of-life processes. The OEF methodology is based on EU OEF guide (Recommendation 2013/79/EU).

Environmental footprint or carbon footprint?

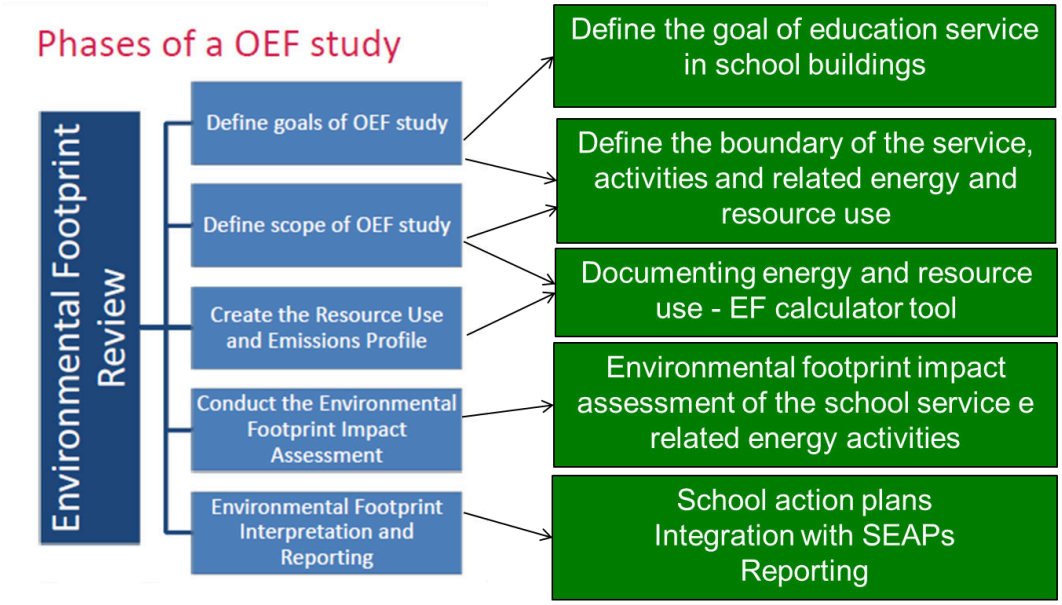
Environmental footprint can be measured using the EduFootprint calculator. It tells how much resources are needed and the total measure of local and global pollution considering one student using the education service in that public building.

Carbon footprint is a type of footprint and it can be measured with EduFootprint calculator. It is measured in tonnes (or kilogrammes) of carbon dioxide per person. It tells us how much carbon dioxide is released by the fossil fuels that are burnt to give us energy (providing transport, heat and electricity to us directly, but also to make, transport and dispose of all the goods we consume).

HOW IS THE ENVIRONMENTAL FOOTPRINT RELATED TO THE EDUCATION SERVICE?

LCA approach and Organisation Environmental Footprint should be used in MED EduFootprint project as a decision support tool to improve energy and environmental impact of education service and to increase resource efficiency. Therefore EduFootprint can be used to analyse the environmental consequences of a change in people behaviour in public buildings (schools and university), and the efforts can be directed towards sustainability solutions. Figure 5 shows how the EduFootprint project provides a life cycle approach in coherence with EU OEF guide. Each step is described hereinafter.

Figure 5 – Phases of a OEF Study



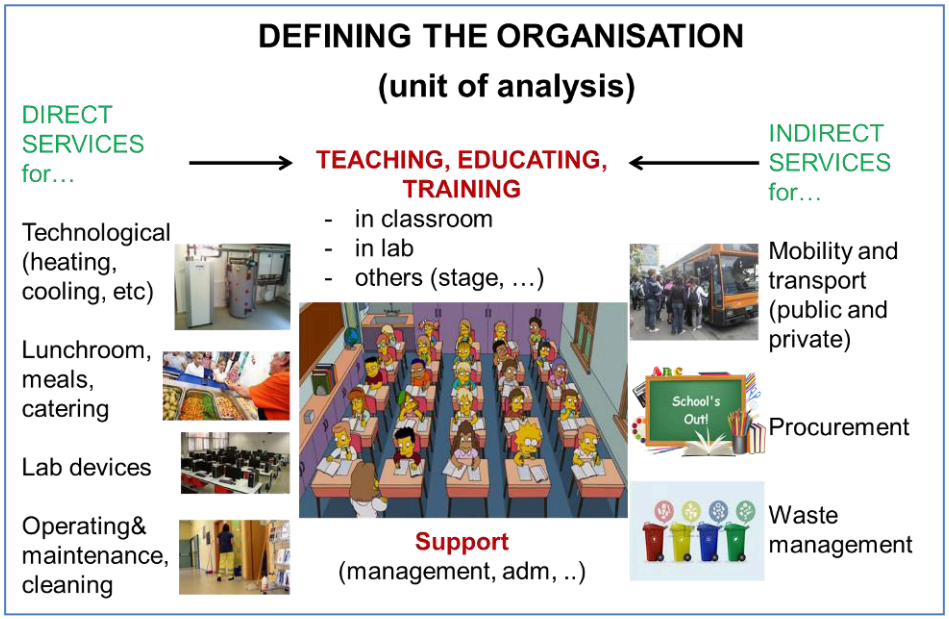
1. Define the goal of the education service

The analysis starts with the definition of the education service in school buildings; the information needed are the dimension of the building, the age of construction, the type of education service provided, the number of students, the number of teachers, the duration of the lesson etc. The list is not exhaustive.

OEF method needs to define the **Product Portfolio**, a term referring to the amount and nature of goods and services provided by the Organisation over the reporting interval, which should be one year. It constitutes the basis for completing the Resource Use and Emissions Profile (inventory) for the Organisation, which equals the input and output flows associated with the provision of the Organisation's Product Portfolio as per the defined system boundaries for the study. As far as EduFootprint is concerned, it is *one student (or child, or pupil) registered in one school or one university*.

2. Define the boundary of the service, activities and related energy and resource use

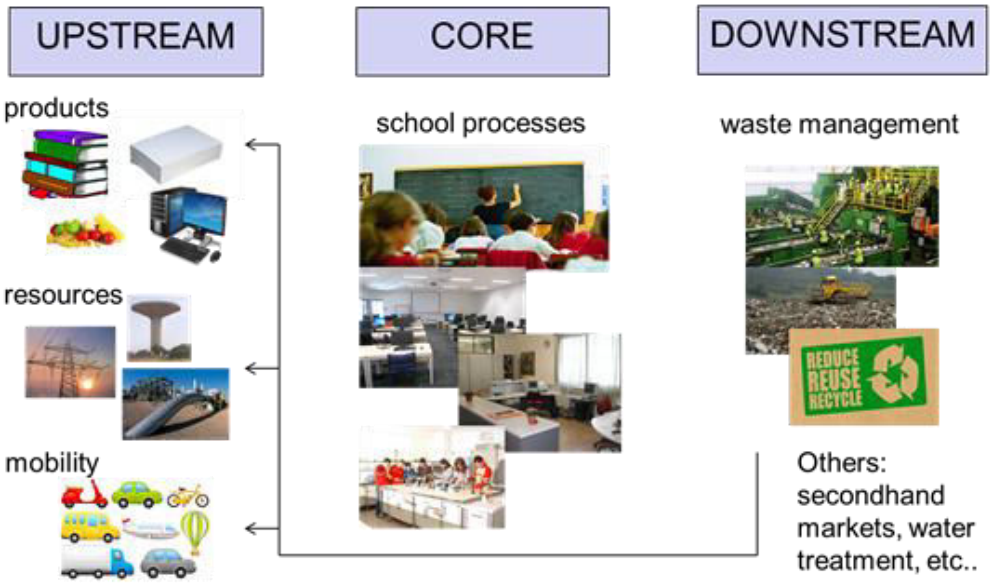
Figure 6 – The system boundary



To correctly calculate the Organisation Environmental Footprint it is necessary to define the boundary of the provided service referring to which kind of service is directly provided (presence of

labs, presence ok kitchen, presence and type of heating and cooling plants, presence of lunchroom and/or catering etc….) and indirectly provided (type of transport, type of waste management, cleaning service, maintenance, type of procurement, distance from the suppliers). The direct and indirect relationship between these services and the building could be different from school to school.

Figure 7 – The three models: upstream, core and downstream



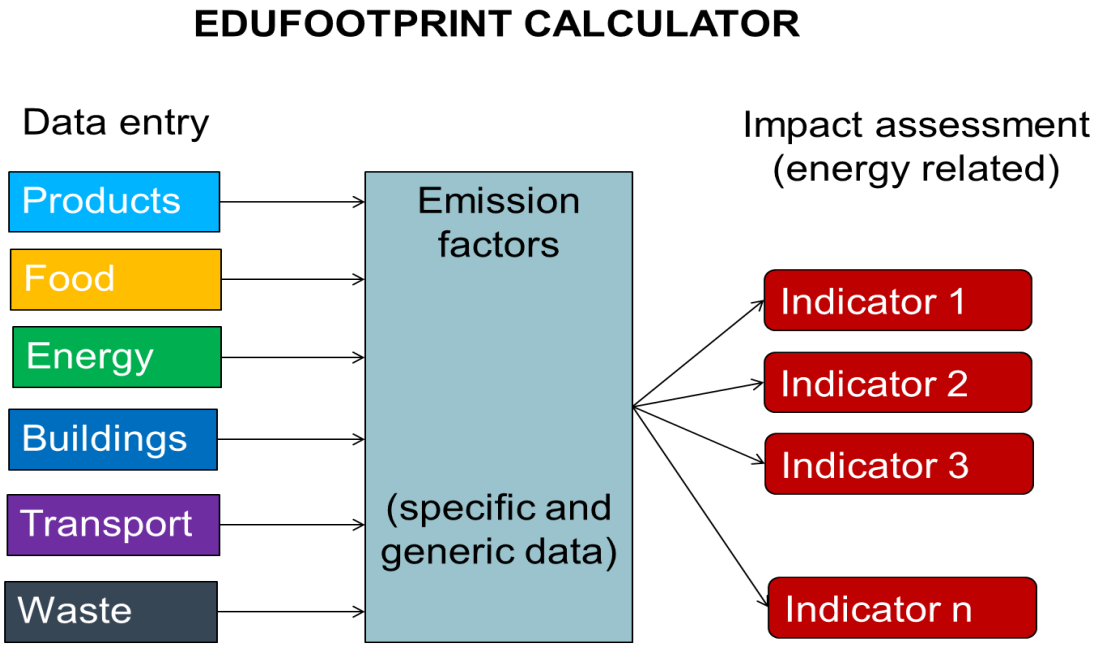
After defining the services to consider and the type of relationships with the school in subject, the entire system (educational service with the other interconnected services) is divided into three modules named *upstream*, *core* and *downstream*. The *upstream* module is related to the phases that are before the analysed process ("educational process" for EduFootprint Project) such as the energy industrial process, the manufacturer process to produce all the products used inside the schools, etc. The *core* module is related to the education processes, provided inside the school, while the downstream module is associated with the management of the waste generated by the educational system.

3. Documenting energy and resource use - See Edufootprint calcutator (Sheet 3)

This phase is characterised by data entry considering the all sections of the calculator (building consumption, product consumption, mobility, food and waste).

4. Environmental footprint impact assessment

Environmental Footprint (EF) impact categories refer to specific categories of environmental impacts considered in the OEF guide (Ref. Ares(2012) 873788 - 17/07/2012). These are related to resource use (e.g. fossil fuels or gas) and emissions of environmentally damaging substances (e.g. Green House Gases or substances that cause ozone depletion), which may influence human health. Impact assessment models are used for quantifying the causal relationships between the material/energy inputs (data entry) and emissions associated with education service and each EF impact category considered (see par 3.3, table 1).



The purpose of the Environmental Footprint (EF) impact assessment is to aggregate the environmental data in the EduFootprint calculator according to the respective contributions to each EF impact category. This subsequently provides the necessary basis for the interpretation of the results related to the goals of the project (for example, identification of procurement phase "hotspots" and options for improving them).

5. Action plan

On the basis of the achieved results, an action plan will be developed by owners, managers and people attending the education buildings in order to improve at least one of the worse environmental impacts . The action plan is the result of drawing together all that has been learnt using the Edufootprint resource. It provides a 'reality check', demonstrating a real commitment to

sustainable development, by taking positive action to reduce the Environmental Footprint. More details about Action Plan will be find in chap. 5.

3. EduFootprint calculator

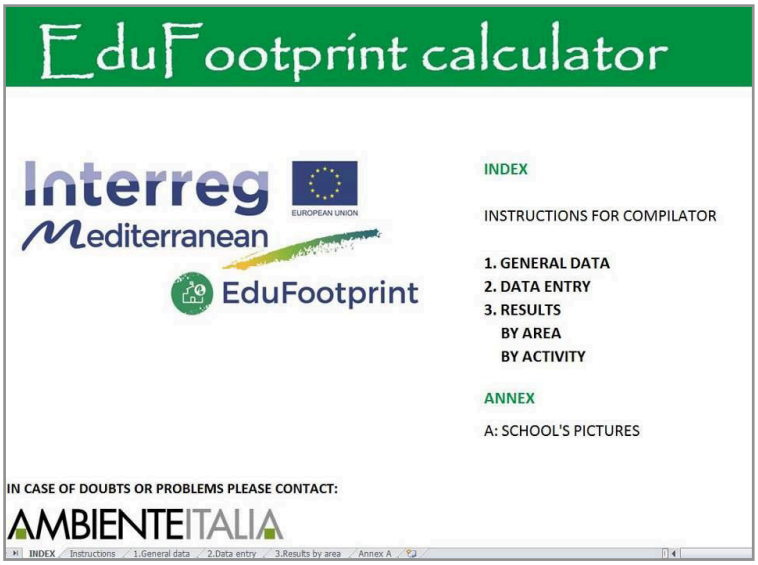
How to use EduFootprint calculator?

Ambiente Italia, partner in EduFootprint project, has developed a tool that allows to calculate automatically Environmental Footprint of schools: the **EduFootprint Calculator**.

The calculator measures **resource consumption and activities carried out in the school** and converts them in the environmental impact. It may help owners and manager of schools to identify the main environmental impacts of everyday activities and implement more sustainable practices. It considers not just building direct consumptions (as for instance, energy or water consumption) but also other activities linked to the school that have impacts on the environment, for instance Mobility (from home to school but also connected to educational trips and travel excursions).

EduFootprint Calculator is based on Microsoft Excel. It's an Excel file with different worksheets; the main one is labelled INDEX (Figure 8) and has links with all the worksheets just by clicking in the name of different sections.

Figure 8: EduFootprint calculator screenshot of main worksheet (Index)



It is possible to come back to the INDEX worksheet from any Section just by clicking on the logo of the project in the top of each sheet (Figure 9).

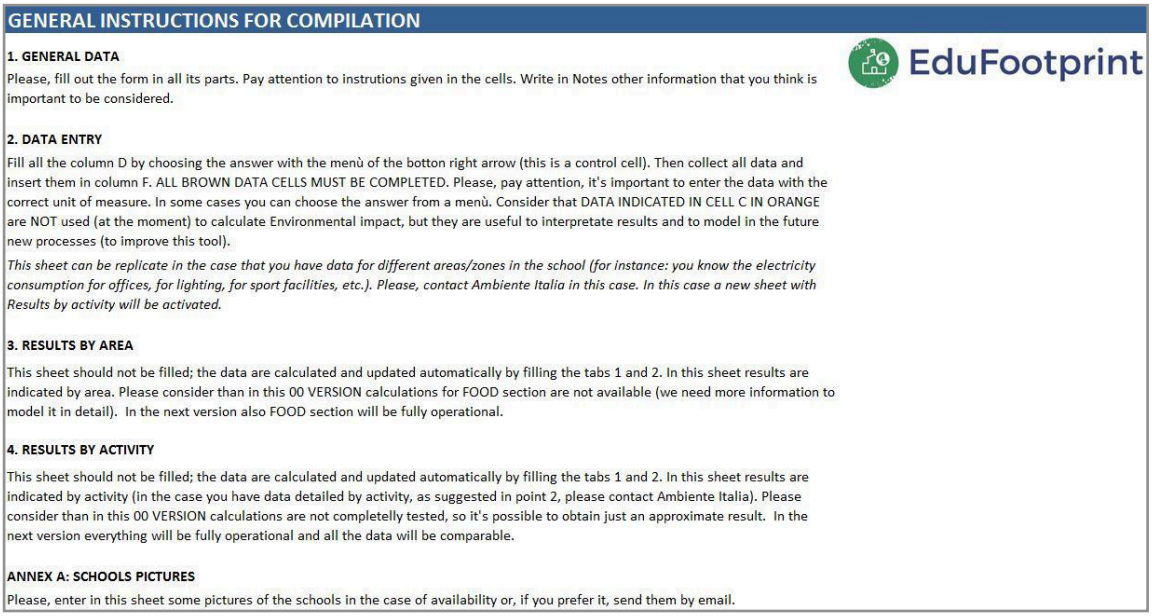
Figure 9: EduFootprint calculator: how to come back to the INDEX worksheet

1. GENERAL DATA			
	Answer	Notes	
GENERAL INFORMATION			
Pilot area			EduFootprint
Name of school			
Web site of school (if exists)			
Contact person in the school			
Contact person of the project partner			
Period of data			
Building construction year			
Building area (m^2)			
Educational stage			
Type of training			
Number of students			
Students' age			
Number of school staff			
School opening hours			
School owner			
External services procurement			

It is necessary to fill in **one file for each school** and **for each year of reference**.

In the worksheet named "GENERAL INSTRUCTIONS FOR COMPILATION" (figure 10) some advices for the use of the calculator and for the requested data entry are given. It is important to follow all the instructions to obtain real and comparable results.

Figure 10: EduFootprint calculator: general instructions for compilation



GENERAL INSTRUCTIONS FOR COMPILATION

EduFootprint

1. GENERAL DATA

Please, fill out the form in all its parts. Pay attention to instrutions given in the cells. Write in Notes other information that you think is important to be considered.

2. DATA ENTRY

Fill all the column D by choosing the answer with the menù of the botton right arrow (this is a control cell). Then collect all data and insert them in column F. ALL BROWN DATA CELLS MUST BE COMPLETED. Please, pay attention, it's important to enter the data with the correct unit of measure. In some cases you can choose the answer from a menù. Consider that DATA INDICATED IN CELL C IN ORANGE are NOT used (at the moment) to calculate Environmental impact, but they are useful to interpretate results and to model in the future new processes (to improve this tool).

This sheet can be replicate in the case that you have data for different areas/zones in the school (for instance: you know the electricity consumption for offices, for lighting, for sport facilities, etc.). Please, contact Ambiente Italia in this case. In this case a new sheet with Results by activity will be activated.

3. RESULTS BY AREA

This sheet should not be filled; the data are calculated and updated automatically by filling the tabs 1 and 2. In this sheet results are indicated by area. Please consider than in this 00 VERSION calculations for FOOD section are not available (we need more information to model it in detail). In the next version also FOOD section will be fully operational.

4. RESULTS BY ACTIVITY

This sheet should not be filled; the data are calculated and updated automatically by filling the tabs 1 and 2. In this sheet results are indicated by activity (in the case you have data detailed by activity, as suggested in point 2, please contact Ambiente Italia). Please consider than in this 00 VERSION calculations are not completelly tested, so it's possible to obtain just an approximate result. In the next version everything will be fully operational and all the data will be comparable.

ANNEX A: SCHOOLS PICTURES

Please, enter in this sheet some pictures of the schools in the case of availability or, if you prefer it, send them by email.

3.1. Worksheet "General data"

This is the worksheet that is used to **collect general information** in order to have a **general overview on the characteristics of the school** building and its facilities, people who attend the building and the activities carried out inside it. So, this data are not used to calculate impacts; just the number of students is necessary to allocate the impact to each student. In case of lack of some data, some cells can be left empty.

It is possible to use the Check list in Annex 1 to collect this kind of data.

3.2. Worksheet "Data entry"

This is the **main worksheet** where all data must be filled in to allow the automatic calculation of the environmental footprint.

It is really important to fill in all the cells of the column D by choosing the right answer to the question "Data available?" with the menu of the bottom right arrow, because they are control cells that will be used, in the future, to check if any information is missing or if it is not possible to obtain direct data. So, from the menu it is possible to choose the following answers:

a) *Yes*: in this case you need to fill in also column F with the data.
b) *No*: it is impossible to have direct data for the school.
c) *Not applicable*: the information is not applicable to the school (for instance, if there is no self-production of electricity from renewable sources, because there is no photovoltaic system or similar, choose this kind of answer).

In case *b)* an average data will be automatically uploaded for the school (data coming from other schools involved in the EduFootprint project activities).

Then, for all the cells where you answers Yes, please collect all the data and insert them in column F. All *brown* cells must be completed, because they are used to calculate environmental footprint. On the contrary, data indicated in *orange* in column C are not used (at the moment) to calculate environmental impact; they are just useful for interpreting the results and modelling new processes in the future (so that to improve the tool).

Information related to the **transport of materials** is needed, so the schools are requested to collect such data, and to fill in the columns G-H-I about the distance (in km) between the supplier and the

school (it is possible just to have an average estimation, but please make an effort to get also this information).

Pay attention when you insert the records; it is important to enter the data with the correct **unit of measure** (as indicated in Column E). Maybe some conversions will be needed.

This Data Entry worksheet can be replicated in case you have data for different zones of the school (for instance: you know the electricity consumption for offices, for external lighting, for sport facilities, etc.). In this case, please contact Ambiente Italia: a new sheet with "Results by activity" will be activated. You will be able to obtain the results of the environmental footprint of the schools not just related to each area of the school, but also by each activity.

Figure 11 - EduFootprint calculator, Data Entry worksheet overview

DATA ENTRY: GENERAL UTILITIES AND PRODUCTS CONSUMPTION

EduFootprint

Fill this column by choosing one answer from the menù | *Please, fill all the boxes in brown.*

		AVAILABLE DATA?	Unit of measure	DATA	DISTANCE FROM SUPPLIER (km by truck)	(km by train)	(km by ship)	NOTES
BUILDING CONSUMPTION								
ELECTRIC ENERGY	**Electricity consumption from network**	Yes	kWh	2.311,00	-	-	-	
	Country where the school is		-	Italy	-	-	-	
	Electricity consumption from network: just certified clean energy from renewable sources	Not applicable	kWh		-	-	-	
	...percentage produced by solar power (thermal, photovoltaic, concentrated)		%		-	-	-	
	...percentage produced by hydroeletric power		%		-	-	-	
	...percentage produced by wind power		%		-	-	-	
	...percentage produced by geothermal energy		%		-	-	-	
	...percentage produced by biofuels		%		-	-	-	
	...percentage produced by the renewable part of waste		%		-	-	-	
	...percentage produced by other sources *(please, specify in Notes)*		%		-	-	-	
	Electricity consumption from self-produced renewable energy	Yes	kWh	450,00	-	-	-	
	...percentage produced by solar power (thermal, photovoltaic, concentrated)	Yes	%	450,00	-	-	-	
	...percentage produced by hydroeletric power	Not applicable	%		-	-	-	
	...percentage produced by wind power	Not applicable	%		-	-	-	
	...percentage produced by biofuels	Not applicable	%		-	-	-	
	...percentage produced by other sources *(please, specify in Notes)*	Not applicable	%		-	-	-	
	Self-produced energy (not consumed but sold)	Yes	kWh	0,00	-	-	-	
	Electricity consumption (TOTAL)		**kWh**	**2.761,00**	-	-	-	
			MJ	**9.939,60**	-	-	-	

Data collected from schools are divided in five groups / sections:

- Building consumption (electric energy, thermal energy, water consumption)
- Product consumption (paper products, stationery products, toilet and cleaning products, equipment, chemical used in labs, gardening)
- Mobility (internal vehicles, home-school run, travel excursions)
- Food (canteen, cafeteria, dispensing machines)
- End of life (waste, wastewater)

For detailed information related to how to collect data, please read §4. Best practices for collecting data from schools.

It is to be noted that some schools are characterized by the presence of extracurricular spaces (such as gymnasiums, libraries / reading rooms, auditorium) that are used not only by students, but also by people from outside such as evening classes, Volunteer associations (Alpine, avis, etc ..), cultural associations (music schools, schools of learning, etc.), sports associations (volleyball, gymnastics, basketball, etc.). The use in extracurricular hours (afternoon / evening) affects the total consumption (electrical, thermal, water consumption and waste generation) of the building and therefore also its environmental footprint. It is difficult to extrapolate the data for the exclusive use of these spaces, primarily because of the lack of dedicated measures pertaining to each single space (meters for gyms, auditoriums, etc ...) and secondly because the use is promiscuous (both school and extracurricular). In order to correctly calculate the environmental footprint of the building, it is strictly recommended to write in the columns named "notes" all the information useful for Ambiente Italia to implement the right improvement to the Calculator, so as to properly allocate the consumption to the real use of the building for the educational service.

3.3. Worksheet "Results by area" expressed by impact categories

In this worksheet it is possible to **check results of the environmental footprint** of the school, totally or related to one student.

All the data inside this sheet are calculated and updated automatically by filling the previous ones (General information and Data Entry). No data input is allowed. The automatic calculation is the result of some conversion factors linking activity to impact in a hidden worksheet (these factors derived from an international database as Ecoinvent 3.3[1] and some specific LCA studies regarding products or services usually connected with educational service). The conversion factors depend on the Country the school is located in.

Results are expressed by all the 15 **impact categories** defined by the European Commission in the 'Product Environmental Footprint (PEF) Guide' (Annex II to Recommendation (2013/179/EU), calculated with the environmental footprint assessment model and in the unit of measure indicated in table 1.

[1] Ecoinvent is a not-for-profit association which created a software for implementing LCA. With over 12,800 LCI datasets in many areas such as energy supply, agriculture, transport, biofuels and biomaterials, bulk and specialty chemicals, construction materials, wood, and waste treatment, ecoinvent version 3 is the most comprehensive, transparent, international LCI (Life Cycle Inventory) database.

Table 1 - PEF impact categories, unit of measure and environmental footprint assessment model

Impact categories	Unit of measure	Assessment model
Climate change	kg CO2-eq	GWP 100 years
Ozone depletion	kg CFC-11 eq	EDIP model based on the ODPs of the WMO over an infinite time horizon
Ecotoxicity for aquatic fresh water	CTUe	USEtox model
Human toxicity- cancer effect	CTUh	USEtox model
Human toxicity- non cancer effect	CTUh	USEtox model
Particulate matter / respiratory inorganics	kg PM2,5-eq	RiskPoll model
Ionising radiations - human health effects	kg U235 eq	Human health effect model
Photochemical ozone formation	kg NMVOC	LOTOS-EUROS model
Acidification	Mole of H+ eq	Accumulated Exceedance model
Eutrophication - terrestrial	Mole of N eq	Accumulated Exceedance model
Eutrophication - aquatic freshwater	kg P eq	EUTREND model
Eutrophication - marine	kg N-eq	EUTREND model
Resource depletion - water use	m^3 eq	Swiss Ecoscarsity model
Resource depletion - mineral, fossil & renew.	kg Sb-eq	CML2002 model
Land transformation	kg C deficit eq	Soil Organic Matter (SOM) model

Below (Figure 12) an overview of the worksheet.

Figure 12: EduFootprint calculator, Results worksheet overview

EduFootprint calculator — EduFootprint

RESULTS BY AREA: School's Environmental Footprint

TOTAL

Impact categories / Unit of measure	Total primary energy MJ	Climate change kg CO2 eq	Ozone depletion kg CFC-11 eq	Freshwater ecotoxicity CTUe	Human toxicity, cancer CTUh	Human toxicity, non-cancer CTUh	Particulate matter kg PM2.5 eq	Ionizing radiation HH kBq U235 eq	Photochemical ozone formation kg NMVOC eq	Acidification mole H+ eq	Terrestrial eutrophication mole N eq	Freshwater eutrophication kg P eq	Marine eutrophication kg N eq	Water resource depletion m3 water eq	Mineral, fossil & ren resource kg Sb eq	Land use kg C deficit
TOTAL	57.426,31	4.568,97	0,00	5.315,54	0,00	0,00	1,02	276,67	5,87	17,33	14,21	0,49	1,41	55,16	0,01	393,61
BUILDING CONSUMPTION		4.568,97	0,00	5.315,54	0,00	0,00	1,02	276,67	5,87	17,33	14,21	0,49	1,41	55,16	0,01	393,61
ELECTRIC ENERGY		1.176,65	0,00	3.081,27	0,00	0,00	0,43	184,08	2,35	6,00	7,63	0,31	0,76	10,95	0,00	292,23
THERMAL ENERGY		3.320,89	0,00	1.754,12	0,00	0,00	0,56	62,10	3,36	10,89	6,03	0,12	0,59	0,50	0,00	48,67
WATER CONSUMPTION		71,43	0,00	480,15	0,00	0,00	0,03	30,49	0,16	0,43	0,56	0,06	0,06	43,71	0,00	52,71

A description of all the Impact categories used by OEF methodology is provided hereinafter:

- **Climate change**: Climate change can result in adverse effects upon ecosystem health, human health and material welfare; it is related to emissions of greenhouse gases to air. The characterization model as developed by the Intergovernmental Panel on Climate Change (IPCC) is selected for development of characterization factors. Factors are expressed as Global Warming Potential for time horizon 100 years (GWP100), in kg carbon dioxide equivalent (kg CO_2 eq).
- **Ozone depletion**: Because of stratospheric ozone depletion, a larger fraction of UV-B radiation reaches the earth surface. This can have harmful effects upon human health, animal health, terrestrial and aquatic ecosystems, biochemical cycles and on materials. This category is output-related and at global scale. The characterisation model is developed by the World Meteorological Organisation (WMO) and defines ozone depletion potential of different gasses (kg CFC-11 equivalent).
- **Ecotoxicity for aquatic freshwater**: This category indicator refers to the impact on fresh water ecosystems, as a result of emissions of toxic substances to air, water and soil. USEtox model calculates characterisation factors for human toxicity and freshwater eco-toxicity; the final unit is Comparative Toxic Units (CTUe).
- **Human toxicity, cancer effect and no cancer effect**: These categories concern effects of toxic substances on the human environment (health risks of exposure in the working environment are not included). Characterisation factors, Human Toxicity Potentials (HTP), are calculated with USEtox model in Comparative Toxic Units (CTUh).
- **Particulate matter / respiratory inorganic**: particulate matter often resulting from the burning of fossil fuels emitting sulphate and nitrate aerosols, causes breathing difficulties. The characterisation factors for fate and intake (referred as midpoint level) and effect and severity (referred as endpoint level) are the result of the combination of different models, called RiskPoll model, and it's expressed in kg of PM 2.5. equivalent ("fine particles" with aerodynamic diameters less than or equal to 2.5 microns).
- **Ionising radiations - human health effects**: The exposure to ionising radiation (radioactivity) can have impacts on human health; Environmental Footprint only considers emissions under normal operating conditions (no accidents in nuclear plants are considered). It is calculated with the Human health effect Model (ReCiPe) in kilogram of Uranium 235 equivalent (kg U235 eq).
- **Photochemical ozone formation**: photo-oxidant formation is the formation of reactive substances (mainly ozone) which are injurious to human health and ecosystems and which also may damage crops. So while stratospheric ozone protects us, ozone on the ground (in the

troposphere) is harmful: it attacks organic compounds in animals and plants, it increases the frequency of respiratory problems when photochemical smog ("summer smog") is present in cities. Photochemical ozone formation is an impact which affects the environment at local and regional scale. It is calculated with the LOTOS-EUROS model, and the unit of measurement is kilogram of Non-Methane Volatile Organic Compound equivalent (kg NMVOC eq).

- **Acidification**: Acidifying substances cause a wide range of impacts on soil, groundwater, surface water, organisms, ecosystems and materials (buildings). The most significant sources are combustion processes in electricity, heating production and transport. The contribution to acidification is greatest when the fuels contain a high level of Sulphur. Acidification is an impact which mainly affects the environment on a regional scale. The unit of measurement is Mole of Hydron equivalent (mol H^+ eq), that are calculated with Accumulated Exceedance model.
- **Eutrophication (terrestrial, aquatic freshwater and marine)**: also known as nitrification, includes all impacts due to excessive levels of macro-nutrients in the environment caused by emissions of nutrients to air, water and soil. Eutrophication impacts ecosystems is due to substances containing nitrogen (N) or phosphorus (P); these nutrients cause a growth of algae or specific plants and limit growth in the original ecosystem. Eutrophication is an impact which affects the environment at local and regional scale. In the case of Terrestrial Eutrophication it is calculated with Accumulated Exceedance model in Mole of Nitrogen equivalent (mol N eq); for aquatic eutrophication with EUTREND model, freshwater in kg of P equivalent and marine in kg N equivalent.
- **Resource depletion (water use and mineral, fossil & renewable)**: These impact categories consider the availability or scarcity of water in the regions where the activity takes place (if this information is known) and non-renewable resources, such as metals, minerals and fossil fuels like coal, oil and gas. Regarding Water use, the withdrawal of water from lakes, rivers or groundwater can contribute to the 'depletion' of available water; in this case it is used the Swiss Ecoscarsity model and as unit of measurement cubic meters (m^3) of water use related to the local scarcity of water. Related to Mineral, fossil and renewable, it is used the CML2002 model and it is expressed in kilogram of Antimony equivalent (kg Sb eq).
- **Land transformation**: Use and transformation of land for agriculture, roads, housing, mining or other purposes. The impacts can vary and include loss of species, of the organic matter content of soil, or loss of the soil itself (erosion). It is used the Soil Organic Matter (SOM) model, and the unit of measurement is kilograms of carbon deficit (Kg C deficit). This is an indicator of loss of soil organic matter content, expressed in kilograms of carbon deficit.

3.4. Worksheet "Annex A: Pictures"

In this worksheet it is possible to add some pictures of the school or, if you prefer, indicate the web site of the school.

4. Best practices for collecting data from schools

How to collect data for the calculator?

Frequently the biggest difficulty in developing a LCA study is collecting primary data; even in EduFootprint Project because, as far as schools are concerned, owners do not often correspond to managers of the building and consequently some data are not directly available. In addition, some services could be provided by external private companies appointed by school owners/managers, as happening usually for the management of the canteen/cafeteria services or, sometimes, cleaning services. In these cases, the involvement of the providers/suppliers will be necessary[2], while considering the daily activities students could help in the collection of data.

4.1. General data collection on public buildings

In the Annex 1 there is a Checklist for the collection of general data on schools buildings and activities. These data can be useful to have an idea on how the school is organised, where it is located, the school activities and the educational paths, The aim is to define a starting point description.

4.2. Data on mobility

In the Annex 2 a model for organising a Survey for collection of data related to school mobility is available. This could be useful to know habits of school community on home-school run. All over Europe, and internationally, parents traditionally drive their children to school, even when they live within a short cycling or walking distance, increasing traffic in the cities. Road transportation is one of the main sources of greenhouse gas emissions, which lead to global warming and climate change.

The aim is to analyse hotspots and foresee improvements, as proposing travelling to school walking, cycling, increasing the use of public transport and car sharing. All the collected data can be elaborated, for instance, with an Excel file and statistics can be prepared to be used in the calculator, but also to plan low impact alternatives.

[2] In the absence of providers/suppliers collaboration, existing databases will be used.

4.3. Estimate data on waste production

To analyse waste generated by the school it could help to identify a program for improving the waste management in school and increase recycling.

Waste analysis might involve one of the following methods or a combination of approaches. It is important to identify which assessment is the best for the school considering factors such as size, age of students, types of generated waste, resources and the scope of the efforts.

1) *Waste management service invoices*: considering the waste management provided by the local municipality, some data about the quantity of waste generated by school and its management could be collected by waste management service invoices.
2) *Visual analysis*: walking through the building is a quick way to assess the school waste generation practices. It is possible to take a look at the school and its spaces, observing the activities and current practices in each area. You must estimate the volume and/or weight of the materials that are currently disposed in each area (for assistance, define a volume-to-weight conversion chart in your case). Record your estimated values in an assessment form.
3) *Waste sort analysis:* It is possible to identify each component of waste generated by the school and calculate its percentage on the total waste production . The analysis can be focused on the entire school waste stream or on some specific area, such as labs, cafeteria or classrooms. This method is implemented if waste is managed by cleaning staff and disposed in a specific collection area inside the school. The table presented in Annex 3 could be used, indicating the daily number of bags produced for each type of waste and the percentage of their filling.

5. Best practices about edu-environmental footprint improvement

How to use the EduFootprint calculator results to increase energy and resource efficiency and obtain environmental improvements?

Environmental Footprint is a measure of how many resources are required and how much pollution is produced by our current lifestyles and behaviours. A recent study[3] about environmental impacts of food consumption applied to a basket of products, selected as being representative of EU consumption (considering an EU-27 citizen in one year) shows an environmental footprint of meat beef for 310 kg CO_2eq (climate change) and 5,5 m^3 of water eq (water resource depletion), an environmental footprint of milk for 110 kg CO_2eq and 3,3 m^3 water eq.

The environmental footprint of car transportation for passenger can be measured with the carbon dioxide emissions: the European average gasoline vehicle may emit 181 gCO_2/km and consume 7,8 l/100 km[4].

In literature the environmental impact of school buildings (energy consumption) is estimated in 255 kg CO_2eq per 1 m^2 and as regards university buildings 69 kg CO_2eq per 1 m^2[5].

An European study of environmental impact of mixed-plastic-domestic waste management estimates 6,44 kg CO_2eq for landfill, 1.942 kg CO_2eq in incineration with energy recovery and 920,84 kg CO_2eq (carbon footprint reduction) in recycling treatment[6].

The impact categories measured by the Edufootprint calculator, in terms of impact of one student in education service, reflect a procedure to identify, qualify, check and evaluate information from the conclusion of impact assessment of education service in a life cycle perspective. By comparing the results of the impact categories between the evaluation period and a baseline period (for EduFootprint project the baseline period is from September 2015 to August 2016) for each phase of the life cycle, school managers, public building owners and policy decision makers can find good solution to carry out environmental improvements.

This part of guideline is intended for providing some examples of best practise regarding energy and resource efficiency in school and university buildings. The introduction of a life cycle thinking motivates students and educators about Citizenship: first of all to be aware of their environmental footprint (with Edufootprint calculator); then to implement the best behaviours and the relevant

[3] B Notarnicola, G Tassielli, P A Renzulli,VCastellani, S. Sala, "Environmental impacts of food consumption in Europe" Journal of Cleaner Production 140 (2017) 753-765
[4] Gary Haq, Martin Weiss "A CO2 labelling of passenger cars in Europe: Status, challenges, and future prospects" Energy Policy 95(2016) 324–335
[5] S. Trachte, André De Herde "Sustainable Refurbishement School Buildings" SHC, IEA, June 2014 and G. Magatti,C.Bellantoni, M. Cavallotti, R. Benocci, M. Gualtieri, M. Camatini "Energy consumption analysis and carbon footprint of a building of the University of Milano-Bicocca: starting point for a sustainability report", 2013
[6] WRAP "Environmental benefits of recycling", 2010 update

life-skills to improve environmental impacts in the life cycle of the education service in public buildings.

5.1. Resource efficiency in consumption phase and in public procurement

5.1.1 Paper and waste paper

Improvement action 1: Measuring and monitoring

Measuring and monitoring paper use should be one of the first steps implemented by an education organisation for improving its environmental footprint; without a good understanding of use, you will be not able to manage resources efficiently. In order to identify some opportunities for implementing environmental improvements, it is recommended to conduct a review of the current practice. The first step is to understand how the activities use resources in school or university buildings (e.g. paper, consumables and energy) and why waste is produced. It is necessary to define the parameters required (i.e. source of data for paper: invoices; units of measure: number of sheets; frequency: weekly or monthly). The collected data will be aimed at:

- tracking the school performance over the time (using the current year to monitor and measure resources use, and then generating a baseline year against which future years can be compared);
- highlighting some areas of improvement by enabling the comparison between performance indicators (paper consumption by administration offices, paper consumption by education activities);
- promoting energy reductions following a 'switch-off' campaign;
- promoting paper waste reduction (ref. cutting paper par. 5.4.1.)

Improvement action 2: Green Procurement

There is a strong link between purchasing and the environmental footprint. Information and communication about life cycle thinking is often rare considering purchasing office. It is recommended to involve all the interested parties (administration staff, teachers, students) in considering the whole life-cycle assessment of the purchased products. As far as paper purchase is concerned there are standards and labels that classify paper according to its raw material, energy consumption and environmental impact of manufacturing process.

List of standards and labels for paper

Name	Symbol	Criteria
EU Eco-label		Specifies maximum limits for discharges to water, emissions to air and energy consumption as well as requiring sustainable forestry management for virgin fibre.
Nordic Swan		Awarded to paper mills meeting minimum environmental performance standards.
ECF, TCF and chlorine free		Elemental chlorine free (ECF), chlorine gas has not been used to bleach the pulp during the pulping process. Totally chlorine free (TCF), no chlorine compounds have been used during the pulping or papermaking process. Chlorine free is often used to mean either of the above; ask for clarification from the paper supplier.
Blue Angel		Label awarded to paper and board products containing 100% waste paper (minimum 51% post-consumer waste).
The international EPD system		An EPD® (Environmental Product Declaration) is a verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products. EPD is available for the assessment of the environmental performance of processed paper and paperboard and the declaration of this performance (www.environdec.com)
FSC Forest Stewardship Council		The Forest Stewardship Council sets standards for responsible forest management. FSC certification ensures that products come from responsibly managed forests that provide environmental, social and economic benefits.

Improvement action 3: Use of paper

In each class, for each matter, and in each administrative office for a given period of time, the

amount of paper used for each type of paper should be monitored. A classroom and office register could be formed by empowering students in the "bookkeeping" of each registry in which a table identifying the type of paper and the type of use for each day will be collected, for example:

Date	Paper layout (A5, A4, A3, A2, A1, envelopes)	Paper Type (Recycled, Normal, Card, Colored Paper, etc ...)	Print Mode (Front, Duplex, 2 in 1 Duplex, 4 in 1 Duplex, etc.)	Use for (homework, classroom exams, deliveries, notes, etc ...)	Discipline	Amount	M.U.	Corrective action

After a period of initial monitoring you should then identify the points that can be improved by indicating for each line the possible corrective actions that are in the guidelines, for example:

- Is it necessary to print this material?
- Can I print in a smaller format?
- Can I print in duplex, 2 in 1 or 4 in 1?
- Can you use paper already used to print these documents?

In addition to the practical bunks listed in the guidelines, another virtuous behaviour could be:

- If you have to print documents, print all the documents together to prevent the printer from getting the right print at all times.

5.1.2 Office equipment

Improvement action 1: Measuring and monitoring

Frequently, when working hours are over, it is possible to find some computers, monitors or lights turned on. Therefore, energy consumption is relevant. If your energy consumption and environmental footprint are high, the first step is to implement a real-time monitoring. Some monitoring equipment is fully wireless and portable, so you can apply it to your personal computers or to other school equipment to immediately identify which one is more energivorous and adjust the use accordingly. Alarms can be set to monitor showing an unusual consumption or changes to base patterns. Furthermore, energy saver devices with automatic power shutdown can put in to avoid energy consumption when equipment is not in use.

Screen savers do not save energy. Enable ‘power-down’ settings and insist that students and school

workers switch off their computer monitors when not in use, including when they are away from their desks.

Another important topic which has a relevant influence on environmental footprint is the toner and ink usage. Consuming just one single LaserJet toner cartridge emits 8 kg CO_2eq, of which 91% from use phase[7]. A lifecycle assessment of manufacturing toner cartridges has calculated the carbon footprint to be 4,4 kgCO_2eq[8]. An easy way to reduce environmental footprint in the use phase is to download existing softwares to control and optimize ink and toner overuse in printer (reduce potential toner and ink demand by up to 70%).

Improvement action 2: Green Procurement

There are two actions that will help you to reduce environmental footprint in the public procurement practices:

- purchasing IT office equipment (pc, monitor, cartridge or others devices) with energy labels criteria (i.e. energy star, EU ecolabel, etc..);
- recycling toner and inkjet cartridges; the carbon footprint of a remanufactured toner cartridge is 2,4 kgCO_2eq; toner cartridges could be remanufactured 3,5 times on average, further increasing the benefits of this activity.

5.1.3 Food

Improvement action 1: sustainable food using

The main environmental impact of food in Europe depends on the agricultural phases. It is characterised by the impacts of all the agronomic and zootechnical activities, which involve high energy consumption with associated emissions of greenhouse gases, particulate matter, ammonia, sulphur dioxide, nitrogen oxide and heavy metals. The second most burdening stages are the processing and logistics, which are characterised by the energy production responsible for emissions to the atmosphere, occurring during the production of heat, steam and electricity and during transport. The typologies of foods with the greatest environmental footprint are meat products (beef, pork and poultry) and dairy products (cheese, milk and butter).

Herewith some examples of plans and activities about sustainable food are given:

[7] Life Cycle Environmental Impact Study "HP LaserJet Toner Cartridges vs. Remanufactured Cartridges in North America" SUMMARY REPORT Prepared for Hewlett Packard Company By Four Elements Consulting, LLC, 2011
[8] The carbon footprint of remanufactured versus new mono-toner printer cartridges, Best Foot Forward for The CRR, 2006

- the students explore and study (with the support of Edufootprint calculator) the processes of the resources involved at every stage of food production and ~~e~~ calculate the environmental footprint from farm to table;
- the students learn the processes involved in the supply chain of one food item and assess the environmental impact of logistic (from farm to school);
- the students set up a vegetable garden to improve knowledge. If possible all school meals should be freshly prepared and include organic and/or seasonal products, some of which are cultivated in the school vegetable garden. All students (or pupils) should be involved in planting, harvesting and maintaining the garden and the surplus of organic products grown on site could be given or sold to parents;
- the introduction of a weekly meat-free day in order to keep costs down, reducing environmental impact and providing an entry point to educate pupils, parents and kitchen staff on the environmental impacts of food production;
- the collection of leftovers and promotion of their use as fertilizer / compost for gardens, flowers or plants.

Improvement action 2: Green Procurement

Most environmental footprints of food could be achieved introducing criteria in the tenders for the catering and vending machines supplier. First of all the school manager should plan different types of food purchased to balance costs and environmental impacts (use Edufootprint calculator). Then it should be put in the tender at least the following technical specification:

- minimization of packaging and ensuring that it is recyclable; use of means of transport with lower possible environmental impact (Euro 6);
- introduction of award criteria not only to promote organic food[9] and biodiversity but also to reward the use of seasonal products;
- assuring a periodic monitoring about the number and type of food products distributed or sold;
- use of energy efficiency for equipment;
- use of a short product chain ("zero km");
- promotion of a Fair Trade;

[9] With Organic Certification

- promotion of a environmental certification of the supplying company;
- promotion of health as a Mediterranean diet.

5.1.4 Water

Improvement action 1: Measuring and monitoring

A system must be in place to rationalise the use of water by toilet and cleaning activities. Water used for all services purposes should come from alternative water sources and not from water fit for human consumption. The water distribution and consumption represent around 2% of energy used in the life cycle perspective of the education service (without considering energy for hygienic hot water).

Calculating your water use: your water bill will tell you the amount of water that you use and how much you spend annually. However, be careful to check if these are estimated or actual readings. Use the equations in the table below to calculate a baseline of annual water use per student.

Annual Water Use (m^3) – detected by the water counter	÷	Number of students in your school	=	Water use (m3/student/year)

Improvement action 1: sustainable using

Taps	School campaigns in turning off taps fully and fixing dripping taps Is your water pressure too high? If so, you may need to consider fitting some form of flow regulation. Tap aerators and flow restrictors are low-cost solutions and can reduce water use by up to 70%.
Shower (in case of gym)	Ensure the shower control unit is regularly maintained as soap deposits and scale can cause blockages and reduce performance. When refurbishing shower rooms, consider water efficient products and make sure they are correctly installed. Consider devices such as push button showers or isolating ball valves to reduce water usage.
Toilets	Where suitable, fit older 9-litre WC cisterns with volume adjusters such as a 'hippo' bag or 'save-a-flush' which reduce the amount of water per flush by up to 2 litres. Also, consider retrofitting flush devices in existing toilets. For example, a

	variable flush or siphon mechanism can save you up to 4 litres per flush.
Water using	If your school has canteen with kitchen sink, fit trigger taps to reduce the volume of water used during food preparation and cleaning. If your school has a garden, if possible don't use drinking water for plant. Collect rainwater in water-collection tanks for watering. If you prefer to use a tube for spraying water, fit a trigger nozzle to control the flow.

5.2. Improvement of the environmental footprint of transport

5.2.1 "Cars are cool?"

The car has become one of our most obvious status symbols. Many young people see achieving a driving licence and owning a car as a natural goal and essential right beyond the age 18. As adults, after buying a house, buying a car is one of our biggest and most expensive purchasing choices. Advertisers are particularly adept at raising our level of 'wants' over 'needs' and our purchasing decisions and mobility choices are influenced by the media. The Edufootprint calculator, in the mobility section, provide comparative information about different mode of transport to go from home to school and vice versa. Therefore energy is a particularly challenging concept to understand, particularly in the context of transport. We rarely think about the means by which we travel, other than in terms of convenience, cost and time, not what raw materials, energy and technology have been used in its design and production, where all this comes from, or where it all goes after we're finished with it, let alone what impact it has, directly or indirectly, on the environment. However, understanding about energy, and the interdependence of the social and cultural, political and economic, and environmental forces affecting the way we travel, is fundamental to appreciating the size of the transport component of our Environmental Footprint, and how to reduce it.

Accordingly with the above issues you should involve students, teachers, school staff and other stakeholders (family groups, public transport agencies, public authorities, etc) to analyse how the car advertisers influence the transport choices (images they use, hidden messages, etc). These activities could be integrated with class, group, students, families survey and compare the environmental footprint in a period (a week, a month) and analysis about urban infrastructures for alternative choices for travel. The results could be the following:

- description of the travel means that make up the transport component of their school's Environmental Footprint and how it may be reduced (alternative choices, calculating footprint);

- examples of the connection between values and attitudes and behaviour;
- description how school and household travel can be managed more sustainably;
- overcome of the lack of knowledge about the planning of car alternative infrastructure;
- example of how quality of life is broader than standard of living;
- assess the economic impacts of alternative choices (new jobs, new enterprises);
- examples of ways to reduce the transport component of their own Environmental Footprint (planning for sharing mobility, walking bus, bicycle bus, etc).

5.2.2 Sharing mobility

Efforts to shift people's travel behaviour towards car independent lifestyles, or to encourage people to rethink car ownership, require a paradigm shift. This is often hampered by social norms that make cars into status symbols. IT technologies could help us to overcome these bottlenecks with low costs. Technologies-driven measures based on internet use and smartcards for sharing vehicles, public bicycles or car alternative choices can be implemented in network of schools or university campus.

Best practice – transport

GoEco! A community based eco-feedback approach to promote sustainable personal mobility styles. The Federal Institute of Technology in Zurich and the University of Applied Sciences Southern Switzerland have developed an app that encourages sustainable mobility. It analyses mobility behaviour and generates alternate routes.

sccer mobility — Swiss Competence Center for Energy Research, Efficient Technologies and Systems for Mobility

Approach

- Participants in the Living lab test a smartphone *app* developed on purpose, that:
  - tracks their trips
  - provides them with eco-feedback on their mobility performances
  - suggests alternative, low-impact modal options
  - lets them define personal reduction objectives and targets
  - sets up a social comparison rewarding scheme within the community of the users
- The Living lab is run both in Canton Ticino and in the City of Zürich => differences in the supply of mobility options and in the socio-cultural attitude of the population towards mobility.
- To get deeper insight into perceptions / attitudes, a selection of participants is closely followed with focus groups and interviews.

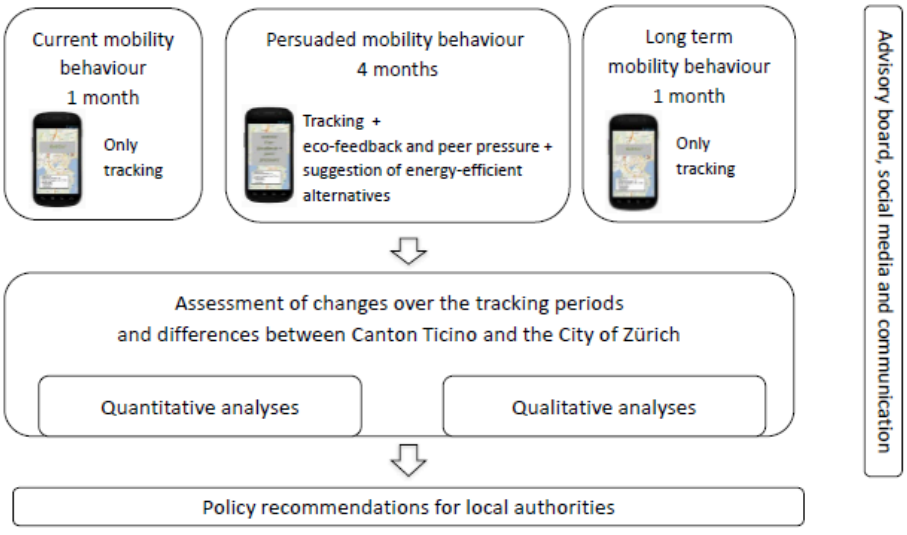
The *GoEco! app* is based on the existing *Moves app*

City of Zürich ↕ Canton Ticino

SCCER Efficient Technologies and Systems for Mobility Study Day BAV 6

The GoEco! Living lab design

Overall 600 active participants (testers) + 200 passive participants (control group) in the City of Zürich and in Canton Ticino.



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5.2.3 Local mobility plan for schools

The action for a mobility plan aims to organize and manage local plans to set out an integrated strategy for the reduction of the car use, improving environmental footprint and safety in the journey to school. The local plan must involve several actors: school students and their families, teachers, public authorities, local public transport agencies, local policy and others local key

stakeholders (i.e. representative of business). A good practice is to establish a working group with all the key actors. The next step is to gather quantitative data with which it can:

• assess current journey patterns;

• assess the potential for modal change;

• discover locations which are both actual and perceived danger points;

• plot routes currently used by students to reach the school.

A range of measures will be needed to put the plan into practice. Following a list of practical measures.

Walking initiatives: the walking bus escorted groups of children, personal safety training, safe route trails, Walk to School campaigns

Cycling initiatives: cycle storage, cycling permits and policies, cycling awareness campaigns, cycle maintenance, helmets and bright clothing, cycling allowances

Road safety training and education: pedestrian training, cyclist training, parent escort training, cycle helmet wearing initiatives, pre-driver training, road safety curriculum work

Promoting use of bus and rail: additional school buses, concessionary bus fare schemes, parent escorts on buses, information and publicity, private minibuses

Highway & traffic engineering measures (for public authorities): 30mph zones outside schools, priority measures for school buses, safe crossings outside schools and along school routes, cycle lanes and cycle tracks, junction narrowing and parking reorganisation, parking enforcement outside schools, school crossing patrols

Classroom work: safe route planning in geography, survey analysis in maths/computing, theatre in education, publicity and promotional work and drama, exploring risk management, health and citizenship

School management issues: school policy, staff supervision of entrances, access restrictions in schools, timetable planning and length of school day, provision of lockers

Involving parents: family cycle training, exploring routes to school, car sharing, walking and cycling on induction days, volunteer trainers, walking bus escorts

Involving business: shared parking spaces, car sharing databases, joint funding and publicity of school travel plan measures, help with IT

Publicity: meetings, induction days and parents evenings, school newsletters, public transport & safe

route information packs, etc.

The European Commission supports the promotion and further development of the concept of Sustainable Urban Mobility Plans (SUMPs), as well as the provision of the necessary tools and guidance to assist cities across Europe with the implementation of their mobility plan. (http://www.eltis.org/mobility-plans/mobility-plan-support).

5.3. Improvement of the buildings carbon footprint

In an education community the complexity of the energy consumption into the school or university campus buildings is very strong. The points are the most effective choices a consumer can take to make a difference in terms of energy consumption and energy efficiency appliances they use (lighting, equipment, etc.). In a school building it can use energy far more efficiently than we used to. These guidelines will not develop energy conservation measures by infrastructural choices (insulation, refurbishments, etc.) and renewable energy sources plants (photovoltaic, thermal solar, biogas, etc.). But it is going to describe actions to ensure that promoting and raising awareness of energy efficiency and conservation in the building are developed and used.

5.3.1 Energy consumption in the schools

The goal of this action is to calculate the energy consumption in the school building, using Edufootprint.

In practice, following the actions that can be done at school:

- collecting information about what types of energy school uses (electric, gas, others);
- looking at the school's last electric, gas or others energy sources bills - each giving the kilowatt hours (kWh) used over last period (two months, six months, a year) – for others sources convert the unit of measure (m^3, tons) in kWh (see conversion factors table in annex 4);
- calculating an appropriate indicator of specific energy consumption (i.e. divide kWh by the number of students in the school);
- involving teachers, staff and students (in agreement with school owners, maintenance service or others stakeholder) to appoint an energy team to identify opportunities to save energy and to equip them with practical skills and knowledge to use daily, both in and out the school.

5.3.2 Behaviours to reduce energy consumption

The goal of this action is to improve the way school buildings are managed and used to promote active learning and positive behaviours.

In practice, following the actions that can be done at school:

- all energy consuming equipment should be switched off when not required; this can be done by staff and students, by timer switches or by adjusting building control systems; run an awareness campaign on switching off lighting and equipment (i.e. students can design their own stickers and posters in art classes);
- getting students involved in energy efficiency can be fun and enrich their studies; it can also raise awareness and give them lifelong skills;
- heating is usually the largest and most expensive energy user in a school: it could be helpful for the students to understand and reporting any areas that are too hot or cold; students should identify easy solutions to save energy (i.e. thermostats control, close the windows, etc.);
- in classrooms and offices blinds are used to control glare when it is bright outside: where possible, encourage students and office staff to use blinds to direct daylight towards the ceiling and the walls; this solution should reduce the need for electric lighting in the classroom whilst reducing glare;
- encourage staff and students to report any failing lamps and replace them immediately to maintain the desired light output and optimum comfort levels;
- promoting information campaign addressed to teachers and staff to turn off lights that are not needed but remember to consider health and safety implications, particularly in corridors and stairwells.

5.4. Environmental footprint of waste management[10]

5.4.1 Cutting paper

The goal of this action is to change the behaviour of students and the school as a whole to produce less waste, more specifically: consume less paper and thus reduce paper waste generation.

In practice, following the actions that can be done at school:

- always make double-sided copies to reduce paper consumption and program school printers to

[10] Partially taken from Educational Kit Med project "ZeroWastePro"

print on both sides of the paper. Paper costs are cut in half, energy consumption is reduced and less environmental footprint is achieved by using both sides of a paper;

- whenever possible, print in the modality 2in1 or 4in1, by setting printers or copiers to print 2 (or 4) pages in the same paper sheet;
- convey messages to parents via email address system or school blog instead of sending out individual copies with children;
- use a routing slip to circulate information to staff, or post notices on a bulletin board;
- use reusable envelopes for interoffice mail.
- when it is necessary, print school circulars on A5 papers thus reducing excessive use of paper and printing devises. When printing, use smaller fonts, narrow margins and remove one and a half line spacing;
- print drafts on paper already printed on one side;
- where it is possible, assignments should be handed via e-mail instead of printing them. When printed they should be printed on both sides of the paper;
- preview of documents before printing - proofread documents on screen before printing and use the spell/grammar function to detect errors. Where necessary print only the pages you need and not the whole document;
- when it is possible save documents in pen-drives or in cloud (i.e. google drive) instead of printing hard copies and allow students to deliver their homework on pen-drives or in cloud;
- when it is possible, dematerialize lessons by using interactive displays;
- when printers or copiers need to be changed, purchase devices with automatic duplex (2-sided) printing or copying and duplex scanning;
- use interesting posters to discourage the excessive use of paper;
- organise paper banks where students can deposit one-sided blank pages to be used as rough paper for various purposes. Such paper can also be used to make notebooks to be distributed to school staff and students;
- use cereal boxes or pasta boxes to create flashcards rather than buying new cardboard paper;
- use the backside of charts when they are outdated for other purposes or to make new charts;
- consider using ring files instead of copybooks. This ensures one to only use paper as much as required;

- fill copier tray correctly to reduce paper jams.

5.4.1 Reduction of waste generation in canteens

This action aims at reducing significantly the amount of waste generated in school canteens, with particular reference to food waste and unnecessary packaging.

In practice, following the actions that can be done at school:

In preparing meals:

- optimize food portions according to the effective and healthy school kid needs;
- define menus suitable and tasty for children and organize specific educational programmes on the importance of a healthy nutrition;

In serving meals:

- don't use single-use disposable tableware and cutlery;
- serve tap water instead of bottled water, eventually by installing high quality public water dispensers in the school canteen;
- recover leftover food not consumed by donating it to charitable associations or kennels.

5.4.3 Use of tap water at school

The objective of this action is to change the frequent habit of students to bring bottled mineral water at school, promoting the use of tap water. In practice, which actions can be done at school?

- promoting the use of tap water by preparing and delivering specific informative material for students and families;
- installing tap water dispensers linked to the main water system to supply high quality drinking water to schools;
- monitoring the quantity of water distributed by the dispensers and the related quality and periodically publish the monitoring results in the school bulletin board, in terms of quantities of waste prevented and quality of water distributed;
- eventually sustaining the action by providing reusable flasks to students

5.4.4 Separate collection in classroom

The goal of the action is to organize an effective separate collection of waste at school.

In practice, following the actions that can be done at school:

- in accordance with the municipality and the waste collection utility, placing in the classrooms and in the common areas of the school a set of bins for collecting the different waste fractions (at least paper in each classroom) and paper, plastic, organic waste – but also batteries, electronic waste or exhausted toner - in the common areas;
- labelling recycling points clearly, so that everyone knows where they are and what should should be thrown in them;
- forming a team of students to monitor and take care of separate collection;
- monitoring the quantity of waste separately collected and publish in the school bulletin board monthly reports about the waste collection trends;
- encouraging the students to separate correctly waste by delivering specific informative materials, organizing educational activities about the importance of separate collection and recycling, organizing competitions and awards for the best performance achieved in the classes;
- joining local awards and competitions. This promotes recycling and keeps up motivation in your school;
- liaising with the local press to share your success.

5.4.5 Dematerialization by students and staff

The goal of this action is to raise the awareness of students and school staff about all the practical actions they can take in their daily behaviours and purchasing choices in order to reduce the generation of waste at school.

In practice, following the actions that can be done at school:

- promotion of re-use and recycling:
- encouraging the students to use their last year's copy books and school bags. Plastic bags should not to be allowed and must be replaced by cloth bags;
- involving the families and students in creating a "Re-use notice board", where they can post announcements about objects they do not use anymore (toys, books, cloths, children facilities etc.), which can be useful to other families;

- organising a second hand/swap reading and school books area in the school to increase a book's lifetime.
- before starting a new scholastic year, sorting through your materials. Many supplies can be reused;
- creating a recycling system that is easy to work with.

Promotion of less packaging in snacks and beverages:

- instead of wrapping your sandwiches, buying a lunchboxes and/or cookie boxes that are reusable every day;
- opting for a reusable flask instead of using disposable soda and water bottles;
- encouraging students to get a healthy snack from home rather than buying ready-made packaged food;
- encouraging furthermore the daily intake of fruit rather than buying packaged sweets or snacks.

In buying material for school by students and administration staff:

- replacing ball-point or felt tip pens with ones that take refills;
- an eraser made of natural rubber can be more environmental friendly;
- using a solar powered calculator which is an environmental friendly product and easy to maintain;
- buying sturdy and resistant stationery that will last longer and thus generate less waste;
- using writing sheets, notebooks and ring binders made of recycled paper;
- using glue without solvent, as solvents are hazardous waste and must to be handled with care;
- using a metal ruler which is more durable and can be used over the years rather than using the fancy plastic breakable ones;
- using a plastic free compass and scissors;
- pt for refillable eco-friendly board markers, instead of disposable ones;
- do not purchase envelopes with cellophane windows. If the windows are necessary, purchase the ones which have no covering over the window;
- encouraging your 'tuck shop' to switch to reusable utensils and crockery instead of throwaways and disposables;

- purchasing reusable and washable cleaning cloths, aprons, tablecloths used during specific lessons rather than single-use disposable products.

5.5. Reduce fuel consumption due to air conditioning

The opportunity to correlate behaviour to the reduction of energy consumption for air conditioning and to the indispensable need for internal comfort is emphasized. As for winter heating it is well known that inefficiency is often due to overheating of the rooms. Therefore, standard or systematic controls by users using simple thermometers or more sophisticated sensors could help operators by providing useful information to determine the start times, calibration curves for the temperature of the delivery temperature in the thermal plant, to highlight any priorities on where to install thermostatic valves or zone controllers. However, the main issue concerns ventilation that in the vast majority of schools is natural, and is entrusted to the manual opening of the windows. Ventilation deficiency is not only a problem of comfort, but also of school and sanitation. It is well known that poor ventilation facilitates the spread of infectious diseases in schools in winter.

The universally recognized index to verify the adequacy of ventilation with respect to the present buffer is the CO_2 concentration expressed in parts per million (ppm).

International standards (ASHRAE, DIN, UK, SIA) identify an acceptable CO_2 concentration for schools ranging from 1000 to 1500 ppm. At over 1500 ppm, initially, ventilation is no longer able to dilute body odours and therefore a condition of discomfort. Subsequent further growth results in a reduction in school yield (drowsiness and inability to concentrate). Over 5000 ppm begin physiological complications from the weaker subjects.

As shown by the measurements, usually a 15-20 minute opening of the classroom windows is within concentration limits, but it is not enough once (for example, at intervals). The openings should be repeated with a frequency that varies in each specific case (actual crowding, opening type, classroom volume).

Ventilation should not be inadequate, but not excessive, as this causes energy inefficiency. Therefore, a virtuous behaviour based on a conscious ventilation must be spread in the schools, and it is necessary to install in each classroom (or some significant ones) a tool that displays and records the temperature / humidity / CO_2 concentration in the environment and which now costs less than

150 €. The teacher can thus properly manage the ventilation of his classroom. Noteworthy, it is the educational relapse of students who will be able to convey this information to their families.

5.6. Other Good Practices to Reduce Consumption Due to Air Conditioning and Lighting

Some corrective actions that can be implemented to reduce light and gas consumption are for example:

- move any obstacle in front of the heating elements;
- where present, maximize the use of thermostatic valves to adjust the temperature inside each room. In unused areas, adjust the position of the thermostatic valves to zero;
- close the roller shutters and curtains at the end of the day to minimize thermal dispersion;
- attach a sheet of insulating material between the heat exchanger and the outer wall to increase the efficiency of the heat exchanger;
- clean the filters and the fan coil batteries to increase their efficiency;
- maximize the entrance of natural light into the classrooms by adjusting the venetian blinds and the curtains on the windows that will be open unless the direct sunlight causes any discomfort;
- where possible, switch on the lights only in half classrooms and in areas where natural light is not exploited;
- switch on only the lights required for the staff to do their job; leave the lights off in the corridors and turn them on only when there are people working in the desks and requiring the ignition;
- turn off the light in the bathrooms if there is no one in these and check out the lights at the exit of the classrooms;
- prepare in the bathrooms, corridors, storage rooms a timer circuit scales that automatically turn off the lights after a certain period of time that is set by the user;
- provide an automatic shutdown of all equipment and all lights at the end of the day.

5.7. Action plan to change

Action Plans should be developed for the components of your school's Environmental Footprint that

you have been working on and combine them into an achievable Energy Plan of your Municipality, involving the whole school community, thereby reducing the overall impact of the school's footprint.

Step 1 – Make a list of the real issues, for each component of the footprint.

Determine the sector/field to improve i.e. reducing the school's overall use of indirect energy consumption

Step 2 – Make a list of the most realistic and effective changes that could be made.

Encourage the learners to use the online Edufootprint calculator and the Internet for the research, and to use what they have learnt to develop their ideas to make realistic and effective changes. They may find out what others have done successfully, and how.

If a whole school approach is to be successful, ownership needs to be shared with others representing the whole school community, at an early stage. A Working Group with representatives from stakeholders and other school representatives will carry forward the momentum of the project.

Step 3 – Develop an Action Plan for each component of the footprint, matching a list of key objectives with actions.

The action depends on a lot of variables, including the availability of time, money, expertise, legal constraints, available help/enthusiasm from others. Sometimes the final selection of objectives and actions has to be a compromise.

Step 4 – Agree the Action Plans and the priorities with everyone across the whole school community and stakeholders.

Encourage the following types of questions:

What are the steps/changes required to achieve each objective?

How long may it take to achieve each step?

Who would need to be involved to make such changes work?

Which actions need to be taken to encourage and motivate people to make the changes and sustain any new habits?

What have got the local campaigning organisations and other local stakeholders to offer?

What can the local Municipality do to help?

What will make a difference?

Step 5 – Draw up an overall Improvement Programme and help the involved people to think about monitoring, evaluating and promoting its progress.

The Improvement Programme should include:

Clear, realistic targets/objectives, prioritised actions to be taken, and by whom;

Timescales (over a three to five year period) and costs/sources of funding;

Ways of monitoring progress and evaluating what is achieved;

Ways of keeping everyone in touch with progress – knowing about it and communicate it.

Step 6 – Communicate the Improvement Programme

Communicate and let people know about every significant success along the way.

Help the learners to organise themselves, make local contacts, find information and make decisions involving small steps towards making a difference. Keep everyone in the school community informed of progress as it happens – dedicated notice board, assemblies, newsletter, etc.

Terminology and acknowledgments

As regards **Terminology**, please refer to COMMISSION RECOMMENDATION of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (Annex II and Annex III)

Centre for Remanufacturing and Reuse, Public procurement of remanufactured products, 11 May 2011 - www.remanufacturing.org.uk

Centre for Remanufacturing and Reuse, Comparative Carbon Footprint Analysis of New and Remanufactured Inkjet Cartridges, 14 April 2010 - www.remanufacturing.org.uk

European Commission, Green Public Procurement, A collection of good practices, 2012, (http://europa.eu/environment/gpp/

Innocat, Sustainable Public Procurement of School Catering Services, August 2015 (see Inventory Resources) www.sustainable-catering.eu

EU Buying Green Handbook, available:
http://ec.europa.eu/environment/gpp/buying_handbook_en.htm

https://www.ontarioecoschools.org/

https://www.generationearth.at/en/

http://www.greenschools.eu/homeen.aspx

http://greeen-eu.net/

http://gef.eu/focus/climate-and-energy/

http://gef.eu/focus/green-economy/

https://www.renew-school.eu/en/home/ (progetto europeo)

http://www.sharingcities.eu/

http://u-mob.eu/ - U-MOB LIFE is a European project funded by the European Commission under the LIFE programme. It is aimed at the creation of a university network to facilitate the exchange and transfer of knowledge about sustainable mobility best practices among European universities.

www.trafficsnakegame.eu.- Traffic Snake Game Network was co-funded by the Intelligent Energy-Europe II Programme (Contract N°: IEE/13/516/SI2.675164) and is composed of 18 consortium partners, coming from 18 countries. The EU supported project ran from 07/02/2014 until 06/02/2017. Henceforth TSG Network remains an international cooperation with national partners.

http://civitas.eu/ - CIVITAS is a network of cities for cities dedicated to cleaner, better transport in Europe and beyond. Over 800 innovative urban transport measures and solutions in over 80 Living Lab cities across Europe since 2002 show why CIVITAS stands for City VITAlity and Sustainability

Annex 1: Check list for collection of general data from schools

Pilot area	*(name of your pilot area and country)*
School	***(Official name of the school)***
Web site of school	*[in case it exits]*
Address and city	
Contact person in the school	*(name, surname, position)*
Contact person if the project partner	*(name, surname)*
PERIOD OF DATA	*[usually school year, so academic period: September to August]*
Building construction year	
Building area	*[total m^2, indicating external and internal surface]*
Educational stage	*[Insert school level: pre-school, primary, secondary, university, other]*
Type of training	*(short description) [Technical, economics, humanistic, arts…]*
Number of students	
Students' age	*[7-10/10-15/15-18 …]*
Number of school staff	*[total number of workers for each category: teachers, support/administrative staff,…]*
School owner	*[Insert the owner of the building: i.e. Municipality of...]*
External services procurement	*[Please write a short description: i.e. energy services, food, cleaning,...]*
SCHOOL ACTIVITIES	
Administrative services	*(yes/no)*
Labs	*(yes/no) [Description and number: i.e. chemical lab, ICT lab, etc.]*
Bar-cafeteria, canteen	*(yes/no) [It's related to the selling of snacks, drinks, fast food, etc.]*
Kitchen appliances used or external catering service?	*(yes/no) [kitchen services for a canteen with daily menu]*
Library	*(yes/no) [In you answer YES please write a short description]*
Pool	*(yes/no) [If you answer YES please write a short description (on dimensions, type, etc.)]*
Gym	*(yes/no) [If you answer YES please write a short description)]*
Technical facilities for practical training activities	*(description) [Please, write a short description on special facilities in the school, especially those with high energy consumption (i.e. mechanical workshops, greenhouses, farms…)]*
Other heated areas	*(description) [If you answer is YES please write a short description (on dimensions, type of area, etc.)]*

OTHER INFORMATION	*[Any other <u>important</u> information to be indicated: i.e participation to other projects]*

Annex 2: Survey for collection of data related to school mobility

SURVEY FOR COLLECTION OF DATA RELATED TO SCHOOL MOBILITY

Choose your position with an X

Student	
Teacher	
Technical and administrative staff	

Please indicate the location and/or address of residence (if possible also the distance between them)

Head of school / university	
Place of residence	

Distance residence - school/university		km
Do you go home in the lunch break?		yes
		no

To be completed for all

	Outward	*Return*	
Transport used to get to school/university *If more than one means is used, tick multiple boxes. Tick "Walking" just in case you do NOT use other type of transport.*			Accompanied by car
			By car alone
			By car with other people
			Motorcycle
			Train
			Bus
			Tram
			Metro
			Cycling
			Walking

Why do you use this mean of transport? *In the case of more than one means, please refer to the prevalent. You can tick up to 2 responses.*	It costs less
	It's the fastest
	I live near school/university
	I have public means close to home/school
	Comfortable schedules and frequencies
	Public means are safer
	Not connected with public transport
	Public transport stations are far away

	Uncomfortable times and frequencies
	The car is safer
	The car is more comfortable
	With the car I feel free

To be completed only for those who use the property car

If you use the car, this is a car powered by:

	Petrol
	Diesel
	Gas - LPG (Liquefied petroleum gas)
	Mixed (gas/LPG - petrol/diesel)
	Hybrid (electrical - petrol/diesel)
	Electrical

Annex 3: Data sheet for collecting data from a waste sort

MONTH: **WEEK: from ___ to ____**

DAY	WASTE TYPE	Bag volume and Number of bags	% filling	Sign
Monday	Paper / cardboard	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Plastic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Glass	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Metallic-aluminium	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Organic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Mixed materials	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
Tuesday	Paper / cardboard	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Plastic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Glass	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Metallic-aluminium	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Organic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Mixed materials	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
Wednesday	Paper / cardboard	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Plastic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Glass	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Metallic-aluminium	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Organic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Mixed materials	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
Thursday	Paper / cardboard	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Plastic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Glass	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Metallic-aluminium	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Organic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Mixed materials	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
Friday	Paper / cardboard	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	

	Plastic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Glass	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Metallic-aluminium	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Organic	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	
	Mixed materials	☐ ___ liters - n.___	☐ 50 % ☐ 75 % ☐ 100 %	

Weekly summary (example):

Type	**Total number of bags**	**Average weight** (examples)	**Total weight** (*n. bags* x *average weight*)
Paper / cardboard	14 (10 full and 8 half)	7 kg	14 * 7 = 98 kg
Plastic	20 (16 full and 4 just 75%)	5 kg	(16 * 5) + (4*0,75*5) = 95 kg
Glass	…	6 kg	…
Metallic-aluminium	…	4 kg	…
Organic	…	3 kg	…
Mixed materials	…	5,3 kg	..

Annex 4: Conversion table for the common energy use

EXAMPLE OF CONVERSION TABLE

Conversion Table for the Common Energy Units

		Joules	BTU	Quads	kcal	mtce	boe	mtoe	m3 gas	ft3 gas	kWh	TWy
1 J	=		9.479 E-4	9.479 E-19	2.39 E-3	3.414 E-11	1.634 E-12	2.234 E-11	2.684 E-8	9.48 E-7	2.78E-7	3.171 E-20
1 BTU	=	1055		1 E-15	0.2522	3.602 E-8	1.724 E-7	2.357 E-8	2.832 E-5	0.001	2.93E-4	3.345 E-17
1 QUAD	=	1.055 E+18	1 E+15		252 E+12	3.602 E+7	1.724 E+8	2.357 E+7	2.832 E+10	1 E+12	2.93E+11	0.03345
1 kcal	=	4184	3.966	3.966 E-15		1.429 E-9	6.838 E-7	9.347 E-8	1.123 E-4	3.966 E-3	1.16E-3	1.327 E-16
1 mtce	=	29.29 E+9	27.76 E+6	27.76 E-9	7 E+6		4.786	0.6543	786.1	2.776 E+4	8,135	9.287 E-10
1 boe	=	6.119 E+9	5.8 E+6	5.8 E-9	1.462 E+6	0.2089		0.1367	164.2	5800	1,699	1.94 E-10
1 mtoe	=	44.76 E+9	42.43 E+6	42.43 E-9	1.07 E+7	1.528	7.315		1201	42,430	12,430	1.94 E-4
1 m3 gas	=	37.26 E+6	35.31 E+3	35.31 E-12	8905	1.272 E-3	6.089 E-3	8.323 E-4		35.31	10.35	1.181 E-12
1 ft3 gas	=	1.055 E+6	1000	1 E-12	252.2	3.6 E-5	1.724 E-4	2.357 E-5	0.02832		0.2930	3.345 E-14
1 kWh	=	3.60E+6	3.41E+3	3.41E-12	860.39	1.228 E-4	5.88E-4	8.042E-05	0.096621	3.412		1.142E-13
1 TWy	=	3.154 E+19	2.989 E+16	29.89	7.537 E+15	1.076 E+9	5.154 E+9	7.045 E+8	8.464 E+11	2.989 E+13	8.76E+12	