ENERGY GUARDIANS SMART-SCHOOL MANAGEMENT PLAN

GUIDELINES

N.DELIVERABLE D.T1.6.1.
Version 01
03.04.2017

Edited by PP6 UNIBO and PP2 CERTIMAC

N.DELIVERABLE D.T1.6.1.
Version 01
03.04.2017

Edited by PP6 UNIBO and PP2 CERTIMAC

CONTENTS

1. THE AIM OF THIS GUIDE

Building sustainability into every aspect of school life not only benefits our environment, it also helps schools to reduce their costs and communities increase their quality of life.

This guide aims to assist schools to:

- Improve energy efficiency
- Move towards sustainability of the renewable energy production
- Managing efficient energy use

There are three main objectives to go through a simple action-learning process designed to assist people in schools with the aim to learn situation, decide and then take action.

1. **Identify the current situation or the baseline consumption inventory:** knowing how you use the energy it is a crucial first step to understanding what changes can be made
2. **Take action or the development of an energy plan:** this involves changes to technology and changes to practise. The templates assist the energy guardians, Senior and Junior, to map their school's energy use and then to plan the changes
3. **Monitoring and sharing results:** monitoring will provide information on how successful you have been and what to plan for next.

In general, the energy costs for the schools are second to personnel costs as well as the energy consumption in a school district governed by a municipality represents till 60% of the total administrative energy consumptions. The guide uses the term "pilot" for the part of the school district involved in the ENERGY@SCHOOL program.

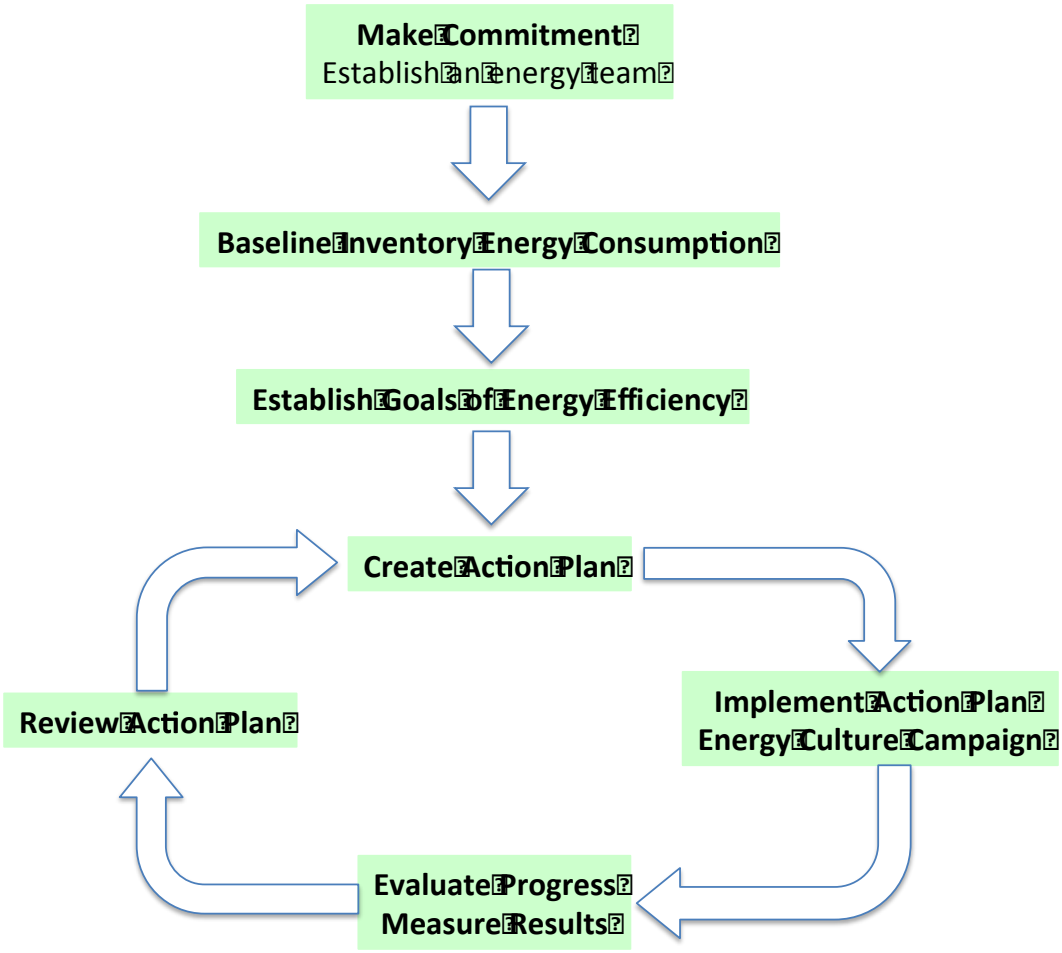
This guide scopes information on how pilot, as extension of local government, have planned and implemented programs to improve energy efficiency and/or renewable energy production in existing school buildings.

It also includes information on the benefits of energy efficiency in school buildings, expected investment and funding opportunities.

The guide outlines key energy saving opportunities that can be adopted by schools as well as demonstrates how simple actions by the teachers, students and parents can result in significant costs saving.

The actions to improve energy efficiency also provide an excellent opportunity for practical, on-the-ground learning for students. These guidelines highlight activities that can be undertaken by students and offers practical opportunities for bringing sustainable energy action plans into the classroom.

The ENERGY@SCHOOL guidelines for the Energy Smart School Management Plan present a seven-step approach:



2. BENEFITS OF AN ENERGY SMART SCHOOL MANAGEMENT PLAN

Improving energy efficiency in school buildings can produce substantial energy, environment and economic benefits, including:

1. Reduce greenhouse gas (GHG) emissions and other environmental impacts by decreasing consumption of fossil fuels;

2. Reduce energy costs due to the fact that schools spend approximately €75 per student on natural gas for heating and €1,3 per student on electricity each year. Figure 1 provides an average breakdown of energy consumption in schools by end use;

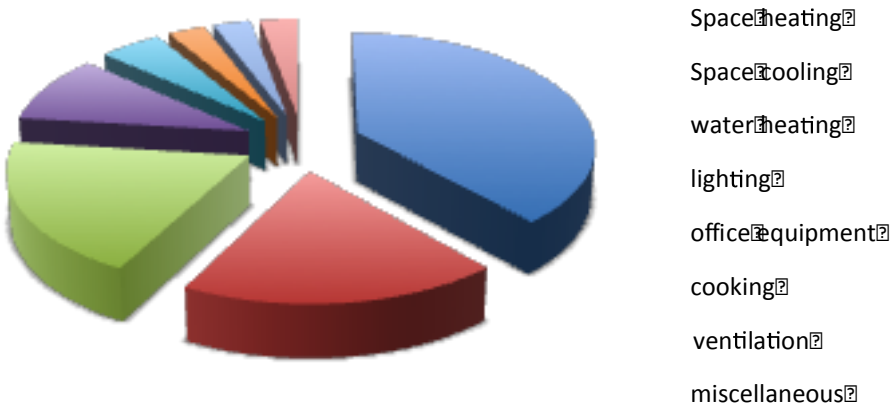


Figure 1. Average distribution of energy consumption in school by end use

3. Increase economic benefits through job creation and market development; in fact, investing in energy efficiency can stimulate the local economy and encourage development of energy efficiency service market;

4. Improve indoor air quality for example maintaining 700 parts per million (ppm) CO2 or less during occupied hours as well as reducing the accumulation of air quality-impairing contaminants (e.g. mold, dust mites, cockroaches and certain chemicals) or optimizing indoor temperature and humidity;

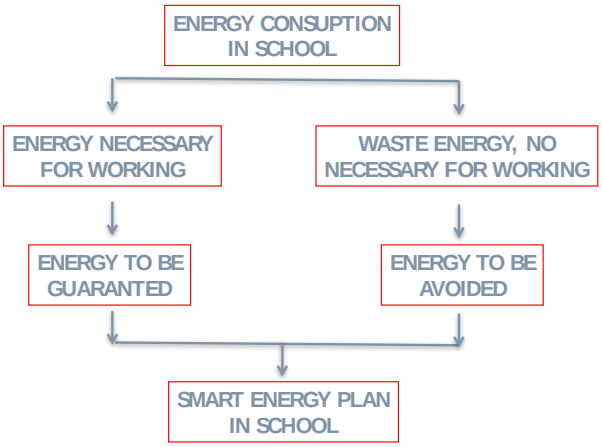
5. Enhance educational opportunities to adapt academic curricula to promote awareness of energy and environmental issues.

3. OVERVIEW OF GUIDELINES FOR ENERGY MANAGEMENT

The most effective way to reduce school consumption is to engage in a portfolio-wide, systematic approach for improving energy efficiency.

This approach involves seven main steps:

1. Make commitment for identify a team of qualified and motivated personnel for developing the overall pilot energy efficiency policy. The ENERGY@SCHOOL program involves professional energy experts for the energy audit in which they have to determine the different consumption of energy:



Waste energy is strictly linked to how people use the energy in the school as the day-to-day energy practise. The energy team will be divided in:

a. the technology is part of the Senior Energy Guardians such as teachers

b. the day-to-day practise is part of the Junior Energy Guardians such as the students

Senior Energy Guardians are involved to the implementation of the smart energy management plan for the total energy consumption and technological solution for energy efficiency as well as in the selection and formation of the Junior Energy Guardians.

Junior Energy Guardians are involved in the audit process as it is a significant learning opportunity. They have to do the check up of the school in order to determine how the energy is used in the school considering the different energy source, eg electricity, gas , coal, firewood, solar, wind and wood pellets for a calendar year in terms of amount of each fuel used and supply costs. They have also to measuring the energy use of specific electric items.

2. Baseline inventory consumption

After making a commitment, the next step is to look at how energy is used in the school building and to identify priority opportunities to improve energy efficiency and to set the goals. Senior Energy Guardians have to fill the template supplied by the Local NOC in which they have to report data concerning the final energy consumption of the school, the local energy production (if applicable), and the emission factors used to calculate the CO2 emissions. Each school should fill its template and the Energy Guardians Smart School Management Plan will collect the data of all the schools involved in the pilot.

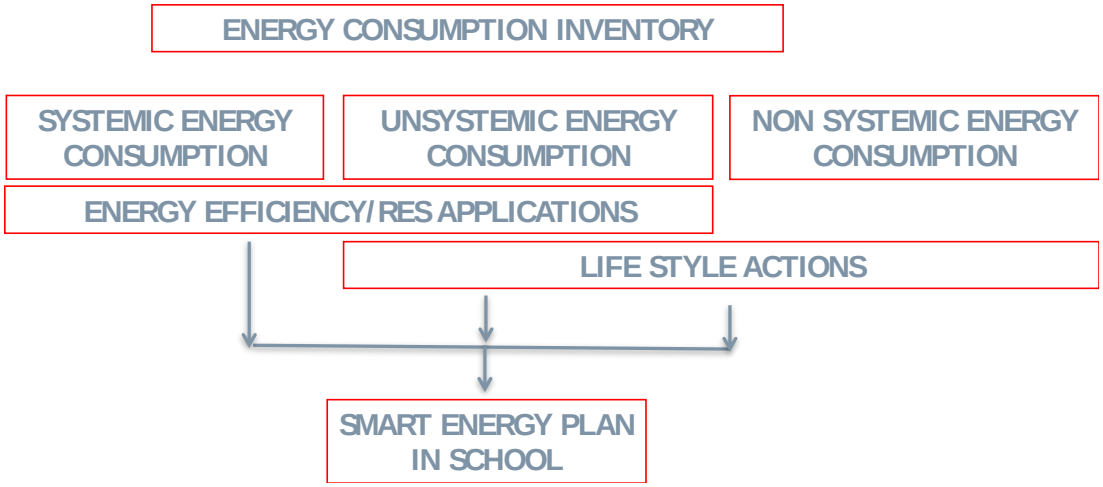
3. Set goals for improving energy efficiency

Each school can establish a portfolio of energy efficiency goals based on the indications by the ENERGY@SCHOOL technical audits.

Assessing potential energy savings helps determine an appropriate portfolio of goals that are clear and measurable. Each school has to establish both short-term and long-term goals for improving energy efficiency.

4. Create an action plan

A regularly updated action plan is a necessary roadmap toward meeting portfolio-wide energy efficiency goals. Create an action plan, involves establishing energy performance targets based on the energy consumption inventory



Systemic Energy Consumption: it is the energy consumption that is characterized by the devices to be necessary to guarantee the energy for working in the school. This energy is the minimum energy to be consumed for the basal metabolism of the school. Senior Energy Guardians have to use a staged approach to identify technical measures for improving energy efficiency to reach the minimum. The selection of the technical measures has to take in account the useful of the renewable energy sources based on the local availabilities. Heating and cooling are usually a typical example of systemic energy consumption representing the largest and most expensive energy users in a school. They work at a fixed rate and setting the

optimal temperature as well as the changing of the devices to produce heating and cooling is a typical action for an expert energy manager. Saving made in heating and cooling can have a positive impact on energy bills with even, low-cost measures making a difference. Optimize the temperatures when using heating and cooling should avoid the overheat or the overcool into the classrooms for preventing cool or warm air from escaping (e.g. opening the windows or the doors)

Non-Systemic Energy Consumption: it is the energy that the school's staff uses directly for working. This consumption generates wasting energy if the school staff has not culture of energy efficiency for example turning equipment off when it is not in use (eg the computer monitor typically uses 67% of the total energy used by the computer system). Junior Energy Guardians should develop good housekeeping practise in their junior action plan using a simple-fix template of life style action to reduce the wasting energy.

Un-systemic Energy Consumption: it is the energy that depends on both systemic and non-systemic energy consumptions for example lighting that is one of school's largest area of energy use. On a part, installing energy efficient lighting is a simple way for schools to reduce their systemic energy consumption while, on the other part, making good use of daylight in a classroom can reduce lighting costs by 20% and then the non-systemic energy consumption: both the action represents an example to reduce a un-systemic energy consumption. Installation of high energy efficiency lights is an action by Senior Energy Guardians while turning off the lights to favour the daylight use is an action by Junior Energy Guardians.

5. Monitoring progress and implement the action plan

The fourth step in implementing an action plan is to develop a tracking system and use it to continuously track and monitor energy use data, which is critical for evaluating program progress. Maintaining an effective centralized tracking system involves the following action:

a. Perform regular updates

b. Conduct periodic reviews

c. Identify necessary corrective actions

4. BASELINE CONSUMPTION INVENTORY

In this part, Senior Energy Guardians will start first by completing the Baseline Consumption Inventory of each school in the pilot. Section is divided in three main parts:

a. Final Energy Consumption – in which SEGs should report final energy consumption data by sector and by energy carrier

b. Energy Supply – in which SEGs should report data related to green electricity purchased and renewable energy production in school

c. CO2 emission – in which SEGs should report the computation of CO2 emissions by sector

Energy factors

Energy factors are coefficients for quantify the final energy consumption by different energy carrier.

Energy Carrier	kgEP	kWh
1 kg heating oil	1.01	11.744
1 kg gasoline	1.051	12.221
1 kg diesel	0.95	11.047
1 litro diesel	0.789	9.169
1 kg Liquid Gas	1.099	12.779
1 litro Liquid Gas	0.56	6.517
1 mc Liquid Gas	2.055	23.897
1 kg Natural Gas	1.126	13.093
1 Smc Natural Gas	0.82	9.535
1 kg solid biomass (humidity 25%)	0.33	3.837
1 kWhe (internal gross consumption)	0.2021	2.5
1 KWhe (final gross consumption)	0.086	1
1 kWht	0.086	1

Emission factors

Emission factors are coefficients which quantify the emission per unit of activity. CO2 emissions are calculated for each energy carrier by multiplying final energy consumption by the corresponding emission factors. We have adopted IPCC approach or emission factors for fuel combustion based on the carbon content of each fuel (Table 1) as well as for renewable energy sources (Table 2).

Table 1. Emission factors for fossil fuel combustion

Energy carriers	tCO_2/MWh
Natural Gas	0.202
Natural Gas Liquid	0.231
Heating Oil	0.267
Lignite	0.364

Table 2. Emission factors for local electricity or thermal production renewable energy sources

Energy carriers	tCO_2/MWh
Wind Power	0
Hydroelectric Power	0
Photovoltaics	0
Biogas	0.197
Wood	0,007
Geothermal	0
Solar thermal	0

IPCC emission factor should be reported close to zero if the biofuels/biomass meet sustainability criteria

Table 3. Emission factors for electricity by country involved in the ENERGY@SCHOOL

	IPCC tCO_2/MWh					
Country	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Austria	0.226	0.212	0.202	0.206	0.200	0.204
Germany	0.619	0.621	0.645	0.626	0.609	0.616
Hungary	0.563	0.551	0.606	0.593	0.516	0.539
Italy	0.491	0.494	0.493	0.484	0.453	0.467
Poland	1.262	1.243	1.188	1.123	1.141	1.165
Slovenia	0.536	0.536	0.539	0.561	0.613	0.582

Source: Joint Research Centre of the European Commission. Last update: July 2016

Category	FINAL ENERGY CONSUMPTION [kWh]													Total
	electricity	Thermal	Fossil fuels				Renewable energies							
			Natural gas	Natural gas liquid	Heating oil	Lignite	Wind	Hydroelectric	Photovoltaic	Biogas	Wood	Solar Thermal	geothermal	
LIGHTING														
SPACE HEATING														
SPACE COOLING														
WATER HEATING														
OFFICE EQUIPMENT														
COOKING														
VENTILATION														
MISCELLANEOUS														
TOTAL														

Category	CO2 EMISSIONS [ton]													Total
	electricity	Thermal	Fossil fuels				Renewable energies							
			Natural gas	Natural gas liquid	Heating oil	Lignite	Wind	Hydroelectric	Photovoltaic	Biogas	Wood	Solar Thermal	geothermal	
LIGHTING														
SPACE HEATING														
SPACE COOLING														
WATER HEATING														
OFFICE EQUIPMENT														
COOKING														
VENTILATION														
MISCELLANEOUS														
TOTAL														

5. ENERGY ACTION PLAN FOR SEGs

In this part, Senior Energy Guardians will describe each action scoping to reduce the systemic energy consumptions by the following scheme:

- CATEGORY (Space heating; space cooling; water heating; lighting; cooking; ventilation;…)
- TITLE (specify the title of the action)
- DESCRIPTION OF THE ACTION
- HOW CAN DO WHAT? (Headmaster; teachers; students; Parents; energy manager; SEGs; JEGs;…)
- IMPLEMENTATION (Start Time)
- IMPLEMENTATION (End Time)
- ESTIMATED COST PER MEASURES
- ESTIMATED ENERGY SAVING PER MEASURES
- ESTIMATED RENEWABLE ENERGY PRODUCTION PER MEASURES
- ESTIMATED CO2 REDUCTION PER MEASURES

Actions are divided into “essential” and “desirable”. A tick means the person in a particular job function is likely to be well suited to the task. For some tasks a number of different people could be involved while for other ones it needs a more specialist nature even if an energy manager.

The energy action plan for SEGs will be integrated by the actions studied and developed in the energy action plan for the Junior Energy Guardians. The energy action plan for JEGs will be focused on the reduction of un-systemic and non-systemic energy consumption.

All the actions have to be reported in the following template:

CATEGORY	TITLE/KEY action	WHO CAN DO WHAT?	Implementation [Start Time]	Implementation [End Time]	Estimated costs per measures	Estimated energy saving per measures [MWh/a]	Estimated renewable energy production per measures [MWh/a]	Estimated CO2 reduction per measure [ton/a]
LIGHTING								
SPACE HEATING								
SPACE COOLING								
WATER HEATING								
OFFICE EQUIPMENT								
COOKING								
VENTILATION								
MISCELLANEOUS								
TOTAL								

6. TAKING ACTION

Action involves changing the technologies that the school is using and changing peoples practices and behaviours.

Regarding the technical aspects, the following order is recommended:

1. avoid the wasting energy,
2. use energy more efficiently,
3. use energy from renewable sources.

The actions to avoid the wasting energy will be developed by the action plan of the Junior Energy Guardians on the second year of the ENERGY@SCHOOL project.

Use energy more efficiency

In this part, this guidelines describes the main technological solutions you can use to reduce consumption by the which the Senior Energy Guardians can fill the schedule for each action as described in the previous paragraph.

Lighting

Lighting is one of schools' largest areas of energy use up to one third of schools' total energy usage.

Installing energy efficient lighting is a simple action for schools to reduce their energy consumption. A detailed energy audit in each classroom, described in the action plan developed by the Junior Energy Guardians, will identify if lighting upgrades are suitable to replace with LED or energy-efficient fluorescent tube lighting.

By installing movement and daylight sensors you can significantly reduce energy use. Occupancy sensors automatically turn off lights in a space after that space has been unoccupied for a period of time.

Furthermore, making good use of daylight in a classroom can reduce the energy consumption up to 20%.

Recommended lighting levels are generally 240-500 lux – see **UNI EN 12464-1.** Lighting should be higher than 300 lux in spaces such as workshops with detailed bench or machine work, laboratories and music, reading and computer rooms, and lower than 300 lux in corridors and stairways, assembly halls, audio-visual rooms, and social areas.

Installing dimmer switches provides flexibility and reduces the power draw, especially in rooms with good natural daylight.

Heating and cooling

Heating and cooling are typically the biggest users of energy in schools.

Only heat or cool rooms you are using such as it will be described in the detailed action plan by JEGs.

One of the main action is to set the school's thermostat at 18-20°C in winter and 24-27°C in summer in order to avoid the overheat and overcool. Temperature needs can vary during the day so check the system operating hours match the times when heating is most needed. Review the setting every month to ensure they are correct. Adjust timers so that the building reaches optimum temperature just as people arrive and begins to cool down as people leave. This is best done by gradually altering setting over a number of days and checking the response of the building occupant. For example, if the school is occupied for different periods over the week, it could be useful to install seven-day timers to allow the system to operate only when the building is occupied. This action can be developed by the JEGs in their action plan.

Ensure thermostats are not influenced by draughts, sunlight, heater or ICT equipment.

Take in account that every degree warmer or cooler can increase your energy consumption by up to 10%. On the basis:

1. ceiling fans are a great alternative to air conditioning. They are much cheaper to install, operate and maintain. Reversible ceiling fans can be set to winter-mode allowing warm air that has collected near the ceiling to be pushed back down to ground level, keeping the air temperature in the room more even and requiring less energy to heat the space.

2. Door seals are a cheap and effective way to reduce heating and cooling costs and improve the thermal comfort of classrooms and office areas by reducing drafts. Door seal should be a priority for older buildings that have large gaps under doors.

3. Different types of glass and coating will have an impact on the light of the room and its insulation. Opt for double or triple glazing as a minimum requirement for all new windows for comfort and energy saving. This is especially important for north-facing or exposed windows

4. Doors that are left open cause a significant loss of heat in winter and cool air in the summer, wasting energy that was used to heat or cool the air. Automatic door closers are a great way of reducing this loss from classrooms and office areas.

5. Schools can reduced their heating and cool energy consumptions by implementing "dress for the weather" policies.

6. Installation of heat pumps in rooms that increase comfort in both winter and summer. Heating and cooling are available and they are regulated within limits. Heat pumps are highly efficient producing an average of 3 kWh of thermic energy by the consumption of 1 kWh of electric energy. This will increase the electrical load but decrease two third of total energy consumption.

Hot water heating

Of your school uses a significant amount of hot water from an electric hot water unit it may be worthwhile upgrading to a natural gas system; however, if the hot water consumption is not high, thus it may be beneficial to install energy efficient electric instantaneous hot water heaters.

Install a power point timer on your boiling hot water unit to automatically turn the unit off when hot water is not in use this will ensure it is not running 24 hour a day, seven days per week to prevent it from continuing to use electricity or natural gas maintaining the water at temperature.

Maintaining the temperature of boiling hot water at 38-42°C, not higher for preventing wasting energy.

Equipment

The increased use of electrical equipment and information communication technology in schools is having an effect on electricity consumption. Computers, ICT and office equipment can amount for a third of a school's total energy consumption.

This part will be specifically described and treated by the JEGs in their action plan

Renewable energy generation

Renewable energy technologies utilise natural and recurring energy sources to generate power.

Installing renewable energy generation is a cost-effective strategy to reduce the school's energy consumption and costs.

Photovoltaic can be a strategic approach when generates power to cover the heat pump consumption as well as the lighting during the day or the consumption of the electrical equipment. The accumulation in batteries of the electric energy, produced in excess during the day, could be strategic too for the cover of electric consumption during the night.

Solar heating of sanitary hot water as well as of pool is one option and the technology is increasingly cost-effective for reducing the amount of the natural gas consumption.

Appliances

Schools can make significant energy savings by choosing energy efficient appliances.

1. refrigerators – refrigerators and freezers consume significant amounts of energy as they are on 24 hours a day, seven days a week. Take the following actions to make sure refrigerators are efficient as possible:
    a. position fridges and freezers away from heat sources
    b. freezers operate more efficiently when full
    c. check the seals are intact and cold air is not escaping
    d. ensure the doors are not open or opened unnecessarily
    e. defrost regularly
2. kitchens and canteens – school kitchens and canteens are a major energy consumption area. Take the following actions to make sure to save energy as possible:
    a. control the curve of temperature before using the modern catering equipment
    b. switch off ovens, grill and fryers immediately after use and ensure appliances are not in stand-by
    c. keep fridge and freezer doors closed and defrost regularly
    d. switch off equipment, lights and extraction fans when not in use
    e. reduce drying times on dishwashers

Behavioural change

In this section each SEG team describe the behavioural change sought within the school (data filled in the grid above), in order to reach the energy saving and green management. SEGs are free to mention any kind of action and people involved, according to the own environment of their school.