

solar heating
energy
CO₂
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**Guide for an Integrated
Sustainable Energy Education,
First steps to climate neutral schools,
for secondary schools**

STUDENT EXERCISES

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Directorate-General
for Energy
and Transport



THEMATIC GROUP EDUCATION



Guide for an Integrated Sustainable Energy Education, First steps to climate neutral schools, for secondary schools

STUDENT EXERCISES

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1 → Exercise - A Sustainable School

Activity Sheet

Exercise : Sustainable Development

EXERCISE TO INTRODUCE THE CONCEPT OF SUSTAINABLE DEVELOPMENT

The following sample exercise is designed to help introduce the concept of sustainable development. This exercise will only be effective if they accompany a solid description of sustainability and a few examples. In addition, the World Wide Web has many sites dedicated to explaining components of sustainability and city sustainability plans. There are of course other similar and complementary exercises that you can find in the « Education for Sustainable Development Toolkit » <http://www.esdtoolkit.org>.

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Drain or Sustain

Purpose: To introduce participants to the concept of sustainable development.

Group size: 4 to 36 participants.

Time Needed: 30 minutes.

Materials:

- A large number of white pebbles.
- A large number of red pebbles (or any contrasting color)
- An opaque bag for each community.

Directions:

- I. Divide the students into communities of four.
- II. Place 16 white pebbles in an opaque bag for each community.
- III. Give each community member a large handful of red pebbles.
- IV. Choose the most culturally appropriate scenario from the following five scenarios. The scenario illustrates that by overusing a resource, that resource or another is damaged in some way. Share the scenario with the participants.
 - a. White pebbles represent one parcel of land farmed; red pebbles represent use of chemical fertilizer, herbicide, and pesticide.
 - b. White pebbles represent one parcel of land used to graze animals; red pebbles represent loss of grazing vegetation and over production of manure.
 - c. White pebbles represent one day's catch from a fishing vessel; red pebbles represent population growth of less-desirable species.
 - d. White pebbles represent travel by air; red pebbles represent exhaust pollution from airplanes.
 - e. White pebbles represent products made from a factory; red pebbles represent pollution to air and water by that factory.
- V. Explain the rules of the game:
 - a. Participants draw one or more pebbles from the bag each turn.
 - b. Each community member must draw at least 1 white pebble from the bag per round to survive. It does not matter how many red pebbles are drawn.

- c. If a participant does not draw a white pebble she/he "dies" and does not continue to play.
 - d. Each community member may take as many pebbles as desired from the bag.
 - e. At the end of each round, the white pebbles in each community's bag are counted; exactly that many white pebbles are added to the bag.
- VI. Rounds 1 and 2: First generation (the present). For each white pebble a participant takes, one red pebble is placed in the team's bag immediately.
- VII. Rounds 3 and 4: Second generation (your children). For each white pebble a participant takes, three red pebbles are placed in the bag immediately.
- VIII. Rounds 5 and 6: Third generation (your grandchildren). For each white pebble a participant takes, three red pebbles must be placed in the bag immediately.
- IX. Discuss how the game progressed.
- Who had the advantage? Why?
 - Why did participants take as many pebbles as they did?
 - How did the actions of the first generation impact the third generation? Is this fair?
 - During what round was the "fatal move" made (the act that caused the demise of the system?) How did this affect the rest of the game play?
- X. Give the communities the chance to play again, without the bags, so that participants can monitor the communal resource and the pollution. The same rules apply.
- XI. Discuss how this game progressed.
- Were communities able to sustain the resource so that the third generation had as little pollution/overuse as the first generation?
 - Did any communities opt to limit: use of chemicals/amount of grazing/catch size/air travel/pollutants created?
- XII. How much communication did it take to sustain the resource?

Extension:

In the first two rounds, participants will have no trouble surviving, and may even show greed by taking four or more white pebbles. It becomes obvious that the community member who reaches into the bag first has an advantage over the other community members.

In rounds 3 and 4, participants will begin to take larger handfuls from the bag, especially at the end of Round 4. They will be concerned when someone gets a large number of white pebbles, as that means fewer white pebbles and many more red pebbles for the next participant.

In rounds 5 and 6, the participants begin to "die off" (be put out of business, be forced to leave the farm, etc.). Participants take huge handfuls of pebbles in fear that they might not survive. By now it becomes obvious that the common resource is so polluted/overused that everyone loses.

From "Greed vs. Need" in *Project Learning Tree: Pre-K-8 Activity Guide*, 3rd edition, American Forest Foundation, 1995, and "Why EE?" in *EE Toolbox – Workshop Resource Manual*, by J.F. Disinger and M.C. Monroe, Regents of the University of Michigan, 1994.

2 → Exercise - Undertaking a Stakeholder Analysis

Activity Sheet

Exercise : Stakeholder Analysis

→ Undertaking a Stakeholder Analysis

There are many different tools to help us to think about our stakeholders. Which ones are used depends upon the questions that need to be addressed. This example is one way (but not the only way) of doing a stakeholder analysis.

There are several steps:

1. List all possible stakeholders, that is, all those who are affected by the project or can influence it in any way. Avoid using words like 'the schools community' or 'the Local Authority'. Be more specific, for example, '16 to 18 year olds' or the 'Health Service'
2. Identify, as thoroughly as possible, each stakeholders' interests (hidden or open) in relation to the potential project. Note some stakeholder may have several interests.
3. Consider the potential impact of the project on the identified stakeholders. Will the project have a positive or negative impact on them? (Award it + or - or +/- or ?).
4. Now consider, how much do we value the interests of each stakeholder? A high 'Priority of Interest' means the project is being designed in the interest of that stakeholder – for their benefit. Rank stakeholders with those with a high priority at the top and low priority at the bottom.
5. Now consider how much influence each stakeholder has. Put each Stakeholder onto the stakeholder matrix according to the 'Priority of Interest' and 'Level of Influence'. The Interest/Influence matrix gives you some guide as to how your project should work with each.
6. Decide when you need to engage with the stakeholder groups and at what level. Remember you cannot work with all groups all of the time. Forming an action team is useful to steer the project process and have feedback.

3 → Exercise - Learning of sustainable energy

Activity Sheet

Exercise : Learning sustainable energy

Name of the activity: Developing a Problem Tree

Background: A way of analysing the topic of study is developing a *problem tree*. Here the problem of sustainable energy in schools is mapped against its causes and effects.

Turning the problem into a positive statement gives the purpose for an intervention. Addressing the causes of the problem identifies outputs and activities. Addressing the effects identifies the indicators.

Activity development: Start with a blank sheet of flip chart paper, pens and 76mmx76mm post-its (or small card and tape). Depending on the group or the situation there are two methods for developing a problem tree...

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Steps to follow:

Method 1: “Brainstorming”

This method can be more creative, but it is risky; you can get tangled up.

- Participants brainstorm issues around a problem (or more problems) as yet unidentified. Each issue is recorded on a separate post-it. Don't stop and think or question, just scatter the post-its on the flipchart. When ideas for issues dry up, stop and,
- Identify and agree the focal problem. It is probably there on the flipchart, but may need rewording. Note that a problem is not the absence of a solution, but an existing negative state.
- Sort the remaining issues into causes and effects of the problem.
- Cluster the issues into smaller sub-groups of causes and effects building the tree in the process. Tear up, re-word and add post-its as you go.
- Finish by drawing connecting lines to show the cause and effect relationships.

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Method 2: Systematic

Better suited to the more systematic and methodical.

- Participants first debate and agree the focal problem. Write this on a post-it and place it in the middle of the flipchart.
- Now develop the direct causes (first level below the focal problem) by asking 'but why?' Continue with 2nd, 3rd and 4th level causes, each time asking 'but why?'
- Repeat for the effects above the focal problem instead asking 'so what?'
- Draw connecting lines to show the relationships.



4.A.→ Exercise - Data gathering and observational exercise

Activity Sheet

Exercise : Data gathering and observational exercise

1) Energy invoice (bill) audit

For knowing the precise figures of energy consumption of a school we shall setup an energy audit based on invoices / bills. It is vital for an effective implementation of an energy saving program that past patterns of energy use, both daily and annual, are known and understood. For students this exercise is an excellent opportunity for making energy calculations and contribute to the curriculum of mathematics and statistics.

Arrange for energy utilities to provide energy usage information over the past two-year period. Negotiate with your School Office Manager to have copies made of all energy bills when they arrive and create a separate file for them.

All specific data of the sub-sectors should be looked to:

- Heating
- Hot water
- Building envelope
- Lighting
- Catering and food technology equipment
- Electrical equipment
- Renewable energy

Member of the Energy Management Team or a class can draw graphs of consumption versus months and publicise the results. Record details of fuels used, account numbers, contacts at energy utilities and fuel suppliers. Record details of energy usage over the last two years as shown on bills for each Fuel and for each meter. Calculate and draw bar graphs of energy use and cost per day, for billing periods recorded.

Compare the real energy use and not only the cost. Those cost can vary immensely and can even lead to increases of energy consumption, cost and greenhouse gas emissions.

Ask students to mark on school energy graphs important changes such as holiday periods, record hot or cold spells, the opening of new buildings, extended operating hours, etc. Can they find any links between these and the energy use? If so, why? If not, why not?

Students can graph the amount the school pays for electricity and gas as consumption increases. They should repeat the exercise using residential tariffs and observe the differences.

Students could set up a computer program or graph that calculates energy costs based on different tariffs for different energy usage patterns.

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Collecting Data of Schools Energy Consumption

➔ Present Energy Consumption

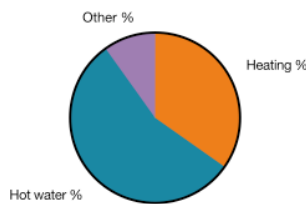
Data of energy consumption from bills for a specific school can be set on a chart.

- Energy use and Cost and for the year
- Natural gas use and Cost and for the year

➔ A sample of chart

Every energy can be visualised into a chart

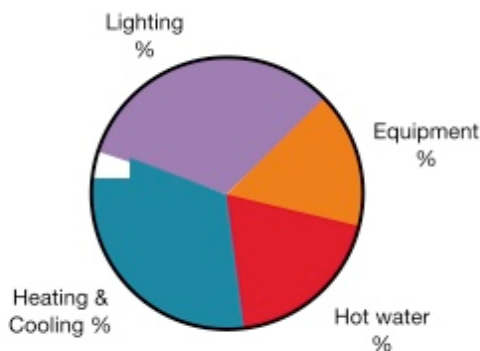
Natural Gas: (Information available from Sheet 7).



The aim is to become a simple to read graph or chart with the energy use of the school for the last school year.

➔ Total energy costs

Fuel	Energy	Annual Cost
Electricity		
Natural gas		
LPG		
Oil		
Total		



4 → Exercise - Identify the issues – energy leaks, data gathering and observational exercise

Activity Sheet

Exercise : Identify the issues – energy leaks, data gathering and observational exercise

The aim is to identify where the heat has escaped and where the electricity is lost by student activities.

Identifying energy leaks are based upon the inventory of all energy operations of the school. Those operations inventories are made on the use of electricity, fuel use, waste production and transport. By estimating the energy use and costs by category, we can determine where the heat is escaping and the electricity is lost. Those energy leaks are the issues that should be the main point of future priority actions. Two strategies can be followed:

- Benchmark strategy: a first point can be to evaluate potential areas for savings in energy use against data coming from surveys in order to compare the school's performance (low – average – high level of energy consumption); this can be used in terms of annual energy use per square meter of floor area, or cost per student.
- Listing strategy: by identifying the most energy-consuming equipment, calculating running costs, lighting, and so on.

Those tasks are to be assigned to students, however the reference data can be delivered by the Energy Agency which can have a crucial role also in supporting teachers in the didactical approach of the exercises, in the animation of the activity, in providing the measuring instruments and in the identification of energy leaks.

The aim can be reached thanks to different exercises:

Testing exercise: meter readings

Students belonging to the Energy Team can make a testing exercise using meter readings to estimate the savings from changes made, i.e. if lights are switched off at lunchtimes or lighting efficiency measures are introduced.

Meters can be read

- ⇒ at the start and end of lunchtimes for a normal week. Use the Energy Team to switch off some lights at lunchtimes for the next week and read the meters again. The difference in energy use shows the benefits of switching off lights.
- ⇒ before and after weekends or holidays so that you can assess whether equipment has been left on unnecessarily and track down energy wastage.

On this basis you can make a case for an Energy Saving Campaign, such as using student monitors to switch off lights, installing automatic switches or other alternatives. Furthermore the meters reading provides evidence of the savings achieved by your Energy Saving Program and the evidence can then be presented to the rest of the school community who can be motivated themselves by your achievements. This is a crucial point if your program is to gain due credit for saving money.

Inventory

A good and simple inventory system, with the use of simple calculation systems can be used. Specific sectors (electricity, thermal, transport, waste etc), with specific data should be taken into account by the Energy Team.

The members of the Energy Team or a class can draw graphs of monthly consumption and communicate the results. Details to be recorded can be: fuels used, costs of fuels per litre or cubic meter or Kwh, account numbers, contacts at energy utilities and fuel suppliers, energy usage over the last two years (or per months) as shown on bills for each fuel and for each meter. After calculations have been made some graphs can be drawn of energy use and cost per day, per month, per year, for billing periods recorded. Students should compare the real energy use and not only the cost, since those costs can vary immensely and can even lead to increases of energy consumption, cost and greenhouse gas emissions.

Students should also mark on school energy graphs important changes such as holiday periods, record hot or cold spells, the opening of new buildings, extended operating hours, etc. Can they find any links between these and the energy use? If so, why? If not, why not?

Students can graph the amount the school pays for electricity and gas as consumption increases. They should repeat the exercise using residential tariffs and observe the differences.

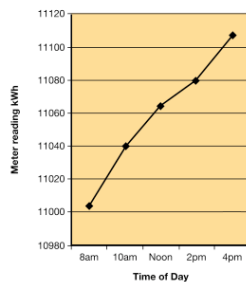
Students could set up simply in an excel file a table (and produce from this some graphs) that calculates

- a) energy costs based on different tariffs for different energy usage patterns.
- b) Co2 emissions (by multiplying the consumption by a special coefficient)

Date: _____ Day: _____ Weather conditions: _____

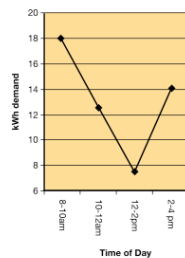
a) Actual Meter Reading.

Time of day	Meter Reading (kWh)	Energy Consumption (kWh)
8:00 AM	11004	36
10:00 AM	11040	
12:00 AM	11065	25
2:00 PM	11080	15
4:00 PM	11108	28



b) Actual Meter Reading.

Period	Hours in the Period	Energy Consumption (kWh)	Average Energy Consumption (kWh)
8-10am	2	36	18
10-12am	2	25	12.5
12-2 pm	2	15	7.5
2-4 pm	2	28	14



5 → Exercise - Developing a sustainable energy action plan

Activity Sheet

Exercise: Develop a strategy (action plan) to reduce energy use

The aim is to develop a sustainable energy action plan for reducing energy, agreed by senior level and the Action Team based upon student work.

In the Action Plan to be developed for reducing energy use and emissions in a school, students will incorporate the information and data they have collected.

This strategy will be based on the development of identified energy leaks. It will set a target for emissions and energy reduction for at least the forecast year. It will be built on actions already formerly taken and will be covering all activities of energy saving including emphasis on no-costs and low-cost measures.

The Energy Management Plan will report the details with the measures to reduce school energy consumption. Actions may include behavioural changes (from staff and students), upgrade of equipment and other minor works. The plan should include a project timetable, any expenditure required, potential sources of funding and estimated financial and greenhouse gas savings.

The educational skills used in this part are:

- Investigation and research
- Data analysis
- Presentation
- Record keeping
- Critical thinking

The Energy Team can prepare the energy action plan and determine opportunities for funding. Specific information sessions with the stakeholders can be organised in order to obtain ideas and a feedback on the plan.

More classes can contribute to the development of the action plan; the different classes can work on sub-sectors such as: waste, transport, heating systems, insulation, building etc. By preparing a theoretical introduction and observational lessons, the students can analyse the data.

The information of sub-plans of classes who were concentrating on specific parts of the building (like lighting, thermal etc) can be brought together and make the Total Plan.

This plan proposed by the Energy Team, should be validated by the school direction. Its implementation generally runs throughout the school year, but can be also the next one and beyond. Some measures are short-term activities, but others especially requiring investment could run for years.

→ The Energy Management Plan:

- Demonstrate clearly how the school will reduce emissions and save energy. The action plan advises activities for short- and long-term target years.
- Set up a target of reduction for the total greenhouse gasses, energy use in the building and transport (or other identified activities).
- Propose actions such as « no cost » - « low cost » and « short term investment » and « long term investment » (but the emphasis must lay on no cost and low cost measures).
- Take into account the cost of electricity per Kwh
- Give priority to lighting and IT, where low-cost measures are available.

- Develop Mitigation Activities for one year, two years and others beyond.
- Foresee a Communication strategy to the direct and indirect stakeholders
- Set up financing modes. Costs of activities are calculated included payback years. Calculation are made for establishment of a baseline year and the quantity of saving realised by the proposed actions.

At this stage every single stakeholder of this Plan should be indicated : what, how, who, when, at what cost and with which paybacks.

Example of a table that can be filled in:

Energy use	List with actions	Carried out by	Costs in euro	Savings in euro	Payback period
Electricity					
1.1					
1.2					
1.3					
Natural gas					
2.1					
2.2					
2.3					

In order to get a **sustainable energy action plan**, the following steps are needed:

- (1) Use the Energy Consumption data
- (2) Use the list with energy leaks and
- (3) Develop a list with possible energy saving actions.

From the list of most identified energy leaks a way of solutions can be developed. Every point can be discussed into the lesson.

In order to promote a solution students will develop some actions. For every action there can be calculation of energy savings, and payback times.

The emphasis of nearly all guidance is on low/no-cost school measures. Similar kinds of actions are repeated in nearly all guidance.

The action plan will usually detail targets, but there is relatively little uniform guidance on appropriate targets. There can be two complementary ways of developing the priority actions:

- 1) Actions directly derived from the energy audit results.
- 2) Actions develop based upon usually from a presented menu of actions.

The implementation activities can be setup into an implementation matrix.

Fuel & Use	Actions recommended	Carried out by	Cost \$	Savings per year \$	Payback period
ELECTRICAL: 1. Lighting	1.1				
	1.2				
	1.3				
	1.4				
	1.5				
	1.6				
2. Heating	2.1				
	2.2				
	2.3				
3. Hot Water	3.1				
	3.2				
4. Plant and Equipment	4.1				
	4.2				
	4.3				
	4.4				
NATURAL GAS 1. Heating 2. Hot Water	1.1				
	1.2				
	2.1				
LPG Heating Oil	2.2				

6 → Exercise - Activities for lowering Thermal demand

Activity Sheet

Exercise: Thermal demand

The aims of the thermal demand should be to reduce space-heating demand and maintain steady comfortable internal environment.

Heating cost are the most important energy use and cost. Those costs can be reduced by several actions, from no-cost to investments. (58% of energy use for space heating and 45% in costs (ref. UK- carbon trust).

Building insulation has improved over the last decade. Loft insulation remains the most common form of insulation. There has been rapid growth in the use of double-glazing.

Measures of good practice of lowering energy use for heating show that appropriate actions to take:

- 1. Attitude related: changing habits of energy use
- 2. Efficient control of temperature
- 3. Appropriate zoning of temperatures
- 4. Systems: installing new more efficient boilers
- 5. Using « building energy management systems” (BEMS)

Measures to be implemented related to heating are to lowering the use in Kwh of fuel for heating systems.

Ask students to draw the layout of their classroom or building, paying special attention to:

- Where furniture is placed
- What equipment is present and where it is located
- The position of heating vents / radiators
- The position of windows
- The position of students tables and teacher's desk

Ask them to make suggestions about how the furniture could be better placed so that vents / radiators are not obstructed and so that the warmth of equipment does not affect students, teachers or thermostats. The best group could present their findings to the class.

Furthermore students could make an energy tour of the school and enquire with the caretaker some technical details of the heating system / boiler, for example its power, the time it is working and the fuel used; they could also check the temperature of the thermostat. All rooms should be checked (if double glazed windows and thermostatic valves are present) and thanks to a thermometer the temperature of each room should be registered , possibly day and night.

Brochures with assignments of tasks, worksheets and protocol sheets for the students could be delivered.

7 → Exercise - Activities for Student for lowering energy of Lighting

Activity Sheet

Exercise: Activities for Student for lowering energy of Lighting

Schools activities need appropriate lighting. Lighting accounts for 20 to 25 % of the total energy use, with a cost of thousand of euros a year. Yet school is operating during daylight and most classrooms have large windows.

Analysis of lighting use can be divided into:

- Classrooms (general lighting and specific task lighting).
- Corridors and passageways.
- Special purpose areas such as the library, workshops, gymnasium, canteen and administration block.
- Toilets and changing rooms.
- Indoor and outdoors security lighting.

Classroom Lighting:

Table for lighting audit should be completed for all locations in the school.

Alternatively if this is not practical, choose a typical classroom and multiply by the number of similar classrooms in the school.

Record the:

- Number of lamps.
- Type of lamps (incandescent or fluorescent).
- Size of lamps (number of watts).
- Type and size of curtains (if present at windows)

Estimate the daily hours of usage:

- Visit the rooms
 - Before school.
 - During morning classes.
 - At recesses and lunchtimes.
 - During afternoon classes.
 - After school.
 - Night time.
- Check the school's timetable to see if rooms are used at night.
- Ask the cleaner how long lights are on during cleaning.
- Try to take into account weather conditions on the day of the survey; on a dull day, lighting use will be above average, and on a bright day, below average.

Example of table for Lighting audit

Room	Room Description	Types of equipment			Operating time/days	Daily consumption	Comments
		Number	Type	Consumption (Watts)			
Total							

1. Carry out a lighting inspection of the various rooms in your school. You will need one set for each room you inspect. Once you have done this for the whole or part of the school, go through all your answers and write in your own words what you think of the lighting situation in the areas you have audited (with lights off is it too dark? Is it ok?). Use a luxmeter to check the level of lighting in each room and compare your results to the standard ones: i.e in a classroom light level must be not lower than 300 lux, in the corridor 100 lux are sufficient, in the stairs 150 lux are sufficient etc)

2. If your school has a trade or technology training area it may be possible to design and make your own reflectors with assistance from the physics and/or trade teachers. This is a very practical application of optics.

3. Students could carry out a range of simple and then complex activities in a range of light conditions. They can record their experiences and compare them.

4. Investigate whether the school should purchase daylight and/or movement sensors.

The class activity could be of making systematic observation of hours of not needed lights and calculation of energy waste. Identifying of light use can be by electronic help devices. Students can make a management plan of more efficient light use.

8 → Exercise - Activities for auditing "hot water"

Activity Sheet

Exercise : auditing Hot Water

In most schools, Natural Gas, LPG or Distillate provides almost all energy for space heating and hot water. Bills for these fuels provide a good indication of energy use. Electrical heating and electric hot water usage if relevant should be recorded on « **Table for Electricity appliances** ». These include:

- Wall mounted electric hot water units (usually in staff rooms).
- Small electric hot water systems (often located in cupboards).
- Electric fan heaters and radiators (small offices). Hourly energy use varies depending on the input wattage. Ask the people who use them to estimate how many hours per day they are used.

Distillate, Natural Gas or LPG heating usage can be recorded on « **Table for Natural gas, LPG, and Oil heating** ».

Table for Electricity appliances

Room	Room Description	Types of equipment	Power rating (Watts)	Operating time per day (estimated hours)	Daily consumption (Kwh)	Comments
Total						

Table for Natural gas, LPG, and Oil heating

Room	Room Description	Types of equipment	Power rating (Mj/hr)	Operating time par day (estimated hours)	Daily consumption (MJ)	Comment
Total						

9 → Exercise - Activities for Electrical equipment

Activity Sheet
Exercise : Electrical equipment

Appliance Nameplates:

Using nameplate ratings provides an alternative for determining energy consumption. They give an upper limit measure of the consumption. However, please note that nameplates are fit to equipment to ensure that supply systems are not overloaded rather than as an accurate measure of consumption.

Nameplates are found:

- On the back of an appliance.
- Underneath small appliances.

Nameplates are not located inside appliances. Do not look inside appliances as there may be dangerous bare wires.

Example of Table for Electricity appliances

Room	Room Description	Types of equipment	Power rating (Watt)	Operating time per day (estimated hours)	Daily consumption (Kwh)	Comments
Total						

Matching the energy use by bills and energy audit.

Total your energy use and compare your result with that shown on the schools Energy bills.

There should be a reasonable match if you have been accurate and thorough.

If there are large differences, review your estimates or check you did not omit major areas or pieces of equipment.

Prepare a pie graph showing the energy used by each major activity. You are now in a position to:

- Report your findings to the school community set priorities for Energy saving actions.
- Carry out more detailed assessments of energy consumption using meter reading Techniques (see below).

Using meter readings to draw your energy use profile:

Set up a Project Team to record meter readings at set times each day for a week to develop an understanding of the school's energy use profile. The team should also note important climatic conditions, such as air temperature or the amount of cloud cover. For example, meters could be read at the following times:

- Early morning before the cleaners arrive. Make sure someone knows how to turn off the security systems.
- When school starts.
- At the start and end of recesses and lunchtimes.
- When school finishes.
- After everyone leaves for the day.
- Before and after weekends and holiday periods.
- A day-use profile with readings every ½ or 1 hour.

As your Project Team gains experience, they may wish to take meter readings at other times to help develop a better understanding of how energy is being used.

For example, they may also wish to read meters half an hour before school starts.

By subtracting the previous reading from the most recent one and dividing by the number of hours between readings, a value of the average rate of energy use for the period of time between readings can be calculated.

Graphs can be plotted to show rates of energy use in each time period. These graphs can give valuable information on issues such as:

- Energy used by lights and equipment left on at recess/lunchtime and savings resulting from switching that equipment off.
- Effect of warmer and colder weather on energy use.
- Effect of sunny and cloudy weather on energy use.
- Energy use by cleaners.
- Overnight energy use and potential benefits of transferring to off peak or time-of-use tariffs.
- Weekend and holiday energy use so that equipment that has been left on or losses can be traced.
- Potential savings available through switching to off peak or time of use electricity tariffs.

You take the Actual Meter Readings above directly from the meter. As you can see in the first graph, the reading is cumulative and so the graph will always show an increase.

To obtain a graphic representation of the peak levels of consumption for a given period it is necessary to do calculation.

The table gives you a checklist of activities to consider while doing this activity.

Example of Summary table

Electrical audit	Average daily consumption (KWh)	Average cost per day	Total cost per day
ACTUAL ELECTRICAL consumption as per bill			

10 → Exercise - Activities for Renewable Energy

Activity Sheet

Exercise : Renewable energy

The most popular renewable technologies for schools are:

- Solar thermal: costs vary widely but heating water for general purposes is cost-effective.
- Wind: a school will realistically only be able to fund a turbine from 6kW to around 20kW. Feasibility will depend on average wind speed and quality, the size of the available site and any planning considerations (so before making the investment an anemometer should be applied on top of school roof to register wind speed and direction, to see if the site is suitable or not)
- Solar PV: is not cost-effective without funding, but is a popular technology for demonstration/education purposes and relative ease of installation.
- Biomass: wood pellet fuel is being used only in a few locations. A wood fuel system is more suitable for new build and also boiler conversions from solid fuel such as coal.

One of the distinctive advantages of incorporating a renewable energy system in a school building is as an educational resource (it is important therefore to ensure that both the installation itself and the meter are placed in visible locations).

There is a wide range of educational resources available to support classroom learning at all stages.

In order to learn how a solar thermal panel works make student build a very simple solar oven with a pizza pox using black paper to attract sun, transparent film to let it enter, aluminium for reflection.

More technical schools can build a real solar oven in special laboratories.

The most important thing is that any renewable application is put in the school must have great visibility among the school community. The RES application must act as a didactical tool since it's no use having on the school's roof a solar PV panel without knowing how it works, how much energy it produces, how much CO2 emission avoids in the atmosphere

11.a → Exercise - Sustainable Transport

Activity Sheet

Exercise 1 : Sustainable transport

Transport is the fastest growing contributor to CO₂ emissions in Europe. It's estimated that road transport makes up around 25% of the man-made CO₂ emissions. Schools can do a lot to reduce transport use, by promoting and taking measures that are in fair of walking and cycling. Walking or cycling for short journeys could reduce the footprint by about 4%.

In the school sustainable energy action plan a part of it can be devoted to transport. A School Transport Management Team can be set up by the school.

A good practice STP (Sustainable Travel Plan) will be a written document with the following features:

- **Background:** including location, size and type of school and age range and numbers of students.
- **Travel Survey:** to identify the mode, direction and number of children currently travelling to/from school and how they would like to travel.
- **Description:** of the travel patterns and problems faced by the school, incorporating after-hours and associated travel.
- **Objectives, targets and measures** with a detailed timetable for implementation. These actions will be a combination of hard measures, such as engineering works or new facilities, and soft measures, such as timetable changes or pedestrian schemes.
- **Monitoring and review.** The minimum recommended monitoring is to re-survey travel patterns once a year.

Good practice guidance on school travel is well developed but largely focused on safety and health. Environmental outcomes are generally seen as a welcome by-product rather than an explicit aim. Local Transport Plans contain targets for modal shift in journeys to school.

The main measures are promoting alternatives such as Walking, Cycling, Public transport, Car pooling

After this STP is made, results must be communicated, together with some possible solutions suggested by students, to the school community but also to the Local Education, Environment, Transport Authorities and Local Transport Companies.

Practically young people will get more options by fostering independence and encouraging them to use alternatives to the car as they grow up. When they grow up students will leave their scooter at home and will not invade streets during times of starting and finishing of lessons.

Local transport and education authorities will develop strong working relationships with local bus companies, to make the best possible use of commercial and tendered networks.

Local education and transport authorities will make more services available for students who are poorly served at present – including dedicated buses, where appropriate and affordable.

More bus services will be encouraged that cater for the extended school day, school sport and students who will be educated in two or more places.

11.b → Exercise - Sustainable Transport

Activity Sheet

Exercise 2 : CO₂ FOOTPRINT OF THE JOURNEY FROM HOME TO SCHOOL

The goal is that the students to become aware of how their contribution to CO₂ emissions depends on their choice of transportation from home to school.

On the same day, all the students record the distance they travel from their home to the school and the time it takes to cover that distance. If their journey includes different types of transport then each of these is recorded separately. The data is used to calculate the resulting daily CO₂ emissions.

Required materials:

- Map of the local area showing where children live, preferably large enough to hang on the wall of the class room.
 - Small flags and colour pens/pencils.
 - String and ruler.
 - Watches.
 - Recording materials
- Presentation materials

Required students skills:

Counting, telling time, measurement in m and km, vehicle classification, directions/orientations (points of compass), map scales, road safety, knowledge of CO₂.

These Aids are referenced in the instructions below and are designed to help you plan and implement the lessons.

Aid 1 – Background information on mobility and CO₂ emissions

Aid 2 – Measuring methods

Aid 3 – Data collection sheet

Aid 4 – CO₂ calculation sheet

Individual steps of the activity:	Required time:
<ol style="list-style-type: none"> 1. Preparation of narration on mobility and CO₂ emission issues. 2. Explain the exercise to the students. The choices we make in our everyday lives have an impact on the CO₂ emissions and the climate of the world. For inspirational background literature you may, for example, consult your local energy agency (see contact list for AL project). 3. Hang a map on the wall of the classroom showing the area from which all students come. Draw the journey of each student on the map for example indicating the name of the student with a little flag. 4. Explain the different methods of measuring the distance and time to the students and agree with each which methods are appropriate for their particular journey. There are various ways to measure the distances. Some suggestions are shown in the table below, but the students might think of other ways to measure their journeys. Methods that can be used by the children on their own are to be preferred if there are more than one option. 	<p>Preparation</p> <hr/> <p>Introduction – 1 lesson (see Aid 1 below)</p>
<ol style="list-style-type: none"> 5. Children measure their journey. 6. For each of the measured journeys calculate the CO₂ impact together with the students and find the total for the class 7. Discuss the difference between the different types of transport <ul style="list-style-type: none"> ➤ Why do we have public transport? ➤ Can two or three travel together in the same car instead of separately? ➤ Are there differences between summer and winter? ➤ Can benefits be gained from changing to a different type of transport i.e. less CO₂, better health or safety etc.? ➤ Is it possible for the students to choose a different type of transport that has a lower CO₂ emission? ➤ What would be the impact of the entire class (or school) over an entire year? 	<p>Experiment and analysis – 1 lesson for calculation and 1 lesson for discussion</p> <p>The exact requirement depends greatly on the size of the group, the age level, and your aim for the activity.</p>
<ol style="list-style-type: none"> 8. The results of the exercise are presented to the school's community. It is important that no one is shamed for their choice of transport. Instead the discussion should focus on the results for the class as a whole and what the class and their parents as a whole can do to reduce their CO₂ emissions caused by their journeys. 	<p>Presentation of results – 30 minutes of parent meeting</p>

Variations:

Incorporation in other lesson topics: The exercise could be integrated with traffic safety training and an exercise to identify what are the hazards on the journey from home to school.

Increased complexity of the activity to suit older students: More complex and accurate calculations can be made using for example the information available from our local energy agency or the internet.

- What is the fuel consumption of different car models?
- Does the journey pattern depend on/change with the age level of the students?
- What are the effects of CO₂ emissions in the long run?

Reduced complexity: To target the younger students the focus of the exercise can be shifted from mathematical calculations to mapping of the journeys and visualisation of the CO₂ impact using footprints which size signifies the CO₂ impact. The necessary calculations can be made by you.

It is possible to focus on the energy consumption – i.e. the amount and type used – instead of CO₂ emissions if this fits better into the planned curriculum.

Increased dissemination: Have the class prepare a presentation or exhibit for the entire school. Compare results with other classes/schools, discussing differences and similarities. Older children could try to find a way to communicate the concept of a carbon footprint to younger children. If the entire school is involved in the activity, the students could arrange a fair at which their results are displayed in a variety of ways.

Active Citizenship!: Apart from influencing the choice of type of transport of children and their families, the results can also be used to influence local decision makers so that improvements can be put in place e.g. school management and/or local traffic authority.

– Background information on mobility and CO₂ emissions

<http://ecoagents.en.eea.europa.eu/> - The Eco Agent website of the European Environmental Agency where one can learn about environmental protection issues through a game as Eco Agents (in all EU languages).

Measuring methods

Type of transport:	Measuring method:
By foot	<p>The student counts the number of steps required and measures together with the teacher the length of a normal step.</p> <p>Number of steps * Length of a step recorded in centimetres / 100 = Distance in metres</p>
Bicycle	<p>The distance of the journey can be measured on a map. If the journey is very twisted and difficult to measure on the map with a ruler, then you may need to use a thread to find the length. Tie a knot on one end of the thread to mark the starting point of the journey and then place the thread so that it follows the line of the journey. Mark the other end of the journey with a pen or simply hold on to the point with the fingers while you lift the thread away, straighten it, and measure the length with a ruler (you can also buy instruments that can do this).</p> <p>Length of thread in centimetres * map scale = length in true life in centimetres.</p> <p>Length in true life in centimetres / 100 = Distance in metres</p> <p>Alternatively a distance meter similar to the one in cars can be used.</p>
Bus, tram/metro, train	<p>The distance of the journey can be measured on a map. If the journey is very twisted and difficult to measure on the map with a ruler, then you may use a thread to find the length. Tie a knot on one end of the thread to mark the starting point of the journey and then place the thread so that it follows the line of the journey. Mark the other end of the journey with a pen or simply hold on to the point with the fingers while you lift the thread away, straighten it, and measure the length with a ruler.</p> <p>Length of thread in centimetres * map scale = length in true life in centimetres.</p> <p>Length in true life in centimetres / 100 = Distance in metres</p>
Car	<p>Together with the driver of the car, the student reads the kilometre meter on the dashboard at the start and the end of the journey.</p> <p>Kilometres at end – kilometres at start = Distance in kilometres</p> <p>Distance in kilometres * 1,000 = Distance in metres</p> <p>Alternatively the distance can be measured on a map in the same way as described under "Bicycle".</p>

Data collection sheet

Student name: _____

The recorded journey is made
 2 times per day,
 5 days each week,
 37 weeks of the year.

That is 370 times per year!

Type of transport	Number of steps (A)	Length of steps in centimetres (B)	Length of steps in metres (C=B/100)	Metres per year (A*C*370/1,000)
By foot		cm	M	km/year

Type of transport	Length of string in centimetres (A)	Scale (map: real life) (B)	Length in metres (C=A/B)	Metres per year (C*370/1,000)
Bicycle	cm	:	m	km/year
Bus	cm	:	m	km/year
Tram/metro	cm	:	m	km/year
Train	cm	:	m	km/year

Type of transport	Kilometre reading at start (A)	Kilometre reading at end (B)	Difference (C=B-A)	Metres per year (C*370)
Bicycle	km	km	km	km/year
Car	km	km	km	km/year

CO₂ calculation sheet

The recorded distances from all students are added up and noted in column B.
Then the CO₂ emissions per year can be calculated and the total emissions found.

Type of transport	Typical energy type	EU average CO ₂ emission (A)	Journey distance per year (B)	CO ₂ emission per year (A*B)
By foot	Food and water	None		
Bicycle	Food and water	None		
Bus	Diesel, gas, electricity			
Tram/metro	Electricity			
Train	Diesel, electricity			
Car	Gasoline, diesel			

Total	
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How does this activity fit into the curriculum:

This activity is well suited for lessons in Mathematics, Science, Geography and Citizenship. Also good literacy opportunities for speaking and listening and presentation (possibly with the assistance of ICT).

With many thanks to the Active Learning Project (www.consortium4al.eu).

12 → Exercise - Catering and Food

Activity Sheet

Exercise : Catering and food

Implementation of lower energy of food technology equipment and food Catering.

In most schools they have a canteen that provide food to the students. Actions taken to lower energy use are related to the use of electrical appliances in the schools canteen and the food catering.

First of all students should collect the data relating electrical appliances in the school canteen and check if they are efficient or not, according to the energy efficiency-labelling scheme that applies to fridges, fridge/freezers, washing machines, tumble dryers and washer dryers. The labels range from A (highly efficient) to G (inefficient)

If the school current appliances are over 10 years old upgrading to an A- rated energy efficient model could save the school vast amounts on the electricity bill per year.

In particular they should look at Fridges, Dishwashers, Pots and pans, Kettles, Washing machines/tumble dryers

Food catering

Schools with an in-house catering service have more flexibility and freedom to offer healthier, more sustainable meals. Food makes 25% of the average person's ecological Footprint. By starting a local and sustainable food plan for the school, the school can reduce the total ecological footprint by as much as 15%.

- Eating more fruit and vegetables and less meat could reduce the footprint by up to 40%.
- Simplified or seasonal menus, buying fruit and vegetables that do not meet high street cosmetic criteria will cut costs.
- Buying produce locally could reduce the footprint by around 10%; Healthier food procurement offers the potential for carbon savings, mainly through reduced emissions from transport when food is sourced locally.
- Local food does not have to be more expensive. Direct sourcing from local suppliers cuts overheads such as minimum orders or transport costs, and offers further opportunities to negotiate price.
- Buying more organic food can reduce the footprint by 15%. Organically grown crops require around half the energy input than conventional crops, and eating less, but better quality meat, will also reduce carbon inputs.

Guidance suggests that:

- Higher quality meals lead to greater uptake and so increased income. Profits can be ploughed back into the catering service.
- Taking a 'whole-school' based on: establishing a working group of committed individuals; involving the whole school with clear roles for all; developing an action plan that combines small and long-term targets, and; setting indicators (e.g. number items fruit eaten per day per student) and measuring any changes.

13 → Exercise - Developing an Energy Management matrix

Activity Sheet

Exercise : Monitor, verify results

The aim of the monitoring activities are to identify the progress of implementation of the sustainable energy measures and evaluate and adapting the action plan for future development.

The progress of implementation of measures should be monitored and verified throughout the year. But as an energy management project the energy saving results is the real short-term progress that should be measured. Based onto the outcome the targets and the Action Plans could be adapted.

The students reports including the reporting results should be announced using practical communication methods, as dedicated energy boards, detailing actions, results and publishing the project.

The monitoring results could be for longer-term project be taken over more than one year, and could span even several. Student can used the historical data in their work. Action at schools level to improve energy efficiency can help to improve these figures year after year, and improve the quality of life for all.

→ Develop an Energy Management matrix

'An efficient, easy to use and effective method of establishing the schools Organisational Profile'

Without the input of external consultants and benchmarking activities, many schools may believe they are doing all they can to reduce their energy use and costs.

You can discover the truth in this by drawing an accurate picture of your school's current approach to energy matters. This is done using the Energy Management Matrix.

The Energy Management Matrix has been devised to:

- Assist you as Energy Agency to identify and describe the current level of sophistication of different aspects of energy management in the school;
- Assist the « Action Team » in organising an energy management a further strategy.

The Matrix provides an efficient, easy to use and effective method of establishing your Schools Profile.

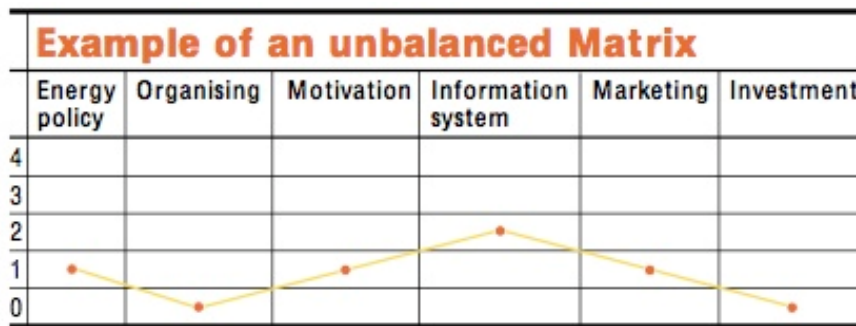
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Student's activities developing an Energy Management matrix

Reading the Matrix is quite simple. Each column deals with one of six crucial energy management issues: policy, organisation, motivation, information systems, marketing and investment. The ascending rows, from 0 to 4, represent the increasingly sophisticated nature of these issues.

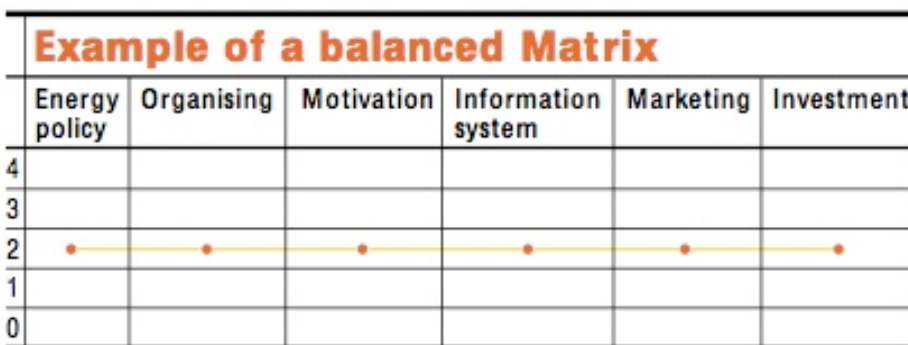
Example of an unbalanced Matrix

Energy Organising Motivation Information Marketing Investment policy system



Example of a balanced Matrix

Energy Organising Motivation Information Marketing Investment policy system



Steps

There are several steps that you can take to facilitate a change to good energy management in your school.

1. Take a photocopy of the Matrix. Create your own Organisational Profile by marking the place in each column that best describes where you think your school is currently located. Join up your marks across the columns to produce a graph line.
2. Make a second (or more) photocopy of the Matrix and ask your colleagues involved in energy management to complete the Matrix. Their profiles will tell you how others see energy management in the organisation.
3. Decide which columns contain the issues that are most important in your own particular circumstances. List what you consider the five main obstacles impeding your progress to the next level in each of these columns. Identify three key opportunities for improving your performance.



Note that it will not always be the columns with the lowest score that warrant immediate attention. If the obstacles you identify seem impracticable from where you stand, or if there are no obvious opportunities for improvement, then you may be better off investing your time and attention elsewhere. Also remember that staff members above you in your school's hierarchy, or located in other departments, may be able to remove obstacles or create opportunities which are not open to you. Try to identify where this is so and what they need to do if they are to help.

4. Ask students and teachers to complete the Energy Management Matrix and return the results to you for collation.

5. Collate the results and provide a report to your senior managers. Include all the labelled Organisational Profiles on the Matrix and the collated lists of obstacles and opportunities. End the report with a set of recommendations proposing how identified obstacles can be overcome and how opportunities can be exploited. Where you are unable to do this, prepare a set of questions asking senior managers what they believe needs to be done to improve the organisation's present situation.

6. Use the dialogue started by these exercises to construct, in consultation with your senior managers, a strategic approach for improving energy management over the next twelve months (see next chapter). Include some interim milestones and specify who is responsible for taking each of the actions listed and how progress is to be measured at the end of the period.

7. A good way to measure your progress is to redraw your Energy Management Matrix at the end of the schools year period. This will identify how the Organisational Profile has changed, and if your strategy has actually improved energy management.

To get the best results from the Matrix, identify those issues in your school that are currently more critical or more in need of review than others by:

- Locating the schools position on the Matrix;
- Concentrating on those columns where the « Action Team » can make the most progress;
- Identifying obstacles and determining how these might be overcome;
- Identifying opportunities for improvement and determining how these can be exploited; and
- Involving others, both senior managers and end users, in the process.

solar heating
energy
CO₂
photovoltaics



managenergy 

Guide for an Integrated Sustainable Energy Education, First steps to climate neutral schools, for secondary schools

Annexe STUDENT EXERCISES

**Susanna Ceccanti (It)
Presentation for Workshop Energy Education
on 12th of February 2009 - EUSEW - Brussels**

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