

# Training methodologies and educational resources in the field of integration of Renewable Energy Sources in an energy efficient home

ADRIANA ALEXANDRU<sup>1</sup>, ELENA JITARU<sup>1</sup>, RAYNER MAYER<sup>2</sup>

1. Research and Development Department  
National Institute for Research and Development in Informatics  
8-10 Averescu Avenue, Bucharest  
ROMANIA

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2. Department of Engineering  
Sciotech Projects  
Whiteknights Campus, Reading, Berkshire RG6 6AY  
UK

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*Abstract:* The EU Kyoto target for greenhouse gas reductions can be met if families realise that they each can do something to reduce the environmental pollution associated with energy usage. The school is the most important source of information and therefore crucial in raising awareness in families. Following the earth summit in 2002, UNESCO launched the decade of education for sustainable development (ESD) in 2005. Efficient use of energy, reducing environmental pollution, preserving fossil fuel resources and preventing climate change are an integral part of ESD which now forms part of the national curriculum in all European countries. The first step in realizing the energy saving potential is to inform and educate students and their families how using energy more efficiently or using renewable energy sources (RES) in the home can help to reduce greenhouse gas emissions and prevent climate change. Suitable resources have therefore developed in TREAM, (4.1031/Z/02-055/2002), KITH (EIE/05/183/512.421632) European projects and CREFEN Romanian research project to be used in educating both students and their families. The emphasis has been on saving energy and the use of RES in the home whenever possible. The European KITH project (“Realising the potential for small scale renewable energy sources in the home”) developed multi-lingual resources by the collaborative work of 17 partners from 10 European countries also accessible via Internet which explain the origins and impacts of global warming, and the necessity of clean energy houses by using set of activities together with resource material suitable for use in primary and secondary schools throughout the EU. A web-based methodology has been developed which will enable families to assess how RES can be incorporated into energy efficient homes.

*Key-Words:* Education, Methodology, Internet, Energy Efficiency, Renewable Energy, Environment.

## 1 Introduction

The EU energy policy is oriented to diminish the energetic dependency for primary resources import. In “Road map for RES” are established, at the political level, ambitious targets for RES contribution in energy consumption. The amount of energy from RES in Europe has to be 12% of the total energy consumption in 2010 (E-15), and the amount of electrical energy from RES 22%. In 2020, the targets are increased at 34% for electrical energy and 20% for energy.

*The Romanian strategy of valorization of RES* (2003) defines the following objectives: integration of RES into the national energy system, the diminish of technico-functional and psycho-social barriers for RES valorization, simultaneously with the assurance of economic competitiveness, promotion of the private investments, energy supply of isolated places by using the local RES potential and facilitation of the participation of Romania in EU market of “Green certificates” for energy from RES [1].

The new energy strategy in debate promotes the development of RES. In the context of *European Directive no.77 concerning the promotion of electrical energy from RES on internal energy market*, Romania has the target of 33% electricity from RES in 2010 and 11% electrical and thermal energy in the same year. In this frame and in accordance with the EU policies, there is a priority for Romania "To remove the non technological barriers by the market formation and education", by developing:

- Campaigns at the national levels for the people education and information concerning the energy efficiency concept;
- Education and information campaigns in general and high schools, universities and even children gardens concerning the energy savings and the use of RES.

## 2 Problem Formulation

Both information and education are important and cannot be separated [2], [3]. The *unique* approach of these projects is to engage *both students and their families* as the concepts of and reasons for saving energy and using RES are best understood through a dialogue.

The target groups and key actors are set out in Table 1.

Table 1: Target groups and key actors

Target Group	Actors	Initial discussion	Likely involvement
Teachers and students	Head teachers Educational authorities	Current trials of TREAM handbook and Green Pack Importance of preventing climate change	Trial new resource material Encouraging schools to take part in trials
Families	Families of students	Students discussing with their parents	Assessing potential for EE savings and RES in the home

The existing resources and trials are extended to cover the possible introduction of RES into energy efficient homes. The global aim is to raise awareness by informing and educating teachers, students and their families so that they can do something in their homes to save energy and help their country and the EU to reach its Kyoto target.

The methodology for identifying the phases and organising the work is described bellow:

### Phase 1: Resources for teachers and students

Expansion of activities:

- Explanation how RES can be used in the home;
- Need for insulating dwelling before introducing RES;

Critical steps:

- Finding a method which will interest the students;
- Cost effectiveness of insulation improvements;

### Phase 2: Resources for families

Expansion of activities:

- Describing the various types of RES in a simple manner;
- Reducing energy bills by insulating dwelling;

Critical steps:

- Understanding why RES have low environmental impact;
- Developing criteria for selecting optimum RES type for a dwelling;

### Phase 3: Educating teachers and students

Expansion of activities:

- Methodology for teaching teachers;
- Practical activities for students;

Critical steps:

- Upgrading the teacher knowledge;
- Finding time within their school year;

### Phase 4: Motivating families

Expansion of activities:

- Involving the families;
- Identifying the potential;

Critical steps:

- Understanding how RES can be included;
- Engaging the owners of social housing and rented property;

### Phase 5: Dissemination

Expansion of activities:

- Expanding the project website with new text;

- Including new languages on the web site;
- Organising workshops for relevant stakeholders and actors;
- Raising awareness during EE and green weeks;

Critical steps:

- Identifying a lay out which is user friendly;
- Integrating activities at local level.

### 3 Problem Solution

#### 3.1 Resource development

The *existing resource materials* have been upgraded to include application of small scale RES to dwellings.

Existing resource materials include:

- Green Pack produced by the Regional Environmental Center for Central and Eastern Europe (REC);
- TREAM handbook on Saving energy in the home through more efficient use of appliances;
- European appliance information systems multi-lingual website ([www.eais.info](http://www.eais.info)) which contains information to complement the TREAM handbook [4];
- Ecoville multimedia resource developed by Ademe, France.

These resources have been extended and integrated to include information about the need for insulating dwellings to reduce their heat loss. The characteristics and benefits of local RES have been described which are suitable for energy efficient dwellings

By working with renewable energy associations like the European Heat Pump Association, the draft of the modules for each of the following renewable energy sources has been developed for:

- Heating solar thermal, passive solar, biomass and heat pumps;
- Electricity generation, photovoltaic and wind energy.

The handbook contains a set of resources and activities suitable for primary and secondary schools. The resource handbook content is presented in Fig.1.. Whilst themes can be selected in any order, it is important for students to understand both the consequences of using energy and the possible solutions to mitigating its environmental impact on global climate.

Each lesson should be self-contained with an introductory discussion followed by a set of activities for which work sheets are provided. Additional

information is provided for teachers to assist with teaching these topics.

<b>CONTENTS</b>	
1.	Sustainable use of energy
2.	Energy efficiency in the home
3.	Renewable energy sources
4.	Heat flow in buildings
5.	Passive solar
6.	Solar water heating
7.	Heat pump systems
8.	Biomass
9.	Wind energy
10.	Photovoltaic systems

Fig.1 The KITH resource handbook contents

The modules can be used in support of a wide variety of subjects taught in schools through self-learning by observation and deduction. The emphasis is on understanding how information that is now available can be used to apply small scale renewable sources to the home.

A typical lesson should comprise:

- Introductory text to encourage a discussion of what students have seen, read or heard;
- Activities generally undertaken in small groups to promote discussion within the group;
- Discussion concerning the outcome of each group's observations and conclusions;
- A summary of the discussion;
- A proposal for possible activities to be undertaken at home.

The *handbook* comprises two parts: a reference section, and the teaching methodology.

The *reference section* providing background information to introduce the various generic themes such as: climate change and the carbon cycle, environmental impact of energy use, impacts of global warming, saving energy in the home, and renewable energy sources.

Whilst the material can be selected as required, it is important to illustrate the linkage between energy usage, resource depletion, environmental impact and global warming at a level, which the class can understand.

A module section which covers the following topics: heat loss, passive solar techniques, solar water heating, heat pumps, biomass for heating, wind energy, and photovoltaic cells.

As with the reference section, each section of text is interspersed with practical activities to encourage learning by observation and deduction.

The *teaching methodology* has been developed in accordance with modern teaching practices.

**Activities** are planned to be the core element of each lesson. A set of 62 activities has been prepared. Every lesson should include one or more activities. These activities can be used individually or alternatively, they can be grouped together to generate not only awareness of the environmental problems associated with energy use, but also identify solutions which can reduce energy use.

For each activity there will be: resource material providing background information for introducing the subject, work sheets for students, and notes for teachers (Fig.2 and Fig.3)

**Activity 10.3:**  
**Let's play marbles**

This mini photovoltaic billiards game represents the photovoltaic effect:

*Playing field*  
= *sheet of silicon.*

*Tube* = *electrical conductor.*

*Blue marbles* = *electrons from the silicon.*

*Yellow marbles* = *photons*

**Tasks:** Roll the plastic sheet into a tube through which the marbles will easily pass. Use scotch to hold the tube together. Cut out a square from the cardboard box, leaving a 2 centimetre wide rim. At one end of the playing field that you have now created, make a hole in which you can fit and level the tube like a funnel. Arrange the marbles in the tray. Knock the blue marbles into the tube with the yellow marbles to create a current of marbles (electrical current).

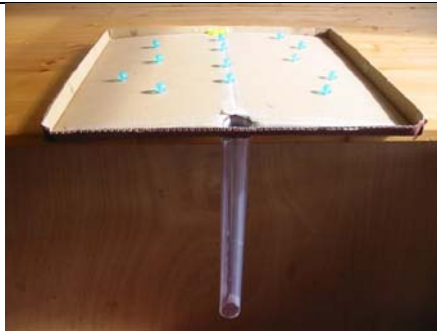


Fig.2 Typical activity – Let's play marbles

*Age range*

- From age 8 to 15;
- Understanding the importance of energy use;

- Understanding the issues associated with climate change;
- Explaining and involving their parents;
- Considering how appliances are used in the home;
- Understanding how the environmental impact of energy use can be reduced;

**Notes for teachers:** You can build a more robust playing field in wood.

**Background:** Photons are light particles. Electrons are electric particles. When photons hit a thin sheet of silicon, they transfer their energy to the silicon's electrons. The electrons then head off in a particular direction, thereby creating an electric current.

**Aim:** To demystify and help intuitive understanding of the photovoltaic effect.

**Material:** Yellow and blue marbles (or round beads), a large cardboard box, a semi-rigid transparent plastic sheet, scissors, a cutter and scotch.

**Key words:** photons, electrons, silicon, photovoltaic effect, electricity

**Skills:** manual skills, imagination

**National curriculum subjects:** Science and technology.

**Age Range:** 7+

**Minimum time needed to complete activity:** 2 hours

Fig.3 Notes for teachers – Let's play marbles

*Working in small groups*

- Discussing and helping one another;
- Exchanging information;
- Easier for teacher to supervise;

*Role of teacher*

- Introducing the topics;
- Helping the groups;
- Discussing the outputs with the pupils;
- Summarising and evaluating the results;

*Discussion*

Many of the themes in this handbook are open ended in that there is not necessarily an answer to the questions the students will pose. For example the answer to "When will the world's oil supply peak?" will depend upon how often personal transport is chosen rather than public transport. This introduces uncertainty as it depends upon individual actions.

The activities have been devised to stimulate discussion based on observation and deduction and to illustrate how science can formulate answers to limiting climate change.

**The “Kielce” discussion** is in essence, a didactic discussion involving the organized exchange of thoughts and opinions on a subject within a group. Discussion is an art of expressing opinion, reasoning and learning to respect the opinions of others. The “Kielce” discussion is a written-oral, multilevel technique of discussion that is combined with visualisation and held in groups. It proceeds as follows:

- The teacher writes questions on a board or on large sheets of paper. Each question is assigned a different colour;
- Students answer the questions anonymously in writing. They can provide more than one answer to each question. They take down each answer on a separate slip of paper the colour of which corresponds to the given question;
- The teachers collect the answers and sort for each question;
- The teacher randomly divides the class into as many groups as there were questions. Each group works on one of the questions, analysing answers of class members and compiling them in the form of a poster;
- Each group then presents their posters that reflect the opinions of the whole class on the various issues discussed.

**Evaluation exercises** help a student express his or her opinion on various issues. The exercises are designed so that: everyone thinks on their own, everyone listens to the others carefully, and everyone can express their opinion

The exercises are based on questions that do not have straightforward answers; there are no ‘good’ and ‘bad’ answers. As a result students avoid a ‘win or lose’ discussion. Evaluation exercises force students to ask themselves, ‘What do I think about it?’. Also students have to take responsibility for their opinions and defend them in subsequent discussions; ‘I think so because ‘. Ability to adopt an approach of this kind and awareness of the consequences of difficult questions allows the building of self-confidence in interaction with others.

One of the evaluation exercises is ordering. Ordering exercises present a question together with a few alternative answers which are then ordered by students. The exercise proceeds as follows:

- The teacher writes on the board questions and a set of answers;
- Each student orders his answers individually - all answers must be ordered;

- The teacher randomly divides students into groups of 4-6 people. Each person in the group presents their own ordering of answers, while the others listen. After that, a discussion follows and participants try to find common ground;
- Each group presents its own ordering;
- A collective discussion and its summary will reflect the whole class’s opinion on the subject.

**Selecting the activities.** The activities are listed in the table of contents under various topics. These can be given in any class, which seems appropriate including languages and in any type or size of school. Activities might be selected either to study only one specific topic or a number of activities can be selected to study various subjects over a period of time. Some examples of lesson plans are given as guidance in the following section.

Before starting the activities, the key concepts need to be introduced to and discussed with the students. The resources provided can be used as introductory material.

When the activities have been chosen, it will be necessary to copy the worksheets. Notes to help teachers are appended to each activity.

As the resource book is also available electronically in the form of a CD, it is possible to print directly from the computer or even to adapt the material should this be more appropriate. The CD also contains additional resources such as PowerPoint presentations which have been found useful in introducing some of the topics.

### 3.2 Developing a web-based methodology

The methodology will enable home dwellers to assess what proportion of renewable energy sources can be incorporated into an energy efficient home.

The multi-lingual web based information system for saving energy in the home through the use of energy efficient appliances ([www.eais.info](http://www.eais.info)) has been extended to include information about the optimum level of insulation and the way in which small scale local RES can be incorporated into an energy efficient home.

The following methodology has been developed:

- Analysing the utility bills to separate the electricity consumed by appliances including lighting and cooking from the cost of space heating and water heating and space cooling (if installed);
- Identifying the level of insulation of the dwelling in terms of its principal components like walls, roof, windows, doors and floor using an Excel spreadsheet;

- Calculating the heat loss by a virtual tour of ones home and/or a heat loss calculation based on current norms;
- Comparing the calculated heating cost with that from the bill and understanding the causes of any major differences;
- Developing criteria which enable the appropriate small scale RES to be identified for use in the home;
- Assessing the potential of small scale RES towards sustainable heat and electricity.

The methodology utilises existing software wherever possible. The method will be of a nature that can be used by families as well as students. However the same approach (and program) can be used by installers, energy or utility advisers through a discussion with the family and establishing the answers to the various questions required by the survey form.

### 3.3 Working with the families

The prime focus in encouraging families to realise the potential of renewable energy sources in their energy efficient homes will be on parents whose children take part in the educational trials within the classroom. This will enable students to discuss with their parents why it is important to save energy and to identify the possibilities for savings energy in the home by way of surveys at various levels of depth. Subsequently to identify the possibilities for incorporating local small scale RES in the form of either water heating, space heating or renewable electricity.

It is important to generate an understanding of the ways in which one can use energy more efficiently because many options will only be cost effective when an appliance needs replacing or the heating system needs repairing or replacing.

Discussions will also be held with local stakeholders so they are able to provide suitable advice and assistance with purchasing of new appliances, fitting of additional insulation or incorporating local RES sources. Such sources have also been displayed on project web site and links will be provided to and from the stakeholders own web sites.

Publicity will be generated in a suitable form to encourage homeowners to assess the potential of their home either by themselves or with the help of an adviser. This should form part of the local public awareness campaigns for an energy sustainable Europe such as 'the EU 'green' and energy efficiency weeks.

Such resources will empower individuals to think globally but act locally.

An important part of this work will be to assess the effectiveness of such an approach and whether the way in which the information has been presented can be improved. Also how the involvement of stakeholders can provide the means of realising the potential for small scale RES locally.

## 4 Conclusions

These resources will enable EU citizens to understand and help to realise the potential for saving energy and applying small-scale RES in the home. The emphasis, as in the public awareness campaign, is to encourage everyone to do something because it is financially beneficial and will help Member States and the EU to reach their Kyoto targets for greenhouse gas reductions.

Motivation is important in energising citizens so the linkage of information to students and their families is a unique feature of this dissemination phase. Students can help inform and thereby educate their families in developing a more sustainable lifestyle in which energy is used more efficiently.

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