

Towards the Use of Renewable Energy Sources in the Home

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Abstract—The paper presents the results of the European EIE project “Realising the potential for small scale renewable energy sources in the home – Kyotointhhome”. The project's global aim is to inform and educate teachers, students and their families so that they can realise the need and can assess the potential for energy efficiency (EE) measures and renewable energy sources (RES) in their homes. The project resources were translated and trialled by 16 partners in 10 European countries.

A web-based methodology which will enable families to assess how RES can be incorporated into energy efficient homes was accomplished. The web application “KYOTOINHOMe” will help the citizens to identify what they can do to help their community meet the Kyoto target for greenhouse gas reductions and prevent global warming. This application provides useful information on how the citizens can use renewable energy sources in their home to provide space heating and cooling, hot water and electricity. A methodology for assessing heat loss in a dwelling and application of heat pump system was elaborated and will be implemented this year. For schools, we developed a set of practical activities concerned with preventing climate change through using renewable energy sources. Complementary resources will also developed in the Romanian research project “Romania Contribution to the European Targets Regarding the Development of Renewable Energy Sources” - PROMES.

Keywords—Education, energy policy, Internet, renewable energy sources.

I. INTRODUCTION

RENEWABLE energy sources (RES) are essential contributors to the energy supply portfolio as they contribute to world energy supply security, reducing dependency on fossil fuel resources, and provide opportunities for mitigating greenhouse gases [1]. The future strong growth of renewable energy must be part of our energy policies. RES

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clearly reduce emissions, both local and greenhouse gas related. In addition, renewable energies generally improve the security of energy supplies, by diversifying and decentralising energy supply both with indigenous sources and with imports. And finally, renewable energy technologies form a dynamic hi-tech sector which provides economic growth and jobs for our economies and help maintain our competitiveness [2].

It is essential to limit greenhouse gas emissions so that the global earth temperature does not rise by more than 2C above its pre industrial level. This requires people to realise that it is important to begin the conversion to a more sustainable way of life as soon as possible. The two key steps are to use energy more efficiently and to convert from using fossil fuels to RES like wind, solar and biomass which have their own characteristics which differ appreciably from that of fossil fuels. Their great advantages of global abundance and non polluting mode of use has to be offset by their variation in intensity on both a diurnal and seasonal basis.

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 [3]. 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.

The paper presents some results of the European IEE project “Realising the potential for small scale renewable energy sources in the home – Kyotointhhome” (KITH) and of the Romanian research project “Romania Contribution to the European Targets Regarding the Development of Renewable Energy Sources” PROMES, which will raise awareness of the potential of RES and will create an understanding of how we can adapt to the use of these sources in our homes. 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.

II. OBJECTIVES

The objectives of KITH project are:

- To upgrade existing educational materials to include the application of RES to energy efficient homes and to trial these resources in schools. Various topics will be introduced and practical activities described to illustrate the principles of the various technologies;
- To develop a web based methodology for assessing the potential for energy savings and small scale RES in the home and to trial this with the student families to illustrate to them ways of saving both money and the environment;
- To develop methodologies for training teachers. These will be developed in collaboration with education professionals across Europe;
- To disseminate the project deliverables particularly during EU energy efficiency and Green weeks when other initiatives and studies are presented which will enable exchange of ideas and best practice.

Both information and education are important and cannot be separated [4-5]. The *unique* approach of this project 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 methodology for identifying the phases and organising the work is described below:

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;

Phase 2: Resources for families - Expansion of activities, Describing the various types of RES in a simple manner, Reducing energy bills by insulating dwelling;

Phase 3: Educating teachers and students - Expansion of activities, Methodology for teaching teachers, Practical activities for students;

Phase 4: Motivating families - Expansion of activities, Involving the families, Identifying the potential;

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.

The Romanian project PROMES has begun this year and intends to enlarge the topics of KITH project by creating an advanced informatic system for information recording and communication regarding RES development and its economic effects in Romania. The project assures both tailored information for the general use and technical detailed information for specialists, all structured in a way that facilitates the training and the building of competences in the field.

We have already developed a database which provides information on Romanian manufacturers, retailers, investors, consultants, products and services in the RES sector, including solar, biomass, wind, hydro but also education and training.

The modern info system on RES, web based, will bring the interest of the young generation for energy and environment issues and will facilitate individual expertise improvement by modern education methods. By rising awareness on the need of using RES, an economic impact may be obtained on long term by RES development. The impact will be as important as the users region is less developed and more isolated.

III. MATERIALS AND METHODS

The Kyotoinhome server is a standard Compaq PC (800 MHz, 20Gb, 512 Mb). The software used is Windows 2000 as operating system and SQL Server 2000 as DBMS to develop the database. The interface was developed in Macromedia Dreamweaver, Java script and ASP (Active Server Pages).

We used for collaborative work and publication space DotNetNuke, an open source web application framework. DotNetNuke promotes human participation and the sharing of knowledge [6]. The following are the main features of the cooperation system that user can access:

- *Authentication:* People have to identify themselves by using their username and password before accessing the KITH workspaces.

- *Member administration:* Furthermore, the system provides facilities for the management of members of a workspace. Members can be added to or removed from workspace by those members who have the authorisation. The administrators can define and assign roles for different user groups, such as: registered users, subscribers, content providers, affiliates, media, etc.

- *Access rights:* The members of a workgroup may have different access rights to the objects contained in their workspace. The creator of a document can define some members to be able to update a document, whereas other members are only allowed to read it.

- *Documents management:* Document production plays an important role in many cooperation task. Therefore KITH workspace offers sophisticated document management. The aim of document management is to allow people to share and organize electronic files.

Users are able to explicitly put new versions of a document in a workspace without overwriting elder ones and only the owners of an object are allowed to delete objects from the file system.

- *Meeting administration:* The system also provides facilities for the management of the meeting. The meeting can be added or removed by the organiser and invitation to the meeting is send automatically to all participants.

- *Discussion forum:* Users may start discussion on a topic and the system presents the threads in a user friendly manner. Interested people can view the progress of the discussion and contribute to it at times of their choosing.

- *Event services:* They allow users to coordinate their work. It provides users with information on the activities of others users, with the respect to the objects within a shared workspace. An event is generated by an access to a

workspace, e.g. a new object is put into the workspace, a new version of an existing one was created or an object was renamed.

The “Kielce” discussion, a written-oral, multilevel technique of discussion that is combined with visualisation and held in groups, was used as a main method in the resources for the school. The Kielce discussion is in essence, a didactic discussion involving the organised 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 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 which reflect the opinions of the whole class on the various issues discussed.

IV. RESULTS

The main resources are available in all partner languages and include: the KITH handbook, and the website application (www.kyotoinhome.info).

The KITH handbook provides: resource information for teachers, practical activities for students including work sheets, and background notes on the key topics. In the KITH handbook it was developed a set of resources for use by teachers and students on the application of small scale renewable energy sources to the home. These resources cover the following topics which can be grouped into three topics – background information, passive means of reducing heat loss and solar gain and renewable energy sources (Fig. 1).

Sustainable use of energy
Energy efficiency in the home
Renewable energy sources
Heat flow in buildings
Passive solar
Solar water heating
Heat pump systems
Biomass
Wind energy
Photovoltaic systems

Fig. 1 The topics of the handbook

Each section of text is followed by a suitable practical activity for the student and notes for teachers (see examples

below). These comprise some 60 in total so the teacher has to be very selective in deciding which source materials to use.

Such activities enable the student(s) to explore a topic and then to discuss their analysis or solution(s) with other groups in the class. Some activities involve measurement and uncertainties arise over the reliability and reproducibility of the data which is inherent in making measurements relating to renewable energy sources.

Activities are planned to be the core element of each lesson. 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 are: Resource material providing background information for introducing the subject, Work sheets for students, and Notes for teachers.

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.

100 schools from Romania have been invited to take part in trialling the KITH resources. 10 of them have been interested in joining KITH project. Workshops lasting a few hours to several days have been held to train teachers in the use of the resources. The teachers have found the training useful and informative and were all willing to trial the resources in their classrooms. This outcome is not surprising as the teachers who have attended are all environmentally aware and so the KITH resources can help them to deliver lessons that are interesting and relevant to their students needs. Teacher’s motivation is an essential factor as the KITH resources have to be fitted to lessons within the national curricula.

Whilst the teachers understand the basic science phenomena, the linking of a wide variety of facts surrounding global warming and renewable energy sources is more difficult to comprehend and to answer any questions that students can pose. This requires teachers to have a broad background knowledge which is not always possible to provide with short discussions of perhaps one or two hours.

During KITH project, 669 students from Romanian colleges have been involved. Average age-group was 15-18 years old students (8-9 class). The evaluation of the feedbacks consisted of questionnaires. A number of 92 evaluation questionnaires have been received from 4 colleges. The questionnaires contain suggestion and proposals of the teachers concerning the KITH project and the educational modules.

Some of teachers’ remarks are:

- very professional and useful information source for many subjects (very well fitted into school curricula of physics, and technical subjects),
- possibility to choose activities with different level of complexity.

Evaluation of the KITH materials (Table I) on the 1-5 scale from different aspects (the figures are the average from 92 evaluation forms).

TABLE I
 EVALUATION OF THE KITH MATERIALS

	Technical	Estetical	Pedagogical	Textual
Background information	4.7	4.4	4.6	4.5
Activities	4.3	4.3	4.6	4.3
Illustration	4.6	4.5	4.4	3.7

The lessons have all been successful for one or more of the following reasons:

- the topics are interesting;
- they link separate subjects – limiting climate change is a ‘horizontal’ topic;
- they are relevant to everyday life;
- students understand the need for local actions to limit global changes.

We used also a questionnaire to measure the interest of students who have had four KITH lessons as part of an environmental project. The responses to this survey is significant – almost all the students (95%) liked the group activities, understood more about renewables and that the experiments with solar water heaters and wind turbines helped them to understand better the nature of renewable energy sources.

A web-based methodology which will enable families to assess how RES can be incorporated into energy efficient homes was accomplished. The web application “KYOTOINHOME” will help the citizens to identify what they can do to help their community meet the Kyoto target for greenhouse gas reductions and prevent global warming. This application provides useful information on how the citizens can use renewable energy sources in their home to provide space heating and cooling, hot water and electricity (Fig. 3).

The web application (www.kyotoinhome.info) provides:

- suitable information to encourage everyone to do something in their home to reduce energy consumption;
- how to reduce the heat loss during the winter and minimise solar gain during the summer
- a simple method for deciding which renewable energy source might be suitable and information on the nature and characteristics of each renewable source.

Unlike the resources for schools where the teacher is able to provide the background knowledge and context, the information to assess the potential for small-scale RES in the home has to ‘stand alone’ and be self explanatory. The KITH web application comprises a systematic rationale of each of the 10 topics in the handbook under the following headings: Description, Advantages, Disadvantages, Basic principles, Climatic and environmental criteria, Installation, Economics, and Further advice.

A two step approach is always recommended:

- to check whether the heat loss or solar gain of the dwelling can be reduced by suitable passive means e.g. insulation of cavity walls or solar shading;
- to identify which micro RES might be suitable for any particular dwelling.

The KITH survey form therefore comprises several sections:

- characterisation of the building type;
- heat demand with respect to floor area;
- electricity demand per person;
- orientation of the building and its location with respect to other buildings;
- which RES might be suitable.

The KITH interactive workspace increases the co-operation between KITH partners and between partners and teachers.

V. CONCLUSION

The resources are comprehensive and useful and are a level which enables them to be used by both teachers and students. The holistic approach KITH has adopted to energy use provides not only an interesting science topic but also reinforces many of the concepts that students will have learnt but yet applied such as energy conversion and the generation of electricity and the production of hot water by non polluting means. The success to the use of these resources are the interest of the teachers, their willingness to find time to provide a set of lessons, the ability to discuss rationally how we maintain an acceptable standard of living whilst transforming our energy dependence from fossil fuels to renewables.

The potential impacts of Kyotoinhome project are:

- to inform EU citizens and empower them to realise the potential for saving energy, money, ever depleting natural resources and the environment;
- to deliver resources which have been trialled and tested in 10 European countries linking EE savings and application of small-scale RES in the home;
- to help communities locally to meet their share in the reduction of greenhouse gas emissions;
- to involve local stakeholders and motivate them to help all families with their community whether they own, rent or occupy their homes.

REFERENCES

- [1] International Energy Agency: “Renewables in Global Energy Supply. An IEA Fact Sheet”, January, 2007, Available: http://www.iea.org/textbase/papers/2006/renewable_factsheet.pdf
- [2] A. Piebalgs, “Preface to the European Renewable Energy Policy Conference”, Brussels 29 - 31 January 2007, Available: http://www.bmu.de/files/pdfs/allgemein/application/pdf/reconference_programm.pdf
- [3] A. Alexandru, G. Gorghiu, Elena Jitaru, Monica Pârvan, “Energy Efficiency in the Frame of Kyoto’s Targets”, Volumul Conferinței Naționale de Surse Noi și Regenerabile de Energie, Secțiunea IX: „Calitatea Energiei și Ecologie”, Editura Bibliotheca, Târgoviște, 2003, ISBN 973-712-011-6, pg. 410 – 413.
- [4] B. Hadzi-Kostova, Z.A. Straczynski, “Teaching renewable energy using multimedia”, Power Systems Conference and Exposition, 2004. IEEE PES, Volume, Issue, 10-13 Oct. 2004 Page(s): 843 – 847, vol.2.
- [5] Oral LaFleur, “Exploring Renewable Energy Education”, Proceedings of the 2002 ASEE Gulf-Southwest Annual Conference, The University of Louisiana at Lafayette, March 20 – 22, 2002.
- [6] DotNetNuke Open Source project, Available: <http://www.dotnetnuke.com/>



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