Feasibility Study on the Instruments and Technologies Enabling the Use of Renewable Energy Resources to Satisfy the Energy Requirements of Public Buildings



GREEN FUTURE

Waste of energy in the buildings owned by local authorities cannot be sustained for a long time, since the rapidly growing operating costs can exhaust their income intended for more important objectives. Moreover, the buildings and projects owned by local authorities shall be a model in regards to their achievements the field of energy saving and reduction of environmental burden. Being a role-mode is especially important in a local authority building, in which energy saving can have a directly impact on the way people think.

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http://www.greenfuture-husk.eu/

This publication is intended to support the below project:

Hungary-Slovakia Cross-border Co-operation Programme 2007-2013

Project Title: **Green Future**
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The objective of the project has been to assess the possibilities of the use of renewable energy resources in public buildings, to develop a typology of buildings and investment objectives and to develop the basic investment models. It is possible to effectively reduce the energy consumption of buildings through the use of renewable energy resources such as solar energy, geothermal energy, wind energy, hydro power and energy from biomass. The developed studies have included the analysis of the results of the research carried out in the sphere of public buildings, descriptions applicable in practice, as well as a set of concrete examples, which may become an important tool for all those who wish to reduce their energy costs taking into account economic and environmental aspects, and who want to prepare or substantiate their decisions relating to the planned investments in this area. The studies can be used for example by local authorities and/or other organizations administering public buildings, which anticipate using renewable energy resources in their institutions and which intend to apply for funding for this purpose.

The project has been implemented by the following organisations:

Regional Development Agency South Region
Svätého Štefana 79, 943 01 Štúrovo,
Slovak Republic
Tel./fax: +421 36 752 3051
web: http://www.rra-juznyregion.sk
mail: info@rra-juznyregion.sk

Kisalföld Foundation for Enterprise Promotion
H-9022 Győr, Czuczor G. u. 30. - HUNGARY
Tel: +36 96 512 530
fax: +36 96 512 534
web: http://www.kva.hu
mail: info@kva.hu

Komárom-Esztergom County Regional Business Development Foundation
2800 Tatabánya, Fő tér 4. - HUNGARY
Tel./fax: +36 34 311 622
web: http://www.kem-hvk.hu
mail: info@kem-hvk.hu

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The content of this publication does not necessarily reflect the official opinion of the European Union!

Summary

Waste of energy in the buildings owned by local authorities cannot be sustained for a long time, since the rapidly growing operating costs can exhaust their income intended for more important objectives. Moreover, the buildings and projects owned by local authorities shall be a model in regards to their achievements the field of energy saving and reduction of environmental burden. Being a role-mode is especially important in a local authority building, in which energy saving can have a directly impact on the way people think.

This study was, on both sides of the border, preceded by an evaluation study, which presented the operational areas of local authorities, their powers, strategic energy policy documents of both countries, the basic knowledge related to renewable energies, and the financial mechanisms and granting schemes available for improving energy efficiency. A special part of the studies was devoted to a questionnaire survey of public buildings and their characteristics, and the presentation of the final results of the survey.

Based on the results of the questionnaire survey, the surveyed buildings were ranked to categories according to their possibilities and potentials to use renewable energies. In relation to the questionnaire survey, we certainly have to point out two major deficiencies:

- Local authorities interviewed during the voluntary survey were not as active as we had expected;
- The categorisation of buildings according to their size (floor area, volume) was not the best choice. The 490 m^2 and 3,000 m^3 limits have proved to be too low, because most of the buildings included in the survey (depending on their purpose up to 50-75%) belonged to the largest category. Thus, a precise determination of specific energy indicators was virtually impossible. Only little conclusion could be driven from the data on absolute energy consumption and cost, although they were represented with a rather high scores in the categorisation.

The evaluation study conducted on the Slovak side enabled us to draw the following conclusions:

- In the three main categories of buildings, a rather high percentage of roofs and walls was not insulated (56-88%).
- 54-63% of buildings had insulated glass fillings in the windows and doors.
- domestic hot water is prevailingly produced locally and not by central boilers (77%); except for schools, about 43% of which produces DHW by central heating systems.
- in most of the buildings there is a natural gas heating system, which applies to almost 100% of schools, and to a somewhat lower percentage of community centres (65-88%).

The results of surveys conducted in Hungary were rather similar:

- around 22% of the 37 buildings had façade insulation,
- in 56.7% of these buildings there are double glass window panes,
- 50% of DHW is produced locally, 50% by central heating systems,
- 75.6% of heating demand is supplied by natural gas central heating systems; 24.4 by district heating.

Based on the aforementioned data we can conclude that in the surveyed regions of both countries involved in the project there is a lot to do in the field of improving energy efficiency of buildings as well as in the area of increasing the use of renewable energies. In the last two years we have recorded a certain progress in Hungary due to the availability of competitive grants providing public institutions 85% of the funding necessary for the implementation of their projects in this field. Recently a whole series of completed projects have been delivered, which were approved one year ago, and currently there is also a number of project applications submitted in 2011 in the evaluation process. Despite of that, most public buildings located in the two concerned Hungarian counties yet have significant development tasks to complete.

Moreover, based on the evaluation studies we can conclude that there are some smaller or bigger differences between the two countries in terms of their legislations, energy policies and available funding. For example:

- different efficiencies are taken into account in regards to gas and biomass combustion facilities;
- the purchase price of electricity produced from renewables in Slovakia is differentiated and, in general higher than the flat purchase price in Hungary;
- due to different investment costs and, mainly to different range of funding, the payback periods may vary considerably in the two countries;
- the opinions on the use of ground collectors differ; in Hungary their use is considered also in buildings with the thermal output of several hundred kW, not only in smaller ones, as it was reported in the relevant Slovak evaluation study.
- there were significant differences between the two evaluation studies also in the energy quality categorisation of buildings.

In this study we wanted to make a comprehensive summary of how local authorities and public institutions could start thinking about preparing an energy-related investment without the need to make even a low-budget preliminary study. Of course, this cannot replace an audit-based comprehensive feasibility study and design, which may, especially in case of larger investments, entail considerable costs. However, it is necessary to convince the respective bodies about the likely benefits of such costs. The study can help in this regard. Using this study and the related software, even people, who are not as familiar with these issues, will virtually be able to elaborate a preliminary study. It is reasonable to make the energy analysis of the existing building starting out from its energy consumption data and its size, in this stage there is no need to make detailed energy calculations, and it may not be advisable to have such calculations done.

We have to emphasise that without knowing the local conditions we cannot strive for complete accuracy. However, the accuracy we are able to achieve can be considered sufficient in the preparatory stage of decision-making. Also in consideration of the above mentioned differences between the two countries we developed an interactive software related to the study in a way that it can handle different conditions and requirements, including the future changes in the price levels.

During the renovation of buildings aimed at reducing their energy demand - if it turns out necessary - we set our objectives in consideration of the requirements expected by the end of the decade in regards to insulation, replacement of windows and doors and modernisation of heating systems. In Chapter 3 – *The evaluation of the present state of mechanical engineering systems (heating, domestic hot water production and ventilation) in the now existing buildings* – relying upon experiences arising from specific surveys, we presented the anomalies that may occur in practice and pointed out the possible solutions.

In terms of renewable energies, we focused on those which can be generally applied by the target group, that is solar energy, wind energy and solid biomass, and we also discussed the utilisation of heat from air and soil. We did not address the direct utilisation of heat generated from biogas, hydropower and geothermal energy for heating applications, because the preparation of such projects is rather complicated and cannot be implemented without involving professionals. (However, information relating to permitting will be presented also in this respect, attached to the Hungarian version.)

In relation to the modes of using renewable energies we did not cover the theoretical background; it will be partly covered within the preliminary studies. Primarily we wanted to provide practical information and technical advice necessary for the selection of a particular version of the project, in each case depending on the specific type of machine, in order to arrive to factual and realistic results for the decision-making. This specifically applies to Chapter 4 –

Application of heat pumps to satisfy the heating and cooling demands of buildings, and to the chapter devoted to domestic hot water production. We provided more detailed information on the possibilities of applying different basic types of heat pumps, on the criteria for their selection and their operating characteristics, since the knowledge in this area is rather limited.

In Chapter 5 – *Utilisation of solar energy to partly satisfy the energy demand of buildings* – we only briefly covered the use of solar energy and we primarily focused on practical issues, providing a concrete example including a calculation guide. In connection to electricity generating solar systems we presented the general solar radiation values applicable to Győr, which can be considered a geographical centre of the project area, as well as the values of energy generation per 1 $kW_{p,}$ and we presented, in a tabular form, the effects of non-optimal placement. At the same time, in regards to domestic hot water generation by solar collectors, we developed a simplified, tabular and interactive calculator. The calculator can help to choose an adequate solar collector system to cover, in the summer, almost 100% of domestic hot water demand of municipal buildings. However, we recommend its application only in residential and hotel-type building; using solar collectors for generation domestic hot water at school facilities may not be advisable because of summer holidays.

Chapter 6 – *Utilisation of biomass to satisfy the buildings heating demand* – also addresses the general as well as practical range of issues of the study. That is the general issues of biomass applications, quality requirements for the fuel, its moisture content, and we also discussed the characteristics of heating systems using biomass-fired boilers.

In Chapter 7 – *Possibilities of utilising wind energy in Hungarian regions involved in the project* – we discussed household-size power plants with the capacity up to 50 kW, because their installation can be considered a realistic target.

A key part of the study is a brief description of sample projects that have already been implemented and projects, which have been designed and are ready for implementation (Chapter 8 - *Sample projects of energy efficient renovations and utilisation of renewable energies in municipal buildings*). We have compiled these samples as to provide the concerned specific examples of buildings of different purpose and size in the field of renovation and utilisation of renewable energies.

During the development of the related software we had to - because of technical reasons, divide the building into the following three categories:

- **Residential and hotel-type of buildings** including colleges, hospitals, elderly homes...
- **Office buildings**
- **Educational buildings** including kindergartens, elementary and secondary schools, and higher educational institutions.

The overall energy demand of buildings other than the above three categories shall be calculated based upon its specific mechanical engineering system, which can be done by professionals in compliance with the effective TNM regulation. Naturally, the software can also be used for these buildings; the only thing the software cannot manage is the energy quality classification. (The Slovak version of the software can, if necessary, use the table included in the evaluation study for the classification purposes.)

Most of the presented sample projects are complex, including 2-6 activities relating to improving energy efficiency of buildings and to the use of renewable energies. In practical life it is quite rare that only a single intervention is applied to improve energy efficiency e.g. the insulation of buildings is usually associated with the replacement of window and doors and the secondary improvement of the heating system, which can be followed by a partial or complete replacement of the existing heating and electric energy supplies by some type of renewable energy.

During the elaboration of the technical background of the study and during the selection of sample project to be presented we largely relied upon entrepreneurs who have declared in writing their intention to cooperate on the project.

Based on the above we hope that we managed to develop a study written in an easy-to understand language along with a user-friendly software, which can provide significant help to the target group of beneficiaries in their decisions aimed at improving the energy efficiency of buildings and increasing the use of renewable energies.

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