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ENERGY EFFICIENCY IN EU UNIVERSITIES – RESULTS OF THE 1ST LEVEL AUDIT

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Abstract. The paper presents the main ideas of the project considering the programme "Intelligent Energy – Europe (IEE) / Use Efficiency: Universities and Students for Energy Efficiency". The article focuses on project goals, outputs, results and work programme. The methods of energy performance analysis and consumption benchmarks are described. Operational Rating method for 1st level analysis is preferred as the most reasonable. The principles of critical buildings, including some examples are identified. The obtained results of the 1st level audit of 9 EU universities are given.

Keywords: energy, efficiency, project, audit, analysis.

Introduction

The "USE Efficiency" project intends to create a common stream for energy efficiency systems in university buildings. Universities and students are proposed as shining examples both for energy efficiency solutions and for energy efficiency behaviour.

The Project involves 10 EU countries (9 Universities and 4 market players), and has the aim to improve energy efficiency in university buildings and to establish training programs for students.

Students are the main actors of the project, learning about energy efficiency, working and interacting together with professors and technicians. To act on students means to act on direct future market players in diffusion of public opinions.

The wide geographical and climatic coverage allows an important crossover of methodologies even at a professional and technological level.

A strong communication action is an important key issue and involves national media, such as TV radio and publisher, student associations and national professional institutions.

Project Goals

- to analyze energy efficiency in university buildings and create a common scenario among different European climatic zones;
- to improve energy performance of University buildings, through technical and not technical actions;
- to promote Universities as shining examples in EU geographical areas;
- to increase EU and cross-national knowledge on EPA (Energy Performance Assessments) methodologies and tools;
- to use and promote past EU projects at technical, professional and student level;
- to train students as future market actors from the very beginning of their technical development;
- to involve students in realistic implementation activity on an energy saving plan;
- to improve relationships among students, professors and technicians;
- to benefit from students raising awareness which can have family and social level effect;
- to encourage cooperation in energy issues among the students from different countries ;
- to foster the exchange of information and experience between educational establishments and experts on energy efficiency training programs and methods.

Outputs and results

- creation of common scenarios among universities giving an overview of the situation of university buildings;
- collection of EPA methodologies to select those suited better for building energy audit;
- relationships between students and professional technicians during training courses, through classes and particularly when implementing EPA activities in team-work as real job experience;
- improvement in energy performances on university buildings as a result of EPAs made by students supported by technicians;

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- more skilled students, future market players because of participating in realistic implementation activity in an energy saving plan;
- exchange of information and experiences among project key actors and students; interaction with technicians and professors is a fundamental step for young people to succeed in their future job;
- best-practice energy solutions and dissemination of training programs among partner-countries;
- increase in cross-national knowledge; universities are reference points for different people (students, professors, user connected to University system), for other national or international Universities that are not project partners, and for other professional categories, such as architects, engineers, wholesalers and installers of energy efficiency systems (Description of the Action 2009).

Work Programme

The project is divided into 9 work packages which consist of different activities such as auditing, training, information exchange and communication. All activities focus on the main objective of developing student awareness and qualification on energy efficiency, EPBD (Energy Performance of Buildings Directive) (EPBD.2002) implementation and achievable new technologies. University students are the nearest category close to future market actors, institutional actors, legislatives actors, final users and decision makers. Therefore it is essential to give them a strong awareness and know-how on energy efficiency issues from the beginning of their professional career (Description of the Action 2009).

Article 5 of the EPBD will be taken into consideration in the project, since the use of renewable energy technologies is one of the basic actions to reduce CO_2 production and therefore it is closely connected to energy saving issues.

Methodology for the 1st level audit

First level audit is concerned with a macro analysis of university sites. It differs from the study of macro University scenarios because it starts going deeper into university data dealing with energy consumption and explaining in what ways they are directly involved with EPBD strategies. This analysis will give an overview of general technical aspects that deal with the buildings sites.

For each university, only the faculty campus connected to the partner department was taken into consideration. In case of many buildings within a department campus (i.e. engineering, architecture), only a maximum of 6 structures per university was included in first level analysis. This is because costs in terms of workload would be too high without proportionally added value related to the implementation of new methodologies, since university buildings are generally remarkably similar. They may only differ according to their specific energy needs depending on their primary activities, i.e. whether didactical activity takes place and whether the structures are general departments or dedicated to research activities.

Operational Rating as the method for 1st level analysis was preferred (Fig. 1).

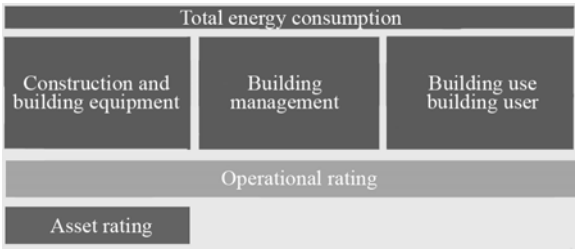

Fig. 1. Asset and Operational rating scheme (Michael Hörner 2010)

The operational rating of the energy performance of the existing buildings as the first step to EPA is not standard in all participating countries. But the goal of the project is to compare the measured energy consumption with national benchmarks or legal standards.

The overall goal is to give a "strong standardized methodology that may be used for all university buildings whenever required".

In first level audit analysis, plausibility check is included: a reference area, climate index, special building utilization, exceptional temporary conditions etc.

A detailed description of the collected data covers:

A. Energy certificate data.

Basic data on the energy certificate, e .g. certification date, the classification of the building according to national indicators used in energy certificates.

B. General data on the building.

Basic data on the type and size of the building, e. g. location, building utilization, conditioned floor area.

C. Building envelope data.

Data describing the thermal performance of the building envelope (enclosing the heated part of the building): U – values (heat transfer coefficients) and the area of the elements, window properties.

D. System data.

Data describing building energy supply systems, e.g. a type of heat generation systems, a type of heat distribution systems, information on air conditioning systems.

E. Calculated energy demand (Asset rating)

The quantitative results of asset rating, e. g. heat demand, hot water demand, energy input and output of heat generators and air conditioning equipment, boundary conditions of asset rating.

F. Basic parameters of operational rating.

Information on the basic conditions of operational rating, the outcome (measured energy consumption) is indicated in the following chapter G.

G. A Summary of energy consumption and generation.

The summary of energy consumption and generation, in the first place for operational rating but also for asset rating.

H. Primary energy, CO_2 Emissions and benchmarks.

Primary energy demand and CO2 emissions for both operational and asset rating (Michael Hörner 2010a).

Benchmarks

Benchmarks for operational rating schemes for building energy consumption are usually derived from the statistics of many comparable buildings. Energy consumption benchmarks e_{comp} are differentiated according to typical building utilization, weather corrected and related to some reference area and a standard accounting period of one calendar year.

Critical buildings

In particular, 2 out of a maximum of 6 buildings of the partner department faculty campus are to be reasonably identified for further analysis in a 2nd level audit (Work Program for University 1st level audit. 2010).

Buildings are considered to be critical when some of the following criteria are fulfilled:

- the mean value of the weather corrected, area related energy consumption of the last three years is considerably greater than national benchmarks:

$$e_c >> e_{comp};$$

- very bad rating of the building energy consumption compared to national indicators or legal standards according to the national rating scheme;
- high absolute values of energy consumption, electricity and thermal energy;
- high consumption is not related to special secondary uses within the building (data centre, kitchen) or exceptional temporary conditions;
- measures for considerable improvements in energy efficiency are obvious or already proposed;
- major renovation scheduled within reasonable time perspective.

Results of the 1st level audit

The results of the first level audit of 9 EU universities where analysed. Electrical and heating energy consumption for the conditioned area was compared. The obtained results are shown in Fig. 2.

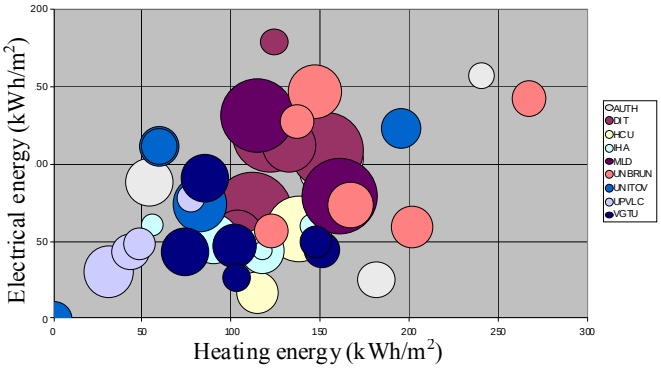

Fig. 2. Specific final energy consumption (Michael Hörner 2010a)

In Figs. 2 and 3, the area of the circle shows the conditioned area of each building respectively. The indexes are:

AUTH – Aristotle University of Thessaloniki
DIT – Dublin Institute of Technology
HCU – HafenCity University Hamburg
IHA – Institute for Housing and Environment
MLD – Maelardalen University
UNBRUN – Brunel University
UNITOV – Univesity of Rome "Tor Vergata"
UPVLC – Universidad Politécnica de Valencia
VGTU – Vilnius Gediminas technical university

For the benchmarks of the buildings of all universities, the average of the buildings of Greek university (AUTH – Aristotle University of Thessaloniki) was chosen. Figure 3 indicates the results of the buildings of all participating universities in the grid of the benchmark.

Fig. 3 displays the index of electrical energy in value of CO_2 emissions and the index of heating energy in primary energy consumption.

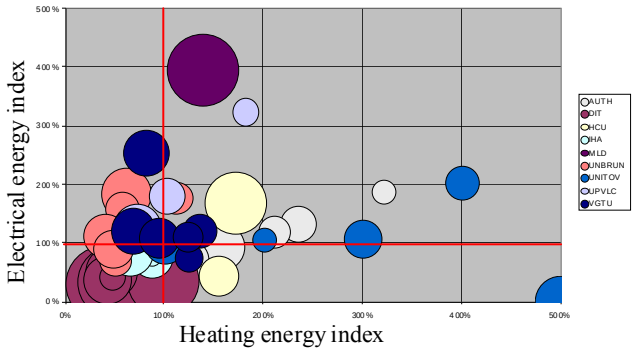

Fig. 3. Benchmarks of 1st level audit results (Michael Hörner 2010a)

The major digress from the benchmarks is seen in the University of Rome "Tor Vergata". The best situation comparing with the benchmarks is the buildings of Dublin Institute of Technology. The results of Vilnius Gediminas Technical University buildings located in the northest place of Europe are approximately on the lines of the benchmarks.

The summary of the results of 1st level audit provides that the amount of the energy consumed cannot show climatic data as it points only to the efficiency of energy use.

General Conclusions

1. The 'Use Efficiency" project is a good opportunity to develop new study programmes for students involving them into the direct energy performance analysis of buildings, to improve knowledge of energy auditing etc.
2. It is strongly recommended to include electricity consumption (not only heat as usually done in Lithuania) analysis for a critical selection of buildings. For this reason, it is very important to define precise energy consumption benchmarks for different types of buildings and even for premises, e.g., presently, there are no (!) electricity benchmarks in Lithuania.
3. The results of 1st level audit have revealed that the amount of the energy consumed cannot show climatic data, it only indicates the efficiency of energy use.

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"USE EFFICIENCY" PROJEKTAS – TIKSLAI, GAIRĖS, TARPINIAI REZULTATAI

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Santrauka

Straipsnyje pristatomos tarptautinio projekto pagal programą „Pažangi energetika Europai" („Intelligent Energy – Europe") "USE Efficiency" – „Universitetai ir studentai už efektyvų energijos vartojimą" – pagrindinės idėjos. Identifikuojami projekto tikslai, laukiami rezultatai, darbo eiga ir kt. Paaiškinti energinio audito analizės metodai, energijos vartojimo gairės (lygiai), „kritinių" pastatų atrankos principai. Pristatomi 1-ojo energinio audito rezultatai.

Reikšminiai žodžiai: energija, efektyvumas, projektas, auditas, analizė.