Knowledge extraction from energy certification of buildings – Results from the ENPER-EXIST project

K. E. Thomsen, K.B. Wittchen, O. M. Jensen, S. Aggerholm
Aalborg University, Denmark

ABSTRACT

The ENPER-EXIST project was initiated and coordinated by Centre Scientifique et Technique du Bâtiment (CSTB) within the framework of the Intelligent Energy Europe (IEE) programme. ENPER-EXIST involved partners from seven countries (Belgium, Denmark, France, Germany, Greece, The Netherlands, and United Kingdom) on the topic of energy performance standardisation and regulation. One objective of the project was to provide information on the level of building stock knowledge and to collect available data on a broad basis. A second objective was to analyse how this information is being used to make decisions on energy improvements and a third objective was to make recommendations on how to improve the building stock knowledge by using certification schemes. This paper presents the main results of this part of the project (Thomsen et. al., 2007).

Energy certification, as proclaimed in the European Energy Performance Building Directive (EPBD, 2002), offers a unique opportunity for improving knowledge about the building stock. Improved knowledge will make it possible to map the energy efficiency of buildings. In addition, it will provide a basis for benchmarking and for calculating energy saving potentials. Moreover, such information will be an important instrument for political decision-making.

The EPBD offers freedom of choice regarding the method of certifying the energy performance. The individual member state's decision on energy certification may therefore range from simple meter readings to detailed energy audits. However, this decision determines what knowledge it is possibly to extract afterwards, and for what purpose this knowledge can be used. When deciding on the standards of energy certificates, three elements are crucial for the outcome: the character of the data input, the procedure of certification and the form of quality control.

Based on the energy certification schemes existing in Denmark since 1997, this paper contribute with knowledge about the relationship between data, procedure and quality control on one hand, and knowledge that can be extracted on the other. Of special interest is the possibility of extracting data about potential energy saving measures distributed on segments of buildings. Such data can be of great importance for finding methods to overcome human and technical barriers to energy savings in buildings.

1. INTRODUCTION

Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings (ENPER-EXIST) project (2005-2007) involved several work packages (WP's) and this paper focus on the findings in WP3.

Information on available data regarding the existing building stock in each European member state (MS) has been collected from the project partners and with help from industry using their marketing investigations. A pre-questionnaire was circulated to the participants of the ENPER-EXIST project aiming to find the level of available information and to indicate the sources and quality of this information.

Characterisation of existing building stock		at	be	de	dk	fr	gr	lt	nl	uk
No. of buildings	Total, Res	X	X	X	X	X	X	X	X	X
	Total, non Res	X	X	X	X		X		X	X
Area / type	Total, Res		X	X	X	X	X	X	X	
	Total, non Res	X		X	X	X	X		X	X
Typical construction period	Total, Res	X	X		X	X	X	X	X	X
	Total, non Res	X			X		X		X	
Statistical	Total, Res	X	X	X	X	X	X	X	X	X
	Total, non Res	X	X	X	X	X	X		X	X
Estimate	Total, Res						X			
	Total, non Res						X			

Figure 1. Overview of available information on general building stock knowledge distributed on residential and non-residential building sectors – number of buildings, floor area, construction period and quality of information.

In general there is more information available for the

residential building sector compared with the non-residential sector. However, in the case of electricity consumption, more information is available for the non-residential sector. Some countries, like Denmark, have a lot of information mainly because they have had mandatory energy certification schemes since 1997 (Laustsen, J.H. & Lorentzen, K., 2003).
The second step was to collect some of the available information about:
- Energy consumption for heating and ventilation,
- Results from national projects concerning estimated energy savings potential,
- Relevant web-sources from each country concerning building stock knowledge,
- Results and information from other EU/IEA projects concerning building stock knowledge and energy savings potential,
- Results from national investigations indicating 1) on what data decisions regarding building regulations are based and 2) what data decision-makers are lacking.

Knowledge about the existing building stock is available at both national and European levels. The most detailed knowledge is of course found in national statistics. For a general view however, some European Statistics can contribute with relevant knowledge. Valuable knowledge is also found in separate databases developed in connection with specific EU projects or other sources. An investigation concerning the non-residential sector was carried out in the Energy Performance Assessment of Existing Non-Residential Buildings (EPA-NR) project. Until now, only few European energy certification schemes have been launched. Still, it is possible to draw attention to elements that must be considered with regard to schemes now on the drawing board and existing schemes that should be revised. Only in this way can building stock knowledge concerning energy consumption, energy savings and evaluation of energy saving potentials be improved.

2. NATIONAL STATISTICS AND SURVEYS

From the pre-questionnaire it turned out that there was general knowledge about the number of buildings, built-up area, and conditioned floor area. But when it came to more detailed information like energy consumption per floor area or division of buildings into energy classes, there was general lack of information. Especially when dealing with non-residential buildings only very little information was found to be available.
After scanning for potential positive answers to questions related to energy issues in the existing building stock, it was decided to conduct a detailed survey within the countries of the project partners.

The first information gathered was about the number of buildings and their usable area divided into different categories of use. Even such a simple question seems to be difficult to answer and the quality of the answers varies. Thus the usable area per person in non-residential buildings varies from 3.1 m² per person in France to 58.7 m² in Denmark. A variation of this magnitude seems strange and may imply that a different fragment of the non-residential buildings is counted and presented in the answers or other such misunderstandings. This kind of information was not available in all countries.
In the non-residential building sector there is a large diversity in energy consumption per heated floor area. In general there is no available information on cooling consumption in the sector – only Greece could provide this information. In the other countries there is a general perception that no cooling is installed, even though cooling systems do exist in many non-residential buildings.

2.1 Extract of selected building stock knowledge

From an energy saving point of view, it is limited, what existing data and statistics can do. Hence, first of all only statistics and databases built on certification schemes already in force contribute to the building stock knowledge Concerning European Statistics both Eurostat and The European Environment Agency provide statistics regarding buildings. The European Alliance of Companies for Energy Efficiency in Buildings (EuroACE) and the European Association of Insulation Manufacturers (EURIMA), representing the interests of all major mineral wool producers throughout Europe also provide information about the European building stock.
The criterion for the utility of existing building statistics in the ENPER-EXIST project is building data that in respect of each member country are distributed on time of erection, type of construction, building dimensions, daily use, and annual energy consumption. If more knowledge of building statistics and databases is available, such as energy certification, energy labels, lists of energy measures performed or recommended this would indeed give added weight to the actual building statistics and databases in question.

2.2 Knowledge based on the Danish certification schemes

The most comprehensive investigation based on data from the Danish certification scheme was carried out in order to acquire knowledge about the potential for heating saving in dwellings. Dwellings have a long service life and obviously old dwellings do not meet current demands and possibilities regarding energy performance. Hence, the purpose of the project was to create an overview of the possible heating saving potential based on

information available in the Danish energy certification scheme and the Danish building stock register (BBR) as well. The investigation was made by the Danish Building Research Institute for the Danish Energy Agency.

Table 1. Potential energy savings for Danish dwellings constructed in different periods (TJ). In contrast to expectations, relatively high energy savings can be obtained in detached houses and row houses constructed in 1999-2003. This is due to the fact that the windows in these buildings have U-values above 1.6 W/m²K, as reported by the energy consultants.

	-1930	1931-50	1951-61	1961-72	1973-78	1979-98	1999-03	Total
Detached	4253	2051	1541	3776	1172	660	25	13478
Row houses	642	308	270	317	205	601	39	2382
Farm houses	3412	457	137	65	40	47	1	4159
Multi-family	3868	2269	1106	1415	316	405	0	9379
Total	12175	5085	3054	5573	1733	1713	65	29398

2.3 Improved knowledge by using certification schemes

When a certification scheme is launched, important issues are the framework for the certification procedure and the administration of the scheme. Another issue is the approach to collecting the data necessary for issuing an energy label. In the following, the principles both of the framework and the approaches of the data collection are examined and pros and contras concerning different measures are listed. Each measure has extremes regarding its quality and level of detail. In between there can be combinations that are useful as well. Some of these are explicitly mentioned, others are incorporated in the text (see Table 2 at end of the paper).

Energy certification schemes are looked upon as vital sources for gathering information about the energy standard and performance of existing buildings. If collected data are stores in a central database, it will be possible to perform more reliable calculations of the energy saving potential in the existing building stock. An example is the calculation of heating saving potential for residential dwellings in Denmark (Wittchen, 2004). The needed building stock knowledge for calculating the energy saving potential was compiled from two separate databases.

One database was the nationwide building stock register, which holds all the general information about buildings such as: construction year, built-up area, floor area, main use, external constructions materials, primary heating source, etc. The main purpose of this register is to collect taxes and develop a general overview of the building stock for the local municipality. The municipality updates the database, but the building owner is responsible for reporting changes in the building to the municipality. The other databases originate from the mandatory energy certification schemes of existing buildings, which have been established and in operation in Denmark since 1997. Two different certification schemes existed, namely the energy certification scheme for small, owner-occupied buildings (EM) and the energy management scheme for large (+1500 m²) buildings (ELO). The ELO scheme was based on measured energy consumptions, while the EM scheme was based on calculated energy consumptions. The information about the thermal envelope, gathered in the EM scheme, was thus the more comprehensive and in this context used for energy saving calculations. Information about the thermal envelope gathered in the EM scheme was i.e. area and U-value of all constructions distributed on different construction types (external walls, roofs, floors or windows) which in turn were divided into different subtypes. This information was supplemented by information about the recorded consumption of energy (types and amount) and water.

Furthermore a source of information used for making the nationwide evaluation of the energy saving potential was human knowledge. This included information about building tradition over time in different Danish building types and energy requirements in the different building codes. By implementation of the EPBD, Europe has a excellent opportunity to improve the general building stock knowledge, and in some years to perform a global evaluation of the energy saving potential in existing European buildings. However, there is some information that must be recorded in a structured way in order to enable such an evaluation.

The recommended minimum information that should be recorded in energy certification schemes with calculated energy consumption related to different parts of the building are:

Building:

– Built-up area and heated floor area, number of floors.
– Construction year and year of major renovations.
– Location of building (climate zone).
– Recorded energy – distributed on energy carrier - and water consumption (for comparison with calculations).

Thermal envelope:

– Type, area and U-value for each opaque construction type.
– Area, U-value and solar energy transmission factors for each transparent element including any shading objects.
– Thermal bridges (length/size, transmission coefficient).
– Thermal storage capacity of the building.

Systems:

– Primary and secondary heating system (including efficiencies and location).
– Ventilation system including an estimate of the natural and mechanical ventilation rate.

– Cooling system (including efficiencies and location).
– Heating and cooling distribution systems (pipe length, insulation level, location).
– Domestic hot water production (including location and distribution).
Default values:
– Internal loads (persons, equipment, lighting, etc).
– Domestic hot water consumption (based on persons and/or floor area).

3. CONCLUSIONS

To investigate how to gain improved knowledge of the building stock and information of possible energy savings, the Danish experience from the existing certification scheme was used as a starting point. A comprehensive investigation based on data from the Danish energy certification schemes was carried out in order to obtain knowledge about the potential for heating saving in dwellings. Apart from energy considerations, an evaluation of the economic consequences is given for the most profitable energy saving measures. Based on this investigation a table can be elaborated that lists recommended minimum sets of information to be recorded in the new European certification schemes.
Until now, only few European energy certification schemes have been launched. Still, it is possible to draw attentions to elements that must be considered with regard to schemes on the drawing board and existing schemes that should be revised. Only in this way can building stock knowledge concerning energy consumption, energy savings and evaluation of energy saving potentials be improved. When a certification scheme is launched, an important issue is the framework for the certification procedure and the administration of the scheme. Another issue is the approach to the collection of data necessary for issuing an energy label. Both principles of the framework and the approaches of the data collection are examined and pros and contras concerning different measures are listed. Each measure has extremes regarding its quality and level of detail. In between there can be combinations that are useful as well.

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