ENPER-EXIST

Applying the EPBD to improve the Energy Performance Requirements to Existing Buildings – ENPER-EXIST

WP3: Building stock knowledge

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ENPER-EXIST project information

The ENPER-EXIST project was initiated and is coordinated by the Centre Scientifique et Technique du Bâtiment (CSTB) in the frame of the Intelligent Energy Europe (EIE) programme in the part SAVE of the European Commission, DG TREN. It involves partners from 7 countries on the topic of energy performance standardization and regulation. Contract EIE/04/096/S07.38645. Duration: 01/01/2005 - 30/07/2007.

The Energy Performance of Building Directive (EPBD) sets a series of requirements specifically dedicated to existing buildings but the member states are facing difficulties to implement quickly these requirements. The main goal of the ENPER-EXIST project is to support the take off of the Energy performance of building directive (EPBD) in the field of existing buildings.

ENPER-EXIST have 4 main objectives:

1. To de-fragment technical work performed on existing buildings. Indeed actions already launched in CEN to apply the EPBD are de-fragmented but mainly focus on new buildings. On the other hand different projects on certification procedures are going on at the European level but are not coordinated.
2. To de-fragment work on legal, economical and organisational problems such as the analysis of certification on the market, the human capital and the national administrations.
3. To achieve a better knowledge of the European building stock.
4. To define a roadmap for future actions regarding existing buildings.

ENPER-EXIST uses an intensive networking of existing national and international projects to reinforce efforts to solve these issues. It works in close coordination with the Concerted Action set up by Member States to support the application of EPBD. The work program is split in 4 technical work packages in addition to dissemination and management activities.

WP1: Tools application

WP1 analyses how existing buildings are taken into account in technical tools such as CEN standards, national calculation procedures. Recommendations on how to improve the consideration of existing building are be defined.

WP2: Legal economical and organisational impact

WP2 analyses the impact of the certification procedures and regulations of existing buildings on the market, on the human capital and on the national administration. Surveys are carried out in the different member states and recommendations are drawn up.

WP3: Building stock knowledge

WP3 analyses the level of information available in each country regarding the existing building stock. A procedure enabling to refine this information and ways to use the certification procedure as a tool to collect data regarding this stock is developed.

WP4: Roadmap

An overview of possible legal measures for existing buildings is written. Indications are given about alternative strategies to improve on a wide scale the energy efficiency of existing buildings. Possibilities (including pro's and cons) to widen the scope of the EPBD in case of a future revision of the requirements of the directive are described.

A website, newsletters and workshops enable a strong interaction between ENPER-EXIST and different interest groups and a wide dissemination of ENPER-EXIST results. The workshops are organised with the different actors involved in the application of the EPBD.

More information on the project website: www.enper-exist.com

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1 Introduction

WP3 aims to provide information on the level of building stock knowledge, to collect available data on a wide basis, to analyse how decisions for energy improvements are based on this information and to make recommendations on how to improve the building stock knowledge.

To get better knowledge about existing building stock, a pre-questionnaire was circulated among the eight project partners about the level of data available. The collected results were analysed and based on these a questionnaire was circulated on the subject of data for energy consumption and energy savings potential.

All information collected from the countries and other EU/IEA projects are gathered and presented in this report. Collection of information from the member states was finalised in December 2006. The report is divided into chapters, and one of the first presents existing building stock knowledge from the ENPER-EXIST project. In the following chapter there is an extract of selected building stock knowledge from international sources and projects. The available buildings stock information sources (web-sources) and publications are compiled in another separate chapter.

Proposals on how to improve the building stock knowledge using new certification schemes have taken their starting point with the Danish approach to the use of statistical data and data obtained in connection with certification to determine the potential for energy savings. Each project partner reported the experience gained in his country or what is ongoing regarding the use of certification to improve building stock knowledge.

When a certification scheme is launched, the framework for the certification system and the administration of the scheme are important. The approach to the collection of data requisite for issuing an energy certificate is also important. The report examines both the principles of the framework and the approaches to data collection and lists pros and contras concerning different measures to improve the building stock knowledge by use of certification schemes.

2 Summary

The objective of WP3 of the ENPER-EXIST project is to conduct a survey of the existing European building stock to obtain better knowledge of the potential for energy savings.

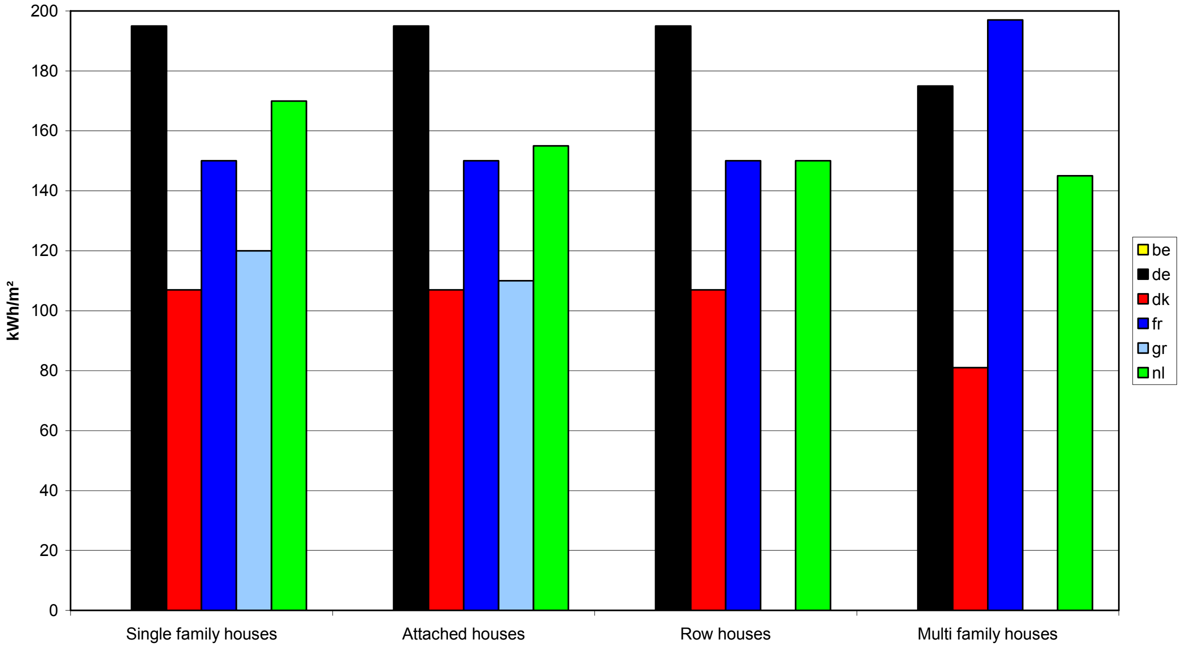
The information of data available regarding the existing building stock in each MS has been obtained from the project partners and also with help from the industry with their marketing investigations. A pre-questionnaire to the participants of the ENPER-EXIST project was circulated aiming to find the level of available information and to indicate the sources and quality of this information.

In general there is more information available for the residential 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.

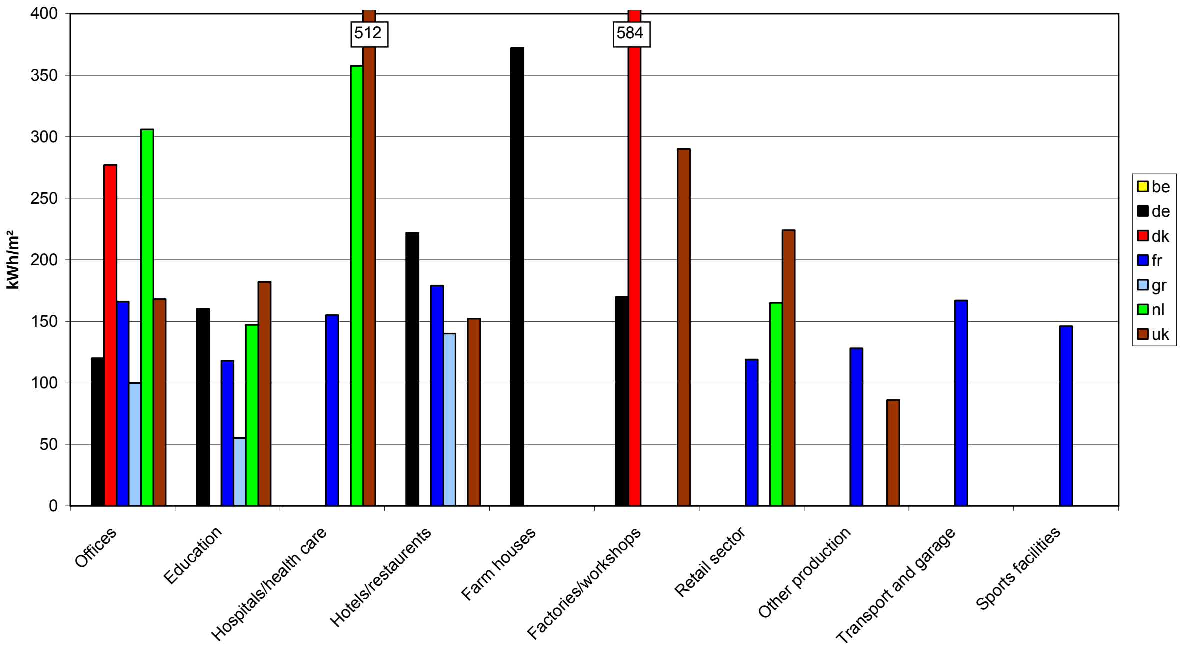
The second step was to collect some of the available information about:

– 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) what data decisions made regarding building regulations are based on and 2) what data decision-makers are missing.

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. Additionally knowledge is found in separate databases created in connection with specific EU projects or others sources. In the EPA-NR project a large investigation concerning the non-residential sector was carried out and the main results are included in this report. Concerning European Statistics both Eurostat and the European Environment Agency are in possession of statistics for buildings.



Energy consumption for space heating per heated floor area in residential buildings of the ENPER-EXIST countries. In some cases, especially where heating and domestic hot water (DHW) is delivered from a central boiler, heating energy also covers energy for DHW.



Energy consumption for space heating per floor area in non-residential buildings in the ENPER-EXIST countries.

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.

Future evaluations of the energy savings potential in existing European buildings requires a minimum set of information to be recorded in the new European certification schemes.

Building part	**Minimum information to record in energy certification schemes**
Building	Build-up area and heated floor area, number of floors. Construction year and year for major renovations. Location of the building (climate zone). Recorded energy – separate per 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 incl. any shading objects. Thermal bridges (length/size, transmission coefficient). Thermal storage capacity of the building.
Systems	Primary and secondary heating system (incl. efficiencies and location). Ventilation system including an estimate of the natural and mechanical ventilation rate. Cooling system (incl. efficiencies and location). Heating and cooling distribution systems (pipe length, insulation level, and location). Domestic hot water production (incl. location and distribution).
Default values	Internal loads (persons, equipment, lighting, etc). Domestic hot water consumption (based on persons and/or floor area).

Until now, only few European energy certification schemes have been launched. Still, it is possible to call 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 building stock knowledge concerning energy consumption, energy savings and evaluation of energy saving potentials can 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 for the collection of data necessary for issuing an energy label. In the report, both the principles of the framework and the approaches of the data collection are examined and pros and contras concerning different measures are listed. For each measure the pros are identified and discussed and then the contras. 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 mentioned explicitly, others are implicit in the text.

In the following some of the measures resulting from the use of the certification scheme to improve the building stock knowledge are listed:

Elements of the overall framework of certification with pros and contras on the building stock knowledge.

	Pro	**Contra**
Central authority	By definition, a central (national) authority can allocate resources to implement certification schemes at all administrative levels from legislation and set-up of general rules to overall control of the scheme, reviews and information for end-users. This enables a fast dissemination of the scheme and a fast build-up of a database of building stock knowledge.	Local authorities may be able to adjust design, performance and data registration with respect to local building traditions and administrative practices.
Standard forms	Standard forms for inspection will increase the accessibility, transparency and objectivity of the energy performance assessment and in addition ensure specific procedures and uniform calculation.	Standard forms require standardisation of data and can hardly adopt additional information. Important knowledge concerning local building traditions might then be missed.
Computer forms	Computer forms for inspection and calculation ensure that the consultants follow specific procedures, remember all necessary data and steps. A standard calculating routine ensures uniform calculations.	Computer forms may require permanent subscription, for instance by use of the Internet. It also requires a stable Internet connection or at least consultants used to work with computers.
Authorised energy consultants	Authorised consultants (authorisation based on education programmes and examinations) ensure transparency and objectivity of the consultants' energy performance assessment.	High costs and slower dissemination.
Use of handbook	A handbook is an important tool for the authorised energy consultant to carry out the inspection, making the calculation and drawing-up of the energy label in a standardised way.	Publishing of a handbook requires both expertise and resources in the form of time and money.
Quality control	Different kinds of checks like automated and manual screening on one hand and technical auditing by inspection at the property on the other are important measures for obtaining high-quality building stock knowledge.	Quality control requires extra resources. At least computer-aided control functionality must be granted.
Public access	Public access to data concerning building certification is a way to obtain quality control and to gain interest of energy certification and its benefits on relevant energy saving measures. Possibility for new purchasers of a house to compare houses with regard to their energy performance.	Public access requires up-to-date check of data, and a reply service in order to prevent confusion and non acceptance of the energy certification system.

3 ENPER-EXIST building stock knowledge

3.1 Available building stock knowledge – ENPER-EXIST pre-questionnaire

Recognising the fact that building stock knowledge regarding detailed energy issues in Europe exists on very different levels of detail in the different member states (MS), a pre-questionnaire was circulated. The aim of this questionnaire was to scan the level of detail at which energy-related information would be available, if a request was sent. Hence the questions went like: *If you were asked to provide information about <some energy-related issue>, would you be able to provide it?* The full questionnaire is found in Annex B.

It turned out that there was a general knowledge about the number of buildings, build-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 different energy classes, there was a general lack of information. Especially when dealing with non-residential buildings, there was very little information available. Information from MS not involved in the ENPER-EXIST project was gathered by the project partners using personal contacts.

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

		at	be	de	dk	fr	gr	lt	nl	uk
Characterisation of existing building stock										
# buildings	*Total, Res*	☺	☺	☺	☺	☺	☺	☺	☺	☺
	Total, non Res	☺	☺	☺	☺		☺		☺	☺
area / type	*Total, Res*		☺	☺	☺	☺	☺	☺	☺	
	Total, non Res	☺		☺	☺	☺	☺		☺	☺
typical construction period	*Total, Res*	☺	☺		☺	☺	☺	☺	☺	☺
	Total, non Res	☺			☺		☺		☺	
statistical	*Total, Res*	☺	☺	☺	☺	☺	☺	☺	☺	☺
	Total, non Res	☺	☺	☺	☺	☺	☺		☺	☺
estimate	*Total, Res*						☺			
	Total, non Res						☺			

Additional comments concerning the source and quality of the available information are listed for each country.

Austria:

The major sources for information in Austria is Robert Lechner und Susanne Geissler (Arsenal and ÖÖI, report of EPA-NR), and Statistik Austria.

Belgium:

(Heating consumption) Studies are available in the different regions (Walloon region, Brussels regions and Flemish region) giving consumption values of a set of buildings not representative of the whole building stock. No extrapolation has been made at the level of the whole building stock - no country average is available since the subset of building is not representative of the whole building stock. The figures are based on questionnaires send to different companies according to the sector considered. The percentage of answers (on voluntary basis) is always relatively limited. Final energy consumption and specific energy consumption (per m²) are given for both electricity and other types of energy consumption, all final uses included (heating, ventilation, DHW, …). In general, no distinction is made in these studies according to the construction period. Information is available in these studies for the following building types:

- Commercial buildings
- Hotels and restaurants,
- Offices and administrations,
- Education,
- Health and related services,
- Other types of services,
- For some regions, figures are also available for swimming pools,

The references of these studies are:

1. Aernouts, K. Jespers K. Bijlage bij de energiebalans Vlaanderen 2003: onafhankelijke methode - energiekengetallen van de tertiaire sector in Vlaanderen 2003, VITO, June 2005
2. Bilan énergétique de la Région de Bruxelles-Capitale en 2003. Consommations spécifiques du secteur tertiaire en 2003, Mars 2005, ICEDD
3. Bilan énergétique de la Région Wallonne 2002. Consommations spécifiques du secteur tertiaire 2002, Mars 2004, ICEDD
4. Employeurs et travailleurs assujettis à la sécurité sociale au 30 juin 2002 - Office national de sécurité sociale - available on: http://www.onssrszlss.fgov.be/onssrsz/index.htm

Typical climate zones are not relevant in the Belgian context. At the level of the standards and regulations, Belgium is characterised by one climate, even if substantial climatic differences can be observed between the seaside and the extreme part of the Walloon region (300 km farther).

The general national survey realised in 2001 regarding the residential sector has asked some question about the heating system. The percentage of dwellings equipped with central heating system is available. Information on the type of boiler is however not available. Statistics are available about the sales of the different types of boilers, not only in the residential sector.

<u>(Domestic hot water)</u> No Belgian studies related to the energy consumption for domestic hot water in any type of buildings are known. Monitoring results limited to specific buildings should be available but they don't give any information about the stock.

In any case, in general, no specific meter is installed for this use of energy in buildings. One meter is generally installed at the level of the building and the consumption for domestic hot water is included within the final energy consumption of the building. Figures relative to the final energy consumption of buildings (including the consumption for the domestic hot water preparation) are available - see references related to the heating consumption.

<u>(Cooling consumption)</u> No Belgian studies related to the energy consumption for cooling in any type of buildings are known. Monitoring results limited to specific buildings should be available but they don't give any information about the stock.

In the residential sector, cooling is not so often applied in Belgium. If applied, these are most of the time mobile systems added afterwards. The consumption of such systems would be included in the global energy bill and it would not be possible to separate this consumption from the rest of the electrical consumption of the building.

In any case, in general, no specific meter is installed for this use of energy in buildings. One meter is generally installed at the level of the building and the consumption for cooling is included within the final electrical consumption of the building. Figures relative to the final energy consumption of buildings (including the consumption for the cooling if present) are available - see references related to the heating consumption.

(Electricity consumption) Statistics should be available at least at the level of the energy providers. It is not sure if segmentation between different type of building (e.g. according to the building age) is available.

For non residential buildings, see comments about heating energy consumption. The same studies include information related to electricity consumption.

(Thermal envelope) About the residential sector, a study (SENVIVV study - BBRI) realised in 1995 has characterised 200 dwellings build in the Flemish region. This study has selected buildings build during three specific period of time when the thermal regulation has changed in this region:

- 50 buildings build before September 1992 when no thermal regulation was in force in this region,
- 50 buildings build between September 1992 and September 1993 when the first thermal regulation has been introduced,
- 100 buildings build after September 1993 when the requirements of the thermal regulation have been strengthened.

The mandatory national survey realised in 2001 for the residential sector has asked questions about thermal insulation of the dwellings. Information at the national level is available for the following topics:

- Presence of double glazing,
- Presence of insulation in exterior walls,
- Presence of roof insulation,
- Presence of heating pipes insulation.

However no information is available about the corresponding U values of these components. This information is available for the different building types mentioned above as well as for typical construction period.

About the non residential sector, a study realised in 2000 (Kantoor 2000 - BBRI - 2000) has characterised 100 offices buildings situated in the Flemish region. Information related to U-value of all the wall types is available for half of the buildings.

For the buildings analysed within the SENVIVV project, the U-values of all the walls of the different dwelling types can be given. For the limited set of buildings analysed in the 'Kantoor 2000' project, the U-values of the walls can also be given for different building types.

(Ventilation heat loss) Estimates of the ventilation rate do exist (values used within national standards and regulations). These estimates are however not based on extensive measurements in real buildings.

The different ventilation systems applicable in the residential sector are described in a Belgian standard (NBN D50-001). A typology is defined there. In practice, only a limited number of residential buildings have complete ventilation system. Most of the time provisions are foreseen to exhaust the air and no specific supply is foreseen. No statistics can be provided about the number and the types of systems installed.

The airflow rate has been measured in a few residential building in the scope of research project (e.g. Etude Maison solaire - BBRI - 1998). In general no representative statistical value is available. Measurement of airflow rates have been realised within the scope of the above mentioned study (Kantoor 200). In this context, ventilation measurement have been realised in a limited set of buildings. The information obtained from this study are however not representative for the entire building stock.

(Use of renewable energy) Figures should be available since subsidies are allocated for the installation of such systems. However subsidies are not available in every place in Belgium.

Germany:

Single-family houses in the statistics are a mix of detached, double and row houses and include also houses for two families.

Properties of the thermal envelope of German houses can be estimated based on experiences and former Building codes.

Some experiences exist on air-change rates, but mainly in recently build houses.

Denmark:

(Heating, domestic hot water, thermal envelope) For non-residential buildings the numbers can be estimated, but the data are not directly available. Domestic hot water is included in the energy consumption as an estimate. Information about heating consumption and building stock thermal condition in Danish residential buildings are found in: Wittchen K.B. (2004). Analyses of the potential energy savings for space heating in existing dwellings (In Danish). Dokumentation 057. ISBN: 87-563-1202-4. Danish Building Research Institute, Hørsholm, Denmark.

(Domestic hot water, cooling, electricity) Data from non-residential buildings can be obtained from the database of the Danish energy labelling scheme for large buildings (ELO). This information is only available for buildings larger than 1500 m², and only for a fragment of the Danish buildings. Data from the same buildings occurs several times in the database (one for each issued label - officially once a year).

Information on cooling consumption is available for residential buildings - divided into building types, but it requires money and a large effort to derive it from a database. Statistical values should be possible to obtain for the total Danish residential building stock.

(Ventilation) Experimental investigation of air-change rates in existing single family houses, conducted by SBi in the late 90'es, give an estimate of the average air-change in this type of dwellings.

France:

In France, the statistics concerning the number of residential buildings are available. Various studies and treatments of these statistics exist as we want to segment the building stock according to a criterion: the location, the size, the age, the type, etc. In addition to these statistics (from INSEE: National Institute for Statistics and Economic Studies), an inquiry is regularly made on national level to a big number of housing, it allows to collect other data such us buildings characteristics, buildings consumptions, users behaviour, etc. The data processing of these inquiries and of The population census allow to have detailed information depending on the target, in particular estimations of energy consumptions and their distribution by use, by type of energy, by region, etc.

The situation for no residential buildings is different, data about the building stock area and is segmentation according the building stock is available but detailed data about energy consumption or thermal buildings characteristics, etc are more difficult to collect. Various detailed data exist but they remain private or not homogeneous between them.

Residential buildings can be divided into two typical construction periods: before 1975 an after 1975.

It has only been possible to give energy consumption per unit. 1 unit=1dweeling (house or apartment).

There are no statistical data on cooling consumption in the total stock of French buildings. Available data about cooling is in-homogeneous. Typically data only covers a part of buildings.

(Thermal envelope and installation) No data are available but estimation can be made according the existing regulations since 1974, the number of buildings by period construction and the estimation of renovation. Available data are only the requirements of U values in thermal regulations since 1974 until 2005 by type by typical climatic zone, type of building (residential, non residential), type of heating system (electrical system or other).

No data available regarding ventilation, but there are requirements of airflow rate values in 'sanitary' regulations.

Greece:

There is no available data on the total area of residential buildings of Greece. The available data on the area of the residential buildings is based on research from the National University of Athens and refers to a restricted sample of dwellings in Athens (approximately 1000 dwellings).

There is no available data on the total area per type for the non residential buildings. The available data for the area of non-residential buildings is based on the average area per type delivered through research. There are no available data on farm houses.

The provided information though is detailed and reliable. The available data is derived from the National Statistical Service of Greece (latest data 2001) and research from the National University of Athens, Physics Department, Group of Building Environment.

(Heating)

- *Residential buildings*: There is information on the heating consumption of individual housing and collective housing in Greece derived from the European Programme MURE (within the framework of the DGXVII SAVE programme). Additionally, there is an estimate on the heating consumption of a restricted sample of dwellings (approximately 1000 dwellings) in the Athens area, based on research from the University of Athens, Physics Department, Group of Building Environment.
- *Offices:* There is an estimate on the heating consumption of office buildings (Ministry of Industry, Research, Technology and trade, Greek centre of productivity, Saving energy on office buildings, April 1992, additionally research within the frames of the National Energy Programme)
- *Education:* There is no available data on the heating consumption of buildings of higher education (Universities, Technical Colleges, Institutions of vocational training). There is an estimate on the heating consumption of schools (primary and secondary schools).
- *Healthcare buildings:* There is estimate on the heating consumption of healthcare buildings -hospital and clinics (M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia: Energy Performance and Energy Conservation in Health Care Buildings in Hellas. Journal Energy Conversion and Management).
- *Hotels/Restaurants:* There is estimate on the heating consumption of hotels (M. Santamouris, C.A. Balaras, E. Daskalaki, A. Argiriou, A. Gaglia: Energy conservation and retrofitting potential in Hellenic hotels, Journal Energy and Buildings, 1995).

- *Farm houses:* No available data.
- *Factories:* No available data.

Sources of information: Research from the National University of Athens, Research within the frames of the National Energy Programme sponsored by the CEC VALOREN, published in Journal of 'Energy Conversion and Management' and Journal of 'Energy and Buildings'.

Ministry of Industry, Research: 'Energy Use and saving in office buildings, school buildings, commercial buildings, hospitals and hotels', Athens 1992.

It is worth noting that the sample of the dwellings represents the Athens area only. Additionally, the average office surface area is not a typical value; Greece is characterised by a majority of very small offices and a small minority of very big corporate headquarters. The standard deviation of the sample is also very high.

European Programme MURE (Mesures d'Utilisation Rationnelle de l'Energie), within the framework of the DGXVII SAVE programme.

(Domestic hot water) Available information on the domestic hot water consumption of individual and collective housing, derived from the European Programme MURE (see above).

Not available data for the non-residential buildings.

<u>(Cooling)</u>

- *Residential buildings:* There is an estimate on the cooling consumption of a restricted sample of dwellings in the Athens area, based on research from the University of Athens, Physics Department, Group of Building Environment.
- *Offices:* There is an estimate on the cooling consumption of office buildings (Ministry of Industry, Research, Technology and trade, Greek centre of productivity, Saving energy on office buildings, April 1992 and National Energy Programme sponsored by the CEC VALOREN programme).
- Education: There is no available data on the cooling consumption of buildings of higher education (Universities, Technical Colleges, and Institutions of vocational training). There is an estimate on the cooling consumption of schools (primary and secondary schools).
- *Healthcare buildings:* There is estimate on the cooling consumption of healthcare buildings -hospital and clinics (M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia: Energy Performance and Energy Conservation in HealthCare Buildings in Hellas. Journal Energy Conversion and Management).
- *Hotels/Restaurants:* There is estimate on the cooling consumption of hotels (M. Santamouris, C.A. Balaras, E. Daskalaki, A. Argiriou, A. Gaglia: Energy conservation and retrofitting potential in Hellenic hotels, Journal Energy and Buildings, 1995).
- *Farm houses:* No available data.
- *Factories/Workshops:* No available data.

The same sources for information as given for heating consumption applies for cooling consumption.

Very common in all type of non-residential buildings: local cooling, i.e. split systems, combined with natural or mechanical ventilation. Residential buildings are dominated by natural ventilation and thus no mechanical cooling.

(Electricity)

- *Residential buildings:* There is available data on the electricity consumption of individual and collective housing in Greece from the European Programme MURE.

- *Offices:* There is an estimate on the electricity consumption of office buildings split into artificial lighting and office equipment (Ministry of Industry, Research, Technology and trade, Greek centre of productivity, Saving energy on office buildings, April 1992, Results from the National Energy Programme).
- *Education:* There is no available data on the electricity consumption of buildings of higher education (Universities, Technical Colleges, and Institutions of vocational training). There is an estimate on the electricity consumption of schools (primary and secondary schools) (Ministry of industry, research, technology and trade, Greek Centre of Productivity: Saving energy on school buildings, final report, University of Athens, Group of Building Environment, July 1992).
- *Healthcare buildings:* There is estimate on the electricity consumption of healthcare buildings -hospital and clinics - artificial lighting, healthcare equipment (M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia: Energy Performance and Energy Conservation in HealthCare Buildings in Hellas. Journal Energy Conversion and Management.
- *Hotels/Restaurants:* There is estimate on the electricity consumption of hotels - artificial lighting (M. Santamouris, C.A. Balaras, E. Daskalaki, A. Argiriou, A. Gaglia: Energy conservation and retrofitting potential in Hellenic hotels, Journal Energy and Buildings, 1995).
- *Farm houses:* No available data.
- *Factories/workshops:* No available data.

The same sources of information as given for heating consumption apply for electricity consumption.

<u>(Thermal envelope and installations)</u> Thermal insulation issues in Greece are covered by the Thermal Regulation, 1981. Only 5.1 % of the Greek dwellings have insulated external walls (a big percentage of the Greek dwellings were built before 1979 when the Thermal Insulation Regulation did not exist). Similar comments apply to the non-residential buildings.

Only 2.1 % of the Greek dwellings have double glazing. The rest of the housing stock has single glazing and its construction is dated quite old (44 % of the Greek housing stock belongs in the period 1960-1980). The non-residential building stock that was constructed before 1990 is estimated with single glazing. Only a small percentage of the building stock is assumed with double glazing.

The use of natural ventilation is the most common ventilation technique in Greek dwellings. The use of split air conditioning units is the most common ventilation technique in office buildings .The most common ventilation system for school buildings is natural ventilation combined with split air conditioning units in offices. Sometimes also ceiling fans in classrooms are being used. Local cooling - split systems is common for hotel rooms in conjunction with natural or mechanical ventilation.

Oil boilers provide heating for approximately 45 % of the dwellings in Greece. The rest of the dwellings have autonomous central heating that consumes electricity, wood products or gas. In the non-residential sector, oil burners are dominating. The boilers follow the construction period of the building and usually they are replaced every 30 years.

Approximately 30 % of the dwellings in Greece have a solar system installed (Greek Solar Industry Association). For the non-residential buildings, solar energy is used mainly in hotels and partly in healthcare buildings.150,000 m^2 of collectors are installed in hotels, including large collective systems, but there are also thermo-siphonic water heaters in studios, apartments, and smaller pensions (Greek Solar Industry Association).

The Netherlands:

The existing residential building stock and its energy performance is quite well documented in statistical figures determined in a large periodical study in which 15 000 dwellings have been inspected (Kwalitatieve Woning Registratie, most recent version: 2000). For non-residential buildings there is far less information available, sources are not always in accordance with each other and there are gaps in the information (see also the European IEE-project EPA-NR, work package 1). There is a range of studies that cover parts of the non-residential building stock, but not one study covering everything.

Sources for information:

Residential buildings:

1) Kwalitatieve Woning Registratie; Damen Consultants, PRC, EBM-consult, (KWR2000): good quality.
2) Website of Statistics Netherlands (CBS) (2005); http://statline.cbs.nl/.

Non-residential buildings:

3) Website of Statistics Netherlands (CBS) (2005); http://statline.cbs.nl/.
4) Plan van aanpak LTGO bestaande U-bouw; Bureau Blesgraaf en Deerns raadgevende ingenieurs, in opdracht van Novem en RGD (1999).
5) Lange-termijn visie energieefficiency kantoorgebouwen; DWA Installatie- en energie-advies, in opdracht van Novem (1999).
6) Energie in cijfers; http://www.energie.nl/stat/index.html (2005).
7) Energieverbruik van gebouwgebonden energiefuncties in woningen en utiliteitsge-bouwen; ECN, in opdracht van Novem (1999); http://www.ecn.nl/docs/library/report/1999/c99084.pdf.
8) Energiebesparingsmonitor gebouwde omgeving 2003; SenterNovem (2004); www.senternovem.nl/mmfiles/EBM 2003_SenterNovem2004_tcm24-110509.pdf.
9) EnergieNed; http://www.energiened.nl/.
10) Energiebesparingsmonitor gebouwde omgeving 2002; SenterNovem (2003).
11) Evaluatie van het klimaatbeleid in de gebouwde omgeving 1995 – 2002; Ecofys bv, in opdracht van VROM, Directoraat Generaal Wonen (2004); www.vrom.nl/get.asp?file=Docs/milieu/Klimaatverandering_evaluatieklimaatbeleid_bebouwdeomgeving130404.pdf
12) Energieprestatieberekening van kantoren versus werkelijk uitgevoerde voorzieningen; PRC Bouwcentrum in opdracht van SenterNovem (2004); www.senternovem.nl/mmfiles/ 138611_EPC en werkelijke voorzieningen%3Bdefinitief_tcm24-72515.pdf
13) Energie Prestatie van Utiliteitsgebouwen – Formulestructuur; EBM-consult en TNO in opdracht van SenterNovem (2004).
14) Secundaire effecten van de EPN; Ecofys bv, in opdracht van Novem (2001).
15) Strategisch kader CO2-reductie gebouwde omgeving 2001, Novem.
16) Referentieraming energie en CO2 2001 - 2010, ECN en RIVM.
17) Kwalitatieve Woning Registratie - Energie, EBM-consult.
18) Basisonderzoek Aardgas Kleinverbruikers BAK2000, EnergieNed.
19) Energie in Nederland - Energy in the Netherlands 2005, EnergieNed
20) Cijfers over Wonen 2004. VROM.
21) Basisonderzoek Elektriciteits Kleinverbruikers. BEK2000, EnergieNed.

22) Building Code.

23) E'novatie.

(Heating) In The Netherlands usually only one climate zone is used, though it is possible to use climate data from different weather stations for energy calculations. However, the construction of a building is not dependent of the location in the Netherlands (typically building construction is the same throughout the country) [6], [8], [17], [18] & [19].

(Domestic hot water) Only overall figures for water consumption and heating of domestic hot water are available [2] & [3].

(Electricity) For residential buildings divided for categories like cleaning, cooling, lighting, space heating and DHW, audio/video/communication, cooking, kitchen equipment, etc [21].

(Thermal envelope and installations) U-values may be estimated based upon building regulations valid in the period of construction of a building. However, large deviations will be possible because of refurbishment and renovation. Presence of insulation of walls, roof and floor, as well as presence of double glazing divided for construction period of the building and type of ownership can be compiled [20].

Key figures for the air-tightness of residential buildings are available (dependent on presence of flat roof or sloping roof), as a result of a study in a number of dwellings [23].

Presence of type heating system and use of renewable energy sources, divided for single/multi-family buildings, construction period and type of ownership [20].

United Kingdom:

Building stock data for the UK is complicated by some statistics being for England and Wales only and others including also Scotland and Northern Ireland. Building categorisations (sectors and sub-sectors) can also vary, especially for the non-residential stock, making reconciliations more difficult.

A variety of sources are available supplementing two 'official' publications:

1) Domestic energy fact file by L D Shorrock & G A Walters, 1998. This publication gathers together some of the more important trends related to domestic energy and the measures that have been taken to improve energy efficiency. This edition covers the period between 1970 and 1996.
2) Non-domestic buildings energy fact file by C Pout, S Moss & P J Davidson, 1998. This document gathers together key statistics relating to structure and energy use of the UK's non-domestic buildings. It includes historical information on the way energy is used and how this relates to carbon dioxide emissions; the occurrence of building services; and the structure of the stock.

Data for total residential electricity consumption can be estimated.

(Thermal envelope) There are no known national data for non-residential buildings. Assumption is that U value will often equal minimum Building regulation requirement at time of construction.

(Ventilation) There are no known national data available for residential buildings regarding ventilation. A small sample of data for non-residential (a few hundred buildings) based on pressure testing of new buildings in last 10 years exist. Statistical information on ventilation rates exist for buildings constructed since 1990.

(Other installations) statistical information about other building installations could be made available after extensive research.

3.2 National statistics – ENPER-EXIST WP3 Questionnaire

After scanning of potential positive answers to questions related to energy issues in the existing building stock, it was decided to conduct a detailed survey within the partner countries of the project.

In general the most detailed information was available for residential buildings. The non-residential building sector is dominated by a large diversity of construction techniques as many of these buildings are considered as messengers for the company or serves a special purpose with respect to different in house activities.

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 seems to vary. 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 in the answers. This kind of information was not available in some countries.

Secondly the energy consumption per heated floor area in the different categories was asked, and these figures were somehow easier to obtain – at least as qualified assumptions. The energy consumption per heated floor area varies from country to country, but not as much as one would expect according to the variations in outdoor climate over the MS. In all cases the energy consumption for production of domestic hot water is part of the energy consumption for space heating.

In the non-residential building sector there is a large diversity in energy consumption per heated floor area, but in this sector it is more closely connected with the outdoor climate. 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 generally no cooling installed, even though cooling systems do exist in many non-residential buildings.

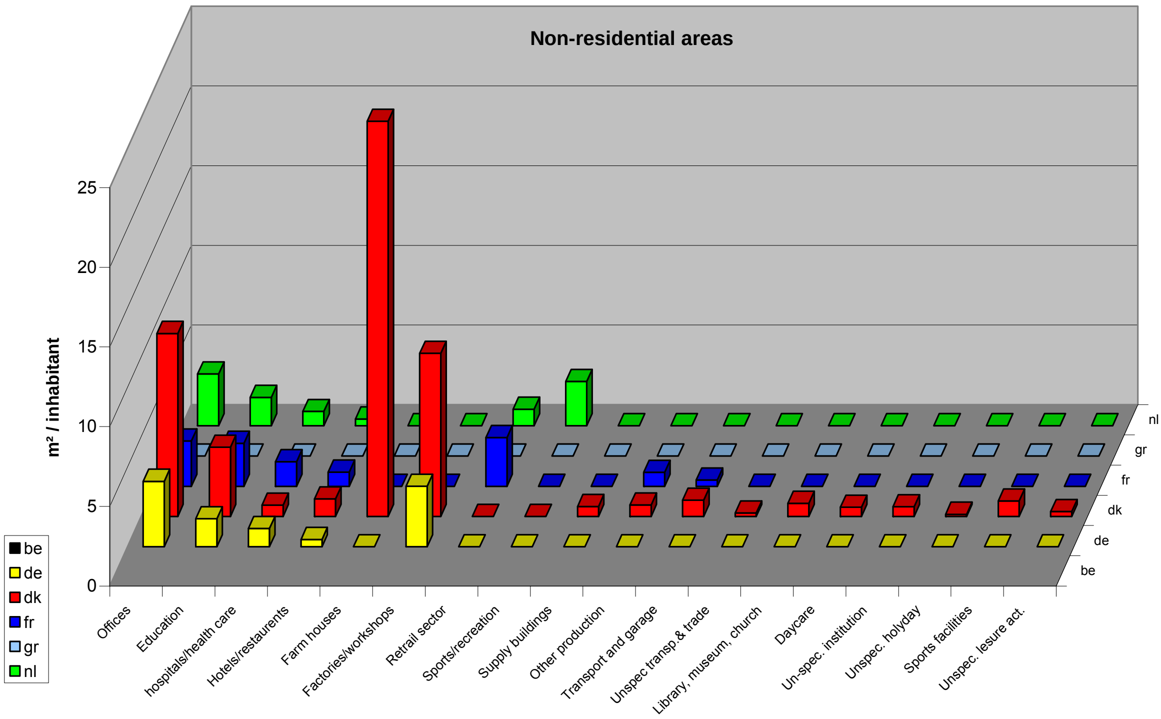


Figure 1. Non residential areas per person in the ENPER-EXIST countries.

The energy consumption shown in next figures are delivered energy in the buildings.

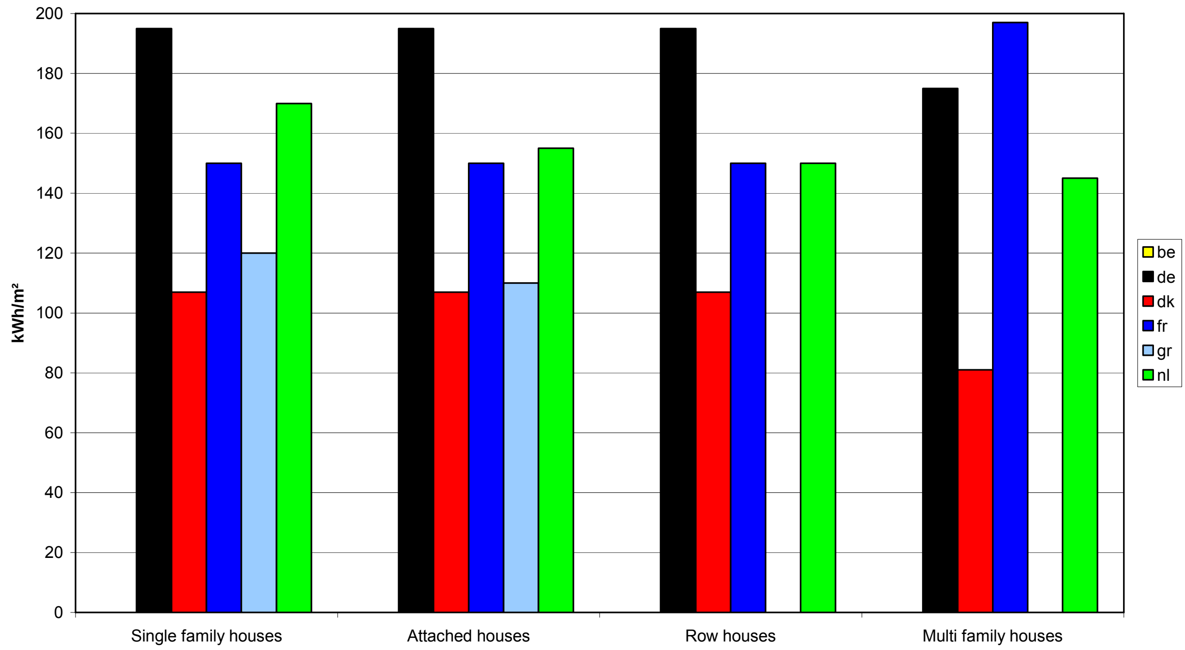


Figure 2. Energy consumption for space heating per heated floor area in residential buildings of the ENPER-EXIST countries. In some cases, especially where heating and domestic hot water (DHW) is delivered from a central boiler, heating energy also covers energy for DHW.

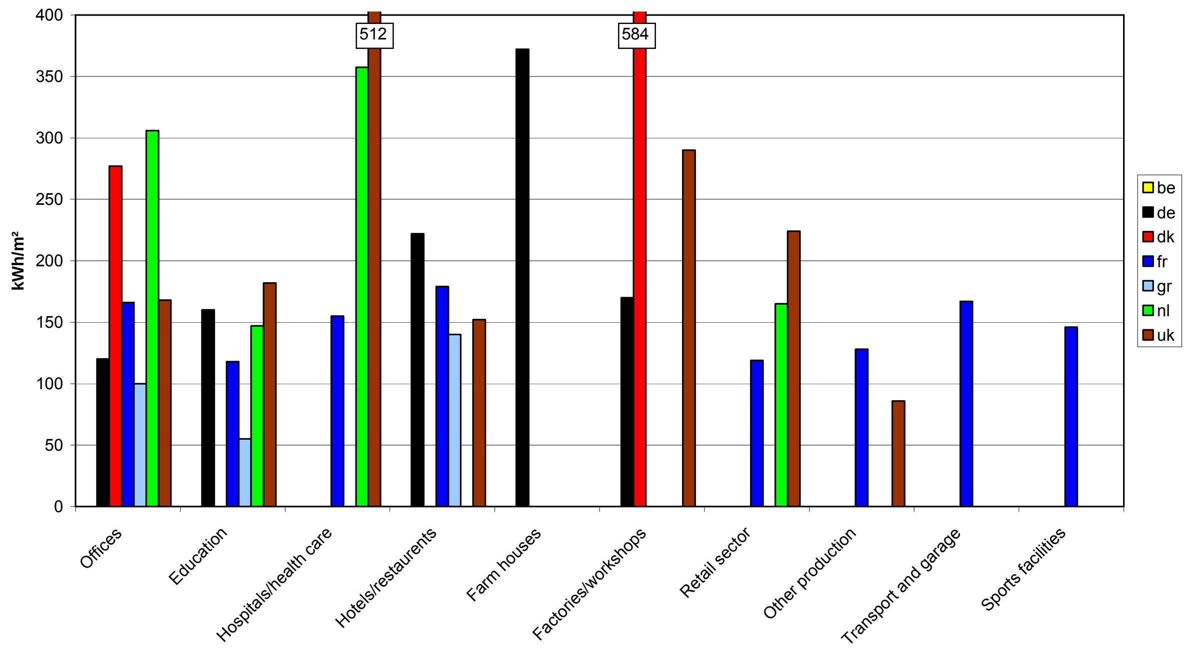


Figure 3. Energy consumption for space heating per heated floor area in non-residential buildings in ENPER-EXIST countries.

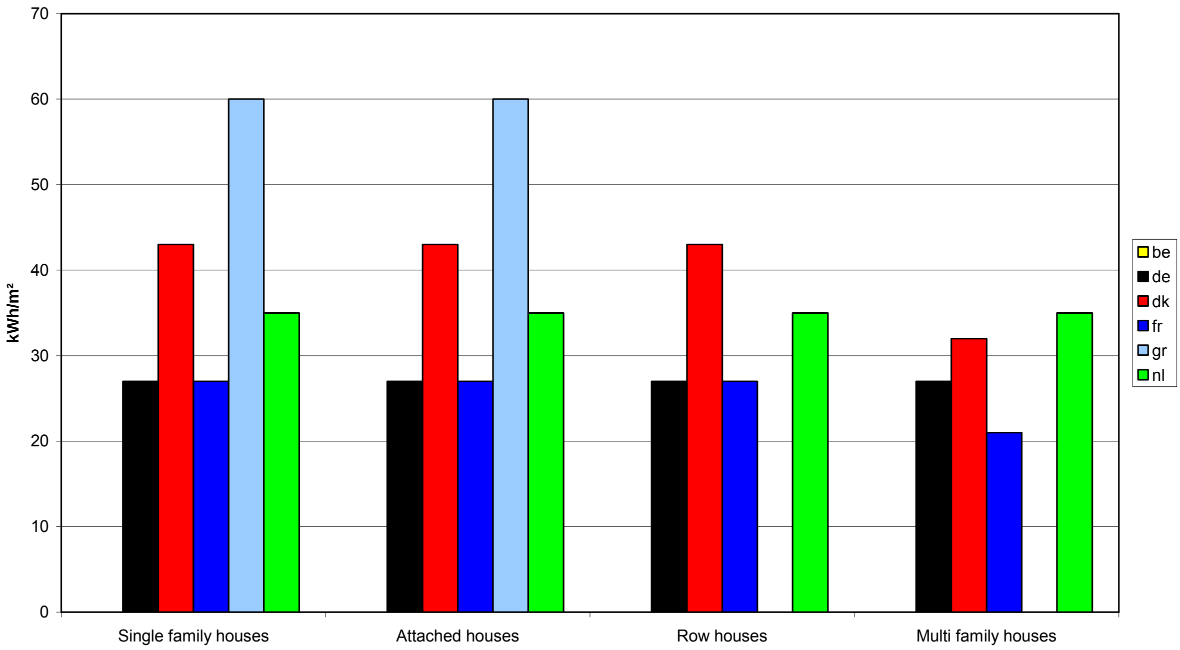


Figure 4. Electricity consumption per floor area in the residential sector.

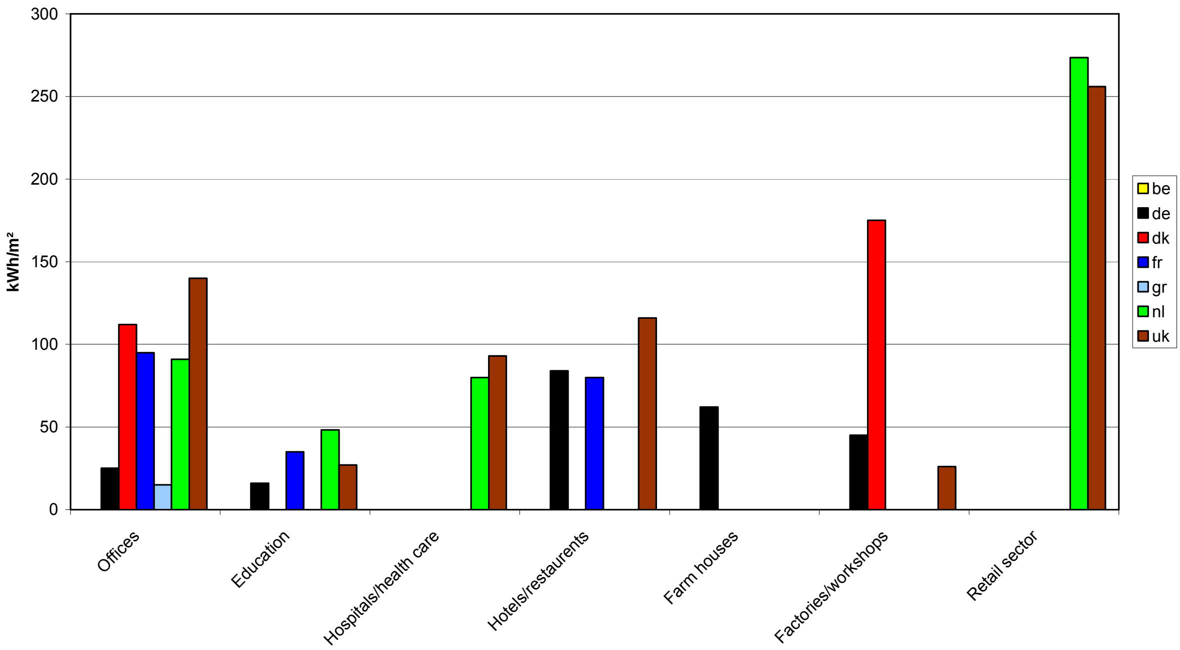


Figure 5. Electricity consumption in the non-residential building sector per floor area.

Based on the national knowledge about the existing buildings and their energy consumption, an estimate was requested relating to the potential energy savings in the building sector. The quality, the consistency and the validity of the data made it difficult to do real calculations of the energy saving potential, so most of figures are based on limited local investigations. Only Denmark and The Netherlands could give an estimate of the potential energy savings, and only in some building sectors.

Based on knowledge from the old energy certification schemes, SBi has previously conducted a survey of the energy saving potential in the residential sector. This survey is summarised in Section 6.3. The potential energy savings for space heating in this sector of the Danish building sector is about 30 PJ per year (0.55 PJ per 1000 inhabitants), or 28 % of the energy consumption for space heating in this sector.

In The Netherlands a local survey *Energy savings in the existing building stock* (EBM-Consult 2006) was conducted with special focus on the different owner situation in the housing sector. The building stock was thus divided into three categories: dwellings for social rent, dwellings for other rent and owner-occupied dwellings. In these categories there was an estimated energy saving potential of 2933 / 726 / 3768 PJ or 0.46 PJ per 1000 inhabitants. The same survey also analysed the energy saving potential in the non-residential building sector with the findings shown in the table below.

Table 2. Potential energy savings in the non-residential building sector in The Netherlands.

Sub-sectors	Heating savings potential PJ	Electricity savings potential PJ	Total energy savings potential PJ
Offices	782.6	764.2	1546.8
Education	430.0	45.4	475.4
Hospitals/health care	227.1	80.3	307.4
Hotels/restaurants	70.0	7.9	77.9
Retail sector	146.3	109.2	255.5
Sports/recreation/culture	252.5	92.0	344.5
Total non-residential	**1908.5**	**1099.1**	**3007.6**

3.2.1 Data that energy requirements in building regulations are based on

Decision makers have been contacted in the MS participating in the ENPER-EXIST project to find answers to two critical questions related to local implementation of the EPBD. The questions were: 1) Which data are decisions based on regarding energy requirements in building regulations? 2) How and where are these data found?

Belgium:

While the Flemish Region has already implemented the EP philosophy in the energy regulations on buildings, the Brussels Region still is in the studying phase.

The Walloon Region, which still did not implement the EP philosophy, did not answer on the questions.

Generally spoken, the data on which decisions are based regarding energy requirements in building regulations are obtained by specific studies carried out by research institutes on behalf of the administration or government. The partners in these studies are mostly the BBRI, the universities and engineering consultants.

The Brussels region described the requirements of the data they were looking for:

1. Technical feasibility,
2. Economic rationality,
3. Tangible environmental benefits,
4. Acceptability by the professionals.

This means they need technical, economical and environmental data on the various ways to reduce energy consumption. Such data are collected as a part of studies actually being made in order to help to determine the energy requirements in Brussels.

Not only the data are needed, but also tools to make a kind of cost/benefit analysis of the different energy saving measures and their combinations.

Such studies are actually being made in order to help to determine the energy requirements in the Brussels Region. On the other hand there are studies and numbers available from research institutes, or national/regional think-tanks (cf. Planbureau, …)

The Flemish Region added as sources the study of countries which had already implemented the EP directive and discussion sessions with the building partners and sector's representatives.

The major sources of data are:

1. Data provided by research institutes who carry out studies on behalf of the administration
2. Data provided by other administrations or form the nation enquiry of 2003. These data consider the amount of dwellings, the insulation level of dwellings, etc.
3. By studying the impact of the EP regulation in countries which did already imply the methodology in their energy regulations for buildings.

Denmark:

There are requirements when a building is renovated in a major way. The definition of a major renovation is taken from the EPBD (25 % of the value of the building or more than 25 % of the thermal envelope). Furthermore it is required that some individual, profitable measures have to fulfil the requirements, regardless the size of the renovation.

Individual measures are:

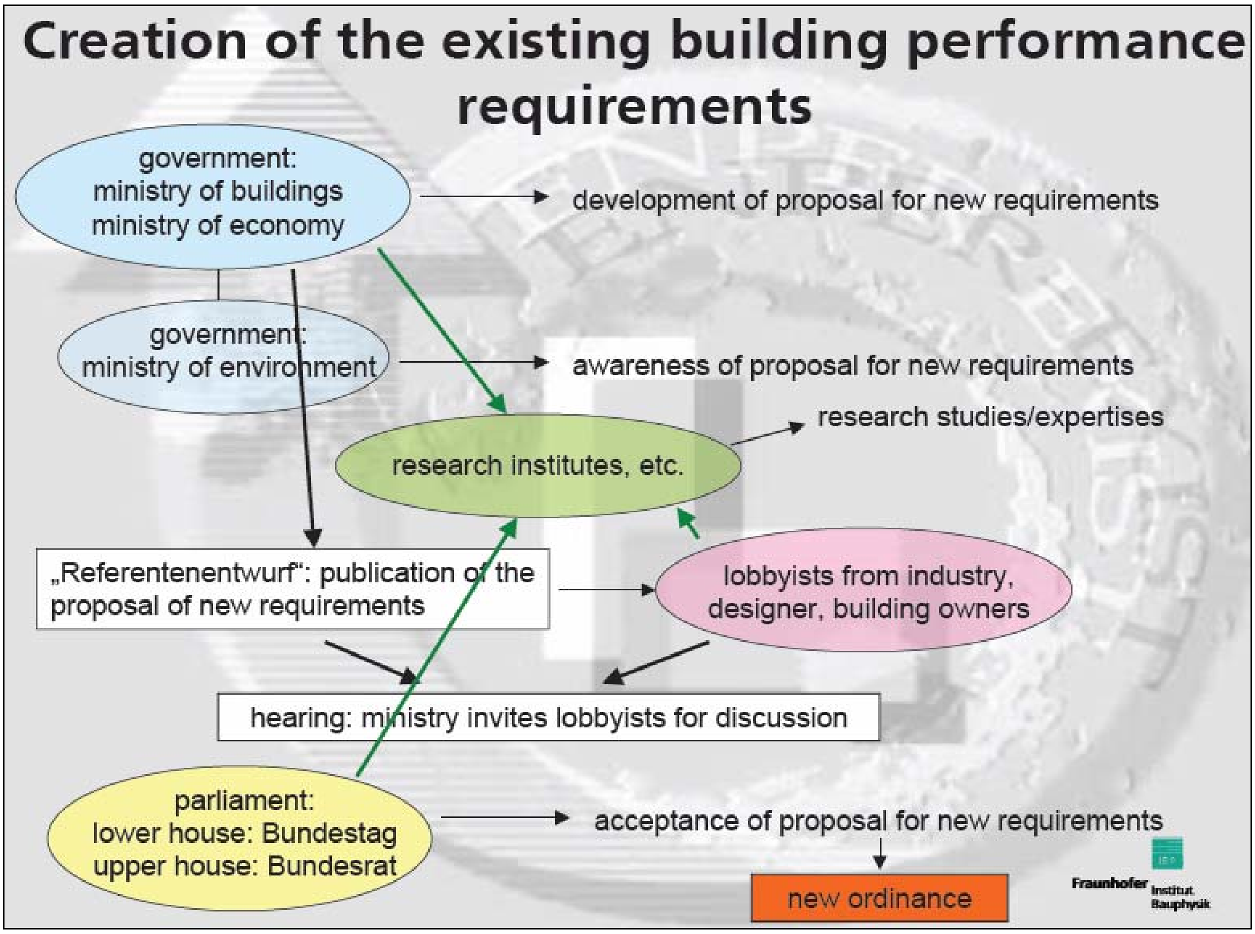
- Insulation of external walls when changing rain shield,
- Insulation of attic and roof when changing roof,
- Change of boilers,
- Change of heat supply,
- Requirement in case of changing windows in a facade.

If people can't find out implementing cost-effective energy saving measures by themselves, the new energy requirements in the Building regulations will "help" them. There is no "Building permit" needed and no public control.

If a building is erected legally, then it is regarded legally always. DK will probably not get any energy frame requirements for existing buildings, so it is up to the building owner to decide (despite the existing rules for components and major renovation).

BBR: The Danish Building Register showing the composition of Danish residential buildings to be able to evaluate the potential energy savings by refurbishment. Danish Building Regulation has since 1966 contains energy requirements.

Germany:



Greece:

The new legislation is not yet ready but it is mainly based on the surveys of NKUA regarding the energy consumption of the various building sectors in Greece. We have the benchmarks for typical, best practice and passive buildings for most of the building types in Greece. In parallel, there are a lot of studies on the energy conservation potential of various techniques for most of the buildings. However, it is very risky to estimate the technical potential for energy conservation as it is very different than the economic potential.

In a separate file I have attached the technical and economic potential of energy conservation, in CO2 terms for the whole energy sector, in Greece. I hope is useful.

Most of the surveys have been carried out by NKUA. Studies on the energy conservation have been carried out by NKUA, and CRES.

The Netherlands:

The Netherlands has no energy requirements in building regulations for existing buildings. Only in case of major renovation there are requirements (on component level) and they are the same as for new buildings. That means that major renovations are regarded as new buildings.

If such energy requirements were to be developed then data would be needed from monitoring and field studies, e.g. with respect to the effects of energy saving measures (including side-effects for e.g. health). To some level data are available but more would be needed and in more detail.

In The Netherlands it is also very important to reckon with the interests of the market (professionals like architects, builders and installers) and the public (represented by the Parliament). In the Netherlands it is the case that the government is dedicated to saving energy (e.g. because of international treaties like the Kyoto protocol), whereas the Parliament wants to make regulations simpler. This is in contradiction, because to increase energy savings in general more complex regulations are necessary. Also the market in general is not in favour of more regulations. This mechanism especially plays a role for the tightening of requirements for new buildings.

3.2.2 Data that decision-makers miss when making new energy requirements

Another crucial question related to local implementation of the EPBD was: Which data do decision-makers miss when making new energy requirements?

The answers to this question can be used as guidance for which data should be collected in the new European certification schemes.

Belgium:

Both regions mention that tools and models in order to make a cost-benefit analysis and to calculate pay-back times are lacking in order to make more funded decisions as far as energy requirements are concerned.

The Flemish region also found that data about the existing building stock and about the energy use in different building types are lacking.

The Brussels administration mentions that it stays difficult to convince the real decision-makers that imposing energy requirements by regulation may be beneficiary for the population in what they call ‘the real world’. Therefore it is necessary to have some real case studies of successful buildings showing:

1. What measures have been taken?
2. What has been the cost?
3. What are the real returns (as measured) : environmental benefits AND reduction of the actual energy costs, compared to a baseline scenario. Other side benefits should be documented too: comfort, …

These studies should also allow concluding that the energy saving measures which have been taken is financially worthwhile (relatively short return of the investment time).

FLANDERS REGION

De MINA-council (*milieu en natuurraad van Vlaanderen*) is able to produce studies; advices and recommendations on demand of the Flemish government or parliament, or on it’s own initiative. In some cases the Flemish government is obliged to ask MinNa’s advice : for proposals of law (decree) concerning the environment or nature, the environmental policy and financial policy linked to it, about environmental quality codes and ‘uitvoeringsbesluiten’ concerning energy and mobility, …

These studies can be done by the MiNa-council itself or can be done on behalf of MiNa by other partners: universities or research institutes as VITO.

Next to the study component the council also links the environmental partners with the social partners, which makes that if they advice by unanimity that the government knows that the solution or proposal is widely supported by all elements of the society.

WALLOON REGION

Conseil Wallon de l'environnement pour le Devéloppement Durable (www.cwedd.be) is a consultative council which advices the public authorities in the Walloon region concerning environmental and durable development questions. The CWEDD is a representation of all social groups. It is the equivalent of the MiNa-raad in the Flanders region.

BRUSSELS CAPITAL REGION

The RLBHG (Raad voor het Leefmilieu van het Brussels Hoofdstedelijk Gewest) or CERBC (*Conceil de l'Environnement de la Région Bruxelles-Capitale*) has a similar function for the Brussels Capital Region.

Denmark:

Existing building stock: As DK probably will only have component energy requirements in the building regulations, there are no specific wishes to that part. Anyhow an important issue is the energy saving campaigns where it is necessary to know the energy saving potential (e.g. how many buildings have wall insulation and with which insulation material). Also when giving subsidies, it is crucial to have a more detailed statistical knowledge of the existing building stock concerning construction and installation. Furthermore it is important for the market (e.g. developers) to know the existing situation when they shall make new development and decide renewal of the market

Germany:

If they miss something it might be more detailed statistical data on building stock and energy consumption. See explanations earlier.

Greece:

I do not think they miss any data. They have just to understand the existing situation and react !!!

The Netherlands:

- Insight in costs of more stringent energy requirements.
- Side-effects (e.g. air quality, moisture problems etc),
- Accuracy of methods and tools.

4 Extract of selected building stock knowledge

Knowledge about the existing building stock is available at both a national and European level. The most detailed knowledge is of course compiled in the national statistics. For a general view however, European Statistics can contribute with knowledge. Additionally knowledge is found in separate databases in connection with specific EU projects, work packages or other sources. From an energy saving point of view, it is limited, what existing data and statistics can do. Hence, only statistics and databases built on certification schemes already in force really contribute to the building stock knowledge

Concerning European Statistics both Eurostat and The European Environment Agency are in possession of statistics regarding buildings. Concerning national statistics, each of the ENPER-EXIST participants has been requested to fill in a questionnaire. The results of this questionnaire will provide a sample of the ability of these statistics.

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 energy consumption annually. If more knowledge of building statistics and databases is available, such as energy certification, energy labels, list of energy measures performed or recommended, this indeed gives added weight to the actual building statistics and databases in question.

4.1 Eurostat

The European statistic service Eurostat cannot give exact data on energy consumption in buildings. Eurostat can only provide data that indicate the level of consumption in households and services. Concerning households only, the energy statistics can provide figures of the total quantity of energy for consumption in each of the member countries annually. At the same time Eurostat can provide figures of the total number of households. If put together, an indicator for the energy efficiency of the European buildings distributed on countries is found. (See Figure 6). Of course, several reservations could be made. One is that the buildings in the member states are equipped differently with electric appliances and white goods. Another is that the daily life displayed in and around the buildings follows quite different patterns.

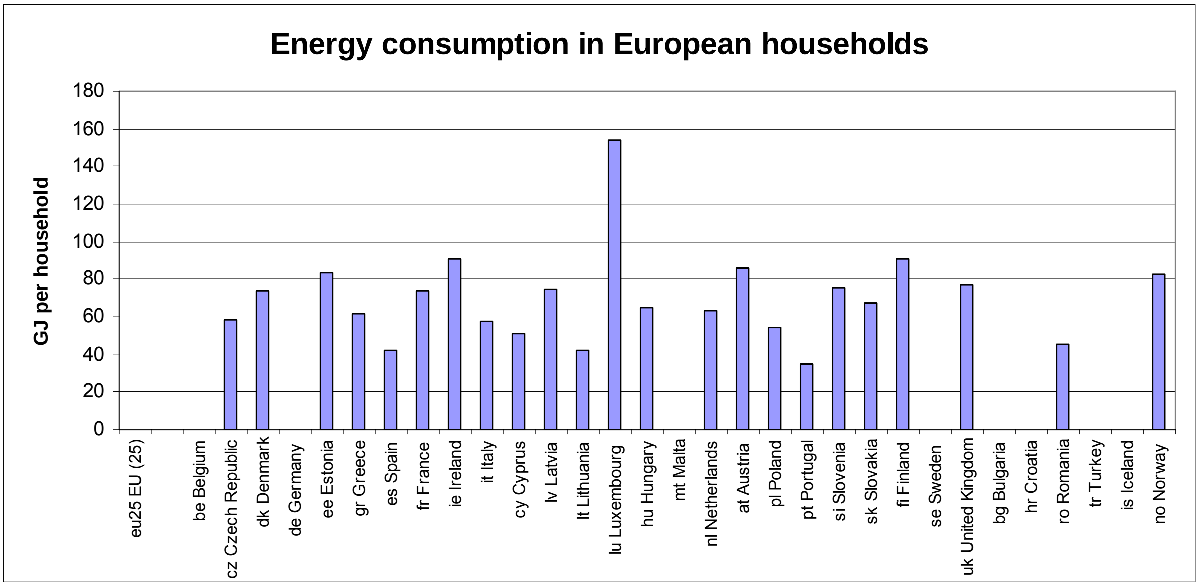


Figure 6. Energy consumption in European Households, a rough indicator for the energy efficiency of the buildings in the European countries. (Source: Eurostat, Energy consumption in households and number of households combined).

4.2 Directorate-General for Energy and Transport

Directorate-General for Energy and Transport of the European Commission (DG TREN) provides statistics and reports on energy consumption. Their annual Pocket Book "Energy and Transport in Figures" (DG TREN, 2005) contains figures on energy demands of households and like Eurostat it gives a hint about the energy efficiency of buildings. The country statistics contain figures about CO_2 emissions, energy and CO_2 intensity, and energy and CO_2 per capita as well. Having in mind the part of energy demand for buildings solely, these figures - although indirectly - contribute to the knowledge about the building stock across countries.

The Directorate-General pays specific attention to energy efficiency in buildings. At the website `http://ec.europa.eu/energy/demand/legislation/buildings_en.htm` information is given on Directives, initiatives/projects, standards, events and contacts. Thus, the Directive (2002/91/EC of the European Parliament and that of the Council of 16 December 2002) on the energy performance of buildings is found in all the language versions of all the member states.

Three initiatives and projects are mentioned. The first is the EPBD Buildings Platform, which is an information service to assist in the implementation of the Buildings' Directive. The second is the EUROPROSPER initiative aiming to harmonise methodologies for energy audits and certification of existing office buildings across the seven EUROPROSPER member states. The third is the ENPER-TEBUC, which deals with the issue of harmonisation of European Building Codes.

Finally the work on standards is mentioned, i.e. the European Committee for Standardisation (CEN) work. A Document to be found here explains the general relationship between various CEN standards and the Directive. Another document lists all European standards relevant for building.

4.3 The European Environment Agency

The European Environment Agency (EEA) does not compile data on energy consumption that focuses on buildings. Still EEA is concerned with energy consumption and CO_2 emissions in member states. A special focus deals with the member states' progression in order to meet the Kyoto Protocol targets. Therefore both diagram's giving the energy consumption and emissions of greenhouse gasses per capita across all member states is found in the latest State and outlook 2005 also called The European Environment (EEA, 2005). Concerning that a rather big amount of energy consumption and CO_2 emission generate from building activities, diagrams like these indicates the level of building consumption in member states.

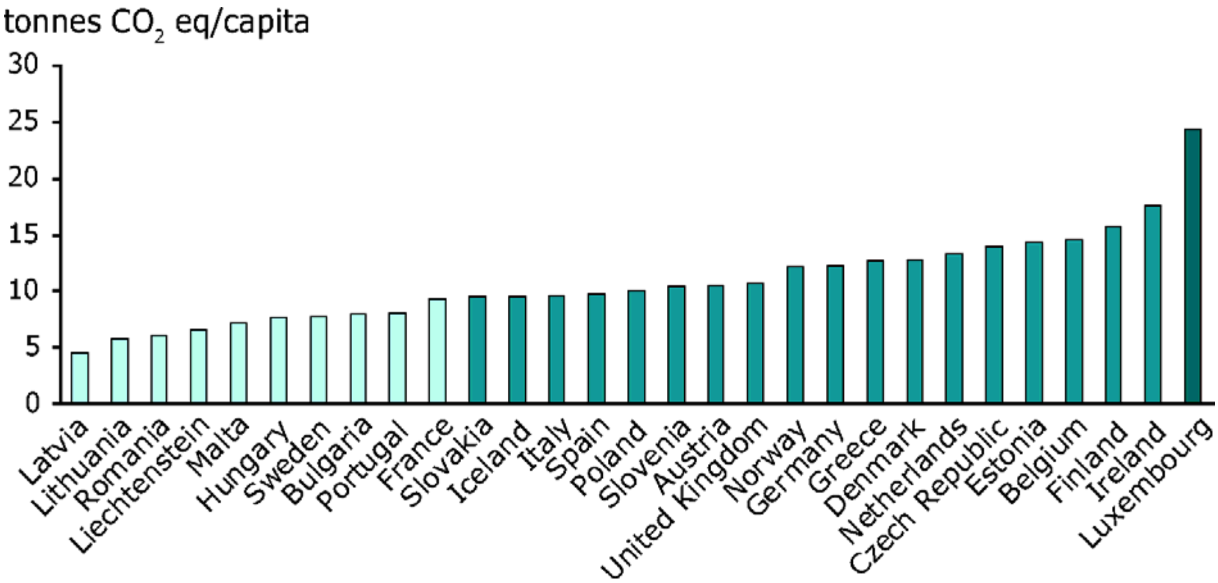


Figure 7. Emission of greenhouse gasses in the form of CO_2 per capita (source: European Environmental Agency,2005).

4.4 International sources

4.4.1 EuroAce

The goal for European Alliance of Companies for Energy Efficiency in Buildings (EuroACE) is to help the European Union to meet its Kyoto Commitments with special focus on buildings. To EuroACE building energy efficiency measures are the most cost-effective of the available technologies. They can result in cost savings per tonne of carbon dioxide saved and will increase the viability of emerging renewable energy generation technologies.

In the report: Towards Energy Efficient Buildings in Europe, (Janssen, 2005) much knowledge about the building stock is found. It is acknowledged that energy efficiency in buildings has been promoted in the European Union with the adoption of the Directive on Energy Performance of Buildings in 2002. In spite of this, it is maintained that much of the cost-effective potential will not be achieved, because of various market barriers. The extent of this non-realised energy saving potential is illustrated by a diagram showing the difference between existing consumption and consumption if Danish regulation was applied. See Figure 8.

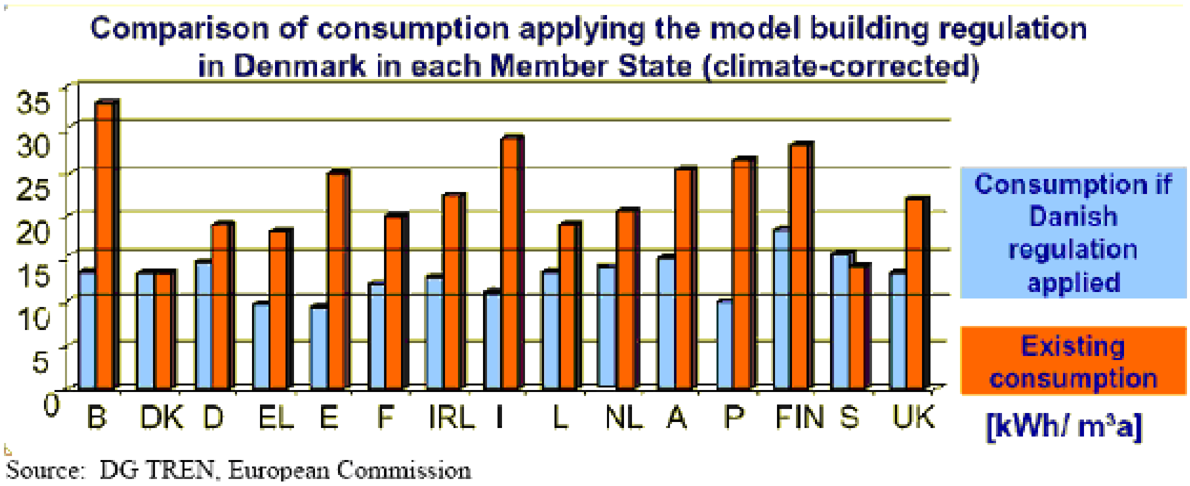


Figure 8. An example of building stock knowledge in EU member states based on work of EuroACE. (Source: Janssen, 2005, p16).

4.4.2 National Allocation Plans

National Allocation Plans (NAP) might be a possible source for building stock knowledge. These allocation plans are concerned with the national plan for the allocation of greenhouse gas emission in accordance with Directive 2003/87/EC of the European Parliament and of the Council.

The plans are usually divided into sectors primarily combustion and industry. This does not allow finding out what emission was caused for the heating, cooling, ventilation and lighting of buildings, whereas NAPs only deals with total energy production. There is no way to extract the CO_2 emissions caused by buildings. Additionally it is impossible to assess the energy consumption from the CO_2 emissions. Consequently, the NAPs are of no use for the objective of ENPER-EXIST WP3 until now.

4.4.3 EPA-ED

Energy Performance Assessment of Existing Dwellings was an Altener Project performed from September 2001 to September 2004. The objective of the project was to develop a method and tools to assess the energy performance of existing dwellings (related to the EPBD).

Of special relevance for WP3 - even though the project only collected data from the participating countries, namely Austria, Denmark, Greece and The Netherlands - was:

– Characteristics of the housing stock (number of dwellings divided in various categories).
– Most common construction typologies.
– Penetration level of thermal insulation.
– Energy saving measures.
– HVAC system typologies (space heating / domestic hot water / ventilation / cooling).
– Typical energy balance in existing dwellings.

The paragraphs below present a summary of some of the results from the project. The complete report (Balaras et al., 2003) can be found at the project web site at: www.epa-ed.org.

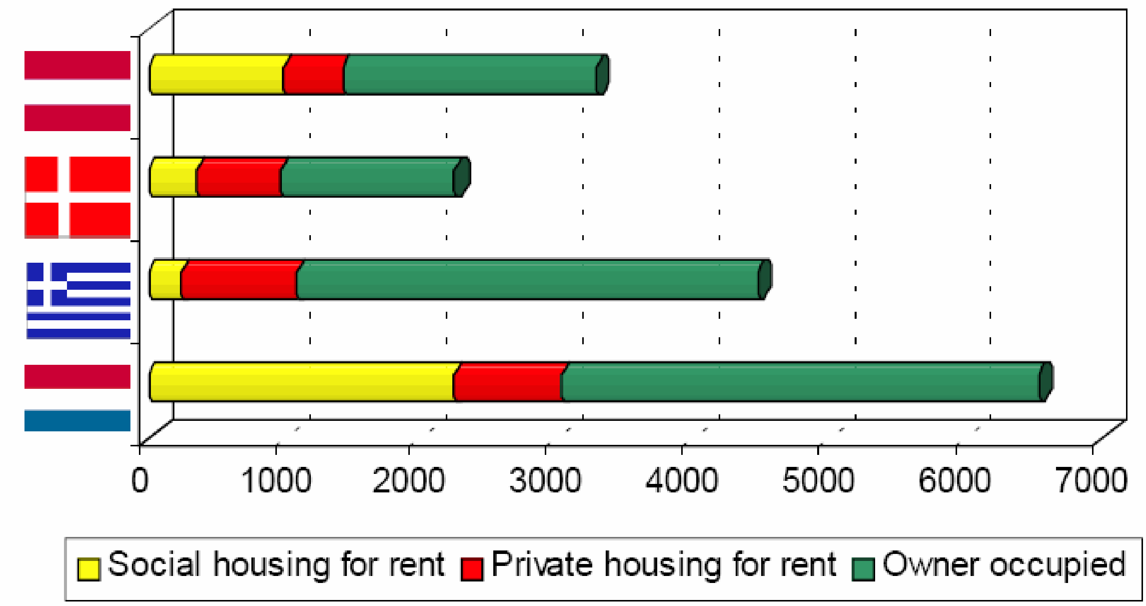


Figure 9. The building stock is dominated by privately owned dwellings. The highest percentage is encountered in Hellenic buildings (76 %). Social housing is significant in The Netherlands (34 %) and Austria (30 %).

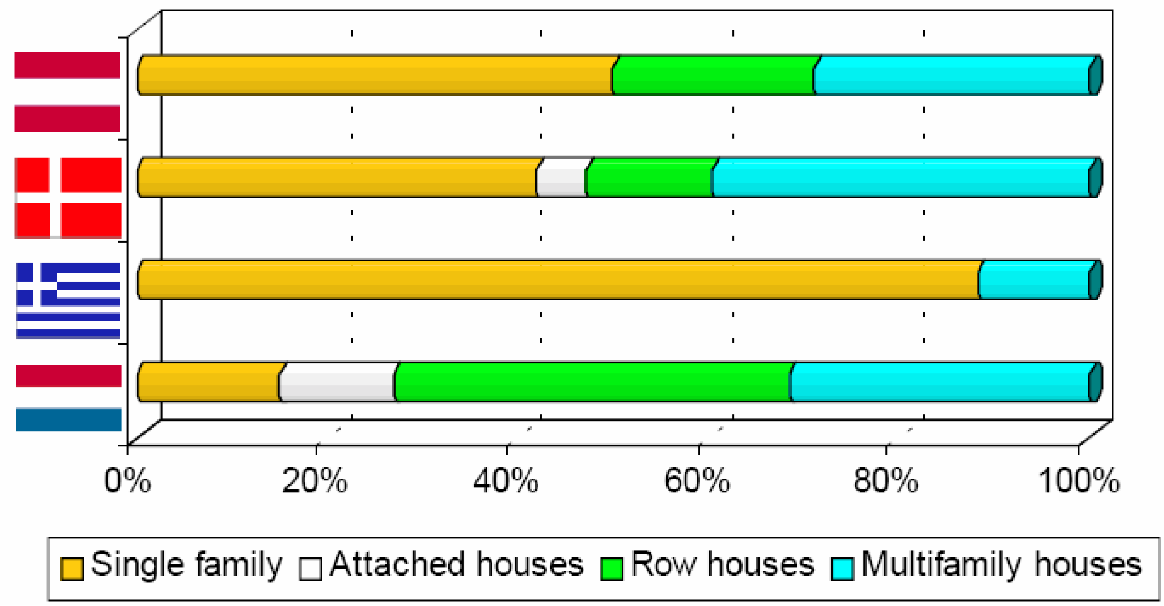


Figure 10. The building stock is dominated by single family dwellings and apartments. Row house typologies are dominant in The Netherlands.

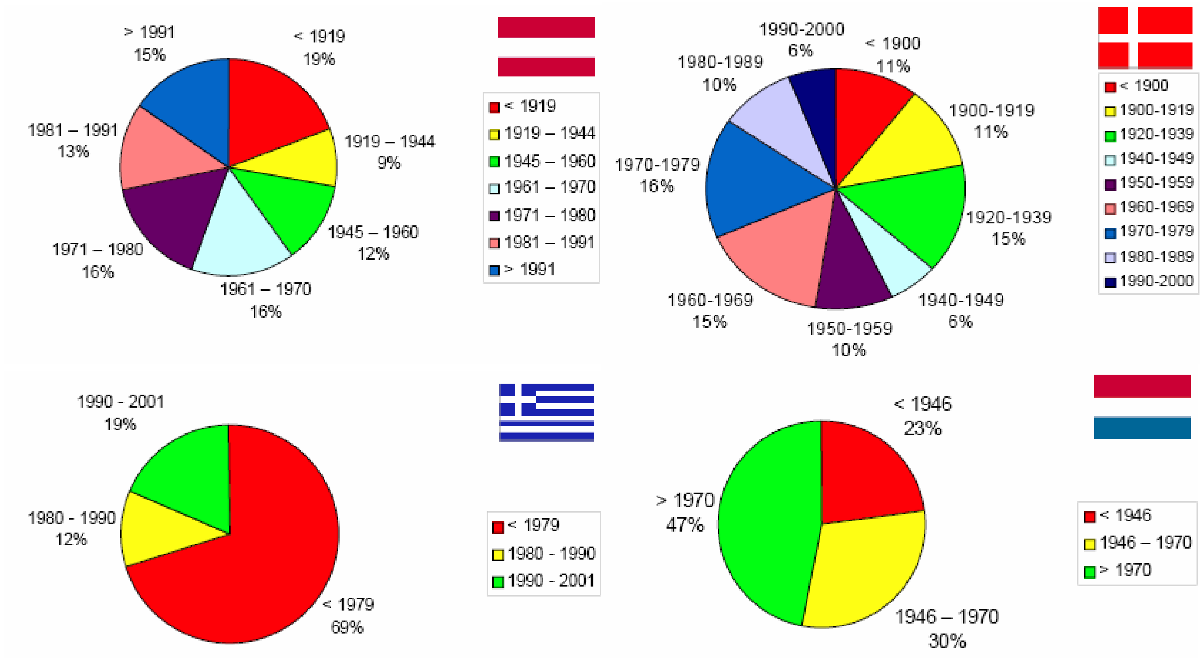


Figure 11. The construction period breakdown is rather uniform in Austria over the last few decades. In Denmark, there has been a noticeable slow-down of new construction in the last couple of decades. The great majority of the Hellenic building stock was constructed before 1980, meaning that buildings are without thermal envelope insulation and with ageing installations. About half of the building stock in The Netherlands is less than 30 years old.

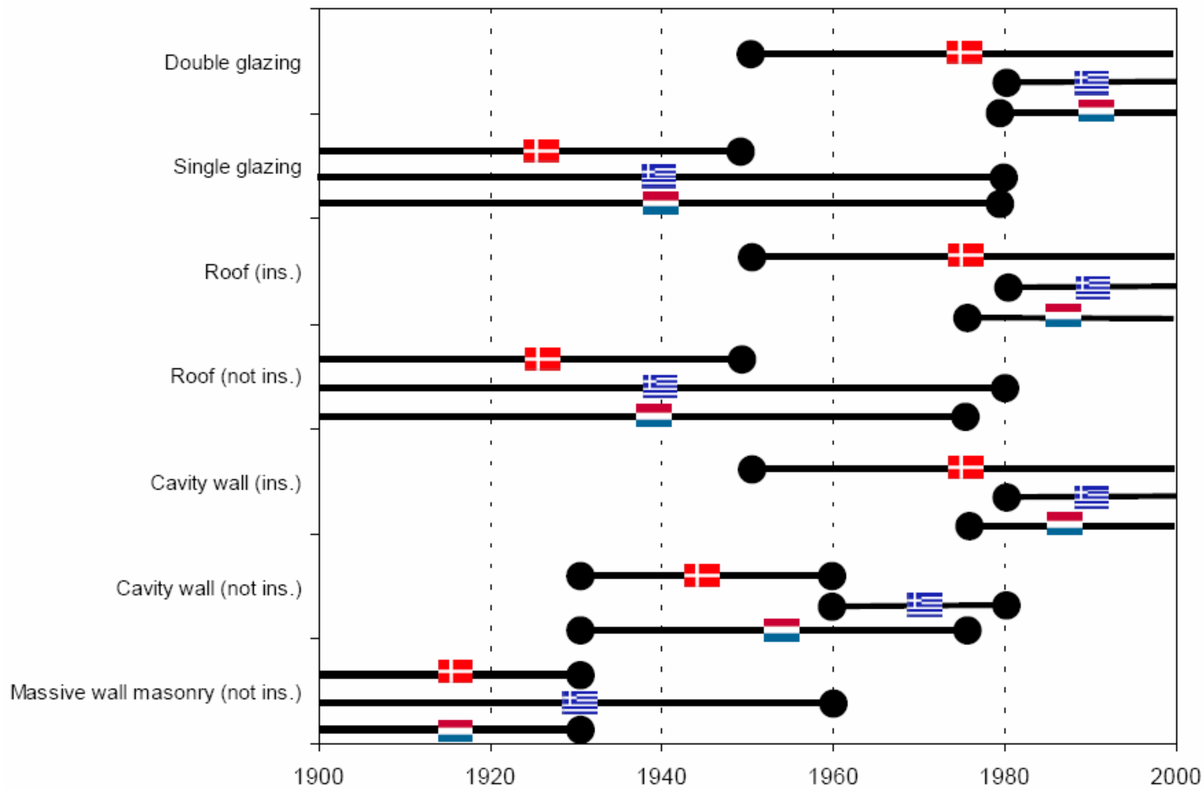


Figure 12. The most common construction typologies in single family houses follow different trends and in most cases independently of the introduction of the national thermal insulation regulations.

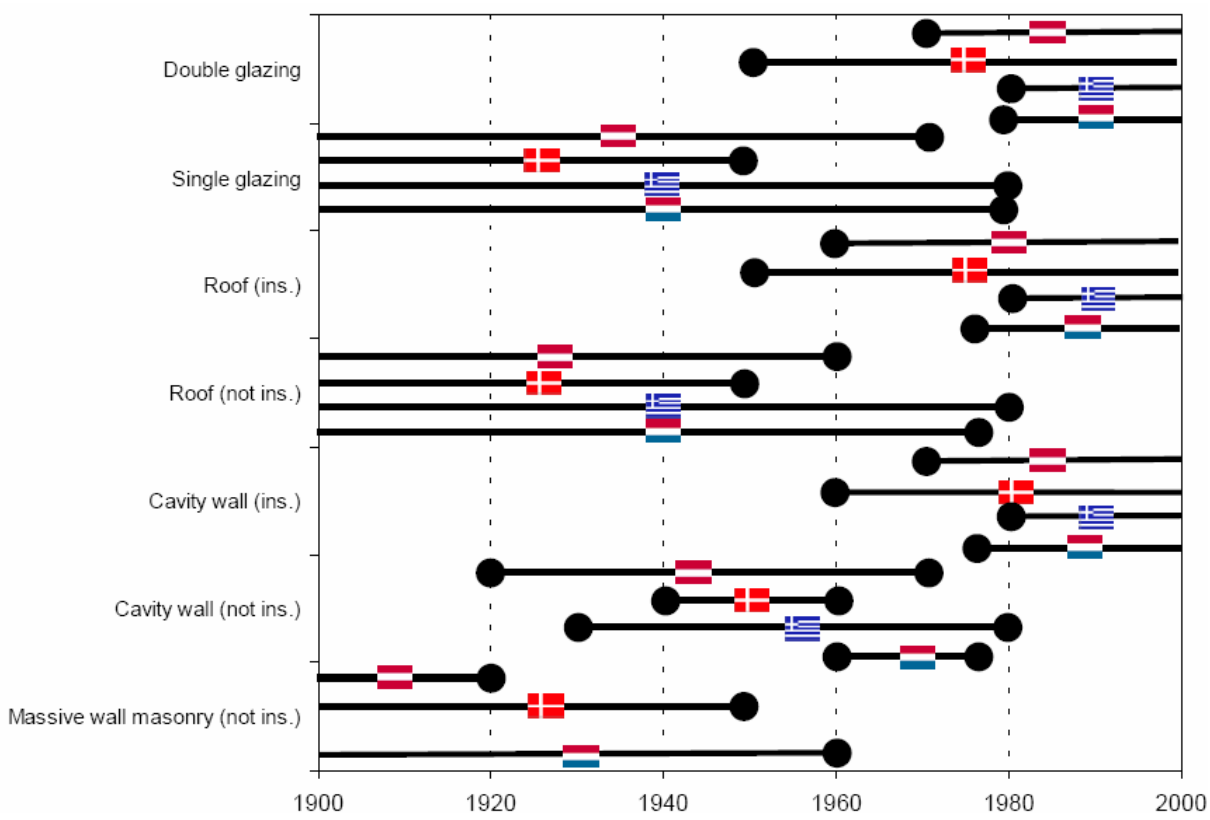


Figure 13. The most common construction types in multifamily houses are generally closer connected to changes in national building regulations than found in single family houses.

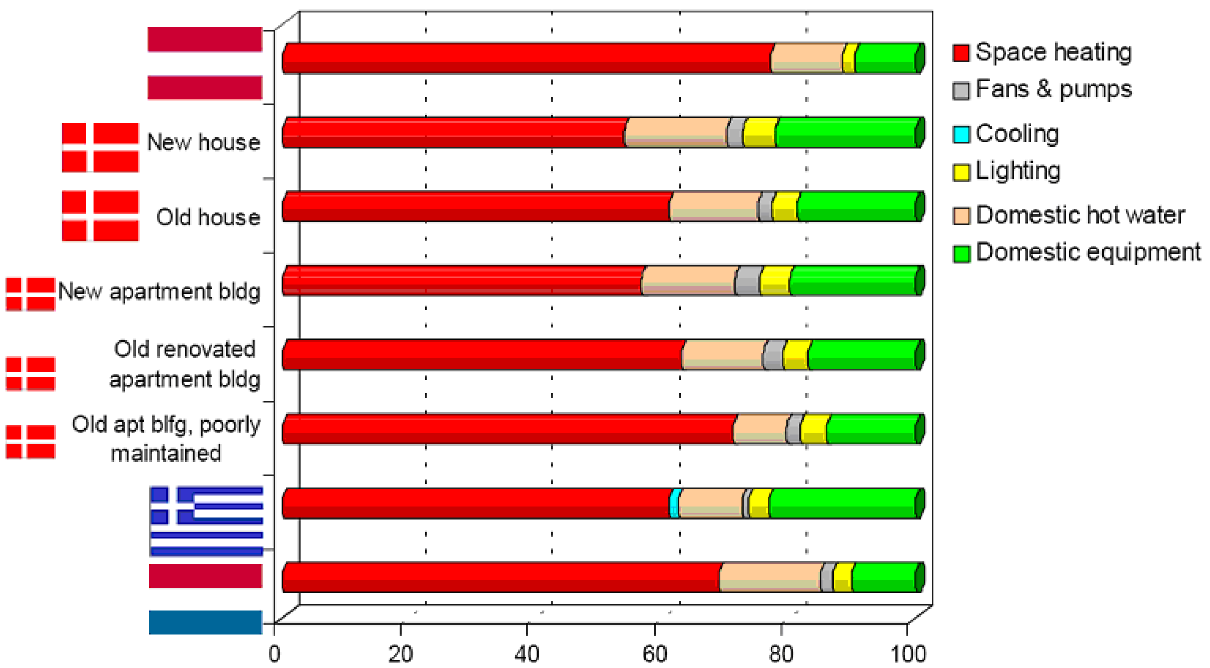


Figure 14. Typical breakdown of energy consumption in dwellings.

4.4.4 EPA-NR

Energy Performance Assessment of Existing Non-Residential Buildings. EIE Project, January 2005 - January 2007.

The objective of the project is to develop a method and tools to assess the energy performance of existing non-residential buildings (related to the EPBD). The project is a follow up project to EPA-ED.

Relevant for EnperExist-WP3:

- Overview of non-residential building sector:
  - o Buildings stock
  - o Typical constructions
  - o Typical HVAC and Electromechanical installations
- Buildings' annual energy and water consumption
- Breakdown of energy consumption in non-residential buildings sector
- Breakdown of energy consumption in different buildings

Note: in many cases information was lacking so not all topics could be answered for all countries. Not only information was lacking, but sources also appeared to be contradictory.

The report (including 25 appendices) can be downloaded from the website: www.epa-nr.org.

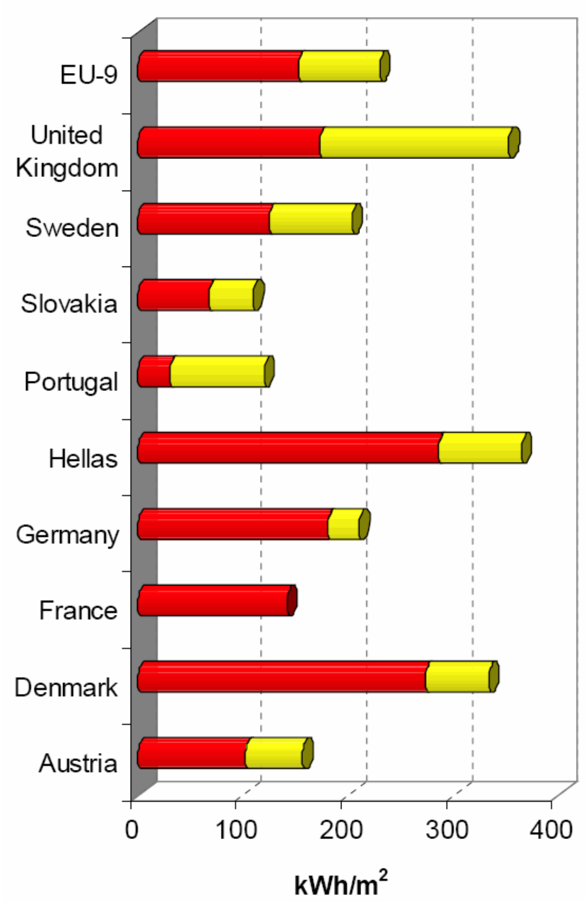


Figure 15. Total annual thermal and electrical energy consumption per unit floor area (kWh/m^2) for office buildings, where data is available.

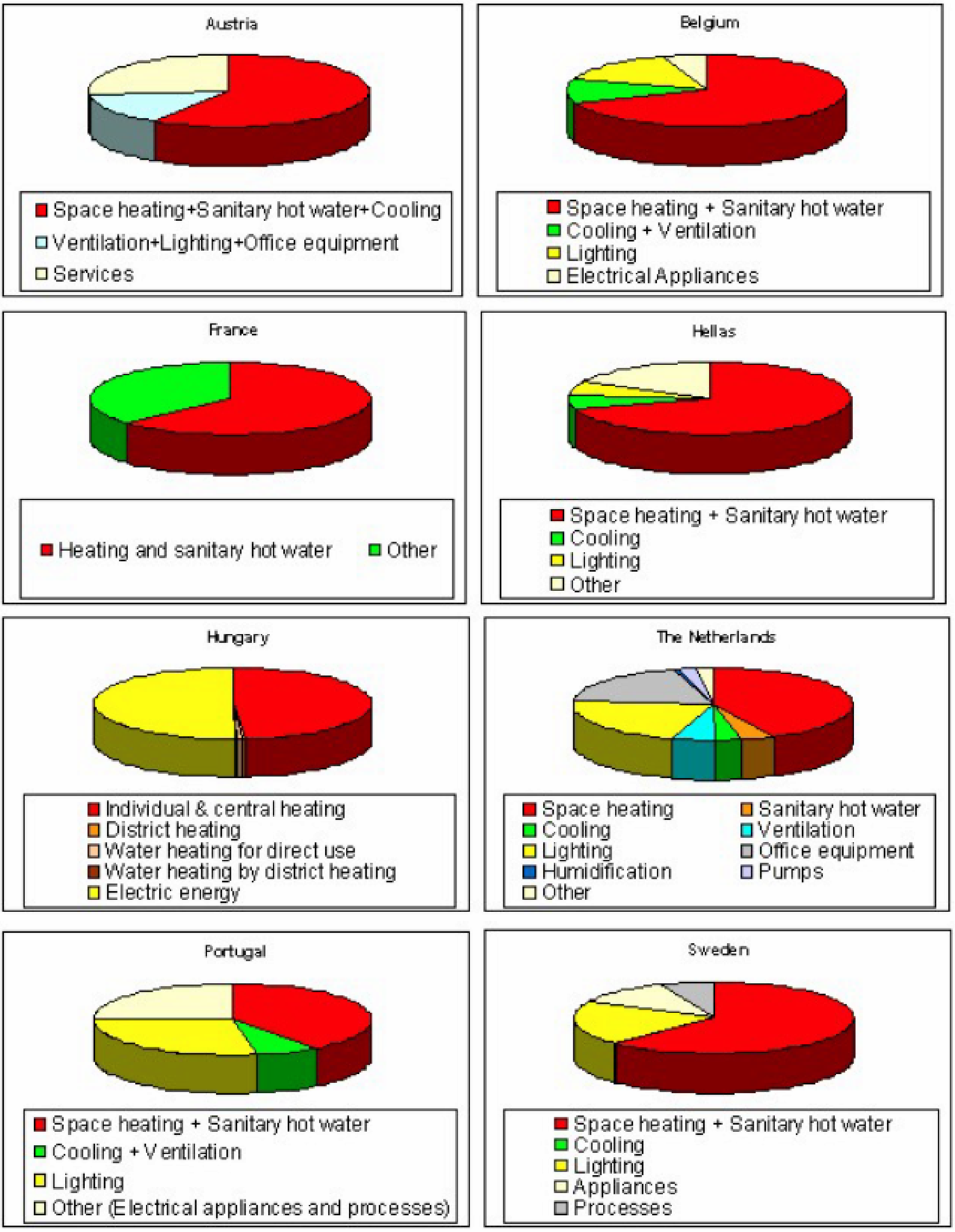


Figure 16. Average breakdown of total energy consumption for different end-uses in non-residential buildings.

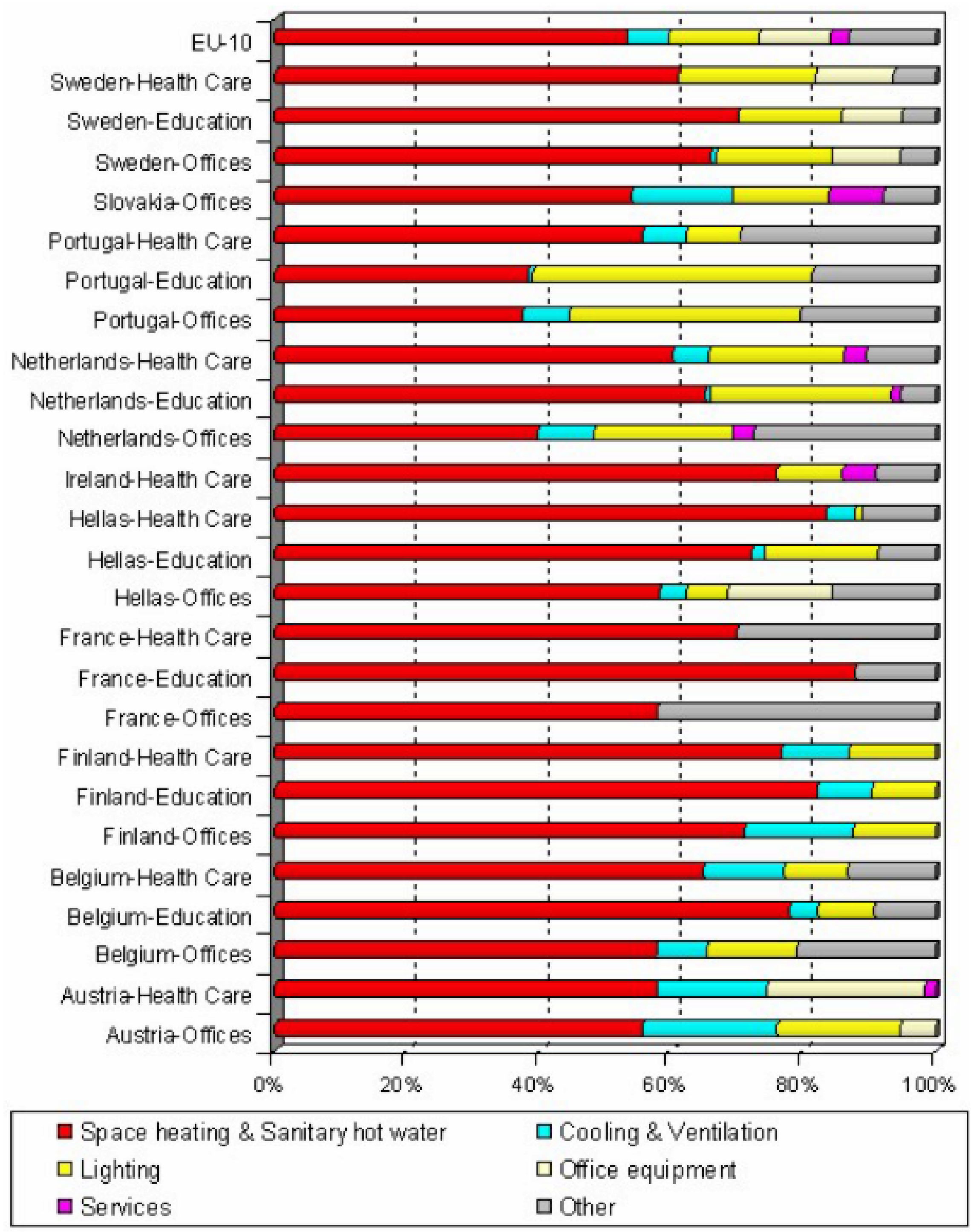


Figure 17. Breakdown (as a percentage) for different end-use non-residential buildings that will be considered in the EPA-NR pilots (offices, education, health care), if data is available.

4.4.5 ODYSSEE

ODYSSEE (2006) is a joint project between ADEME, the EIE programme of the European Commission/DG TREN and all energy efficiency agencies in the EU-15 and Norway The project was set up in 1993 and relies on a comprehensive database that contains, on the one hand, detailed data on the energy consumption drivers by end-use and sub-sector and, on the other hand, energy efficiency and CO_2 related indicators. The data are updated regularly by the network of national teams. The database is managed by ENERDATA.

See also ODYSSEE reports, primarily "Energy efficiency trends by sectors". In the chapter on households, several diagrams explaining the energy efficiency in buildings are presented and explained. See for instance "average consumption per dwelling at EU climate: different trends across countries (Figure 18). See also diagrams below showing the 'Regulation on building codes' (see Figure).

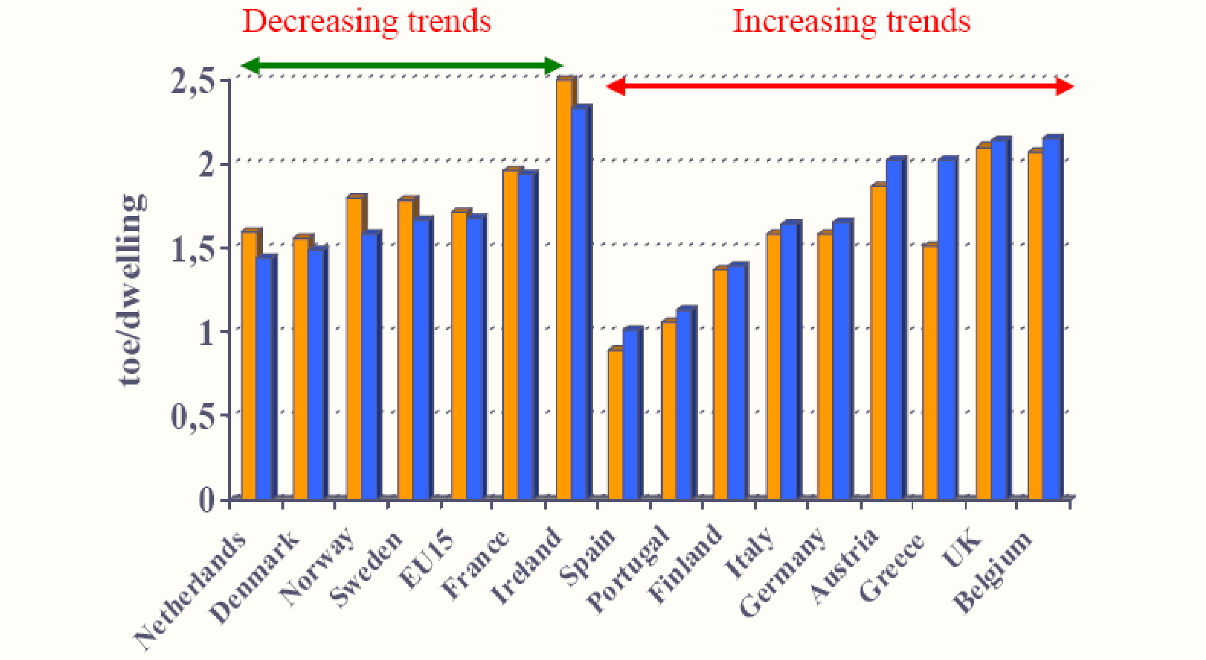


Figure 18. Average consumption per dwelling and trends across countries (Source: ODYSSEE, 2004).

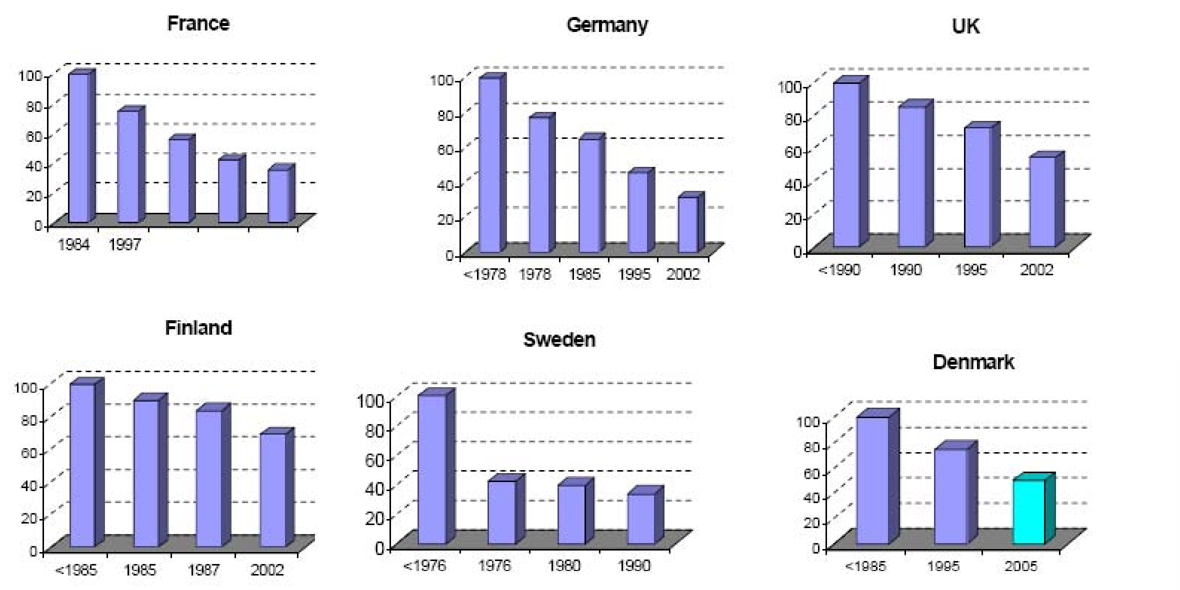


Figure 19a. Energy requirements in building codes in EU countries (Source: ODYSSEE, 2004).

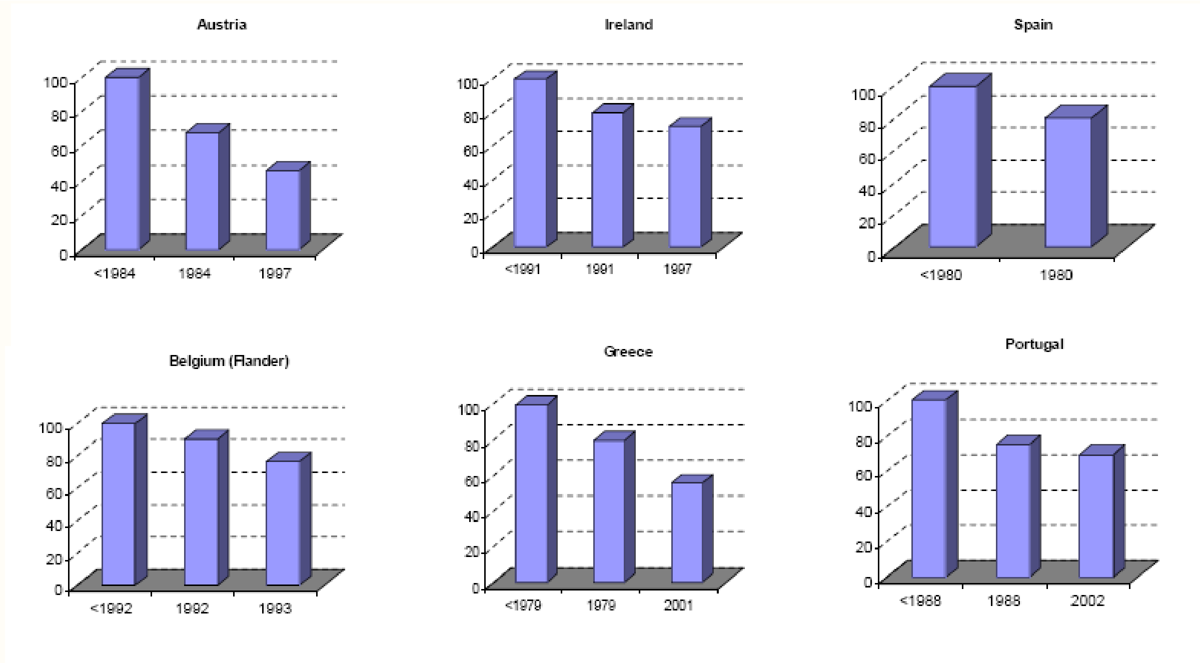


Figure 19b. Energy requirements in building codes in EU countries (Source: ODYSSEE, 2004).

4.4.6 Best CERT

The project objective of the original proposal was:

"To carry out pilot studies to establish energy standards in each of the participating countries for selected building types". To use the new standards as the basis of an energy certification tool for these building types. It is proposed that the certification tool will use a new methodology which will generate building specific benchmarks from the standards. Comparing a building's actual performance with the building specific benchmark will identify the potential for energy savings. It is proposed that a report generator is developed for the tool to provide guidance on possible energy saving measures. A key objective of the project will be to provide a pilot building energy certification service to all member states through a web page".

During the course of the project, the objectives needed to be modified to take account of the emerging CEN standards and the way national governments were implementing the Energy Performance of Buildings Directive (the Directive). In particular building specific benchmarks were replaced with asset ratings, legislative reference values and building stock reference values. Furthermore, national governments are implementing the Directive in different ways each using nationally preferred tools. The objectives of the project were therefore adapted to provide inputs into the evolution of certification tools in each partner country.

Results

User interfaces

BRE developed an initial user interface based on Design Builder to create the input files required for 3TC, Energy Plus and a new calculation method developed by BRE known as SBEM. SBEM is based on the Dutch methodology NEN 2916:1998 which complies with CEN/TC 89/WG4/N249. The interface allows the user to work with a constrained set of data in order to minimise the effort required to certify the energy performance of a building. This interface was adopted by the Energy Research Group in Ireland and ITC in Italy.

In France Centre d'Energetique selected the COMFIE simulation tool, while CSTB used their DPE method and Denmark modified the tool that was already in use for the Danish Energy Management Scheme to an asset-based scheme using a new calculation tool Be06.

Databases and calculations

Information was collected either from surveys or existing databases covering several hundred buildings including schools, offices, university buildings, public buildings and social housing. These data were used to draw up standardised occupancy schedules in each country which were then used with the five calculation tools to calculate the energy performance of selected buildings for standard use. Furthermore, these data were used to define good practice and typical practice (or in some countries best practice and worst practice) for construction and HVAC performance. These standards were used with the tools preferred in each country to calculate building specific benchmarks.

Generating a building rating

At this stage of the project various CEN standards relating to the Directive were becoming available in particular CEN/TC89/WG4/N249 and draft prEN 15217. These define a number of ratings and standards:

- **Asset rating** based on calculations of the energy used by a building with standard input data relating to internal and external climate and occupancy,
- **Design rating** based on calculations using building drawings and design values calculated for a building at the design stage,
- **Operational rating** based on measured energy use,
- **Energy performance regulation reference/benchmark.** This corresponds to the limit value that should be expected of new buildings in conformity with national or regional energy performance regulations in 2006,
- **Building stock reference/benchmark.** This corresponds to the value that should be expected to be reached by approximately 50 % of the national building stock in 2006 – similar to a typical benchmark in the UK.

4.4.7 ENPER-TEBUC

The European project ENPER-TEBUC project[1] (2001 – 2003) dealt with the issue of harmonisation in European Building Codes. It integrated the project proposals 'ENPER' and 'TEBUC' into one single project. At that time, discussions about the EPBD directive were ongoing, while the project was already started.

In 2001-2003, several countries had already an Energy Performance Regulation (EPR) in place (Netherlands, France, Spain, Sweden, Germany, etc.) and/or are preparing a new regulation (Belgium, Denmark, France, Germany, Greece, etc.). Whereas a whole range of European standards are prepared and/or adopted that cover several sub-domains of an EP standard, there are major differences in the overall approach used in the different countries for determining the EP level of a building. Setting up a platform for information exchange among the prominent national players, to systematically collect and summarise the different approaches and to develop suggestions for a European 'model code' was therefore the main goal of the ENPER project.

[1] www.enper.org

The ENPER project was launched to create a European platform for exchange of information on existing energy regulations in the participating countries and on the development of new procedures and regulatory measures. The aim was to learn from the experience gained in the other countries and to draft a set of best practice methods and recommendations for design, eventually, a harmonised model code for the energy performance assessment of buildings.

An important new element in these developments has been the new European Directive on the Energy Performance of Buildings (published 4 January 2003). This directive requires member states to develop calculation procedures according to a number of requirements and to set minimum standards for the energy performance. The project has provided basic information fitting into the objectives of the directive. Certainly, the work was not finished: the implementation of the energy performance directive in all member states requires a lot of efforts for which ENPER cannot provide all of the answers. But at least, ENPER has provided a route map, which may serve as a guide through the world of Energy Performance Regulations. The ENPER project was initiated and coordinated by the Belgian Building Research Institute (BBRI-WTCB-CSTC) within the framework of the SAVE programme of the European Commission, DG TREN. It involved partners from 15 countries on the topic of energy performance standardisation and regulation. In addition, 6 other European countries were associated on a voluntary basis.

On request of DG TREN, the ENPER project was combined with TEBuC 'Towards a European Building Code', another SAVE project three participating countries, which also deals with the issue of harmonization in European Building Codes.

The ENPER work was subdivided into 9 tasks:

- Task A: Project Coordination
- Task B1: EP calculation procedures
- Task B2: Innovative concepts
- Task B3: Legal aspects
- Task B4: Applicability on existing buildings
- Task B5: Impact on market
- Task B6: Model building code
- Task B7: Website
- Task B8: Seminars
- Task B9: Priorities

4.4.8 Concerted Action

The European Directive on the Energy Performance of Buildings poses significant challenges for EU Members States in terms of the practical details of the transposition. The European Commission has consequently established a series of initiatives to try to overcome these difficulties and move towards a certain degree of harmonisation on a voluntary basis.

One of the main initiatives towards promoting the dialogue between the Members States is the Concerted Action (CA)[2], funded by the 'Intelligent Energy-Europe' Program of DG TREN.

Within the global objective consisting of sharing the information and experiences among countries, the programme has the following specific objectives:

- To discuss and to prepare a structure for the energy certification of buildings to maximise similarities and reduce the range of different options selected by the MS;
- To discuss and prepare a coherent basis for the methodologies for inspection of heating boilers and air-conditioning equipment;

[2] www.epbd-ca.org

– To discuss and prepare ways to implement adequate schemes for accreditation of energy audit and inspection experts in Member States;
– To discuss criteria for the implementation of common methodologies for calculation of the energy performance of buildings.

To reach this goal, the CA is structured on 4 working groups, related to these 4 core themes:

– Theme 1: Certification of buildings,
– Theme 2: Inspection of boilers and air-conditioning systems,
– Theme 3: Procedural aspects for energy performance characterisation,
– Theme 4: Specifications and training requirements for experts and inspectors.

Moreover, special attention is given to promote formal and informal contacts between the Concerted Action and all the relevant groups that are working towards the transposition of the EPBD in the MS. In particular:

– The CEN working group in charge of preparing the new standards required for implementation of the EPBD,
– The SAVE projects financed by the EIE program to develop and demonstrate various issues related to the EPBD implementation.

There is no direct link from CA to sources of information on building stock knowledge.

4.4.9 IEA ECBCS Annex 36

Retrofitting of educational buildings (REDUCE).

In this international project energy efficient retrofit measures for existing educational buildings have been analysed in nine different European countries plus the US. The gathered know-how gained from exemplary retrofit projects in the participating countries. The main result is a software tool (the Energy Concept Adviser = ECA) that was developed to give advice on energy-efficient retrofit measures to decision makers in administrations. REDUCE started in 2000 and ended in 2003 (www.annex36.com).

Issues in connection with ENPER-EXIST WP3:

– The ECA enables the assessment of energy savings due to different combinations of retrofit measures. (Part retrofit concept development).
– The ECA includes a benchmarking tool. The energy consumption of a certain educational building can be compared with the national average of buildings of the same typology. The tool refers to the studies that from the basis of this benchmarking part and additional national benchmarking tools on websites. (Part performance rating).
– The ECA contains 33 realised retrofitted case studies. The aims of the retrofits differ from each other (from main aim being energy saving, to solutions to special problems such as IAQ). The retrofits that focus on energy savings might give an insight into what is reasonably possible in the countries. (Part case study viewer).

4.4.10 IEA ECBCS Annex 46

Holistic Assessment Tool-kit for Energy Efficient Retrofit Measures of Government Buildings (EnERGo)

Like IEA Annex 36, Annex 46 deals with energy saving retrofits, but has broader scope i.e. governmental (public) buildings (excl. dwellings). Its goals are:

– to provide tools and guidelines for decision-makers and energy managers, contractors, consulting engineers, practising architects and designers to improve the working environ-

ment of Government buildings through energy-efficient retrofitting projects. Though this Annex focuses on Government buildings, many results can be applied to similar private-sector buildings;
- to provide recommendations on how to operate the retrofitted buildings;
- to promote energy- and cost-efficient retrofit measures by providing successful examples;
- to support decision-makers in evaluating the efficiency and acceptance of available concepts;
- to find improved ways of using Energy Performance Contracts (ESPCs) for Government buildings retrofit measures.

The main result besides several reports will be a tool that covers all working parts of the project.

Issues in connection with ENPER-EXIST WP3:

- work will include screening of plenty of retrofit measures for different building typologies and climates. Therefore representative examples of buildings were defined. The screening will show how much energy can be saved with different retrofit strategies (Subtask B). This database will also be used in the IEA Annex 46 tool (Subtask D).
- the best-practice guidelines for innovative energy performance contracts (Subtask C) might give valuable information on how the energy-efficient retrofit can be accelerated by using the financial mechanism Energy Service Performance Contracts (ESPCs).

4.4.11 BRITA in PuBs:

Bringing retrofit innovation to Application in Public Buildings

The BRITA in PuBs proposal on Eco-buildings aims to increase the market penetration of innovative and effective retrofit solutions to improve energy efficiency and implement renewables with moderate additional costs. In the first place, this is realised by examples of retrofit of nine demonstration public buildings in the four participating European regions (North, Central, South, and East). By choosing public buildings of different types such as colleges, cultural centres, nursery homes, student hostels, churches etc. for implementing the measures, it is easier to reach groups of differing age and social origin. Public buildings can be used as engines to heighten awareness and sensitise society on energy conservation.

Secondly, the research work packages includes socio-economic research such as the identification of real project-planning needs and financing strategies, the assessment of design guidelines, the development of an internet-based knowledge tool on retrofit measures and case studies and a quality-control tool box to secure a good long-term performance of the building and the systems.

The third main pillar of the BRITA in PuBs project is dissemination. This is divided into a minor part, the training of users and maintenance personnel, and a larger section on publishing the research and demonstration work to different target groups. This is done in a combination of targeted PR-campaigns and using local, national and international networks such as Energie Cités, the internet and other media, and arrangement and participation in symposia and conferences.

Issues in connection with ENPER-EXIST WP3:

- The 8 (originally 9) demonstration buildings have as a minimum goal the reduction of the primary energy consumption by at least 50 % due to the retrofit and at the same time be close to economically efficient. This might be used as indicator of how much energy can be saved for different building types.
- Part of the research work is further development of the IEA Annex 36 ECA tool. Therefore the benchmarking tool will be extended to include all types of public buildings. The participating experts from 9 European countries are in the process of gathering data on national

average energy consumption for heating and electricity and water consumption for various building types.

The tables below shows information about the average consumptions for: energy for space heating, electrical energy, and water in selected building types and some European countries.

Attention should be drawn to the following comments related to the tables with selected consumptions.

Country	Comment
Denmark	Danish figures from are 1997-2006. More recent figures are more difficult to extract as Denmark have got a new scheme. Categories: – community centres could be libraries as well – museums should be specified more detailed – administrative buildings do also include private owners Missing information about military buildings, railway stations, banks.
Italy	Missing items could be covered in a new project that might start in the next year.
Norway	The split between heating and electricity is confusing since all Norwegian data are biased by the fact that a lot of electric resistance heaters are being used. In the data attached some of the energy put under electricity is in fact heating. The figures for heating are mainly oil, natural gas and such liquids.
Lithuania	The building typology in Lithuania is different *: Average data available for DHW in kWh/m² area.
Greece	Hospitals: 25 large hospitals covers all geographical areas of Greece Administration buildings (public off.): Data from eleven public buildings of central administration.
Czech Republic	Data are partly based on a small number of buildings.

Table 3. Energy consumption for space heating in selected building types.

		Unit	Country								
			Czech Republic	Den-mark	Finland	Ger-many	Greece	Italy	Lithu-ania	Norway	UK
1. public dwellings (multi-family houses)	average	kWh/m²a	160	120	160	130			-	89	334
	low	kWh/m²a	55	90	100	50			-		200
	high	kWh/m²a	312	150	200	380					417
2. community centres	average	kWh/m²a	150	120	137	160			-	26	134
	low	kWh/m²a	65	80	60	80			-		115
	high	kWh/m²a	237	160	250	240					164
3. nursery homes, senior homes, rehab centres	average	kWh/m²a	170	140	200	280			-	32	345
	low	kWh/m²a	110	100	100	140			-		247
	high	kWh/m²a	339	180	280	420					417
4. hospitals	average	kWh/m²a	215	165	224	320	221		-	92	413
	low	kWh/m²a	113	125	100	160	81		-		339
	high	kWh/m²a	436	205	300	480	420				518
5. schools	average	kWh/m²a	143	120	170	135			-	16	137
	low	kWh/m²a	79	80	55	68			-		108
	high	kWh/m²a	242	160	250	203					164
6. nursery schools	average	kWh/m²a	183	130	200	180			-		-
	low	kWh/m²a	119	85	100	90			-		-
	high	kWh/m²a	326	175	280	270					-
7. university buildings	average	kWh/m²a	173	125	200	135			-	26	-
	low	kWh/m²a	87	80	100	68			-		-
	high	kWh/m²a	456	170	280	203					-
8. research institutes	average	kWh/m²a	184	125	140	120			-	26	-
	low	kWh/m²a	100	80	65	60			-		-
	high	kWh/m²a	321	170	250	180					-
9. theatres	average	kWh/m²a	157	110	240	400			-	32	576
	low	kWh/m²a	89	70	100	200			-		515
	high	kWh/m²a	246	150	330	600					630
10. libraries	average	kWh/m²a			170	105			-		154
	low	kWh/m²a			80	53			-		112
	high	kWh/m²a			260	158					172
11. museums	average	kWh/m²a		125	165	105			-		124
	low	kWh/m²a		60	70	53			-		82
	high	kWh/m²a		170	250	158					192
12. (student) hostels	average	kWh/m²a	215	135		150			-		?
	low	kWh/m²a	52	95		75			-		278
	high	kWh/m²a	325	175		225					385
13. hotels	average	kWh/m²a		135		195			-	37	320
	low	kWh/m²a		85		98			-		240
	high	kWh/m²a		185		293					460
14. administration buildings (public offices)	average	kWh/m²a	157	100	148	105	97		-	39	-
	low	kWh/m²a	74	50	70	53	20		-		-
	high	kWh/m²a	246	150	250	158	207				-
15. gyms/ sportshalls	average	kWh/m²a		105	190	150			-		?
	low	kWh/m²a		55	70	75			-		141
	high	kWh/m²a		155	280	225					449
16. indoor swimming pools	average	kWh/m²a	698	380	400	2590*Fläche Becken			-		?
	low	kWh/m²a	628	180	200				-		573
	high	kWh/m²a	769	580	600						1336
17. town halls	average	kWh/m²a			140	105			-		136
	low	kWh/m²a			70	53			-		112
	high	kWh/m²a			250	158					170
18. court buildings	average	kWh/m²a	146			120			-		185
	low	kWh/m²a	72			60			-		165
	high	kWh/m²a	241			180					220
19. churches	average	kWh/m²a							-		135
	low	kWh/m²a							-		80
	high	kWh/m²a									150

Table 4. Electricity consumption in selected building types.

		Unit	Country								
			Czech Republic	Den-mark	Finland	Ger-many	Greece	Italy	Lithu-ania	Norway	UK
1. public dwellings (multi-family houses)	average	kWh/m²a	3	7	43				30	150	77
	low	kWh/m²a	1	2	18				-		44
	high	kWh/m²a	19	12	87						100
2. community centres	average	kWh/m²a	26	43	62	20			20	245	28
	low	kWh/m²a	13	13	20	10			-		22
	high	kWh/m²a	37	73	130	30					33
3. nursery homes, senior homes, rehab centres	average	kWh/m²a	21	45	68	50			30	240	67
	low	kWh/m²a	1	20	20	25			-		44
	high	kWh/m²a	60	70	135	75					79
4. hospitals	average	kWh/m²a	37	75	85	71	135		30	275	98
	low	kWh/m²a	13	45	35	36	28		-		48
	high	kWh/m²a	101	105	160	107	316				122
5. schools	average	kWh/m²a	17	25	53	40			10	180	29
	low	kWh/m²a	7	15	20	20			-		22
	high	kWh/m²a	40	35	100	60					33
6. nursery schools	average	kWh/m²a	17	40	68	26			10		-
	low	kWh/m²a	8	15	30	13			-		-
	high	kWh/m²a	47	65	120	39					-
7. university buildings	average	kWh/m²a	60	45	140	40			10	170	-
	low	kWh/m²a	19	15	40	20			-		-
	high	kWh/m²a	253	75	200	60					-
8. research institutes	average	kWh/m²a	52	45	42	30			10	170	-
	low	kWh/m²a	48	15	15	15			-		-
	high	kWh/m²a	58	75	90	45					-
9. theatres	average	kWh/m²a	53	45	125	24			20	240	200
	low	kWh/m²a	9	5	40	12			-		135
	high	kWh/m²a	125	80	200	36					270
10. libraries	average	kWh/m²a			80	32			20		41
	low	kWh/m²a			35	16			-		32
	high	kWh/m²a			160	48					47
11. museums	average	kWh/m²a		40	75	25			20		47
	low	kWh/m²a		10	30	13			-		26
	high	kWh/m²a		70	160	38					68
12. (student) hostels	average	kWh/m²a	28	40		20			30		-
	low	kWh/m²a	4	15		10			-		-
	high	kWh/m²a	49	65		30					-
13. hotels	average	kWh/m²a		80		61			30	230	?
	low	kWh/m²a		25		31			-		46
	high	kWh/m²a		135		92					68
14. administration buildings (public offices)	average	kWh/m²a	42	45	82	24	71		20	200	-
	low	kWh/m²a	18	5	30	12	40		-		-
	high	kWh/m²a	71	85	150	36	230				-
15. gyms/ sportshalls	average	kWh/m²a		40	120	12			10	240	?
	low	kWh/m²a		20	40	6			-		64
	high	kWh/m²a		60	200	18					194
16. indoor swimming pools	average	kWh/m²a	188	135	200	715*Fläche Becken			60		?
	low	kWh/m²a	178	70	80				-		152
	high	kWh/m²a	198	210	300						258
17. town halls	average	kWh/m²a			80	20			30		96
	low	kWh/m²a			30	10			-		84
	high	kWh/m²a			150	30					111
18. court buildings	average	kWh/m²a	25			24			30		124
	low	kWh/m²a	4			12			-		100
	high	kWh/m²a	49			36					135
19. churches	average	kWh/m²a							30		17
	low	kWh/m²a							-		10
	high	kWh/m²a									20

Table 5. Water consumption in selected building types.

		Unit	Country							
			Czech Republic	Den-mark	Finland	Ger-many	Greece	Italy	Lithu-ania	Norway	UK
1. public dwellings (multi-family houses)	average	l/m²a		850	440				*		-
	low	l/m²a		550	150				*		-
	high	l/m²a		1150	900						-
2. community centres	average	l/m²a		420	720				*		-
	low	l/m²a		120	300				*		-
	high	l/m²a		820	1000						-
3. nursery homes, senior homes, rehab centres	average	l/m²a		800	700				*		-
	low	l/m²a		450	300				*		-
	high	l/m²a		1150	990						-
4. hospitals	average	l/m²a		770	840				*		-
	low	l/m²a		540	300				*		-
	high	l/m²a		1000	1100						-
5. schools	average	l/m²a		260	350				*		-
	low	l/m²a		140	70				*		-
	high	l/m²a		380	550						-
6. nursery schools	average	l/m²a		570	700				*		-
	low	l/m²a		250	300				*		-
	high	l/m²a		890	1000						-
7. university buildings	average	l/m²a		300	400				*		-
	low	l/m²a		140	100				*		-
	high	l/m²a		460	900						-
8. research institutes	average	l/m²a		300	350				*		-
	low	l/m²a		150	70				*		-
	high	l/m²a		450	550						-
9. theatres	average	l/m²a		300	450				*		-
	low	l/m²a		80	40				*		-
	high	l/m²a		520	600						-
10. libraries	average	l/m²a			270				*		-
	low	l/m²a			30				*		-
	high	l/m²a			450						-
11. museums	average	l/m²a		250	250				*		-
	low	l/m²a		100	30				*		-
	high	l/m²a		400	400						-
12. (student) hostels	average	l/m²a		1300					*		-
	low	l/m²a		700					*		-
	high	l/m²a		1800							-
13. hotels	average	l/m²a		1200					*		-
	low	l/m²a		600					*		-
	high	l/m²a		1800							-
14. administration buildings (public offices)	average	l/m²a		250	320				*		-
	low	l/m²a		100	70				*		-
	high	l/m²a		400	550						-
15. gyms/ sportshalls	average	l/m²a		550	550				*		-
	low	l/m²a		250	100				*		-
	high	l/m²a		850	800						-
16. indoor swimming pools	average	l/m²a		3300	4200				*		-
	low	l/m²a		1100	1000				*		-
	high	l/m²a		5500	9000						-
17. town halls	average	l/m²a			300				*		-
	low	l/m²a			70				*		-
	high	l/m²a			550						-
18. court buildings	average	l/m²a							*		-
	low	l/m²a							*		-
	high	l/m²a									-
19. churches	average	l/m²a							*		-
	low	l/m²a							*		-
	high	l/m²a									-

5 Building stock information sources - literature

5.1 General European information sources

EURIMA — European Association of Insulation Manufacturers, representing the interests of all major mineral wool producers throughout Europe.
www.eurima.org/

- Cost-Effective Climate Protection in the Building Stock of the New EU Member States.
- Cost-Effective Climate Protection in the EU Building Stock.

Both documents can be downloaded from:
www.eurima.org/document_library/eurima_publications.cfm

EuroACE — European Alliance of Companies for Energy Efficiency in Buildings.
www.euroace.org

– R. Janssen, 2005. Towards Energy Efficient Buildings in Europe. Final Report 2005, London.
(www.euroace.org/EuroACE%20documents/050731%20Towards%20Energy%20Efficient%20Buildings%20in%20Europe%20(Jul%2005%20update).pdf)

– High Rise report(s)
http://www.euroace.org/highrise/downloads.htm

Relevant downloads to this study:
- summary report:
- full report:
- case studies:
  - Radomir, Bulgaria:
  - Budapest, Hungary:
  - Riga, Latvia:
  - Lisbon, Portugal:
  - St Petersburg, Russia:
  - London, United Kingdom:

– All the afore mentioned reports can be downloaded from:
http://www.euroace.org/highrise/downloads.htm

– Information on base regions:
Each of these regional data summaries contains three data tables. The first lists (amongst other data) the energy saving potential across the whole of the high-rise stock in each country; this is based on what national European housing ministries estimated to be the energy saving potential of their own stock. The next two tables show the energy saving potential in a typical high-rise building for each country. This is not based on housing ministry estimates, but on modelling the implementation of best available technologies in a high-rise building that is assumed to be refurbish-able in every respect.
- Base region A, warm climate EU15 countries: France, Greece, Italy, Portugal, Spain:
- Base region B, warm climate EU10 countries: Cyprus, Malta:
- Base region C, warm climate AS3 countries: Turkey

- o Base region D, moderate climate EU15 countries: Belgium, Ireland, Luxembourg, Netherlands, United Kingdom
- o Base region E, moderate climate EU10 countries: Czech Republic, Hungary, Slovakia, Slovenia
- o Base region F, moderate climate AS3 countries: Bulgaria, Romania
- o Base region G, cold climate EU15 countries: Denmark, Finland, Germany, Sweden
- o Base region H, cold climate EU10 countries: Estonia, Latvia, Lithuania, Poland

– All the afore mentioned reports can be downloaded from: http://www.euroace.org/highrise/downloads.htm

BBRI Belgian Building Research Institute
www.bbri.be

Misc. European projects related to the Energy Performance of Buildings Directive.
(www.epbd-ca.org/Medias/Pdf/7_PUB_SAVE%20projects.pdf?OpenDocument)

EPA-ED Energy Performance Assessment of Existing Dwellings.
www.epa-ed.org

- Results from a survey on energy-related building stock knowledge in existing, residential buildings.
(www.epa-ed.org/results/upload/Documents%2520Task%25201%252edb/EPA%2dED%20NOA%200301%20Benchmarking%20Task%201%20%2b%20Appendix.PDF)

EPA-NR Energy Performance Assessment of Existing Non Residential Buildings.
www.epa-nr.org

- Results from a survey on energy-related building stock knowledge in existing, non-residential buildings.
(www.epa-nr.org/mbUpload/upload/Project_results%252edb/EPA%2dNR_WP_1_Final_Technical_Report.pdf)
- Country specific answers to survey questionnaire (zip archive).
(/www.epa-nr.org/mbUpload/upload/Project_results%252edb/WP1%2dSurvey_Country%20Annexes.zip)

DG TREN 'Annual Pocket Book “Energy and Transport in Figures' 2005,
http://ec.europa.eu/dgs/energy_transport/figures/pocketbook/2005_en.htm

ODYSSEE 'Energy efficiency trends by sectors', Households, 2004
http://www.odyssee-indicators.org/Publication/PDF/households_eu04.pdf

Comprehensive database with detailed data on the energy consumption drivers by end-use and sub-sector and energy efficiency and CO_2 related indicators.

http://www.odyssee-indicators.org/

CEN Hogeling, Jaap 'New CEN standards related to the implementation of the Energy Performance Buildings Directive' 2005, Chair CEN-BT-WG173 on EPBD, Managing director ISSO, Rotterdam.
http://www.rehva.com/workshops/ws_06_4_hogeling_jaap.swf

EEA 'The European environment - State and outlook 2005.
http://www.eea.europa.eu/main_html/

EUKN Sustainable Refurbishment of High-Rise Residential Buildings and Restructuring of Surrounding Areas in Europe. Ministry of Housing, Spatial Planning and the Environment, the Netherlands.
http://www.eukn.org/eukn/themes/Urban_Policy/Housing/Housing_quality/Sustainable-Refurbishment-of-High-Rise-Residential-Buildings_1001.html

5.2 National sources

The following national sources were identified in the ENPER-EXIST survey among the countries participating in the project.

5.2.1 Belgium

www.statbel.fgov.be
Statistical information about dwellings, number of companies, etc.

www.ibgebim.be
Information about energy consumption in the Brussels region.

www.vmm.be
Information about energy consumption in the Flanders region.

www.vito.be
Information about energy consumption in the Flanders region.

www.wallonie.be
Information about energy consumption in the Walloon region.

mineco.fgov.be
Information about energy consumption in Belgium.

www2.vlaanderen.be/ned/sites/economie/energiesparen
Information about energy consumption in the Flanders region.

mineco.fgov.be/energy/rational_energy_use/report.pdf
Information and predictions of the energy savings potentials in Belgium.

www.odyssee-indicators.org
Information about energy consumption in the EU countries (limited information about Belgium).

www.mina.vlaanderen.be
Information and comments on the climate plans of Flanders.

5.2.2 Denmark

www.statiskikbanken.dk
Statistics Denmark provide statistics on Denmark in general. Some information is available free of charge.

www.ens.dk
Danish Energy Agency provide statistics on energy consumption in Denmark in general, including the building sector (not very detailed).

www.elsparefonden.dk
Electricity savings trust - collects information about electricity savings and supports (on a campaign basis) use of electricity efficient appliances and transfer for electricity heating to district heating.

www.ebst.dk
National Agency for Construction and Enterprise is responsible for making the Danish Building Regulation, including rules for energy consumption in new buildings.

www.sbi.dk
Evaluation of the heating saving potential in existing dwellings. In Danish (Vurdering af potentialet for varmebesparelser i eksisterende boliger) By og Byg, Dokumentation 057. Danish Building Research Institute, SBi. 2004.

www.byg.dtu.dk
Energy savings in existing and new dwellings. In Danish (Energibesparelser i eksisterende og nye boliger). BYG*DTU, 2004. R-080.

5.2.3 France

www.ademe.fr
ADEME: Agence de l'Environnement et de la Maîtrise de l'Energie. Les chiffres clés du bâtiment, Energie – Environnement, Edition 2004 – Données et références, ADEME.

CEREN: Centre d'Etudes et de Recherches Economiques sur l'Energie.

www.statistiques.equipement.gouv.fr
DAEI: Direction des Affaires Economiques et Internationales du Ministère du Logement.

www.industrie.gouv.fr/energie
DGEMP: Direction Générale de l'Energie et des Matières Premières – Secrétariat d'Etat à l'industrie.

www.insee.fr
INSEE: Institut National de la Statistique et des Etudes Economiques.

www.industrie.gouv.fr/energie/statisti/se_stats.htm
OE: Observatoire de l'Energie du Ministère de l'industrie.

5.2.4 Germany

www.destatis.de
Data from the German Statistical Office.

5.2.5 Greece

grbes.phys.uoa.gr
Most of the information is in Greek.

NAP National allocation plan, for the period 2005 – 2007. Hellenic Ministry for the Environment, Physical Planning and Public Works. December 2004.

Energy Policy Georgopoulo, E et al. Evaluating the need for economic support policies in promoting greenhouse gas emission-reducing measures in the building sector: The case of Greece. Energy Policy, 2005 (www.elsevier.com/locate/enpol)

5.2.6 The Netherlands

www.senternovem.nl
Dutch Energy Agency: enormous source for all kinds of energy-related studies.

www.energie.nl/sts/index.html

Portal on Energy in The Netherlands (in Dutch), including a wide range of policy reports and other relevant literature, links to related websites, annual energy report, wide range of figures related to energy consumption and Monit-Web, a website that allows to produce self-defined tables and graphs. The site is being updated regularly.

www.energiened.nl

Umbrella organisation of energy companies in the Netherlands. Have good insight in energy consumption in the Netherlands for all sectors, both gas and electricity.

statline.cbs.nl

Central Bureau of Statistics: lots of statistical data, but not always in a format we would like.

www.vrom.nl

Ministry of Housing: studies on building stock.

www.ez.nl

Ministry of Economical Affairs: responsible for various energy policies (e.g. emission trading, white certificates).

EBM-consult (on request from Ministry of Economical Affairs). Energiebesparing in de bestaande bouw - Eerste verkenning van potenties (In Dutch). Energy savings in the existing building stock – First recognition of the potential. Second draft. 27 January 2006.

KWR Kwalitatieve Woning Registratie:
Large periodical, Dutch project on the quality of 15.000 Dutch houses (including energy issues) by order of the Ministry of Housing. Most recent version (June 2007): WoON 2006.

5.2.7 United Kingdom

Residential buildings:

– Domestic energy fact file, Shorrock and Utley, 2003, BRE.

Non-residential buildings:

– Bruhns, H. R. (2000). Property taxation data for non-domestic buildings in England and Wales, Environment and Planning B: Planning and Design, Vol 27(1).
– Bruhns, H .R. Steadman, P. Herring, H. Moss, S. Rickaby, P. A. (2000). Types, numbers and floor areas of non-domestic premises in England and Wales, classified by activity, Environment and Planning B: Planning and Design, Vol (27(5).
– DTI (2004). Digest of UK Energy Statistics, Department of Trade and Industry, The Stationery Office, London.
– Mortimer, N. D. Ashley, A. Rix, J. H. R. (2000). Detailed energy surveys of non-domestic buildings, Environment and Planning B: Planning and Design, Vol 27(1).
– Pout, C.H. MacKenzie, F. Bettle, R. (2002). Carbon dioxide emissions from non-domestic buildings: 2000 and beyond, BRE Report 442, Building Research Establishment, Watford, UK.

– Steadman, P. Bruhns, H. R. Rickaby P. A. (2000). An introduction to the national Non-Domestic Building Stock database, Environment and Planning B: Planning and Design, Vol 27(1).

6 Knowledge based on actual certification schemes

In some of the European countries energy certification and certification have taken place for a while. Thus Denmark has had an energy certification scheme since 1996. This has been coordinated centrally and administrated by two secretariats. Both of them have entered data from all issued labels into databases. Thanks to this, it was possible to create different statistics and to make some calculations explaining about the energy saving potentials in that part of the Danish building stock that include dwellings. Correspondingly, Germany has had a certification scheme for residential and non-residential buildings since 1995 and the Netherlands a voluntary certification scheme for residential buildings since 2000 and for non-residential buildings since 2004. In the end of this part, the findings concerning use of existing certification schemes are listed.

6.1 Belgium

Since the legal framework for EPBD implementation is not yet adopted in the Brussels and Walloon Regions, the information is primarily derived from the approach adopted in the Flemish Region.

6.1.1 New buildings and renovations

For new buildings, the decree and related execution orders:

- Oblige to have at the end of the works a detailed description of energy performance related building and installation data which are used to evaluate if the legal requirements are met;
- Oblige to guarantee that the described performances are met during a period of at least 5 years
- Foresee a system of financial fines in case of non-compliance whereby the applicable rules are very clearly defined;
- Oblige that all data are communicated through the internet to the Flemish Energy Agency.

This approach is expected to generate a wealth of very interesting statistical data, not only for purely energy-related topics but also for other areas of interest, e.g. building volume, window areas or type of installations.

The Flemish Energy Agency has ordered the development of a rather powerful tool for the analysis of the collected data.

For renovated buildings, the same legal framework applies as described for new buildings. The only, but important difference, is that the collected data apply only to the new parts of the building and/or new components. There is thus no information available on renovated buildings specifically, e.g. on total building volume.

6.1.2 Statistical information on existing building stock

The implementation of Article 7 of the EPBD requires the delivery of certificates when buildings are built, sold or rented. It is not fully clear how detailed the data have to be provided, in particular regarding the calculation of surfaces and volumes.

Energy audits realised on a voluntary basis of single-family dwellings (EAP) in the three Belgian regions are also coupled with a central database collecting the information coming from all the realised audits. A similar mechanism will probably be implemented for the energy certificates of the existing buildings.

6.1.3 Conclusions

Overall, it is expected that the Flemish approach will provide very precise data and probably more precise than those of most other EU countries. For the existing building stock, it is probably realistic to expect that the level of detail and accuracy is similar to that of many other EU countries.

6.2 Germany

Despite an existing certification scheme for both residential and non-residential buildings in Germany since 1995, the information that lies within the certificates according to "Wärmeschutzverordnung (1995)" and "Energieeinsparverordnung (2001)" have not been collected or analysed centrally. However other sources for such information have existed and do still.

6.2.1 Building stock knowledge and estimations on energy saving potentials

The Statistische Bundesamt (Statistical Office of the Federal Republic of Germany) collects limited information on dwellings such as building type (detached house, terrace row house, multifamily house, dwellings included in non-residential buildings) dependent on the amount of residential units, the floor area and the location (federal state) based on building permits. This information is updated annually, but obviously represents only new buildings at that time.

Information on the existing building stock as a whole is gained through sporadic population censuses which include building censuses. The first of such census for the Federal Republic of Germany was conducted in 1957, the last one so far in 1987. Additionally there are representative inquiries called Mikrozensus made frequently at 1 % of the population. Both, the population censuses and the representative inquiries are analysed by the Statistical Office and offer the same kind of information as listed before (amount of residential units, floor area, location).

It has to be mentioned that the knowledge on the building stock and the potential for energy savings in both residentials and non-residentials has been assessed by studies financed by different Germany ministries. One important and very comprehensive study is the IKARUS study that was performed in 1995 for the Enquête Commission “Klimaschutz im Gebäudebestand”. The study defined various representative buildings for which the actual status and potential energy savings due to many different energy saving measures were calculated in order to give an estimation of possible savings at the whole building stock.

6.2.2 Use of the EPBD certifications

In the run-up of the official German EPBD implementation the German Building Ministry has initiated two field studies, the first covering more than 4000 residential buildings, the second covering about 40 non-residential buildings, for which the dena (Deutsche Energie Agentur) compiled the results in a database. The evaluation of both studies was done by Fraunhofer, main parts by the Fraunhofer Institute of Building Physics. The result is the actual primary energy demand for heating, ventilation and domestic hot water and the final energy consumption for heating and electricity in the case of the 4000 plus residential and the actual primary energy demand for heating, cooling, ventilation, domestic hot water and lighting and the final energy consumption for heating and electricity in the case for the 40 non-residential buildings based on the certificates issued by mostly engineers and architects. In both studies the certifiers were asked to propose two different variants for energy saving measures at the building envelope and or the service systems. Therefore these field studies can give indications on the actual building status and possible energy savings.

Unfortunately the German government does not organise the central gathering of building and energy demand or consumption database on the EPBD implementation in Germany. As much as this would be useful, there does not seem to be enough money for such a database. There are considerations going on to collect this type of information on a voluntary basis. The offer should be that certifiers insert their data into an internet database, which could be hosted by dena.

Most probable the certification scheme according to EPBD will not cause comprehensive additional data on the actual state and the potential energy savings of the German building stock. The further assessments of this item will presumably again be based on studies performed by research institutes.

6.3 Denmark

6.3.1 The potential for heating saving in the Danish housing stock

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 Danish Building Research Institute for the Danish Energy Agency. Apart from considerations relating to energy consciousness, an evaluation of the economic consequences is given for the most profitable energy saving measures.

6.3.2 Method

The calculations of the energy saving potential were performed using the so-called P-factor method. The P-factor expresses the heat loss through the building construction in W per. m² heated floor area per. degree temperature difference between indoor and outdoor. This method is applicable as the calculations are made on the average building, representative for large number of dwellings.

The P-factor of four categories of buildings and seven periods of erection was carried out. The four categories of buildings are the four most common categories of housing, namely: detached houses, terrace houses, farm house and multifamily houses. The seven periods of construction are identified from distinguishable changes in building tradition and later on from changes in the energy requirements stated in the Danish Building Regulations. Thus the first three periods represent a change in building traditions and their corresponding techniques, whereas the last four periods represent changes in the energy requirements in the Building Regulations. The seven periods are shown in the table below.

Table 6. The Danish housing stock can be divided into seven time-typical periods of construction.

1	2	3	4	5	6	7
-1930	1931– 1950	1951– 1960	1961 – 1972	1973 – 1978	1979 – 1998	1999 – 2003

In each period of construction the building category and construction types are judged to be uniform.

To be able to evaluate the potential for energy savings the starting point was selected from knowledge obtained from the Danish building stock register (BBR) and reports submitted by certified energy consultants in the energy certification scheme for small buildings (EM). This energy certification scheme has been mandatory since 1996 at the sale of a house.

Data from the BBR register was collected as an extract from the global database in September 2003 and constitutes information about the size of the dwellings and their construction. Information from BBR was used as background to create calculation models for Danish dwellings in the seven typical periods regarding area, number of floors and the possibility of further insulating external walls and roofs.

Reports from the energy consultants is organised in different databases, dependant on the year of issuing the certificate. In the current investigation reports submitted in a period from August 1998 to December 2002 were used. Thus data do not contain the latest reports. From a control extract from the database for the period from February 2002 to June 2003, it was judged that the registered U-values from the two periods were the same. The information from the EM reports was thus used to create models for the insulation level of the existing dwellings as an average, divided into different construction periods and building constructions.

The EM certification scheme in principle only covered small buildings and when multifamily buildings occur in the databases from the scheme, it is because owner-occupied flats administratively belong to the same category. This means that the information given for multi-family houses might not be representative for the entire Danish building stock of multi-family houses.

6.3.3 Calculation

The calculation of an overall potential of heating saving, consisted of several steps. First step was a calculation of heat losses through the thermal envelope by using the P-factor method. Next step was to combine this with an estimation of the energy consumption for heating domestic hot water. This way it was possible to find the total loss of energy from the buildings. By means of this intermediate computation, it was then possible to set up the total energy balance of both low and high rise dwellings. Now the estimation of potential energy savings for each category of buildings and for each period was carried out. Finally, based on the energy balances and the estimation, it was possible to calculate the total heat saving potentials.

In the first step data from the EM certification scheme and the building models were used to create an overview of the P-factor for the different building constructions and also the heat loss by ventilation. The contributions to the P-factor for each of the four dwelling types in each of the seven construction periods can be shown by using radar diagram. See Figure 20 and Figure 21 below, where dwellings from the period 1930-1950 and the period 1979-1998 are shown.

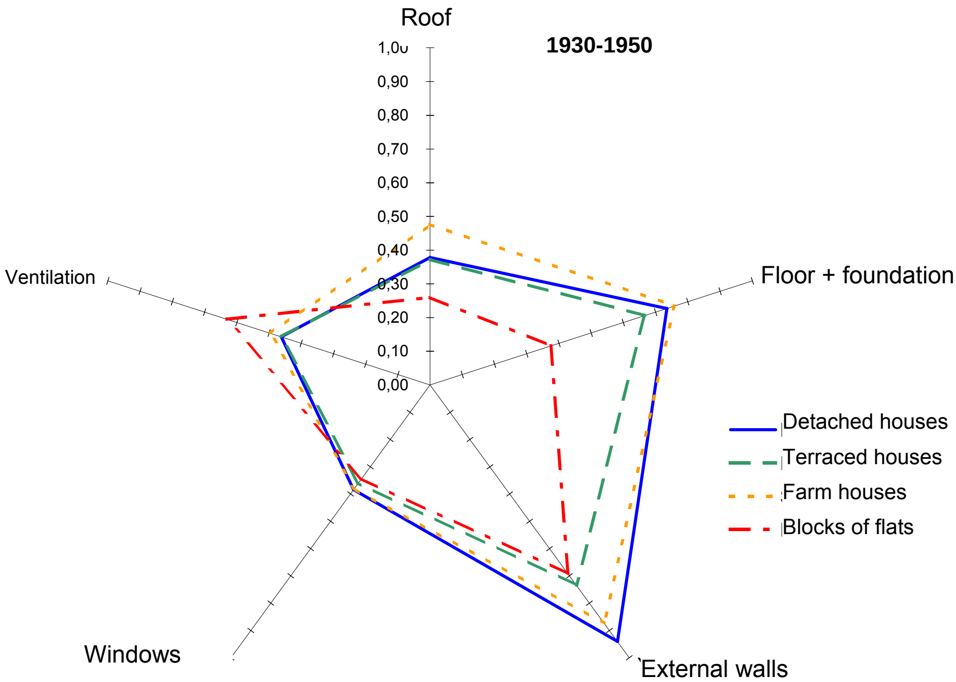


Figure 20. P-factor [W/m²K] for dwellings constructed in the period 1931-1950 External walls cause the largest heat loss per m² heated floor area.

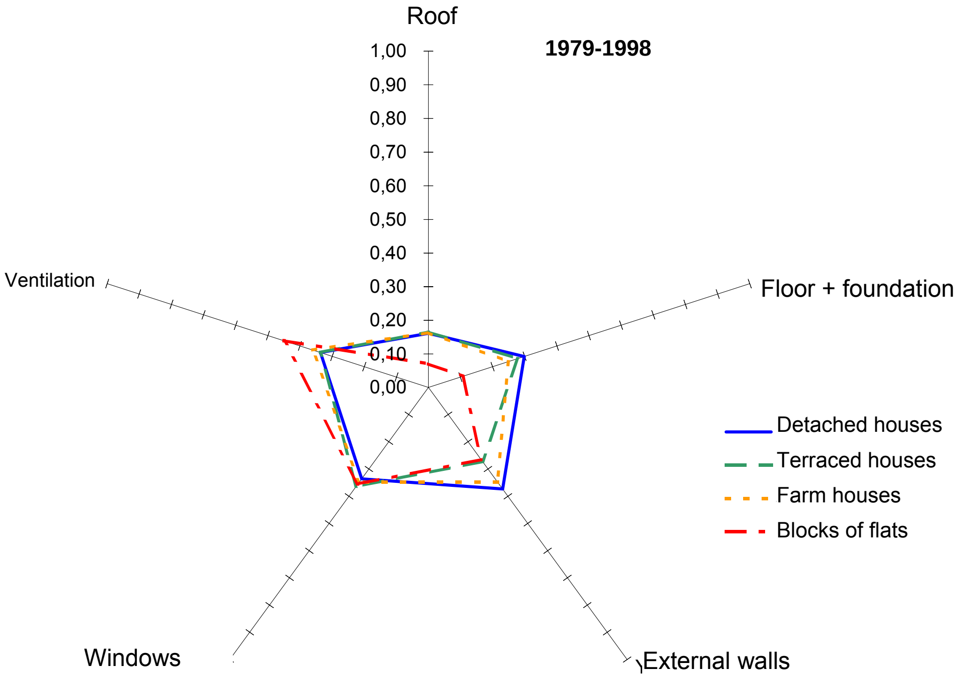


Figure 21. P-factor [W/m²K] for dwellings constructed in the period 1979-1998. Heat losses through windows and via ventilation are generally the largest and equally large contributors to the overall heat loss from buildings constructed in the period. The windows are improved compared with buildings constructed in the period 1972-1978 and in low buildings the ventilation heat loss has been further reduced.

In the next step, the energy consumption for heating domestic hot water was estimated. According to Danish experiences, the consumption of hot water can be estimated to 45 l per person per day and the average rise of cold water temperature is 45 °C. This gives an energy consumption of about 850 kWh per person per year. In addition to this losses occur in the hot water distribution system. The distribution losses can be divided into two losses, one that can be utilised for heating the building and another that is totally lost. Together the losses are of the same magnitude as the energy consumption needed to heat the cold water. Then, involving the average distribution of households over the four dwelling types (Danish Statistics, 2003), it was possible to estimate the energy consumption for heating domestic hot water for the four building types in the seven construction periods.

Table 7. Estimated energy consumption for heating domestic hot water, incl. distribution losses distributed according to the dwelling area in the construction period and the average household size (TJ).

	-1930	1931-1950	1951-1961	1961-1972	1973-1978	1979-1998	1999-2003	Total
Detached	1725	959	808	2802	1138	967	146	8544
Row houses	177	83	93	172	134	415	38	1111
Farm house	801	114	40	39	27	42	42	1107
Multi-family	1619	972	523	935	298	527	527	5401
Total	4322	2128	1464	3948	1597	1951	753	16163

Calculation the potential energy savings in the dwellings, energy consumption for hot water productions and distribution was not taken into account. This element is however needed for the next step. In this step a total energy balance of low and high rise dwellings was set up.

The total energy balance table is on one hand based on the results from calculation using the heating loss model and on the other hand on the estimated contribution from free gains. The free gains is assumed to contribute by 55 kWh per m² heated floor area, 28 kWh of which comes from utilisation of passive solar energy. The contribution from the heating system is calculated as the difference between the heat losses and the free gains (see Table 8).

Table 8. Calculated heat balance (PJ) for low (single family, row houses and farm houses) dwellings in the different construction periods. A corresponding table was carried out concerning multi-family houses.

	-1930	1931 -1950	1951 -1960	1961 -1972	1973 -1978	1979 -1998	1999 -2003	Total
Roof	5.97	1.89	1.49	4.52	1.79	1.55	0.22	17.42
Floor+foundation	8.77	3.52	2.94	8.07	2.90	2.74	0.32	29.25
Ext. walls	12.25	4.37	3.68	9.56	3.35	3.13	0.48	36.82
Windows	5.15	1.84	1.60	6.77	3.00	3.30	0.49	22.15
Ventilation	6.41	2.25	1.99	7.80	3.28	3.19	0.58	25.50
DHW	2.70	1.16	0.94	3.01	1.30	1.42	0.23	284
∑ Losses	363	315	472	310	275	246	232	627
Solar gains	4.36	1.56	1.38	5.45	2.52	3.06	0.49	18.83
Free gains	8.29	3.02	2.68	9.86	4.80	5.87	0.97	35.49
Heating system	286	253	363	165	137	145	86	1.435,00

6.3.4 Findings

Finally an evaluation of possible energy saving measures was carried out. In this evaluation it was assumed that only 50 % of all external walls and floors with U-values at 1.0 W/m²K and above can be improved to a U-value of 0.45 W/m²K. Accordingly it is assumed that 50 % of all roofs with a U-value of 1.0 W/m²K can be improved to a U-value of 0.35 W/m²K. It is assumed that all windows (glass units) can be replaced with windows of today's standard, corresponding to an average U-value of 1.6 W/m²K. In all improved constructions the resulting U-value is the average U-value, taking into account thermal bridges or those constructions that can hardly be improved due to constructional difficulties.

The assumption that only 50 % of all constructions can be improved is a somewhat conservative attitude. However it can be considered on the safe side regarding energy saving measures. As only constructions with a U-value above 1 W/m²K are estimated to be improved, it is due to the assumption that these constructions will have the most favourable payback time.

No energy savings due to retrofit of the ventilation systems in the dwellings were taken into account in the calculations. This was due to the high investment costs, especially in existing single-family dwellings, because of the comprehensive rebuilding involved. In the renovation of existing multi-family dwellings, the establishment of mechanical exhaust ventilation is a normal procedure. Balanced mechanical ventilation, though, involves a major investment, and this is the reason for not considering energy saving measures in connection with ventilation systems.

The before-mentioned changes in existing dwellings will result in energy savings up to 32 %, depending on the building type and construction period. Energy savings are shown in the table and figure below for the different building types and construction periods.

Table 9. Potential energy savings for dwellings constructed in seven 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 for these buildings, reported by the energy consultants, have U-values above 1.6 W/m²K.

	-1930	1931 -1950	1951 -1961	1961 -1972	1973 -1978	1979 -1998	1999 -2003	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

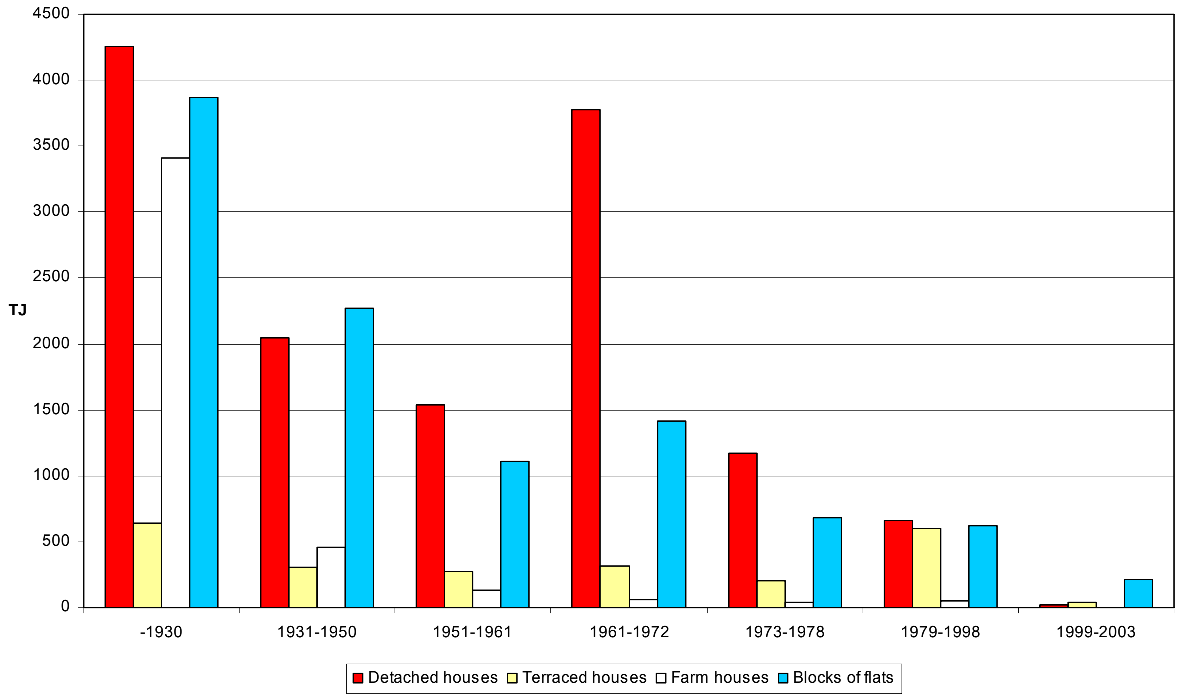


Figure 22. Energy saving potential by energy renovation in detached houses, row houses, farm houses and blocks of flats, constructed in the seven typical periods.

It is clear that large energy savings can be obtained in the older building stock, but also detached houses constructed in the period from 1961 to 1972 have a large potential. The potential in this group of buildings is not due to poorly insulated constructions compared with other periods. The relative energy saving potential is as low as 16 %. The reason for this is the large number of detached houses constructed in this period, covering a heated floor area of almost 50 million m² or 36 % of the total heated floor area in detached houses in Denmark. Generally the largest energy saving potential is found in the detached house sector, which is due to the very large heated floor area found in these houses (48.7 % of the total heated floor area in all Danish detached houses).

Altogether, 29 PJ out of 88 PJ used for heating the Danish stock of dwellings might be saved. In other words, the potential for heating saving in the Danish dwelling stock can be estimated to one third of the total amount of energy used for heating the dwellings.

Sources:

– Wittchen K.B. (2004). Analyses of the heating saving potential in existing Danish dwellings (In Danish). Dokumentation 057. Danish Building Research Institute, Hørsholm, Denmark.

6.4 France: Using certification to improve building stock knowledge

6.4.1 Energy certification (Article 7): national status

The whole disposition for implementation of energy certification of buildings was approved by official texts (law n° 2004-1343 of December 9th 2004, Ordonnance n°2005-655 of June 8th 2005). The main elements are the following:

The energy performance diagnosis (energy performance certification) of buildings will come into force on 1 July 2006[3] in case of sale of building or part of building and on 1 July 2007 in case of rent of building or part of building. These dispositions concern residential and non-residential buildings.

In the event of sale, the energy performance diagnosis is a part of a whole global technical diagnostic of building that includes a diagnosis of lead (only for residential buildings), diagnosis of asbestos, diagnosis of termites, diagnosis of interior installation of gas (only for residential buildings) and diagnosis of technological risks.

The energy performance diagnosis must be carried out by a person presenting guaranties of competence and having an organisation and appropriate resources. This person must be covered by an insurance against the consequences of his/her professional responsibility. It is also made obligatory to be independent and impartial. The criteria of competence will be defined by a decree.

The energy performance diagnosis will have only an informative value. The difference in other diagnoses, like the diagnosis termites or the diagnosis lead is that the purchaser or the tenant will not be able to prevail about it against the owner.

The decree that aims to define and specify the conditions of application of energy certification has not been published yet.

What is planned on the use of certification for building stock knowledge?

One conclusion reported on the climate plan 2004 (an action plan drawn up by the French Government to respond to the climate change challenge, firstly to comply with the Kyoto Protocol target by 2010 and, secondly beyond this date) is that there is a big lack on building stock knowledge about the characteristics of buildings in regard to 'energy consumption'.

A project is now under discussion on the possibility to collect all the certificates and the data behind the certificates to improve the building stock knowledge.

The project proposes that the expert, who performed the certification of a building, send the following electronic documents to a body established by the state:

– The certificate as defined at national level
– A document that contains all the information about the building, in particular the description of the building and its equipments, the use and the management of the building,
– Currently, the government is studying the feasibility of such a project from a legal point of view
– If it is impossible from a legal point of view to impose the collection of such information, the government will have recourse to surveys and investigations

What already exists?

Nothing.

6.5 Greece

The new regulation has not yet been published and there is no specific information. Thus, there is a lot of uncertainty. Through the certification, a database has to be created and maintained by the authorities. The database will include data collected on the building stock and would help to improve our knowledge of its present status. There are different ways to

[3] The date of application was moved to autumn 2006.

implement such an idea. The best is for each expert to collect the data and submit them electronically to the official database. For sure a control has to be implemented.

6.6 The Netherlands

The Dutch government aims to fully implement the EPBD by January 2007. Energy certification in the Dutch existing building stock (i.e. buildings built before 1997) will be based on the EPA (Energy Performance Advice), which has been in use as a voluntary instrument to calculate the energy performance of existing residential buildings (EPA-W, since 2000) and non-residential buildings (EPA-U, since 2004). Presently the calculation procedures are being optimised and they are expected to be ready by end of 2006. By that time a quality assurance system will be ready as well.

So, there are no quantitative results available yet of the official certification method that will be used in the framework of the implementation of the EPBD starting January 2007. However, as this method will be largely based upon EPA-W and EPA-U we can use results from these methods as an indication of results that the official method will produce. EBM-consult has been heavily involved in the development of these methods and also has executed energy audits and ratings on a large scale, particularly for the existing housing stock of a range of housing associations (on a strategic level). Data are available for about 60 000 dwellings of six housing associations which have been audited and rated in the period June 2004 – June 2005 using EPA-W version 4.0. And since June 2005 the work has been going on for other housing associations. For non-residential buildings audits and ratings have been executed using EPA-U but on a far smaller scale (100-200 buildings for the Ministry of Defence, small numbers of buildings for a range of other owners of non-residential buildings).

6.6.1 Existing residential buildings

As stated before, EBM-consult has available data on about 60 000 dwellings (audits date from June 2004 – June 2005) and an energy performance benchmark has been executed for this stock of dwellings. It has not been studied to what extend this amount of 60 000 dwellings is representative for the Dutch dwelling stock.

The energy performance of existing residential buildings has been expressed in the Energy Index (EI), which is defined according to EPA-W version 4.0, Formula structure version 1.0:

$$EI = 0.13 \frac{Q_{tot} \cdot A_{schil}}{56 \cdot A^2_{schil} + 0.06 \cdot Q_{tot} \cdot A_g}$$

where

EI	= Energy Index	[-]
Q_{tot}	= total energy consumption in standard conditions	[MJ]
A_{schil}	= area of thermal envelope	[m^2]
A_g	= usable floor area	[m^2]

Thus EI expresses the energy consumption independent of the measurements of a building (i.e. usable floor area and the area of the thermal envelope), which makes EI comparable for buildings with identical energy quality (i.e. identical energy measures like level of insulation, type of installations etc). When energy performance improves, EI goes down.

Table 10 shows the concept energy performance label (as published in 'De EPA-Adviseur' of July 2003, volume 2, no. 6) that was used when the 60 000 dwellings were labelled (June 2004 – June 2005). It consists of seven levels A-G, A representing the best energy performance (EI<0.60) and G representing the worst energy performance (EI>1.35). Table 10 also shows a benchmark of the energy performance (expressed by the EI) of 60 000 dwellings for which an EPA-advice has been produced.

Table 10. Benchmark of the energy performance of 60 000 dwellings owned by 6 housing associations according to a concept label (as published in 'De EPA-Adviseur' of July 2003,Vvolume 2, No. 6).

EI	0.60	0.75	0.90	1.05	1.20	1.35		
Label	A	B	C	D	E	F	G	Total
Benchmark	0 %	9 %	32 %	27 %	17 %	10 %	5 %	100 %

A wide range of other data (including calculation results of several energy saving scenarios) is available in a large database for these 60 000 dwellings, but no other benchmarks (than the one on the EI) have been produced so far. Apart from that the data base has been growing since June 2005 with over 15 000 other dwellings. So, it would be very interesting to execute an extended benchmarking study in the near future.

Note: Presently the energy performance label is being redefined. To some extend it will be similar to the concept label presented above. The final label is expected to be available by end of 2006.

6.6.2 Existing non-residential buildings

No data on the energy performance of existing non-residential buildings are available other than for individual buildings.

6.6.3 Further activities

Monitoring[4] files related to the EnergiePremie subsidy (until October 2003)

Until October 2003 a subsidy scheme ('EnergiePremie') was linked to the EPA for residential buildings. A bonus subsidy was available if energy saving measures were implemented based on an EPA-advice. In that case a 'monitoring file' for each dwelling, containing data about the building in its existing situation and in the new situation with energy saving measures, was to be sent to a central database. Over 600 000 dwellings received EPA-advice, so the database must contain about this amount of monitoring files. The monitoring files were used for checks of EPA-consultants and the subsidy procedure. These data could also be used for benchmarks, but it is not known if this has actually been done.

DATAMINE – IEE-project

In January 2006 a new IEE project was started called DATAMINE: Collecting Data from energy certification to Monitor performance Indicators for New and Existing buildings. The project aims to gain basic experience in data collecting and analysis on a practical level and draw conclusions for establishing harmonised monitoring systems.

[4] Monitoring plans based upon the new energy performance certificate (resulting from the implementation of the EPBD in 2007). The Dutch government has developed an approach for national monitoring, taking into account Energy Performance Certificates, but the documents are not final and therefore not publicly available yet. It is expected to become available in spring 2007.

* KWR - Kwalitatieve Woning Registratie

In the Netherlands a large scale study for the quality of the Dutch dwelling stock is being performed periodically (Kwalitatieve Woning Registratie - KWR). Since 1995 the energy performance of the dwellings is included as well. A statistically representative selection of 15.000 dwellings is being audited extensively addressing issues like technical condition, energy performance, safety, health, economic value. The energy performance has been calculated using the EPA-calculation method. From this study energy saving potentials for the Dutch dwelling stock have been derived, including the economic and energy saving consequences if all dwellings were to be upgraded to a certain level of energy performance. In 2006 the most recent KWR-study (now called: WoonON2006) is being executed.

Sources:

– Strategische analyse energieprestatie Haag Wonen – EBM-consult BV, L. Weevers, Juni 2005, reference: 050248
– Basismethode EPA versie 4.0 – Formulestructuur versie 1.0, Reference: 020740jo, Damen Consultants Arnhem BV, Ecofys BV, EBM-consult BV. November 28 2002.

6.7 United Kingdom

The government is planning to ensure a central database is established and maintained for energy certificates produced for the domestic sector. It is also considering a comparable scheme for non-domestic buildings. No details of these plans have yet been published.

7 Improved knowledge by use of certification schemes

Until now, only few European energy certification schemes have been launched. Still, it is possible to call 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. To refine the information collected in accordance with the new energy certification procedures, this chapter highlights important elements that can be used to improve building stock knowledge acquired through energy certification schemes. Most of the referred experience comes from the Danish Energy Certification Scheme, which has been mandatory since 1997.

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, both the principles of the framework and the approaches of the data collection are examined and pros and contras concerning different measures are listed. For each measure the pros are identified and discussed and then the contras. 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 embedded the text.

7.1 The framework for energy certification procedure

Either a national or a local authority could be responsible for the framework of building energy certification. Consequently, decisions concerning standardisation of data, use of specific forms, authorisation of energy consultants (auditors), and access to an authorised handbook are decisions that are left with this authority. Likewise, continuous quality control and public insight/access to the energy labels are important long-term issues for obtaining high quality of the building stock knowledge. See overview in Table 11.

7.1.1 Central authority

A central or local authority can be responsible for the energy certification procedure as well as the performance of the energy certification. The starting point of the certification scheme is on one hand the EU Energy Performance of Buildings Directive (EPBD) and thereby a demand for an energy certification scheme. On the other hand, the energy performance "should be calculated on the basis of a methodology, which may be differentiated to regional level" (EU, 2002, § 10). And "*in accordance with the principles of subsidiary and proportionality as set out in Article 5 of the Treaty, general principles providing for a system of energy performance requirements and its objectives should be established at Community level.* However, *"the detailed implementation should be left to Member States, thus allowing the Member States to choose the regime which corresponds best to its particular situation*" (EU 2002, § 21).

Going beyond the EU Directive, there are both pros and contras concerning the capability of central regimes to disseminate an energy certification scheme. A central (national) authority can by definition allocate more resources to implement a new certification scheme at all levels of the administrative hierarchy starting with legislation and set-up of a set of general rules for overall control of the scheme, reviews and information to end-users. Thus, a central authority may enforce fast dissemination of the scheme and a fast build-up of a high-quality database of building stock knowledge.

However, local authorities have very often the capability to adjust performance and data registration with respect to local building traditions and administrative practices. This means that the detailed implementation of the certification scheme in the member states can be left to regional and local authorities with advantage.

7.1.2 Standard forms for inspection

Central authority or not, standard forms will ensure uniform procedures, standard in-data and uniform calculation with the aim to obtain best possible building stock knowledge. Thus, the EU Commission has from the very beginning issued a mandate (M343) to the European standardization body (CEN) to support the implementation of the EPBD in order to develop standards covering different work items. To carry out this, five CEN Technical Committees have been assigned the task. Thirty-one standards are proposed and by now hearing versions for all are available. The formally approved versions will be available ultimo 2006, whereas publication will take place in April 2007 (Hogeling, 2005).

Standards will increase the accessibility, transparency and objectivity of the energy performance assessment. Furthermore, it is expected that standards for calculation methods and guidelines for inspection of boilers and indoor climate systems will reduce costs compared with developing and maintaining separate standards and guidelines at regional and national levels.

Nonetheless, it cannot be guaranteed that standards will always generate high-quality reports and high-quality data. In the EPBD applied standards it is important that the standards are flexible enough to allow for necessary national and regional differentiation. If not, the standard forms and standard data will either result in building certification reports that comply with the standards, but do not correspond with the actual buildings or reports that correspond with the actual buildings, but do not comply with the standards. This will provide wrong or at best not improved knowledge about the building stock. Put in another way, if building traditions or building administration in regions does not fit the way of thinking in the standardisation work, the implementation will be difficult. Moreover, a standard form usually cannot or only marginally adopt additional information.

7.1.3 Computer forms

Computer forms are suitable for both inspection and calculation, and it can be either online Internet connections or interactive programs on a stand-alone computer. Computer programs are by now in widespread use in consultants' circles. In Denmark, for instance, calculation programs have been in use since the introduction of the certification scheme in 1997. Computer programs for inspection will probably become widespread in the near future. Both kinds of computer forms ensure that the consultants follow specific procedures, remember all necessary input data and steps on the way toward a final certification and final calculation of a label index. Beside that, they provide a simple check of the validity of the entered data, e.g. if a value is within the physically possible range. Moreover, computer forms linked to one single calculating method ensure uniform results and thus open the possibility for easy administration of the data. Altogether, computer forms can be an important tool for obtaining high-quality data concerning building stock knowledge.

Nonetheless, computer forms make demands to the technology. First of all computer forms require permanent subscription arrangements or a web-based server software so that all changes resulting from fault finding or improving the program can be distributed continuously and records of changes kept in a central place. But still, if not all energy consultants take part in such arrangements, or if consultants and auditors are not used to using computers, the consultants must have their skills updated.

7.1.4 Appointment of energy consultants

In Denmark, authorisation of energy consultants has been part of the energy certification schemes since 1997. The certification has been linked to education programmes in order to ensure transparency and objectivity of the energy performance assessment and with the overall purpose of obtaining high-quality certification of the buildings. The education programmes have dealt with different subjects like general building knowledge, energy performance, data registration, data storage, and calculation. Depending on the educational background, whether engineering or architectural, the education programmes have focused on different subjects. Finally an examination has been carried out in order to give authorisation to those who pass. Thus, examination of future consultants, who are to issue energy labels, is certainly a way to improve the building stock knowledge.

In return, education programmes are expensive in time and money. If nevertheless, a certification scheme for energy consultants is the bottleneck that delays dissemination of the EPBD building certification, it might be better to offer on-the-job training. In this way certification can be initiated from the very beginning of the certification practice. The credibility and the quality of the building stock knowledge can thus be improved gradually in step with the number of trained consultants.

The level of knowledge and skills of the energy consultants should be well tuned to the required quality level of the Energy Performance Certificate and to the building stock knowledge that is to be derived from that. If a high level Energy Performance Certificate is to be produced then the requirements to the energy consultant should be high as well. If a simpler Energy Performance Certificate is sufficient then the requirements to the energy consultant can be less accordingly. Consequently we might expect to derive less knowledge, and/or knowledge of less quality, about the building stock from a more simple Energy Performance Certificate.

7.1.5 Handbook for energy consultants

Despite certification of energy consultants and education programmes, there is a daily need for knowledge for performing certification in accordance with the EPBD rules and national specifications. For that reason a handbook covering the general rules for certification and the rules decided at the national level for carrying out the certification, the inspection and the calculations, and the drawing up of the energy label is absolutely necessary. In Denmark the handbook is a central element in the education programme and examination leading to the actual authorisation of energy consultants. Furthermore, the handbook is a big help for the consultant in his/her daily work.

A handbook can either be an Internet version or a printed version or both. In either case the handbook should be approved by the authority as the official tool. Either a central or local authority can publish the handbook.

Except for the work of compiling and preparing the handbook, which requires high expertise, actually no disadvantages are connected with having a handbook. It takes time to compile an all-embracing handbook. Still, a small handbook is better than no handbook, and a small handbook can always be amplified. Especially, an Internet-based version can easily be continuously updated.

7.1.6 Quality control

Systematic quality control will raise the quality of reported data and probably improve data collection continuously. Particularly in countries with no authorisation of energy consultants or a systematic quality control procedure this will be useful. Even with certification of energy consultants, like in Denmark, quality control is necessary. Control prevents sloppy work and unfinished certification reports. At the same time, control can be used to identify systematic faults and for improvements of the assessment procedure. Several steps of quality control can be identified.

- Automated screening
- Electronic screening
- Manual screening
- Desk control
- Technical revision

Automated screening takes place when data are reported. In this way out-of-range data, unlikely data, and missing data can be identified. Electronic screening can be carried out by using a computer program that screens the whole database at regular intervals. Manual screening can be performed by statistical analysis and moreover desk control without inspection of the building either. In contrast, a technical audit of already issued labels, demand an inspection of the property by an authorised consultant. This auditing, usually based on spot control, can check data, documentation and proposals for energy saving measures as well.

Effective control is expensive and depends on the availability of high-quality expertise. Thus, if sufficient resources to perform a broad-spectrum control are not available, resources for automated control should be allocated. No other contras or disadvantages are identified with respect to quality control schemes.

7.1.7 Public access/insight

Like telephone numbers, taxable value of properties, building areas and other pieces of information, access to data concerning building certification is a way to ensure public quality control and to foster a growing interest in energy certification and its benefit. Moreover, if public insight is connected with a benchmark tool, it will put the labels of the owner's house into perspective and highlight relevant energy saving measures. To new purchasers of a house, benchmarks will be a standard of reference and make it easy to compare houses with regard to their energy performance. In Denmark a public Internet server for building knowledge (OIS) already exist. Still, energy labels or other information about the energy efficiency of buildings are not yet available.

Transparency of the energy label would need a more up-to-date and possibly continuous check by means of automated control (see above) as wrong values and poor information would lead to poor acceptance. In accordance with this, public access must be combined with a reply service so that public complaints can be answered and wrong data can be found and corrected. A problem with public access to energy certificates of buildings is that the energy performance of the building will be mixed up with the energy performance of the users of the building, i.e. life style and behaviour with regard to energy consumption. To prevent this, a reply service with FAQ at the Internet or telephone could be established.

7.1.8 Database structure and database management

Once the certification of the existing building stock starts running properly an enormous amount of EP Certificates is to be expected. It is important that the data base in which the data from the EP Certificate is to be stored have a well-considered structure. Before setting up the data base, its purposes and objectives have to be considered carefully. It must be flexible and extendable as objectives might change over time. Setting up and maintenance of a database is costly but a necessity.

When designing a database for EP certificates, it is crucial to ensure that it includes data that enables a unique identification of the certified building. The identifier should be the same as identifiers being used in other building related databases, e.g. the Danish building stock register number, the address, the title number in the land registry, or even the global positioning system coordinates. Such common information enables future use of different databases to compile new combinations of information for various purposes and thus achieve a certain level of synergy.

Table 11. Elements of the overall framework of certification with pros and contras regarding the building stock knowledge.

	Pro	**Contra**
Central authority	By definition, a central (national) authority can allocate resources to implement certification schemes at all administrative levels from legislation and set-up of general rules to overall control of the scheme, reviews and information for end-users. This facilitates fast dissemination of the scheme and fast build-up of a database of building stock knowledge.	Local authorities may be able to adjust design, performance and data registration with respect to local building traditions and administrative practices.
Standard forms	Standard forms for inspection will increase the accessibility, transparency and objectivity of the energy performance assessment and in addition ensure specific procedures and uniform calculation.	Standard forms require standardisation of data and can only with difficulty adopt additional information. Important knowledge concerning local building traditions could then be missed.
Computer forms	Computer forms for inspection and calculation ensure that the consultants follow specific procedures, remember all necessary data and steps. A standard calculating routine ensures uniform calculation.	Computer forms may require permanent subscription, for instance for use of the Internet. They also require stable Internet connection or at least consultants used to working with computers.
Authorised energy consultants	Authorised consultants based on education programmes and examinations ensure transparency and objectivity of the consultants' energy performance assessment.	High costs and slower dissemination.
Use of handbook	A handbook is an important tool for the authorised energy consultant to carry out the inspection, making calculations and drawing up of the energy label in a standardised way.	Publishing of a handbook requires both expertise and resources in the form of time and money.
Quality control	Different kinds of checks like automated and manual screening on one hand and technical auditing by inspection at the property on the other are important measures for obtaining high-quality building stock knowledge.	Quality control requires extra resources. At least computer-aided control functionality must be granted.
Public access	Public access to data concerning building certification is a way to obtain quality control and to gain interest for energy certification and its benefits on relevant energy saving measures. Possibility for new purchasers of a house to compare houses with regard to their energy performance.	Public access requires up-to-date check of data, and a reply service in order to prevent confusion and non-acceptance of the energy certification system.

7.2 Approaches to data collection

Next to the overall framework for the energy certification scheme, the approaches for collection of data are most important. It must be considered whether a general framework for calculation of an energy certificate must rely on asset rating (building registration and computation) or on operational rating (meter reading and standardisation) in order to obtain high-quality building stock knowledge (see Figure 23). And independent of asset- and operational rating is the item of establishment of a database for data collection. For the different approaches, see pros and contras in Table 11.

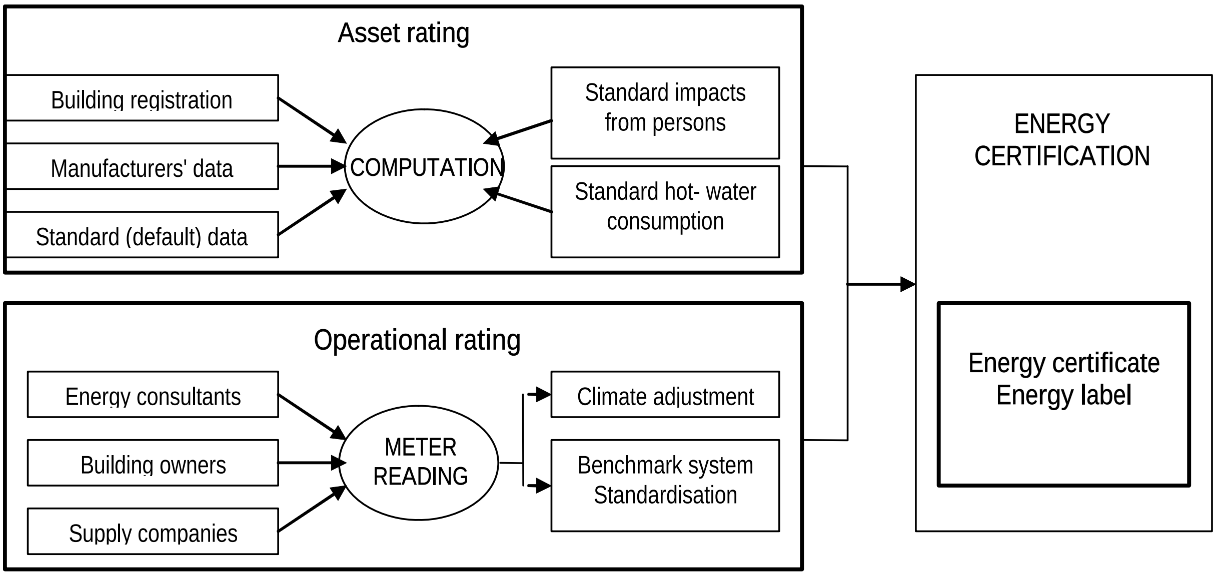


Figure 23. Route diagram showing the data flows needed to carry out an energy certificate.

7.2.1 Use of asset rating

From an ideal point of view, asset rating, e.g. building registration, calculation of heat losses through the thermal envelope, consumption for domestic hot water, consumption of mechanical cooling etc. is the best solution for obtaining knowledge of the energy performance of the building stock. In this way it is easy to make a break-down of consumption into single contributions from the individual elements of the energy balance for the building. It is easy to make adjustments to a standardised use of the building and moreover it is easy to estimate savings. Last, but not least, this is the most adequate estimation in relation to the concept of energy performance, as provided in the EBPD.

Nonetheless, asset rating does not only depend on a reliable computation tool. A lot of data, of an acceptable quality, must be available. In this procedure standard data concerning the building physics can be helpful. These data may come from manufacturers, general research or a combination. An incentive for the manufacturers to deliver all data on building components and all energy consuming appliances may be necessary to make them visible directly in the computation program. Still the computation tool must also be able to handle data relevant to old buildings. Here standard data coming from old building regulations, building research, for instance by means of statistical analysis, are indispensable. Finally a realistic computation cannot be carried out without inspection of the physical building. On the inspection, detailed registering and measuring may be a necessity.

To summarise the disadvantages of this approach, calculation has a considerable demand of manpower. Therefore, this approach is the most expensive, especially concerning large buildings. Moreover, it depends on a corps of well-educated energy consultants, a reliable database representing almost all existing building components and appliances. Last but not least, asset rating needs an agreement on a specific computation tool. See Table 12.

7.2.2 Use of operational rating

Reliance on operational rating of the energy consumption gives an immediate picture of the actual energy consumption. The method is cheap and it is possible to use automated readings. This approach, however, focuses on both the energy efficiency of buildings and the energy behaviour of users. A standard use of the building must be defined and different kinds of corrections are needed in order to relate to this. Readings of heating or cooling must be further adjusted in accordance with climate data of the actual year. Thus climate adjustments ensure that the influence of the actual climate in a specific year is eliminated. However, climate independent consumption, e.g. electricity consumption, must be kept out.

To emphasise: operational rating depends on meters. Without meters, there is no reading to base the operational rating on and no certificate can be issued. Data logging and online meter reading can be very valuable for estimating a "true" consumption, and relating to standard use. For large buildings, where the individual aspects of use are reduced and the efforts to establish a label based on calculation are difficult, certification based on authorised meter reading is obviously an advantage.

To summarise the disadvantages of this approach, data collection based on operational rating and thereby meter reading require reliable meters, or better high-technological meter reading and possibly reliance on cooperativeness of utilities. Then reliable, local or regional climate data is needed. What is more, meter readings mix up building efficiency and users' behaviour. Therefore some kinds of standardisation by means of correction parameters are needed. And finally, if building certification depends on meter reading only, it is difficult to identify energy saving measures as user behaviour and building performance are mixed up.

7.2.3 Combining asset and operational rating

It is possible to combine asset rating and operational rating. The simplest approach for data collection is operational rating based on meter reading reported by the building owner. Less simple and more reliable is operational rating based on meter reading reported by the utility companies. Meter reading controlled and adjusted for standard use and standard climate is a yet more advanced level, but also more expensive. Next level of advance is meter reading combined with authorised inspection of the building. In this way, unreliable meter readings can be corrected and relevant energy saving measures identified. At the top of the quality steps of advance is asset rating based on building inspection and standard, default data. Certainly, the top quality steps imply more manpower, more basic building information and calculation facilities and consequently more costs than the bottom steps. As mentioned, certification of small building speaks in favour of calculation and large buildings in favour of meter reading.

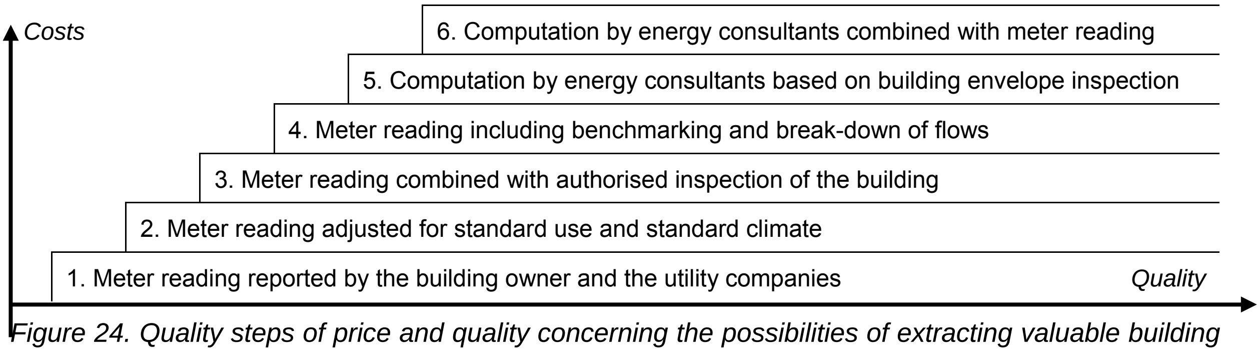


Figure 24. Quality steps of price and quality concerning the possibilities of extracting valuable building stock knowledge of certification and certification schemes. Full operational rating starts from stair 2 whereas full asset rating starts from step 5.

7.2.4 Establishment of database

Regardless of the data collection approach, the establishment of a database must be decided upon. In this several levels of ambition may be considered.

- All data registered for each certification are collected in one central database.
- Different parts of the data delivered by specific partners, like local authorities, utility companies and manufacturers of building materials will be due to databases delivered by these partners.
- Only part of the data is registered in databases.
- No data are registered in databases.

The advantage of a central database is an overall access to new and old data concerning all aspects of building stock knowledge. Not only research, but also statistical analyses and recommendations to the local and central politicians might benefit from these sources. In return, decentralised data registering is cheaper. The distributed database managers will take care of the data, and probably be the best to evaluate parameters within their expertise as well. If only parts of the data are registered in databases or the registering does not take place at all, the price will be low. However, this will not provide data for increased building stock knowledge.

Table 12. Two approaches to data collection, and an approach to data registering.

	Pro	Contra
Use of asset rating	Reliance on registration and computation makes it easy to make a break-down of energy consumption into single contributions. Easy to make adjustment to standardised use of the building and to estimate energy savings.	Expensive. Depends on a corps of well educated energy consultants, and agreement on a specific calculation method. Not necessarily useable for large buildings.
Use of operational rating	Reliance on meter readings gives a realistic picture of the energy consumption. The method is cheap, and it is possible to use automated readings. Focuses on energy efficiency of buildings and energy behaviour of users as well. Data logging of online meter reading is of great value to estimate a "true" consumption, not least concerning large buildings.	Data collection based on meter readings mixes up building efficiency and users' behaviour. Moreover, it depends on the existence of meters, or better meter readings or credible reports from supply companies. Standardisation is needed. Difficult to identify energy-saving measures.
Establishment of database	A central database will give access to new and old data and provide information for different aspects of the building stock knowledge. This will give material not only for research and statistical analyses but also form the basis for political recommendations.	Decentralised data registering is cheaper and the distributed database managers will be the best to evaluate its parameters. Partly data or no-data registering will be cheapest, however, this will not provide data for the general improvement of building stock knowledge.

7.3 Building stock knowledge and energy savings calculations

Energy certification schemes are looked upon as vital sources for gathering information about the energy standard and performance of existing buildings. If data are collected 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 savings potential was compiled from two separate databases.

One database was the nation wide building stock register, which holds all the general information about buildings such as: construction year, build-up area, floor area, main use, external constructions material, primary heating source, etc. The main purpose of this register is to collect taxes and create a general overview of the building stock for the local municipality. It is the municipality who updates the database but the building owner who is responsible for reporting changes in the building to the municipality.

The other databases originate from the mandatory energy certification schemes of existing buildings that have been operating 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 was based on calculated energy consumptions. The information about the thermal envelope, gathered in the EM scheme, was thus the most 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, windows) which again were divided into different sub-types. 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 the building tradition in different Danish building types over time and energy requirements in the different building codes.

In the Netherlands a large scale study for the quality of the Dutch dwelling stock is being performed periodically since 1995 (Kwalitatieve Woning Registratie - KWR). Since 2000 the energy performance of the dwellings is included as well. A statistically representative selection of 15.000 dwellings is being audited extensively addressing issues like technical condition, energy performance, safety, health, economic value. The energy performance has been calculated using the EPA-calculation method. From this study energy saving potentials for the Dutch dwelling stock have been derived, including the economic and energy saving consequences if all dwellings were to be upgraded to a certain level of energy performance. In 2006 the most recent KWR-study (now: WoonEnergie 2006) is being executed.

By implementation of the European Energy Performance in Buildings Directive (EPBD) in 2006, Europe has an excellent opportunity to improve the general building stock knowledge, and in some years to perform a global evaluation of the energy savings potential in existing European buildings. There is though some information that must be recorded in a structured way to enable such an evaluation. This recommended minimum required information is listed in the table below.

Table 13. Future evaluations of the energy savings potential in existing European buildings requires a minimum set of information to be recorded in the new European certification schemes.

Building part	**Recommended minimum information to record in energy certification schemes with calculated energy consumption**
Building	Build-up area and heated floor area, number of floors. Construction year and year for major renovations. Location of the building (climate zone). Recorded energy – separated per 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 incl. any shading objects. Thermal bridges (length/size, transmission coefficient). Thermal storage capacity of the building.
Systems	Primary and secondary heating system (incl. efficiencies and location). Ventilation system including an estimate of the natural and mechanical ventilation rate. Cooling system (incl. efficiencies and location). Heating and cooling distribution systems (pipe length, insulation level, location). Domestic hot water production (incl. location and distribution).
Default values	Internal loads (persons, equipment, lighting, etc). Domestic hot water consumption (based on persons and/or floor area).

ANNEX: ENPER-EXIST questionnaires

Annex A holds the answers from the building stock knowledge questionnaire circulated among the ENPER-EXIST project partners. This questionnaire was circulated after a pre-questionnaire among the ENPER-EXIST partners, set up to investigate the possibility of finding information making it possible to estimate the potential energy savings in different sectors of the existing building stock.

Annex B holds a blank pre-questionnaire that contained questions like *if you were asked to give <some energy related question>, would you then be able to provide this information.* Given the answers from the pre-questionnaire, it was decided to circulate the real questionnaire only among the participating countries of the ENPER-EXIST project.

A.1. Belgium

Answered by: Heert Houvenaghel
Belgian Building Research Institute
e-mail: geert.houvenaghel@bbri.be
Date: 22.02.2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock - number and area.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Type, residential and non-residential	Number of buildings expressed in 1000 units	Σ area expressed in 1000 m²	Percentage of the total area (residential / non-residential)	Information source
Residential:				
Single family houses	1288	unknown (2)		statbel.fgov.be
Attached houses	716	unknown (2)		idem
Row houses	974	unknown (2)		idem
Multifamily houses	131 (1)	unknown (2)		idem
Other types:				
unknown single family house	20			statbel.fgov.be
caravanne	7			statbel.fgov.be
other undefined house	16			statbel.fgov.be
unknown type	25			statbel.fgov.be
Total residential	**4227 (3)**	**301980**		
Non-residential:				
Offices	unknown (4)			
Education	unknown (5)	unknown (5)		
Hospitals/health care	unknown (6)	unknown (6)		
Hotels/Restaurants	unknown (7)	unknown (7)		
Farm houses	unknown (8)	unknown (8)		
Factories / workshops	unknown (9)	unknown (9)		
Total non-residential	**unkown**	**unkown**		

Comments: General remarks on the questionnaire are given in the document general remarks. Some data can not been given for the moment in the expected format, therefor we refer to specific documents which contain relevant data.

(1) 130671 buildings represent 955563 living units.

(2) There are no specific data available about the surface, but distributions of surface and of surface against age are available. Most energy consumption studies take this as a starting point.

Occupied private housing spaces by surface (expressed in 1000 units):

total	< 35	35-54	55-84	85-104	105-124	> 125	no answer	surface / inhabitant
4084	326	714	1021	815	476	364	368	33.7 m²

(*) no answer is not taken into account in the average surface per inhabitant

(3) All data are based on the national enquete of 2001, except the number of buildings for multi-family houses which is based on the numbers of the national registration system (Cadaster). The latter does not include that a building is counted twice when it is extended over two administrative parcels.

(4) The number and surface of offices is unknown. For the Brussels regions some numbers of buildings are available, also the number of newly constructed surface area is available for the whole country. Studies estimate the area of offices in the Brussels region at 10 to 12000000 m². [Vereniging van de Stad en de Gemeenten van het Brussels Hoofdstedelijk Gewest, Overzicht van het kantorenpark] [websites of real estate companies]

(5) The number of school buildings is unknown, even the overall surface area is unknown until now. On the other hand there are data available for the number of institutions and the number of pupils.

6202 schools, 2224005 pupils, students and university students

[http://www.eurydice.org/Eurybase/Application/frameset.asp?country=BN&language=VO]

9898 schools (higher non-university and university institutions are not included), 2224005 pupils, students and university students [several references at the official websites of the Flemish, French and German communities]

10704 schools

[http://www.onssrszlss.fgov.be/Onssrsz/NL/Statistics/Brochures/Yellow/2003/pdf/tabellen_2003_nl.pdf]

Some studies seem to show a relation between the type of education and the energy consumption, depending on the age/type of the students and the organisation responsible for the education.

(6) The number of buildings is unknown, even the overall surface area is unknown until now. On the other hand there are detailed information about the number of hospital beds and beds in other types of institutions.

1464 institutions for 121048 beds, also homes for elderly people are included in the study. The number of beds varies significantly with the type of health care institutions. Detailed numbers for each type of health care institution are available.

[https://portal.health.fgov.be/portal/page?_pageid=56,512866&_dad=portal&_schema=PORTAL&_MENU=menu_4]

149 hospitals for 55352 beds [http://statbel.fgov.be/pub/d3/p363y2003_nl.pdf]

(7) The number of buildings is unknown, even the overall surface area is unknown until now. On the other hand there is detailed information about the number of hotels and restaurants.

Tourism and hotels: 3538 institutions with a total capacity of 442946 persons. In this number also youth houses for summer camps etc are included.

http://statbel.fgov.be/figures/d73_nl.asp#Verdeling_per_logiesvorm

Hotels and restaurants: 22413 institutions are registered at the TVA services

http://www.onssrszlss.fgov.be/Onssrsz/NL/Statistics/Brochures/Yellow/2003/pdf/tabellen_2003_nl.pdf

Bars, pubs, discos, camping, hotels : 33733 institutions: http://statbel.fgov.be

(8) The number of buildings is unknown, even the overall surface area is unknown until now. On the other hand there is detailed information about the number of exploitations and the type of exploitation. The surface area of greenhouses is known.

(9) The number of buildings is unknown, even the overall surface area is unknown until now. On the other hand there is detailed information about the number of exploitations and the type of exploitation.

(10) The industrial markets are estimated at 14.2 million m² for the whole of the provinces Antwerp-Limburg and Vlaams-Brabant. The industrial markets are defined as ?????. The same studies estimate the offices at 778000 m² in the Antwerp and Mechelen area and at 12076274 m² in the Brussels area. These studies do cover the most important economical centres, but are far from complete for the whole country. (Kingsturg real estate company).

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock - energy.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Summary of the available information about energy consumption in the existing building stock dependent on type

Type, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential:					
Single family houses					
Attached houses					
Row houses					
Multifamily houses					
Total residential					
Non-residential:					
Offices					
Education					
Hospitals/health care					
Hotels/Restaurants					
Farm houses					
Factories / workshops					
Total non-residential					

Comments: There are no overall energy consumption numbers available for the whole country.

The available information is:

1) The total energy and electricity consumption per sector, but not subdivided in heating and cooling. The electricity consumption could be known by the registration company but they do not deliver their numbers. There is no information available for the hot water use. This energy consumption is always included in the overall energy consumption. If numbers of energy uses are available, they are never expressed in energy use per square meter.

2) For the different regions there are 'typical' energy consumption numbers which are based on a question nary on a set of buildings. These sets are nevertheless not necessarily representative for the whole building stock. No extrapolations are made to the whole building stocks; at best some averages are made in terms of energy consumption per m² or per student. The studies are done for the three regions, which makes that overall numbers for the whole country are not available.

   Relevant references are:

   1. For the Flanders region:

http://www.milieurapport.be/Portals/sitesource/uploads/miradata/MIRA-T/01_SECTOREN/01_02/AGHUISHOUDENS_2005_OKTOBER_ONTWERPVERSIE_WEBSITE.PDF

http://www.emis.vito.be

2. For the Walloon region:

   http://energie.wallonie.be/xml/doc-IDC-3205-IDD-10018-.html

3. For the Brussels region:

   http://www.ibgebim.be/francais/contenu/content.asp?ref=1887

3) The final energy consumption per capita in the residential sector is estimated at 1.02 toe/capita. The energy consumption per capita in the residential sector is estimated at 2300 kWh/capita. In the tertiary sector the energy consumption per employee is about 1.42 toe per employee and the electricity consumption about 4100kWh/employee. All numbers are corrected for a standard European climate.
http://www.ceps.be/files/IDDRI%20-%20Sectoral%20emission%20trends%20in%20Europe.pdf

4) A detailed study of the energy consumption based on modelling and measurements can be found in:
http://mineco.fgov.be/energy/rational_energy_use/report_annex.pdf
http://mineco.fgov.be/energy/rational_energy_use/report.pdf.
Unfortunately the m² of households and offices is unknown in this study. Under-laying table gives an overview of the energy consumption of the households and the residential sector. All data are given for 2001 as a reference year.

4.1. HOUSEHOLDS

4.1.a. Total energy consumption per end-use expressed in 1e^{10} kWh/year

Heating =	8.385
Hot water =	1.349
Cooking =	0.523
Specific electricity =	0.930
TOTAL =	11.188

4.2. TERTIARY SECTOR

4.2.a. Total energy consumption per end-use expressed in 1e^{10} kWh/year

Thermal uses =	3.861
Electric specific =	0.67
TOTAL =	4.640

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock – energy savings.xls*") to collect the different information **and** make an area-weighted summary in the table below. If you have used the *Existing stock – energy savings* Excel sheet, please return this also!

Summary of typical heat savings in the existing building stock dependent on type.

Type, residential and non-residential	Savings [PJ]	Savings [PJ]	Savings [PJ]	Savings [PJ]	Savings Total [PJ]	Information source
Construction period						
Residential:						
Single family houses						
Attached houses						
Row houses						
Multifamily houses						
Total residential	**27.21**					**1**
Non-residential:						
Offices						
Education						
Hospitals/health care						
Hotels/Restaurants						
Farm houses						
Factories / workshops						
Total non-residential						

1) http://mineco.fgov.be/energy/rational_energy_use/report.pdf

Comments on the table: The specific data for potential energy savings are lacking, most reports are comparing the CO2-emissions in stead of primary energy consumptions. Nevertheless some studies are made on a few prototypes of buildings and offices in order to evaluate the potential energy savings, although these studies are never extrapolated to the complete building stock. e.g. [http://www.belspo.be/belspo/home/publ/rappAS_en.stm] ?

A detailed study of the energy consumption based on modelling and measurements can be found in:

http://mineco.fgov.be/energy/rational_energy_use/report_annex.pdf

http://mineco.fgov.be/energy/rational_energy_use/report.pdf.

In this study three possible scenarios are used: a reference scenario, a benchmark scenario (BMS) and an economical potential scenario (EPS). The reference scenario implies no changes in the energy policy but takes into account socio-economical evolutions. The BMS applies technologies which are introduced in other countries taking into account the economical, social and … barriers. The EPS model is a comparison with best practice, i.e. this model does not take the eventual barriers into account. We took the potential energy savings for 2012 as data. This model did take into account the variation of the socio-economical parameters concerning energy consumption.

If no specific measures are taken (reference scenario) the energy use in 2012 would augment with 59.03 PJ for heating, 12.98 PJ for hot water, 0 PJ for cooking and 79.95 PJ for specific electricity with reference to 2001. In the BMS model the energy use will decrease with 3.77 PJ for heating, increase with 12.98 PJ for hot water and 0PJ for cooking and decrease with 0.87 PJ for specific electricity with reference to 2001. In the EPS model the energy use will decrease with 27.21 PJ for heating, increase with 12.98 PJ for hot water and 0 PJ for cooking and 4.61 PJ for specific electricity with reference to 2001.

For the tertiary sector the same scenarios are used. With no change in the policy, the thermal energy use increases with 2.93 PJ and the specific electricity use with 8.79 PJ in 2012 with respect to 2001. In the BMS model the thermal energy use increases with 7.11 PJ and the specific electricity use with 5.02 PJ with respect to 2001. In the EPS model, the thermal energy use decreases with

12.14 PJ, and the specific electricity use decreases with 5.02 PJ in 2012 with respect to 2001. The tertiary sector includes HoReCa, health care, offices and administration and others.

In which categories of the building stock are the highest potential and how much? In the residential sector there is a huge energy saving potential since both the energy use for heating and the electricity use are high compared to other European countries, taking into account the local climate. The bad average insulation quality of the existing building stock, in which elder dwellings are an important fraction, makes this category has a high energy saving potential. The same remark can be made for the tertiary sector. The overall primary energy savings by 2020 are estimated at 18 up to 25 % compared to a scenario with no changes in energy policy. This number includes as well residential as tertiary sector as industry and traffic. For a more detailed discussion we refer to the numbers mentioned here above.

In which categories of the building stock are the highest potential and how much? In the residential sector there is a huge energy saving potential since both the energy use for heating and the electricity use are high compared to other European countries, taking into account the local climate. the bad average insulation quality of the existing building stock, in which elder dwellings are an important fraction, makes this category has a high energy saving potential. The same remark can be made for the tertiary sector. The overall primary energy savings by 2020 are estimated at 18 up to 25% compared to a scenario with no changes in energy policy. This number includes as well residential as tertiary sector as industry and traffic. For a more detailed discussion we refer to the numbers mentioned here above.

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

Describe: The data missing in Belgium in order to be able to make these assumptions are:

1. A better statistical description of the current building stock. in hardly any sector the knowledge of the existing building stock is of a format useful to make energy consumption predictions. Number of buildings, age of the building stock and surface of the building stock are lacking.
2. A better statistical description of the current energy uses in order to calibrate models and to get a better idea about the different fractions of energy uses.

Results from national investigations

Results from national investigations of 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

Describe: This answer is based on email correspondence with:

- the administration of the Brussels Region. It is clear that the administration can prepare well documented proposals on energy requirements, the final decision is made by the politicians which seem to be more difficult to convince with general or global numbers but who like very basic and applied information.
- the administration of the Flemish Region
- the cabinet of the Flemish Minister of Energy

While the Flemish Region has already implemented the EP philosophy in the energy regulations on buildings, the Brussels Region still is in the studying phase.

The Walloon Region, which still did not implement the EP philosophy, did not answer on the questions.

Generally spoken, the data on which decisions are based regarding energy requirements in building regulations are obtained by specific studies carried out by research institutes on behalf of the administration or government. The partners in these studies are mostly the BBRI, the universities and engineering consultants.

The Brussels region described the requirements of the data they were looking for:

1. Technical feasibility,
2. Economic rationality,
3. Tangible environmental benefits,
4. Acceptability by the professionals.

This means they need technical, economical and environmental data on the various ways to reduce energy consumption. Such data are collected as a part of studies actually being made in order to help to determine the energy requirements in Brussels.

Not only the data are needed, but also tools to make a kind of cost/benefit analysis of the different energy saving measures and their combinations.

Such studies are actually being made in order to help to determine the energy requirements in the Brussels Region. On the other hand there are studies and numbers available from research institutes, or national/regional think-tanks (cf. Planbureau, …)

The Flemish Region added as sources the study of countries which had already implemented the EP directive and discussion sessions with the building partners and sector's representatives.

How and where are these data found?

Describe: The major sources of data are:

1. Data provided by research institutes who carry out studies on behalf of the administration

2. Data provided by other administrations or form the nation enquiry of 2003. These data consider the amount of dwellings, the insulation level of dwellings, etc.

3. By studying the impact of the EP regulation in countries which did already imply the methodology in their energy regulations for buildings.

Which data do decision-makers miss when making new energy requirements?

The answers to this question can be used as guidance for which data should be collected in the certification schemes.

Describe: Both regions mention that tools and models in order to make a cost-benefit analysis and to calculate pay-back times are lacking in order to make more funded decisions as far as energy requirements are concerned.

The Flemish region also found that data about the existing building stock and about the energy use in different building types are lacking.

The Brussels administration mentions that it stays difficult to convince the real decision-makers that imposing energy requirements by regulation may be beneficiary for the population in what they call 'the real world'. Therefore it is necessary to have some real case studies of successful buildings showing:

1. What measures have been taken?
2. What has been the cost?
3. What are the real returns (as measured) : environmental benefits AND reduction of the actual energy costs, compared to a baseline scenario. Other side benefits should be documented too: comfort, …

These studies should also allow concluding that the energy saving measures which have been taken is financially worthwhile (relatively short return of the investment time).

FLANDERS REGION

De MINA-council (milieu en natuurraad van Vlaanderen) is able to produce studies; advices and recommendations on demand of the Flemish government or parliament, or on it's own initiative. In some cases the Flemish government is obliged to ask MinNa's advice : for proposals of law (decrete) concerning the environment or nature, the environmental policy and financial policy linked to it, about environmental quality codes and 'uitvoeringsbesluiten' concerning energy and mobility, …

These studies can be done by the MiNa-council itself or can be done on behalf of MiNa by other partners: universities or research institutes as VITO.

Next to the study component the council also links the environmental partners with the social partners, which makes that if they advice by unanimity that the government knows that the solution or proposal is widely supported by all elements of the society.

WALLOON REGION

The Conseil Wallon de l'environnement pour le Devéloppement Durable (www.cwedd.be) is a consultative concil which advices the public authorities in the Walloon region concerning environmental and durabile development questions. The CWEDD is a representation of all social groups. It is the equivalent of the MiNa-raad in the Flanders region.

BRUSSELS CAPITAL REGION

The RLBHG (Raad voor het Leefmilieu van het Brussels Hoofdstedelijk Gewest) or CERBC (Conceil de l'Environnement de la Région Bruxelles-Capitale) has a similar function for the Brussels Capital Region.

A.2. Denmark

Answered by: Kim B. Wittchen and Kirsten Engelund Thomsen
Danish Building Research Institute
e-mail: kbw@SBi.dk and ket@SBi.dk

Date: 3 and 25 February 2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock - number and area.xls"*) to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Types, residential and non-residential	Number of buildings expressed in 1000 units	Σ area expressed in 1000 m²	Percentage of the total area (residential / non-residential)	Information source
Residential:				
Single family houses	1064	151219	49.8	BBR
Detached houses	124	21924	8.3	BBR
Row houses	182	29650	10.5	BBR
Multifamily houses		80147	25.8	BBR
Other types				
Students hostels		1366	0.4	statistikbanken
Summer cottages		14392	4.6	statistikbanken
Total residential		**298698**		
Non-residential:				
Offices	73.5	62171	18.2	statistikbanken
Education	18.2	23519	6.5	statistikbanken
Hospitals/health care		3829	1.2	statistikbanken
Hotels/Restaurants		5946	1.9	statistikbanken
Farm houses		134175	43.3	statistikbanken
Factories / workshops	70.9	55420	17.1	statistikbanken
Other types (make a new line for each type)!				
Supply buildings		3415	1.1	statistikbanken
Other production		3900	1.3	statistikbanken
Transport and garage		5522	1.8	statistikbanken
Unspec transp.& trade		1208	0.4	statistikbanken
Library, museum, church		4490	1.4	statistikbanken
Daycare		3163	1.0	statistikbanken
Un-spec. institution		3299	1.1	statistikbanken
Unspec. holyday		746	0.2	statistikbanken
Sports facilities		5277	1.7	statistikbanken
Unspec. lesure act.		1668	0.5	statistikbanken
Total non-residential		**317848**		

Comments: BBR: Extract of residential buildings from the Danish Building register for to investigate the composition of Danish residential buildings to be able to evaluate the potential energy savings by refurbishment.

statistikbanken: www.statistikbanken.dk free of charge on-line information from Statistics Denmark.

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - energy.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Available information on energy consumption in existing building stock dependent on type

Types, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential:					
Single family houses	107	0	16	43	EM
Detached houses	107	0	13	43	EM
Row houses	107	0	11	43	EM
Multifamily houses	81	0	19	32	EM
Total residential					
Non-residential:					
Offices	277	?	?	112	ENS
Education					
Hospitals/health care					
Hotels/Restaurants					
Farm houses					
Factories / workshops	584	?	?	175	ENS
Total non-residential					

Comments: EM: Energy certification scheme for small buildings. The scheme was in effect in Denmark from 1996 to 2005. A building should be labelled when it was sold if a current label was more than 5 years old or not existing.

ELO: Energy certification scheme for large buildings (+1500 m²), have been running in Denmark from 1996 to 2005. Every large building should be labelled once a year.

ENS: Free information source on www.ens.dk about energy consumption on different sectors.

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock – energy savings.xls*") to collect the different information **and** make an area-weighted summary in the table below.

Summary of typical heat savings in the existing building stock dependent on type.

Types, residential and non-residential	Savings [PJ]	Savings [PJ]	Savings [PJ]	Savings [PJ]	Savings Total [PJ]	Information source
Construction period						
Residential:						
Single family houses					13478	SBi 057
Detached houses					4159	SBi 057
Row houses					2382	SBi 057
Multifamily houses					9379	SBi 057
Total residential					**29398**	
Non-residential:						
Offices						
Education						
Hospitals/health care						
Hotels/Restaurants						
Farm houses						
Factories / workshops						
Total non-residential						

Comments on the table: SBi 057: Analysis of the heating saving potential in exiting dwellings (In Danish). Danish Building Research Institute. By og Byg Documentation 057.

In which categories of the building stock are the highest potential and how much?

Single family houses have the highest potential, not because they are poorly insulated, but because of the number of units. The highest potential is for single family houses constructed before 1930 and from the period from 1960 to 1972.

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

Most of the needed data are available from the EM certification scheme and the ELO certifications scheme. Data needs to be extracted and compiled from the two databases. This has not been done on a general basis, but we hope to be able to conduct such a study in the future.

Results from national investigations

Results from national investigations of: 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

Interview February 2006 with Ejnar Jerking, ENS.

There are requirements when a building is renovated in a major way. The definition of a major renovation is taken from the EPBD (25 % of the value of the building or more than 25 % of the thermal envelope). Furthermore it is required that some individual, profitable measures have to fulfil the requirements, regardless the size of the renovation.

Individual measures are:

- Insulation of external walls when changing rain shield,
- Insulation of attic and roof when changing roof,
- Change of boilers,
- Change of heat supply,
- Requirement in case of changing windows in a facade.

If people can't find out implementing cost-effective energy saving measures by themself, the new energy requirements in the Building regulations will "help" them. There is no "Building permit" needed and no public control.

If a building is erected legally, then it is regarded legally always. DK will probably not get any energy frame requirements for existing buildings, so it is up to the building owner to decide (despite the existing rules for components and major renovation).

How and where are these data found?

BBR: The Danish Building Register showing the composition of Danish residential buildings to be able to evaluate the potential energy savings by refurbishment. Danish Building Regulation has since 1966 contains energy requirements.

Which data do decision-makers miss when making new energy requirements?

Existing building stock: As DK probably will only have component energy requirements in the building regulations, there are no specific wishes to that part. Anyhow an important issue is the energy saving campaigns where it is necessary to know the energy saving potential (e.g. how many buildings have wall insulation and with which insulation material). Also when giving subsidies, it is crucial to have a more detailed statistical knowledge of the existing building stock concerning construction and installation. Furthermore it is important for the market (e.g. developers) to know the existing situation when they shall make new development and decide renewal of the market

A.3. France

Answered by: Rofaïda Lahrech
CSTB
e-mail: lahrech@cstb.fr
Date: February 2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - number and area.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Type, residential and non-residential	**Number of buildings expressed in 1000 units**	**Σ area expressed in 1000 m²**	**Percentage of the total area (residential / non-residential)**	**Information source**
Residential: Single family houses Attached houses Row houses Multifamily houses				
Other types:				
* Single family houses (main home)	14050			1
*flat in collective building (main home)	10782			1
* Single family houses (second home)	1942			1
Flat in a collective building (second home)	1040			1
Single family houses (vacant)	1037			1
Flat in a collective building (vacant)	1006			1
Total residential	**29857**			
Non-residential:				
Offices		176912		1
Education		168148		1
Hospitals/health care		95983		1
Hotels/Restaurants		55191		1
Farm houses				
Factories / workshops				
Other types (make a new line for each type)!				
Commercial		190625		
Transport		24477		
Other		54145		
Total non-residential		**828 452**		

Comments:
1) CEREN (in Chiffres clés du bâtiment 2nergie - Environnement, édition 2004-ADEME).

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - energy.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Summary of the available information about energy consumption in the existing building stock dependent on type

Type, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential: Single family houses Attached houses Row houses Multifamily houses					
Other residential (all) * Single family houses (after 1975) * single family houses (before 1975) f Flat in a collective building (after 1975) Flat in a collective building (before 1975)	 150 * 197 * 89 * 193 *		 19 19 20 27	 27 21 23 29	 1 1 1 1
Total residential					
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops	 166 118 155 179			 120 * 16 * 67 * 80 *	
Other types Sport Commercial Transport Other	 146 119 167 128			 61 * 126 * 159 *	
Total non-residential	**141**			**83**	

Comments: For non residential building: available data: heating + DHW (shown in column heating) and other uses (shown in column electricity).

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock – energy savings.xls*") to collect the different information **and** make an area-weighted summary in the table below. If you have used the *Existing stock – energy savings* Excel sheet, please return this also!

Summary of typical heat savings in the existing building stock dependent on type.

Type, residential and non-residential	**Savings [PJ]**	Savings **[PJ]**	Savings [PJ]	Savings [PJ]	Savings Total **[PJ]**	**Information source**
Construction period						
Residential: Single family houses Attached houses Row houses Multifamily houses						
Total residential						
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops						
Total non-residential						

In which categories of the building stock are the highest potential and how much?

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

Results from national investigations

Results from national investigations of 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

How and where are these data found?

Which data do decision-makers miss when making new energy requirements?

A.4. Germany

Answered by: Heike Erhorn-Kluttig
Fraunhofer Instittute of Building Physics
e-mail: hk@ibp.fhg.de
Date: 8 May 2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - number and area.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Type, residential and non-residential	Number of buildings expressed in 1000 units	Σ area expressed in 1000 m²	Percentage of the total area (residential / non-residential)	Information source
Residential: Single family houses + Attached houses + Row houses Multifamily houses	13971 3006	1872114 1599192	54 % 46 %	[1] + [2] [1] + [2]
Other = hostels + other buildings that include residential areas	442	n.d.		[2]
Total residential	**17419**	**3471306**		**[1] + [2]**
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops	 678 40 31 11 n.d. 793	 338800 144500 93800 37300 n.d. 313200	 36 % 16 % 10 % 4 % 34 %	 [3] + [2] [3] + [2] [3] + [2] [3] + [2] [3] + [2]
Other types -> included in factories				
Total non-residential	**1553**	**926600**		**[3] + [2]**

Comments:

The German statistics divide into buildings with one residential unit, two residential units, 3-6 residential units, 7-12 residential units and 13 and more residential units plus the other types described above.

For this table we have added the one and two residential units and included it into the group “single family houses + attached houses + row houses”. All types with 3 and more residential units were added and included into the “multi-family houses”.

Farm houses might be included in the residential houses

Sources:

[1] Reiß, J. and Erhorn, H.: Stand und Tendenzen der Neubautätigkeit in Deutschland – Analyse und Entwicklung energierelevanter Gebäudekenndaten“. gi – Gesundheits-Ingenieur 115 (1994), Heft 5, Seite 233-246.

[2] Clausnitzer, D.: Potenzial and Fachleuten zur Umsetzung der GebäudeRL. Bremer Energie Institut ITB, 2005.

[3] Gierga, M. and Erhorn, H.: Bestand und Typologie beheizter Nichtwohngebäude in Westdeutschland. IKARUS-Bericht 5-14. Forschungszentrum Jülich GmbH, Jülich (1994).

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock - energy.xls"*) to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Summary of the available information about energy consumption in the existing building stock dependent on type

Type, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential:					
Single family houses +		0	*		[5]
Attached houses +	195	0	*	27	[5]
Row houses		0	*		[5]
Multifamily houses	175	0	*	27	[5]
Total residential	**186**	**0**	*****	**27**	**[5]**
Non-residential:					
Offices	120	****	*	25	[4]
Education	160	****	*	16	[4]
Hospitals/health care	22800 **	****	*	5100 **	[5]
Hotels/Restaurants	222	****	*	84	[4]
Farm houses	372 ***	****	*	62	[4]
Factories / workshops	170	****	*	45	[4]
Other types (make a new line for each type)!					
swimming halls	2223	****	*	597	[4]
Total non-residential	**n.d.**	**n.d.**	**n.d.**	**n.d.**	

Comments: see previous table.

* DHW included in heating consumption.

** Unit is **not** kWh/m²a but kWh/designated bed, hospitals only.

*** Includes also agricultural production facilities (glass houses).

**** Cooling (if applicable) is included in electricity consumption.

Sources: see previous table and:

[4] Richtlinie zur Ermittlung von Vergleichswerten für den Energieverbrauch von Nichtwohngebäuden im Rahmen des Feldversuchs der Deutschen Energie-Agentur. Herausgeber: Bundesministerium für Verkehr, Bau- und Wohnungswesen. Berlin (2005)

[5] VDI-Richtlinie 3807-2: Energieverbrauchskennwerte für Gebäude. Heizenergie- und Stromverbrauchskennwerte. Beuth-Verlag, Berlin (1998).

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock – energy savings.xls"*) to collect the different information **and** make an area-weighted summary in the table below. If you have used the *Existing stock – energy savings* Excel sheet, please return this also!

Summary of typical heat savings in the existing building stock dependent on type.

Type, residential and non-residential	**Savings [PJ]**	Savings **[PJ]**	Savings [PJ]	Savings [PJ**]**	Savings Total **[PJ]**	**Information source**
Construction period						
Residential: Single family houses Attached houses Row houses Multifamily houses						
Total residential						
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops						
Total non-residential						

Comments on the table:

This is unfortunately a rather undefined question. What kind of savings do you ask for? Economical energy savings? In what period? Savings that are mostly realised during retrofits? Savings that would be technically possible?

As this is not based on any statistics we can't give a reliable answer. Our experiences is that with a good planning and a careful realisation you can most of the time reach the requirements for new buildings with an economy-efficient retrofit in the time of 20 years.

There was a nationally funded project called "IKARUS" which developed a computer tool that is used for the calculation of energy savings, related costs (operation and investment) for different types of strategies. However they never ended up with determining the best strategy to follow.

In which categories of the building stock are the highest potential and how much?

The categories with the highest consumptions and the most buildings.

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

Statistics. These kinds of statistics will be very hard to achieve in Germany. Even at collections of realised projects within incentives programmes (e.g. KfW-bank), the information does not represent the whole building stock but only projects with especially high aims. With the start of the general certification procedure according to the EPBD a statistic on buildings will be created, but this will not cover many types of buildings such as factories and private-owned hospitals as unless they are sold or let (not very probable) they don't have to provide certifications.

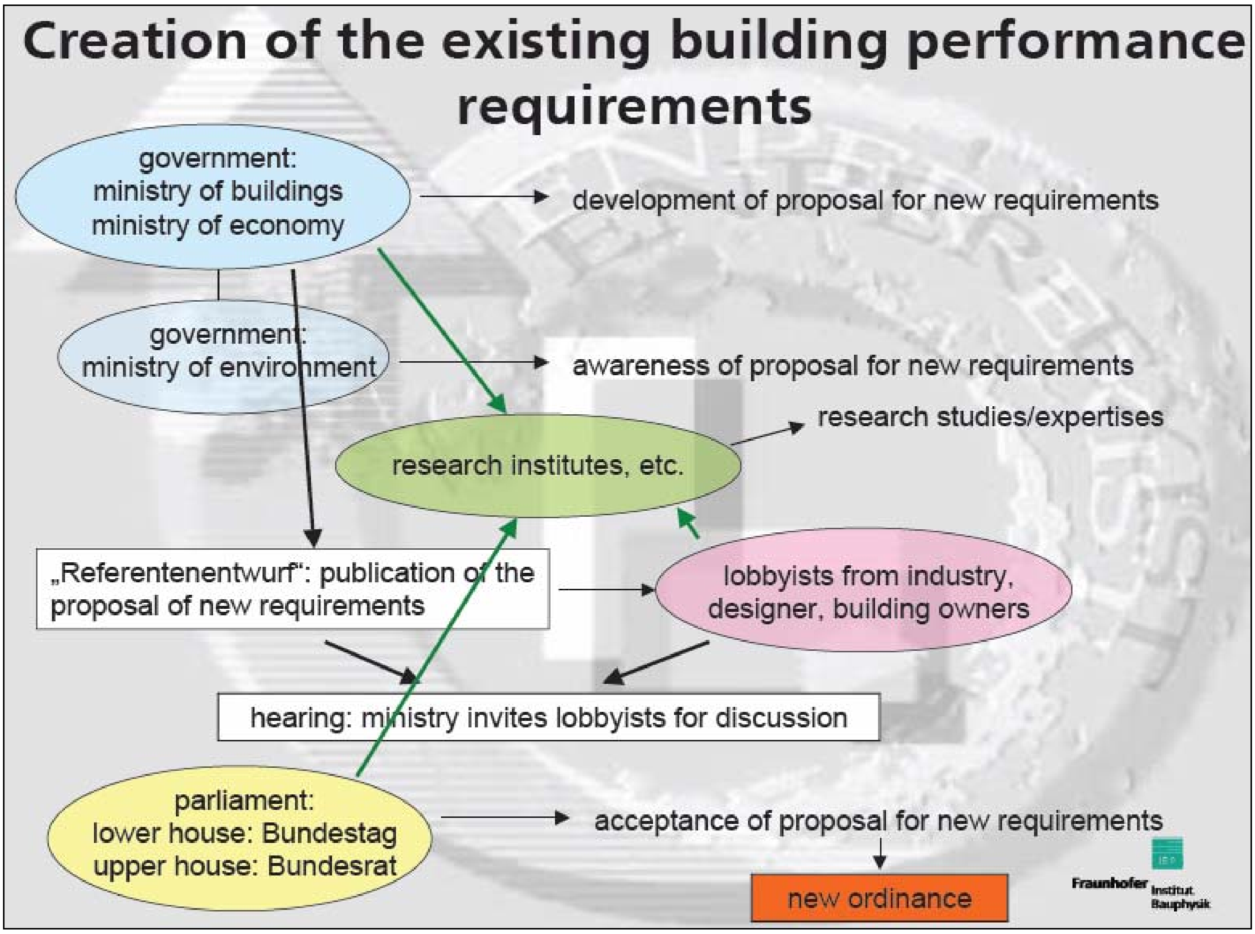
Results from national investigations

Results from national investigations of 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

Describe: Studies + calculations done by researchers paid by the specific ministry. Commented by lobbyists in order to not discriminate specific technologies or industry branches. Decisions by the responsible ministry. Acceptance by the government.



How and where are these data found?

See above.

Which data do decision-makers miss when making new energy requirements?

If they miss something it might be more detailed statistical data on building stock and energy consumption. See explanations earlier.

A.5. Greece

Answered by: Mat Santamouris
NKUA
e-mail: MSANTAM@PHYS.UOA.GR
Date: 9 February 2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - number and area.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Type, residential and non-residential	Number of buildings expressed in 1000 units	Σ area expressed in 1000 m²	Percentage of the total area (residential / non-residential)	Information source
Residential:				
Single family houses	2238			
Attached houses				
Row houses				
Multifamily houses				
Total residential	**5,465.**		**1**	**2**
Non-residential:				
Offices	111			2
Education	16			2
Hospitals/health care	2			2
Hotels/Restaurants	23			2
Farm houses	-			
Factories / workshops	-			
Total non-residential	**155**			

Comments:

1) Not possible to divide apartments against buildings.
2) National Statistical Office.

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock - energy.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Summary of the available information about energy consumption in the existing building stock dependent on type

Type, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential: Single family houses Attached houses Row houses Multifamily houses	 120 110 - -	 not available	 not available	 60 60	 1 1
Total residential					
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops	 100 55 140	 15 0		 95 35 80	 1 1 1
Total non-residential	**?**				

Comments:

1) Survey of the NKUA in 1100 dwellings.

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock – energy savings.xls*") to collect the different information **and** make an area-weighted summary in the table below. If you have used the *Existing stock – energy savings* Excel sheet, please return this also!

Summary of typical heat savings in the existing building stock dependent on type.

Type, residential and non-residential	**Savings** **[PJ]**	Savings **[PJ]**	Savings [PJ]	Savings [PJ]	Savings Total **[PJ]**	Information source
Construction period						
Residential: Single family houses Attached houses Row houses Multifamily houses						
Total residential						
Non-residential: Offices Education Hospitals/health care Hotels/Restaurants Farm houses Factories / workshops						
Total non-residential						

Comments: I have data but not on this format!!!

In which categories of the building stock are the highest potential and how much?

Almost the same everywhere

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

We have an estimation of the energy potential of each technique for typical buildings. The global potential for CO_2 reductions is also known, 2.3 Mtones CO_2 eq,

Results from national investigations

Results from national investigations of 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

The new legislation is not yet ready but it is mainly based on the surveys of NKUA regarding the energy consumption of the various building sectors in Greece. We have the benchmarks for typical, best practice and passive buildings for most of the building types in Greece. In parallel, there are a lot of studies on the energy conservation potential of various techniques for most of the buildings. However, it is very risky to estimate the technical potential for energy conservation as it is very different than the economic potential.

In a separate file I have attached the technical and economic potential of energy conservation, in CO2 terms for the whole energy sector, in Greece. I hope is useful.

How and where are these data found?

Most of the surveys have been carried out by NKUA. Studies on the energy conservation have been carried out by NKUA, and CRES.

Which data do decision-makers miss when making new energy requirements?

I do not think they miss any data. They have just to understand the existing situation and react !!!

A.6. The Netherlands

Answered by: Gerelle van Cruchten
EBM-consult
e-mail: gvancruchten@ebm-consult.nl
Date: February 20 2006

Characteristics of the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - number and area.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - number and area* Excel sheet, please return this also!

Summary of the available information about number and area of the total existing building stock dependent on type

Type, residential and non-residential	Number of buildings expressed in 1000 units	Σ area expressed in 1000 m²	Percentage of the total area (residential / non-residential)	Information source
Residential:				
Single family houses	957		0.15	[1]
Attached houses	788		0.12	[1]
Row houses	2707		0.41	[1]
Multifamily houses	2056		0.32	[1]
social rent	2330		0.35	[2] p34
other rent	700		0.11	[2] p34
owner-occupied	3590		0.54	[2] p34
Total residential	**6620**		**1,00**	**[2] p34**
Non-residential:				
Offices				
Education				
Hospitals/health care				
Hotels/Restaurants				
Farm houses				
Factories / workshops				
Offices		53125	0.32	[2] p43
Education		29065	0.18	[2] p43
Health care		14676	0.09	[2] p43
Hotels/restaurants		7000	0.04	[2] p43
Retail sector		17000	0.10	[2] p43
Sports/recreation/culture		45371	0.27	[2] p43
Total non-residential	**285,745**	**166237**	**1,00**	

Comments:

- Numbers of non-residential buildings are very unreliable as various sources present widely diverging figures. The figures for the floor area are much more reliable. Therefore only figures for the floor area are presented here.
- For residential buildings / houses the number of dwellings is a much more common figure than the total floor area. Therefore only the number of houses is presented here. As a consequence the percentage of each category as part of the total is based on the number of dwellings (and not on the floor area).

[1] Benchmarking for existing European dwellings. EPA-ED (project for the European Commission in the Altener programme, contract no. 4.1030/Z/01-142/2001), WP1, April 16 2003.

[2] Energiebesparing in de bestaande bouw - Eerste verkenning van potenties. Second draft. EBM-consult, in opdracht van Ministerie van Economische Zaken, 27 januari 2006. NOT YET FORMALLY APPROVED BY MINISTRY OF ECONOMICAL AFFAIRS.

Energy consumption in the existing building stock

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet ("*Existing stock - energy.xls*") to collect the different information **and** make a summary in the table below. If you have used the *Existing stock - energy* Excel sheet, please return this also!

Summary of the available information about energy consumption in the existing building stock dependent on type

Type, residential and non-residential	Heating consumption [kWh/m²]	Cooling consumption [kWh/m²]	Domestic hot water [kWh/m²]	Electricity consumption [kWh/m²]	Information source
Residential:					
Single family houses	170 1)	2)	3)	4)	(2004)[1], p6
Attached houses	155 1)				(2004)[1], p6
Row houses	150 1)				(2004)[1], p6
Multifamily houses	145 1)				(2004)[1], p6
Total residential	**170**			**35**	**(2004)[1], p18**
Non-residential:					
Offices	*	*	*		
Education	*	*	*		
Hospitals/health care	*	*	*		
Hotels/Restaurants					
Farm houses					
Factories / workshops					
	1)			5)	
shops	175			80	(2003)[1], p5
supermarkets	155			467	(2003)[1], p5
offices 200-500 m2	205			109	(2003)[1], p5
offices 500-10.000 m2	125			85	(2003)[1], p5
offices > 10.000 m2	590			79	(2003)[1], p5
primary schools	130			18	(2003)[1], p5
secondary schools	135			33	(2003)[1], p5
higher education	205			57	(2003)[1], p5
universities	120			85	(2003)[1], p5
nursing homes	225			65	(2003)[1], p5
hospitals	490			95	(2003)[1], p5
Total non-residential					

Comments:

1) Figures concern gas consumption (generally for heating and domestic hot water).
2) In general there is no cooling in Dutch houses.
3) Energy consumption for DHW is included in the figures for heating consumption which are actually the figures for gas consumption. In the Netherlands almost all houses are connected to the gas net and they use mainly gas for space heating and DHW.
4) Electricity consumption includes electricity for domestic appliances but also a small part is used for space heating and DHW.
5) Cooling included in electricity consumption (when applicable)

Sources:

[1] Cijfers en tabellen 2006. SenterNovem in opdracht van Ministry of Housing. January 2006. Averaged figures.

For dwellings the following average floor area has been assumed: single family: 150 m^2, attached: 120 m^2, row: 100 m^2, multifamily: 80 m^2.

Potential energy savings in typical buildings

If there is a distribution of different building types in different climate zones in your country, then you can use the attached MS-Excel spreadsheet (*"Existing stock – energy savings.xls*") to collect the different information **and** make an area-weighted summary in the table below. If you have used the *Existing stock – energy savings* Excel sheet, please return this also!

Summary of typical heat savings in the existing building stock dependent on type.

Type, residential and non-residential	**Savings [PJ]**	Savings **[PJ]**	Savings [PJ]	Savings [PJ]	Savings Total **[PJ]**	**Information source**
Construction period						
Residential: Single family houses Attached houses Row houses Multifamily houses						
	Heating	Cooling	DHW	Electricity	Total	
Social rent	2933,1				2933,1	[1] p41
Other rent	725,6				725,6	[1] p41
Owner-occupied	3767,7				3767,7	[1] p41
Total residential	**7426,4**				**7426,4**	
Non-residential:						
Offices	782,6			764,2 1)	1546,8	[1] p48
Education	430,0			45,4 1)	475,4	[1] p48
Hospitals/health care	227,1			80,3 1)	307,4	[1] p48
Hotels/Restaurants	70,0			7,9 1)	77,9	[1] p48
Farm houses						[1] p48
Factories / workshops						[1] p48
Retail sector	146,3			109,2 1)	255,5	[1] p48
Sports/recreation/culture	252,5			92,0 1)	344,5	[1] p48
Total non-residential	**1908,5**			**1099,1**	**3007,6**	

Comments: * General:

I assume that the 4 columns with the same title 'savings' should concern, sequentially:

- savings heating
- savings cooling
- savings domestic hot water
- savings electricity consumption

* No information available on potential savings for cooling and domestic hot water, though it is considered that both is by far of minor importance when compared to the potential savings for heating and electricity (i.e. lighting).

* Savings for heating are based on insulation of roof//floor, improved glazing and improved heat generation system.

1) Electricity savings are only related to lighting

[1] Energiebesparing in de bestaande bouw - Eerste verkenning van potenties. Second draft. EBM-consult, in opdracht van Ministerie van Economische Zaken, 27 januari 2006. NOT YET FORMALLY APPROVED BY MINISTRY OF ECONOMICAL AFFAIRS

In which categories of the building stock are the highest potential and how much?

1) Owner - occupied houses
2) Social rent houses
3) Offices

Which data do you miss in your country to be able to make these assumptions of the potential energy savings of typical buildings?

Results from national investigations

Results from national investigations of 1) on which data are decisions regarding building regulations based? 2) which data do decision-makers miss? Please contact your decision-makers and ask how decisions regarding energy requirements for existing buildings are made. What information about the building stock are the decisions based on in the building regulations?

Please write a synthesis to explain how this is done in your country.

Which data are decisions based on regarding energy requirements in building regulations?

The Netherlands has no energy requirements in building regulations for existing buildings. Only in case of major renovation there are requirements (on component level) and they are the same as for new buildings. That means that major renovations are regarded as new buildings.

How and where are these data found?

If such energy requirements were to be developed then data would be needed from monitoring and field studies, e.g. with respect to the effects of energy saving measures (including side-effects for e.g. health). To some level data are available but more would be needed and in more detail.

In The Netherlands it is also very important to reckon with the interests of the market (professionals like architects, builders and installers) and the public (represented by the Parliament). In the Netherlands it is the case that the government is dedicated to saving energy (e.g. because of international treaties like the Kyoto protocol), whereas the Parliament wants to make regulations simpler. This is in contradiction, because to increase energy savings in general more complex regulations are necessary. Also the market in general is not in favour of more regulations. This mechanism especially plays a role for the tightening of requirements for new buildings.

Which data do decision-makers miss when making new energy requirements?

- Insight in costs of more stringent energy requirements.
- Side-effects (e.g. air quality, moisture problems etc),
- Accuracy of methods and tools.

A.7. United Kingdom

Answered by: Robert Cohen
Energy for Sustainable Development Ltd
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Date: 18 January 2007.

Residential:

Breakdown by region and ownership

Total Existing Dwellings (in millions)
UK total in all sectors = 25.83 million

	Owner occupied	Private rented	Social rented
England	15.16	2.58	3.88
Wales	0.89	0.15	0.23
Scotland	1.54	0.26	0.39
Northern Ireland	0.53	0.09	0.13
Total	**18.11**	**3.09**	**4.63**

Breakdown by dwelling type

	Owner occupied	Private rented	Social rented
Detached	23%	5%	3%
Bungalow	10%	3%	6%
Semi-detached	32%	12%	20%
Terraced	27%	38%	31%
Flat	8%	42%	40%
Other			
Total	**100%**	**100%**	**100%**

Breakdown of new build by region and ownership

New Build Per Year
(in thousands)

	Owner occupied	Private rented	Social rented
England	124.3		13.6
Wales	7.1		0.8
Scotland	19.2		4.8
Northern Ireland	13.2		1.1
Total	**163.8**		**20.3**

source: http://www.statistics.gov.uk/STATBASE/

Breakdown of new build by region and ownership

	No. Existing Dwellings changing hands (sold or rented out) per year (thousands)		
	Owner occupied	Private rented	Social rented
England	1667	284	426
Wales	98	17	25
Scotland	169	29	43
Northern Ireland	58	10	15
Total	**1,992**	**340**	**509**

Non-residential:

Breakdown of number and area by sector

	Number buildings	Area (km²)	m² each (ave)
Offices	237,200	107	451
Higher education	5,315	28	5,268
Schools	36,505	77	2,109
Leisure	52,966	27	510
Pubs and clubs	114,000	21	184
Hotels/residential	43,340	48	1,108
Sports & recreation	63,230	32	506
Health care	29,030	43	1,481
Warehouses	389,025	184	473
Factory buildings	131,000	269	2,053
Mixed use	5,000	12	2,400
Misc government	11,875	37	3,116
Retail	405,440	125	308
Transport and communications	35,330	35	991
TOTALS	**1,559,256**	**1,045**	**670**

Energy use by sector

	Elec TWh/year	Gas TWh/year	Oil TWh/year	Solid TWh/year
Offices	15	13	5	0
Higher education	2	6	2	0
Schools	2	9	9	1
Leisure	2	2	1	0
Pubs and clubs	7	3	0	0
Hotels/residential	6	10	4	0
Sports & recreation	2	9	1	2
Health care	4	10	8	4
Warehouses	8	22	8	0
Factory buildings	7	28	41	9
Mixed use	2	2	0	0
Misc government	4	6	5	2
Retail	32	28	0	0
Transport and communications	3	2	1	0
TOTALS	96	148	84	18

CO_2 emissions by sector

	Elec.	Gas	Oil	Solid	Total
	mt CO_2	mt CO_2	mt CO_2	mt CO_2	mt CO_2
Offices	10.27	2.66	1.41	0.00	14.35
Higher education	1.72	1.17	0.44	0.00	3.32
Schools	1.65	1.82	2.43	0.49	6.39
Leisure	1.19	0.48	0.27	0.00	1.94
Pubs and clubs	4.92	0.56	0.00	0.00	5.48
Hotels/residential	4.40	2.01	1.08	0.17	7.66
Sports & recreation	1.15	1.88	0.34	0.60	3.97
Health care	2.49	2.06	2.10	1.24	7.90
Warehouses	5.67	4.58	2.17	0.04	12.46
Factory buildings	4.71	5.78	11.59	3.04	25.12
Mixed use	1.17	0.35	0.00	0.00	1.52
Misc government	3.02	1.26	1.54	0.61	6.42
Retail	22.60	5.91	0.00	0.00	28.51
Transport and communications	2.39	0.44	0.14	0.02	2.99
TOTALS	67.33	30.98	23.52	6.20	128.03

B. ENPER-EXIST pre-questionnaire

General information

Country:

Filled in by:

- Name:
- Date:
- Company:
- e-mail:

The first part of the questionnaire aims at action 3.1 “Survey of data available”.

Characterisation of the building stock

Please indicate if you can provide the following information:

Number and area of buildings divided into different type of use:

	Number of buildings	Total area per type	Divided in typical construction periods	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes
Residential buildings:					
Residential totally	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐
Multifamily houses	☐	☐	☐	☐	☐
Other types:					
Non-residential buildings:					
Commercial totally	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐
Other types:					

Comments:

Indicate the source and quality for this information:

Energy consumption in the existing building stock

Is there an existing study from your country concerning the potential energy saving in the existing building sector, divided into different building types (use of buildings, e.g. single family houses, blocks of flats, offices, hospitals, etc)?

Yes ☐, if "Yes", give sources: .

Some types ☐, which and sources?

Heating consumption of the existing building stock

Please indicate if you can give the requested information, divided into the different categories.

Heating consumption

	Typical construction period	Typical climate zones	Country average	Is DHW included?	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes	Yes
Residential buildings:						
Residential, total	☐	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐	☐
Other types:						
Non-residential buildings:						
Non-residential, total	☐	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐	☐
Other types:						

Comments: *Indicate the source and quality for this information*:

Domestic hot water consumption in the existing building stock

Please indicate if you can give the requested information, divided into the different categories.

Domestic hot water consumption.

	Typical construction period	Typical climate zones	Country average	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes
Residential buildings:					
Residential, total	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐
Other types:					
Non-residential buildings:					
Non-residential, total	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐
Other types:					

Comments: *Indicate the source and quality for this information*:

Cooling consumption of the existing building stock

Please indicate if you can give the requested information, divided into the different categories (*only if you have cooling needs in the different building types)*.

Cooling consumption

	Typical construction period	Typical climate zones	Country average	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes
Residential buildings:					
Residential, total	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐
Other types:					
Non-residential buildings:					
Non-residential, total	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐
Other types:					

Comments: *Indicate the source and quality for this information*:

Electricity consumption in the existing building stock

Please indicate if you can give the requested information, divided into the different categories.

Electricity consumption.

	Typical construction period	Typical climate zones	Country average	Total consumption	Building related*	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes	Yes	No
Residential buildings:							
Residential, total	☐	☐	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐	☐	☐
Other types:							
Non-residential buildings:							
Non-residential, total	☐	☐	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐	☐	☐
Other types:							

*"Building related" is the electricity for fans, pumps and lighting in commercial buildings (EPBD related)

Comments: *Indicate the source and quality for this information*:

Thermal insulation in the existing building stock

Please indicate if you can provide the following information

Heat loss coefficients (U-values).

	Typical construc-tion period	Typical climate zones	Country average	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes
Residential buildings:					
Residential. total	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐
Other types:					
Non-residential buildings:					
Non-residential. total	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐
Other types:					

Comments: *Indicate the source and quality for this information*:

If "Yes" to information about U-values, please indicate in the table below, for which constructions you can provide the information.

U-values.

	Roofs	Floors	Ext. walls	Windows	Other	Statistical	Estimated
	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Residential buildings:							
Residential, total	☐	☐	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐	☐	☐
Other types:							
Non-residential buildings:							
Non-residential, total	☐	☐	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐	☐	☐
Other types:							

Comments: *Indicate the source and quality for this information*:

Please indicate if you can provide the following information

Ventilation heat loss.

	Typical construction period	Typical climate zones	Country average	Statistical values	Estimated values
	Yes	Yes	Yes	Yes	Yes
Residential buildings:					
Residential, total	☐	☐	☐	☐	☐
Single family houses	☐	☐	☐	☐	☐
Attached houses	☐	☐	☐	☐	☐
Row houses	☐	☐	☐	☐	☐
Other types:					
Non-residential buildings:					
Non-residential, total	☐	☐	☐	☐	☐
Offices	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Hospitals/health care	☐	☐	☐	☐	☐
Hotels/Restaurants	☐	☐	☐	☐	☐
Farm houses	☐	☐	☐	☐	☐
Factories/workshops	☐	☐	☐	☐	☐
Other types:					

Comments: *Indicate the source and quality for this information*:

Additional description of components

Insulation

Do you have alternative statistics than U-values on information regarding the insulation levels (e.g. typology of walls, floor, roof, percentage of cavity walls insulated, etc.?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Windows

Can you give the statistical % of windows with simple glazing/ double-glazing / double glazing with low e coating / triple glazing?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Ventilation system

Can you give the statistical on the typology of ventilation system?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical on the assessment of airflow rates?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Heat generation and distribution

Can you give the statistical % of different heating systems: boiler, district heating etc.?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical % of different boiler ages?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical % on different boiler technologies?.

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical % of heat pumps?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Renewable

Can you give the statistical % of solar domestic hot water systems?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical % of PV systems?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Control systems

Can you give the statistical % of automatic control: room control e.g. thermostatic valves, simple control e.g. supply temperature or advanced control e.g. BEMS?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Cooling

Can you give the statistical % on buildings with/without cooling?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Lighting

Can you give the statistical % on the use of compact fluorescent lamps?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Can you give the statistical % on the use of electronic ballast?

Residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Non-residential buildings Yes ☐ Yes, partly ☐ Yes, estimate ☐

Description

Tools used to assess the impact of political measures on energy consumption.

This part of the questionnaire aims at point 3.2 "Analysing how decision made regarding regulations is based on this information". In this part of the questionnaire you have to answer if it will be possible to collect the following information's together with policy makers or teams supporting the policy makers.

Please indicate if you can provide the following information later on:

When you define a measure regarding existing buildings how do you take into account the information on the building stock to define it?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

When planning a measure do you perform calculation of its potential impact?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

Which type of tool do you use to assess the impact?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

How do you calculate the impact on the building stock? E.g.: what will be the impact if all simple glazing was replaced by double-glazing?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

How do register the number of building in which the measure is actually implemented?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

Will a tool to facilitate your work to assess the impact of measures be a help?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments

Do you have any demands to the function in such a tool?

Yes, possible to answer ☐ Relevant to ask in my country ☐

Comments