DATAMINE
Collecting Data from Energy Certification to Monitor Performance Indicators for New and Existing buildings

– FINAL REPORT –

DATAMINE Project Team

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EXECUTIVE SUMMARY

Basics of the DATAMINE Project

The Root Idea:
Take advantage from large scale EP Certificate data collection in Europe

The starting point of DATAMINE was the fact that the current state of the European building stock and the on-going retrofit processes are not very well known. This information gap can be seen as a great obstacle for taking well-tailored measures to reduce the buildings' energy consumption.

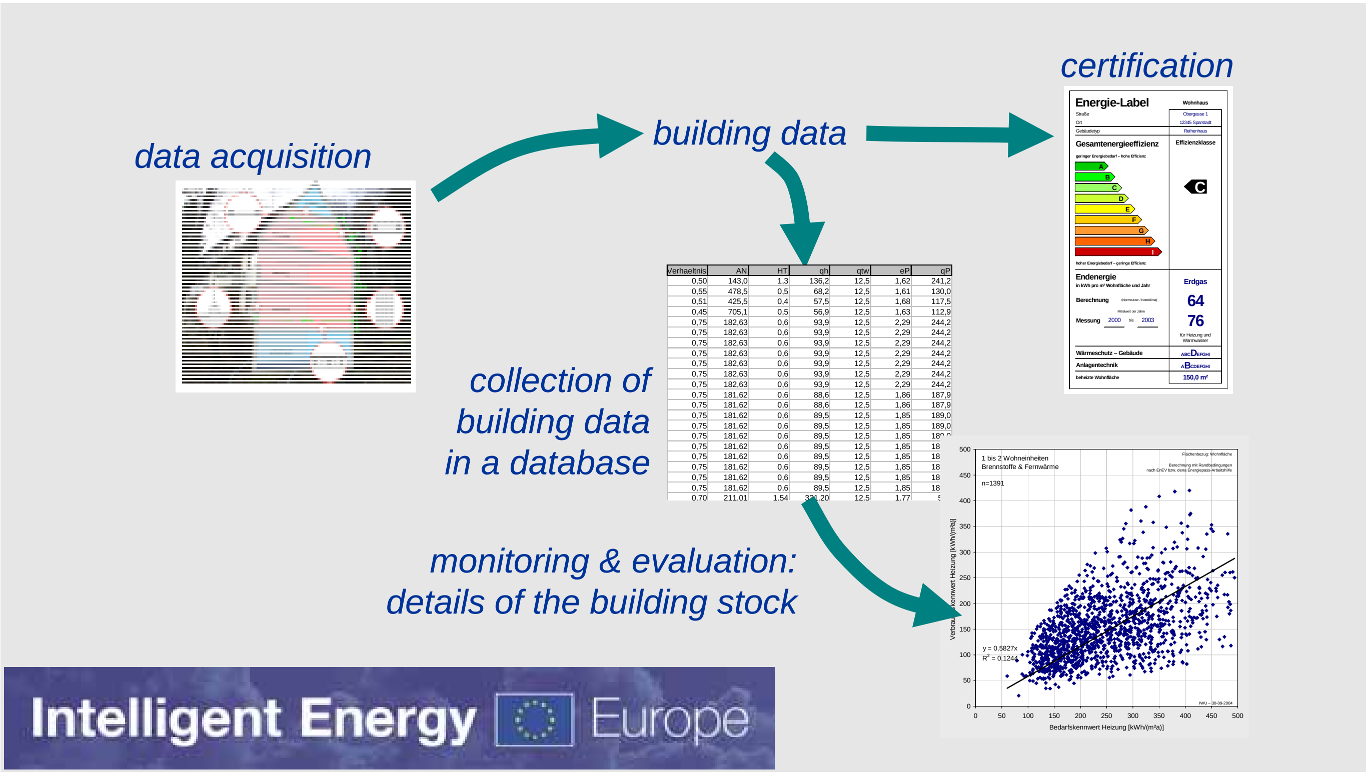
The idea of DATAMINE is to use Energy Performance (EP) Certificates as a data source for monitoring purposes. Given the great variety of buildings as well as certificate types in Europe and the very different status of national EPBD[1] implementation efforts, a general monitoring system can only be implemented in the long run. Thus the objective of DATAMINE is to make basic experiences in data collection and analysis on a practical level and to draw conclusions for establishing harmonised monitoring systems.

[1] Energy Performance of Buildings Directive

A Bottom-Up Approach:
Make basic experiences in Model Projects

For this purpose Model Projects were carried out in 12 EU member states. In each Model Project data collection and monitoring using EP Certificates or energy audits were tested on a small scale. Each Model Project has an individual design, addressing different building utilisations and certification types, as well as data collection methods and monitoring targets – depending on the focus of the involved key actors. Accordingly, each Model Project considers different national certification or data collection activities.

This means that DATAMINE is a bottom-up project: There was no standardised monitoring approach to be realised during the 12 Model Projects - quite the opposite: Each model project had its own aims, data sources and solution approaches reflecting a large variety of monitoring problems. The idea of DATAMINE is to first learn from the execution of these different Model Projects, and then to generate ideas for other, maybe similar monitoring activities in the future.



The Benefits of a Common Language: Compare Data from Different Countries by use of a Harmonised Data Structure

Given that the 12 projects were simultaneously carried out in 12 EU countries raised an issue of whether there is a way for a common analysis of the collected data or at least for a common understanding of the data from different projects. To handle this issue a harmonised data structure with 255 data fields was defined. The "philosophy" of this approach was as follows: Each project partner could use his own data structure (for example specified by the applied software) and carry out his analysis on an individual basis according to the objectives and conditions of the individual Model Project. At the end the national data base was translated to the harmonised data structure that was then delivered to the project coordinator IWU who collected all data in a common evaluation data base. This made possible a comprehensive analysis during which a number of energy performance indicators from different countries could be compared. Since the harmonisation of definitions enabled each partner to gain an easy understanding of the data from other countries, the DATAMINE Data Structure can be seen as a simplified "common language" that facilitates an understanding of data bases from different projects.

The Conclusions: How to Extend Energy Performance Monitoring Activities in the European Building Sector

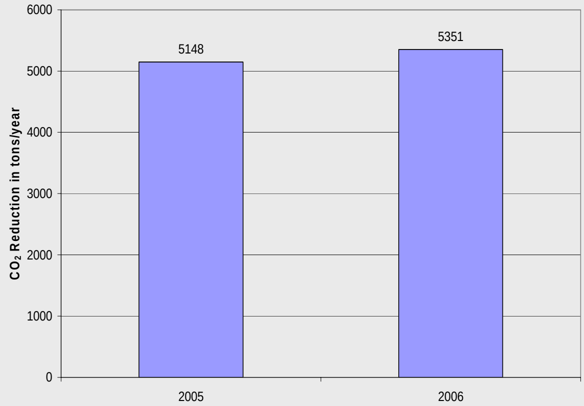
The DATAMINE project partners also draw general conclusions concerning monitoring with the help of energy certificates. Based on the experiences with data collection during the Model Projects and with cross-country comparison, concrete recommendations are given for future steps. The problem of answering the basic questions about energy performance of the national building stocks is addressed as well as specific monitoring aims and the harmonisation and international comparability of the results.

Results from the Model Projects

Model Project 1: Germany (IWU)

The German project had a very specific aim: The carbon dioxide emission reduction of the measures which were supported by an energy saving support programme in the region of Hannover had to be estimated. There were good basic conditions for applying the DATAMINE approach because the issuing of an energy certificate was a prerequisite for getting support from the programme. So by analysing the data of more than 500 energy certificates (asset rating, reflecting the state of the buildings before modernisation) and the programme statistics (number and type of supported energy saving measures) the carbon dioxide emission reduction in 2005 and 2006 could be calculated. Apart from that a survey of the energy performance of the supported buildings before modernisation was given. A DATAMINE interface was developed and implemented in an energy certificate software tool which is very common in Hanover.

Fig. 1: Exemplary result from Model Project 1

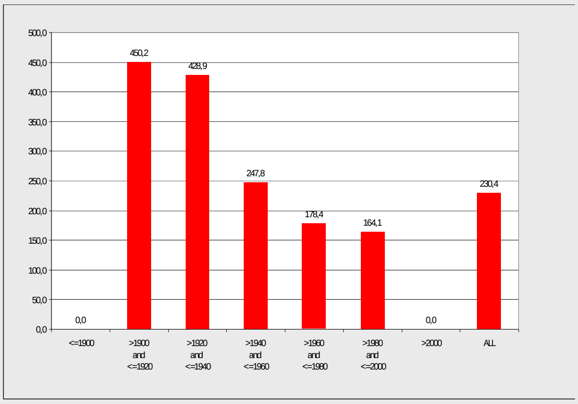


Saving of carbon dioxide emissions by the measures which were funded in the proKlima-Altbau programme in 2005 and 2006

Model Project 2: Poland (NAPE)

In the Polish project a sample of 130 energy audits (mainly asset rating) was used to get an overview of the energy properties of residential buildings in Poland. Inter alia the U-values of walls, roofs, windows and basement areas were examined in relation to the construction period of the buildings. The analysis was concentrated on large buildings with a living space of more than 1000 m².

Fig. 2: Exemplary result from Model Project 2

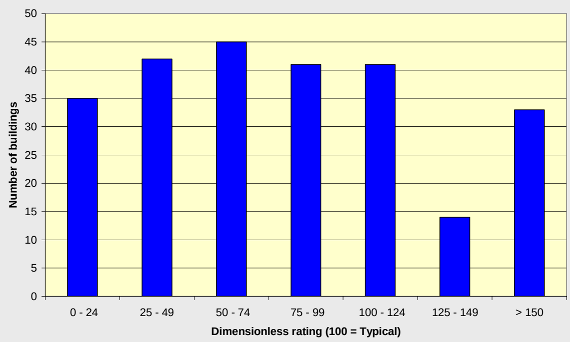


Average calculated energy consumption per m²

Model Project 3: UK (ESD)

The project was dealing with operational rating of different types of non-residential buildings. The building data were collected by an existing internet tool (EPLabel) and transferred to the DATAMINE data structure by a new software application. EPLabel is working on international level, so that building data from different countries can be collected. Circa 300 data sets were available, the analysis was concentrated on buildings from UK, for the most part office buildings.

Fig. 3: Exemplary result from Model Project 3

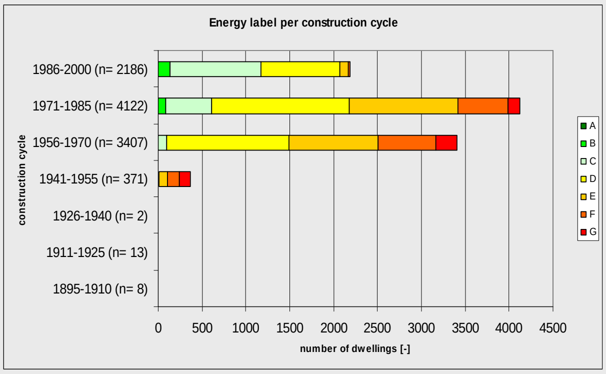


Operational performance of the 251 buildings in the UK datasets (100 = Typical, < 100 is better than Typical, > 100 is worse than Typical)

Model Project 4: Netherlands (BuildDesk)

The main aim of the Dutch project was to improve the portfolio management of two big housing companies in Tilburg. The data bases included altogether more than 10.000 data sets (mostly apartments). Energy data were analysed in combination with cost data. Inter alia social aspects were considered: It was pointed out that especially low-rent apartments (usually inhabited by low-income renters) have a relatively high energy consumption and relatively high energy costs. The analysis also showed that a good overall energy performance may often be caused by energy-efficient district heating – but nevertheless the heat demand of the buildings and the heating costs may be considerably high.

Fig. 4: Exemplary result from Model Project 4

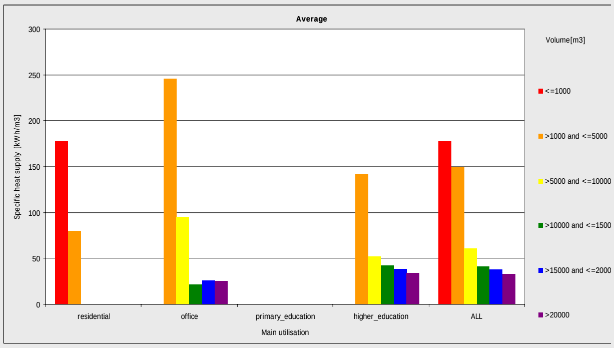


Average energy indices and energy labels related to building construction cycle

Model Project 5: Italy (POLITO)

Two different samples were analysed: Data from 138 buildings in the Province of Torino – most of them higher education schools – gave an overview of the energy consumption depending on the used energy carrier, the size of the buildings and the climate data (which may considerably differ within the province). A second sample of 50 asset and operational rating data sets from social multi-family buildings of a social housing company in the city of Torino did not only provide an overview of the energy performance of the buildings stock but was also used for a comparison of the measured and the calculated energy consumption as well as for a comparison of five different regional Italian energy balance calculation methods.

Fig. 5: Exemplary result from Model Project 5

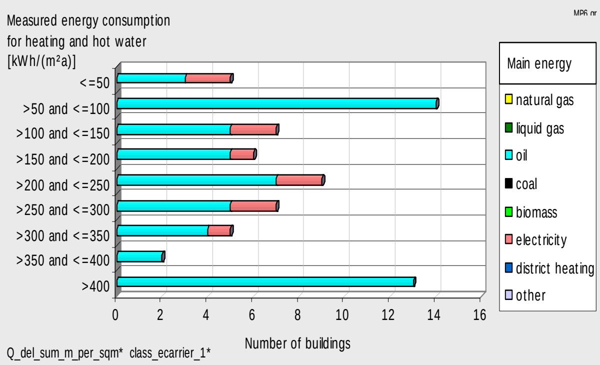


Distribution of the specific heat supply as a function of the main utilisation and of the volume

Model Project 6: Greece (NOA)

The Hellenic model project was based on a sample of 250 buildings from different regions in Greece available from pilot energy audits performed in the framework of European projects for the development of audit methodologies and software (40% of available data), and other short energy audit campaigns using standard questionnaires and energy audit reports (60% of available data). NOA performed data quality checks and implemented in the evaluation data base (EDB). In total, 70% of the available data are residential buildings, and the rest different end-uses of non-residential buildings (offices, hospitals, hotels, sports centers, airports, and schools). About 40% of the available data (72 buildings) were for asset rating, while for the remaining 178 buildings with operational rating there was often additional available data on energy performance and thermal envelope characteristics. A detailed analysis of the energy related building properties of the sample was carried out including the U-values of the different building elements, the different types of heat supply systems and the energy balance – including measured and calculated energy consumption.

Fig. 6: Exemplary result from Model Project 6

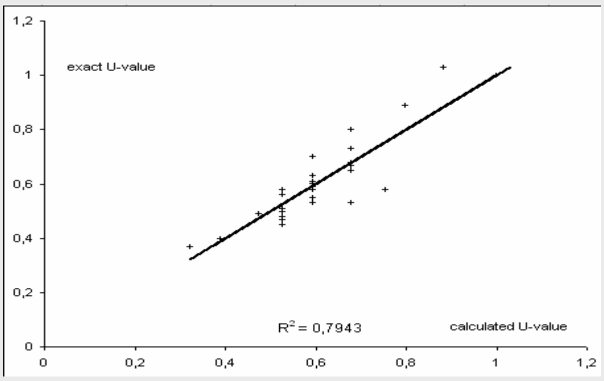


Frequency of measured energy ware consumption – tertiary sector (consumption summarized for all energy carriers, per m² reference area)

Model Project 7: Belgium (Vito)

The project made use of an auditing procedure for single family houses with official audits being uploaded to a central server of the Flemish Region. A number of 113 data sets were analysed (asset rating). The main target was the making of a “typology” of building elements in order to simplify energy auditing that means to save time and costs. For example a procedure for the estimation of the U-value of a wall depending on the type of the wall, the year of erection and the insulation layer thickness was developed.

Fig. 7: Exemplary result from Model Project 7



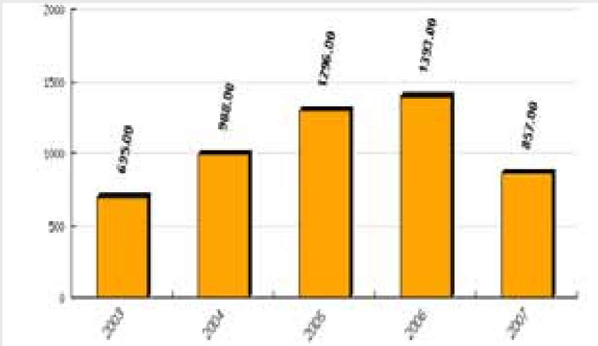
Deviation between calculated and exact U-value for wall-type 1

Model Project 8: Austria (AEA)

n Austria there is already a software tool to collect the information of all leading energy performance certificate programmes in regional data bases (Salzburg, Styria and Carinthia) . Since the good experiences during the DATAMINE project, the Austrian Energy Agency forced to create one national database. So now there are even better conditions for systematic and large-scale approaches to collect and analyse data from energy performance certificates.

During the model project an interface was defined and programmed to transfer the data of the existing data base into the DATAMINE format. Moreover an analysis of more than 7,000 energy performance certificate data sets from the Austrian province Carinthia was carried out. Most of them (more than 5,200) were from new buildings which were erected between 2003 and 2007. So a special emphasis of the analysis was put on new buildings. But there was also a large number of energy certificate data from older buildings (almost 1,500 cases) so that also the existing building stock could be examined.

Fig. 8: Exemplary result from Model Project 8



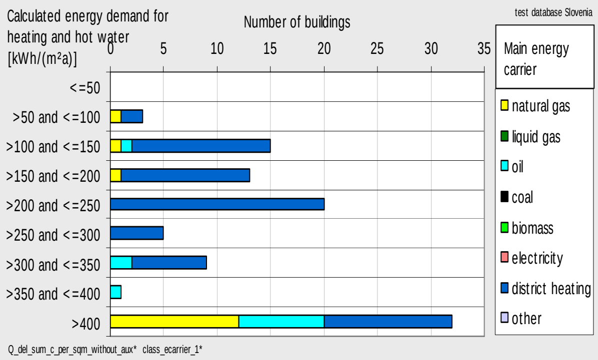
Number of new buildings (“Neubau”)

Model Project 9: Slovenia (ZRMK)

A number of 100 data sets were considered. The analysis was concentrated on big residential buildings which were erected in the 1960s and 1970s and which are now due for modernisation measures. The results show that the energy efficiency of those houses is quite low compared to buildings from other erection periods so that the energy saving potentials should be considerably high.

During the project a data preprocessor software tool was developed which will also in the future make possible the automatic creation of DATAMINE data sets from the existing energy certificate scheme. For the future the chances of an application of the DATAMINE approach in Slovenia are also seen in the quality control of energy certificates.

Fig. 9: Exemplary result from Model Project 9

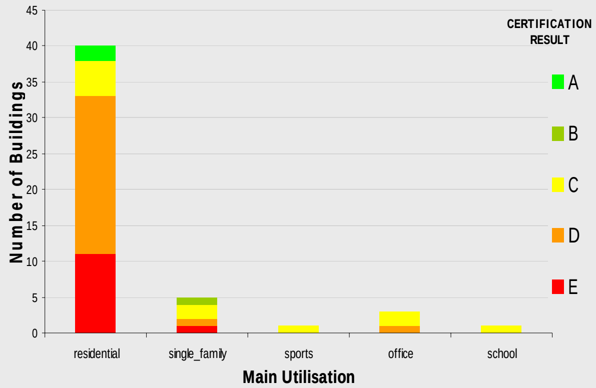


Frequency of calculated energy demand (demand summarized for all energy carriers, per m² reference area)

Model Project 10: Spain (Ecofys)

In the Spanish model project 50 energy certificate data sets, most of them from residential houses, were analysed to obtain an overview of the energy performance of the buildings. In order to prepare future monitoring approaches and make possible the analysis of a larger number of certificates a software tool for the data transfer from the files of a common energy certificate programme to a DATAMINE data base was developed.

Fig. 10: Exemplary result from Model Project 10

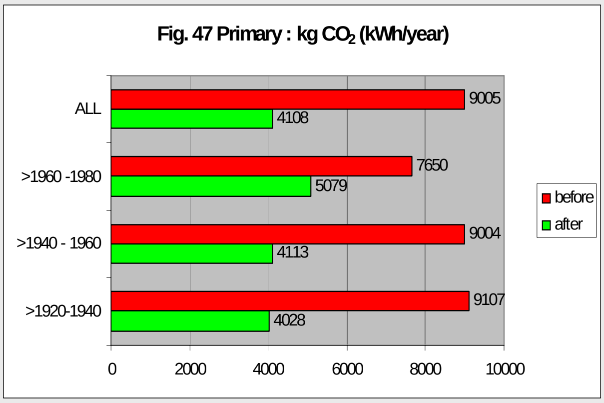


Frequency of energy efficiency class per utilisation type

Model Project 11: Ireland (Energy Action)

There were 126 asset rating data sets of residential buildings available. Besides attaining an overview of the energy performance of the sample a main goal of the project was to compare the "old" Irish energy rating method which was applied in the past with the "new" method according to EPBD which is currently introduced. The results show that altogether there is a reasonably close correlation of the methods and only in the case of the hot water energy values there seem to be considerable deviations.

Fig. 11: Exemplary result from Model Proj. 11

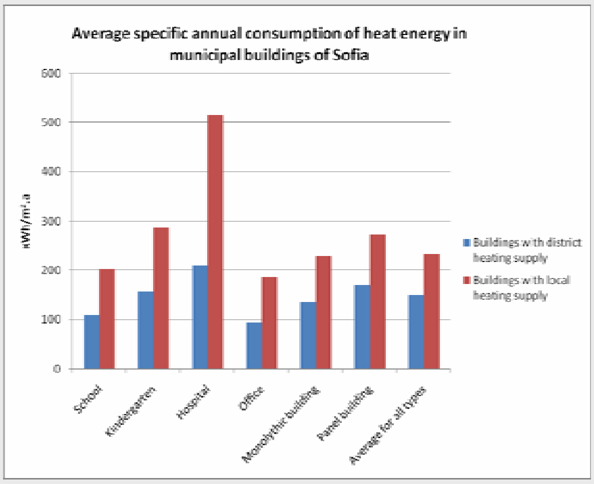


Carbon dioxide emissions before and after refurbishment

Model Project 12: Bulgaria (SOFENA)

The results of operational rating of 493 non-residential buildings were available. Most of them (428) are municipal buildings from Sofia so that the analysis could in the first place deliver a detailed overview of the measured energy performance of the different segments of the capital's buildings stock (schools, kindergartens, hospitals, administrative buildings).

Fig. 12: Exemplary result from Model Proj.12



Average specific consumption of heat energy in municipal buildings of Sofia

The DATAMINE Data Structure

The DATAMINE Data Structure provided a framework for the data to be collected during the monitoring process. A total of 255 parameters were defined of which a suitable sample could be selected to describe the building's energy performance, depending on the concrete case and the type of energy certificate. The following groups of quantities were considered in the Data Structure:

A. Energy Certificate Data

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

B. General data of the building

Basic data of the type and size of the building: e.g. location (city), building utilisation, conditioned floor area

C. Building envelope data

Data describing the thermal performance of the building envelope (enclosing the heated part of the building): U-values and area of the elements, window properties

D. System Data

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

E. Calc. Energy Demand (Asset Rating)

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

F. Basic Parameters of Operational Rating

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

G. Summary of Energy Consumption and Energy Generation

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

H. Primary Energy, CO2 Emissions and benchmarks

Primary energy demand and CO_2 emissions for both operational and asset rating

Fig. 13: Excerpt of the DATAMINE Data Structure: Data fields No. 91 – 96 out of a total of 255 DATAMINE data fields

D	System Data					
	heat generation for space heating and hot					
91	degree of centralisation of 1. heat generator	centralisation_heatgen_1		see predefined values. If possible the main system of heat generation in the building (that one which produces the largest amount of heat) should be chosen as first heat generator	p	**dh**: district heating **cb**: central system for the building **ap**: system for each apartment (or for a group of rooms e.g. in office buildings) (in case of one-appartment buildings use cb) **rm**: heat generators in the rooms (e.g. stoves, small electric hot water devices) **other**: other
92	type of 1. heat generator	type_heatgen_1		type of main heating system, see "predefined values". Heat generators of the same type are combined, e.g. if a building is heated by 6 stoves in different rooms they are all united in type_heatgen_1: st (stoves)	p	see "classification lists": heat generator types
93	energy carrier of 1. heat generator	ecarrier_heatgen_1		energy carrier see "predefined values"	p	see sheet "classification lists": energy carrier type
94	use of 1. heat generator	use_heatgen_1		A code indicating the use of the heat generation system (Is the system supplying heat for heating or hot water?). See predefined values. If the heat generator also produces heat (or in case of a "reversible" system even cold) for the air conditioning/cooling system this will be considered below (see quantities assigned to air conditioning)	p	binary code **1. digit**: heating **2. digit**: hot water => 10: only heating, no hot water 11: heating and hot water 01: hot water, not heating
95	erection year/period of 1. heat generator: first year	year_1_heatgen_1	a (year)	Erection year of the heat generator. If it is not exactly known, but the approximate time period is know, insert here the first year of this time intervall (e.g. 1970 if the heat generator was installed some time between 1970 and 1980). If a part of the heat generator was modernised (e.g. boiler installed 1980, new burner installed 1995) insert here the installation year of the main part of the heat generator (in this case: 1980).	f	For example the year 2000 is indicated "2000" (and not: "00")
96	erection year/period of 1. heat generator : last year	year_2_heatgen_1	a (year)	If the installation year is exactly known, insert it here a second time. If only the approximate period is known, insert here the last year of that period (e.g. 1980 for a heat generator that was installed between 1970 and 1980).	f	
97	degree of centralisation of 2. heat generator	centralisation_heatgen_2		similar to 1. heat generator. As far as possible the second largest heat generator (that one which produces the second largest amount of heat) should be considered here.	p	

p: insert predefined values only (e.g. only 5 symbols are allowed for data field No.91: dh, cb, ap, rm or other),
f: free data entry (according to given rules, here for example for the year of erection)

Fig. 14: Example for a DATAMINE classification list (heat generator types / predefined values)

Heat Generator Types	
b	boiler (type unknown)
b_nc	non-condensing boiler (further details unknown)
b_nc_ct	constant temperature non-condensing boiler
b_nc_lt	low temperature non-condensing boiler
b_c	condensing boiler
dh	district heating
el_d	direct electric: any device which uses electricity for direct heat generation, e.g. electric stoves (no heat pumps which use also heat from the environment)
hp	heat pump (type unknown), remark: also reversible engines that work as a cold generator in summer are to be considered here or (if heat source is know
hp_air	heat pump, using the outside air as the heat source
hp_soil	heat pump, using the soil (the ground) as the heat source
hp_exair	heat pump, using exhaust air of a ventilation system as the heat source
hp_water	heat pump, using ground water or a water stream as the heat source
hp_other	heat pump, using more than one or other heat sources (e.g. industrial exhaust heat, low-temperature district heat)
stove	stove (fuel fired, in case of electric stoves use el_d)
chp	cogeneration system: combined heat and (electric) power generation
solar	solar thermal system
steam	steam generator (any type)
other	other
Remark:	
An air/air heat exchanger for heat recovery in a ventilation system is not defined as a heat generator (also not: "ot") but indicated in the ventilation system.	

The Data Structure accounts for different types of energy certificates in the EU countries and in the project partners' Model Projects, as well as the different monitoring aims: For example, the data to be delivered from asset rating (calculation of the energy demand of the building) and from operational rating (measured energy consumption) are very different. The same applies to different types of buildings (certificates of residential and non-residential buildings with or without air-conditioning and lighting).

Against that background the Data Structure neither aims at collecting all available data of a certain type of energy certificates nor will it be necessary (or in many cases even possible) to fill in all of its data fields during a certain application: The basic idea of the Data Structure is to provide a "common language" for the monitoring of energy certificate data: It aims at making possible the documentation of all relevant (not the complete) energy certificate data of a certain monitoring project in a way that it can be clearly understood by others and compared with other projects which are documented in the same way. For this purpose it may be applied on national as well as on international level.

Cross-Country Comparison of the Collected Data

During the above described Model Projects more than 19,000 datasets were collected in the 12 different countries. The below shown table (Fig. 15) gives a break down for certificate types, rating types, energy uses, utilisation types and building age classes.

Since the data structure was the same for all databases a comprehensive analysis and cross-country comparison could easily be performed. This was done by use of an MS Excel Workbook, the “DATAMINE Analysis Tool”, which was created during the project.

The following quantities were compared:

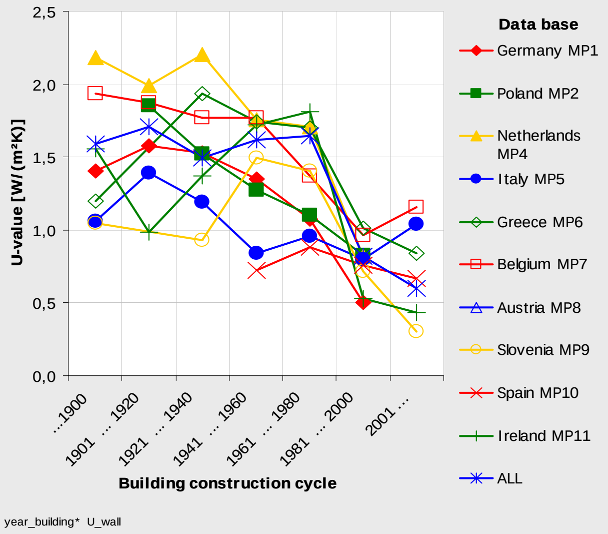
- U-values of walls, windows, roofs and floors: average values for different building age classes (see example in Fig. 16) and frequency distributions;
- envelope areas (specific window, façade, roof and floor areas): frequency distributions;
- calculated heat demand for space heating: average values for different building age classes (see example in Fig. 17), dependence of the thermal transmittance;
- energy carrier types and heat generator types: frequency distributions;
- measured consumption: average values for different utilisation types, correlation with calculated consumption.

Of course, it cannot be assumed that the determined average values are representative for the respective national building stocks. Each Model Project had a different collection scheme and monitoring target, often a certain region was considered, therefore the datasets are more or less a limited case study. The objective of this analysis was not to provide a survey of national building stock properties but to show the benefits resulting from data harmonisation: the possibility of comparing energy-related building data by using a simplified international “language”.

Fig. 15: General statistics of the collected datasets of the 12 Model Projects

Total number of collected datasets			**19095**
Certificate types		**Utilisation types**	
whole buildings	10927	residential buildings	17727
building parts	0	offices	215
apartments	8168	education	612
Rating types		higher education	137
only asset rating	17542	hospitals	68
only operational rating	1112	hotels and restaurants	15
both asset and oper. rating	421	others	378
Considered energy uses		**Buildings constructed ...**	
heating	19053	1900 or earlier	160
hot water	18679	from 1901 to 1940	352
cooling / air conditioning	524	from 1941 to 1980	8616
lighting	10614	from 1981 to 2000	3920
others	10504	since 2001	4313
Contribution of the Model Projects			
MP 1 Germany	515	MP 7 Belgium	113
MP 2 Poland	133	MP 8 Austria	6715
MP 3 United Kingdom	302	MP 9 Slovenia	100
MP 4 The Netherlands	10109	MP 10 Spain	50
MP 5 Italy	188	MP 11 Ireland	126
MP 6 Greece	250	MP 12 Bulgaria	494

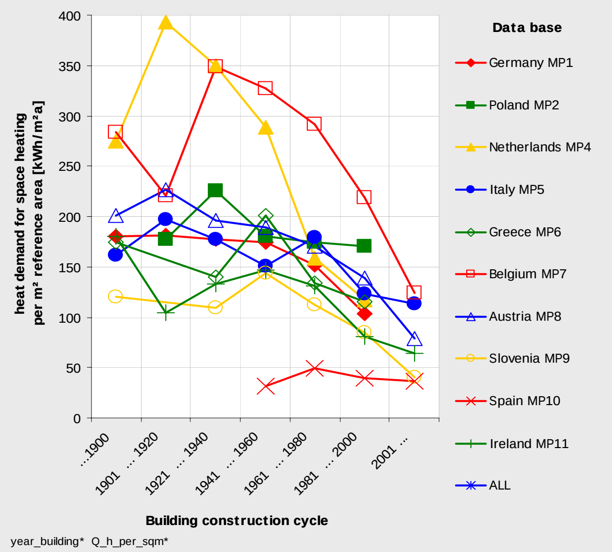
Fig. 16: Cross-country comparison example



U-values of walls – average values depending on building age class

The comparison of average U-values gives an impression of the improvement of the thermal envelope quality during the last 100 years. Whereas the U-values only slightly decreased until the seventies a considerable drop occurs in the last two decades of the 20th century. Comparing the countries a great variety of U-values can be observed for each construction cycle. Of course, these values may not in every case reflect the actual state but also – depending on the certification method – the standard values given by national typologies or by the used EPC software.

Fig. 17: *Cross-country comparison example*



Calculated heat demand for space heating per m² reference area

In this chart the annual heat need for space heating is shown, which was calculated using the respective national methods. Comparably very high values of more than 300 kWh/(m²a) are found for the databases of the Netherlands and of Belgium. This can be mainly explained by higher U-values. For the other countries a band of 100 to 200 kWh/(m²a) for older buildings is typical (with the exception of Spain, due to different climate conditions). In the case of new buildings the heat demand amounts typically only half of the value of older buildings.

Comparing of Energy Performance Certificate data from different countries: Lessons learnt

An important precondition for comprehensive comparisons like the one used in the analyses mentioned above is that the entire databases are available for all considered countries. Since this may cause problems during future activities (e.g. data privacy) an alternative way for comparison was shown during the evaluation: Subsets of the databases are aggregated in form of building types. Each building type is represented by an “average building”, a dataset determined by averaging the specific envelope areas, the U-values and the energy need for heating. If this aggregation is performed using the same method for each database, cross-country comparisons of the buildings’ energy performance can be performed in a similar way. As a result a simple typology for residential buildings was created for 8 Model Project databases as a showcase for such a procedure.

Apart from comparing the energy-related features of buildings from different countries building typologies can also be used for calculating the energy saving potential for a distinct regional or national building stock (as has been done e.g. in Model Project 1). In consequence one of the conclusions of the DATAMINE project is to set up activities for the design of harmonised National Building Typologies (see chapter 0).

In summary the DATAMINE data structure proved to be a suitable approach for information exchange between countries and for harmonised monitoring activities on EU level. The showcase analysis shows that proper information about trends and characteristics in the building sector can in principle be attained by the proposed indicators and by the data analysis concept.

General Experiences and Recommendations

The DATAMINE project is characterised by its bottom-up approach: In the 12 Model Projects a large variety of experiences was made with data collection and analysis. Different types of buildings (residential and non-residential) were analysed using different types of energy certificates and energy audits (asset rating as well as operational rating). Different methods of data collection were applied: Existing databases were used but there was also data transfer from single energy certificates or building energy audit reports – carried out by hand or by a new developed interface for energy certificate software. Also data collection via internet was realised. Even the monitoring aims were very different: Of course, there was always a general motivation to learn more about the energy performance of the building stock, but the specific questions to be answered were very different: For Example, the carbon dioxide savings by refurbishment subsidies of a grant programme were calculated, portfolio analysis of housing companies was supported, energy balance calculation methods were compared.

The variety of conditions and approaches in the 12 Model Projects can be studied in detail in the respective reports (see Overview of DATAMINE reports). However, DATAMINE also intended to make the results comparable and to draw general conclusions. One aspect is the comparability of the different data sets which was made possible by the common Data Structure and which was demonstrated by the cross-country comparison described above. Apart from this remains the basic questions which formed the starting point of DATAMINE: How can we proceed with monitoring the energy performance of the building stock? What can be learned from the DATAMINE project? Which are the next steps?

Certainly we can not give final answers in this complex issue. But on basis of our experiences during the project (also including dissemination activities and the exchange of opinion with representatives of key actors and target groups such as national experts on energy saving and monitoring) we would like to give the following recommendations:

1. Use the DATAMINE Data Structure to make monitoring data bases comparable

The DATAMINE Data Structure has demonstrated its ability to serve as a "common language" that can make data from different projects comparable, also on an international (European) level. So it would surely be useful for the understanding and comparability of monitoring results if this data structure would be more and more used in projects dealing with data collection about the energy performance of buildings. Of course this does not mean that the DATAMINE Data Structure was the one and only concept for systemising the collected data. Such a harmonised structure is necessarily simplified and will not be able to meet the specific needs of every monitoring approach. This was even not the case within the DATAMINE model projects. But a translation will usually be possible: The DATAMINE Data Structure was designed to include the most relevant results of different types of energy certificates issued for different types of buildings in different European countries. Accordingly, what we will usually only need are interfaces which export ("translate") the existing data to the harmonised structure.

Of course the DATAMINE Data Structure is just a first approach. If it was successfully disseminated in the future, it would certainly be advanced and improved, maybe a bit like a 'living language'. But care should be taken with creating dialects which might finally result in a 'Babel of languages'.

2. Use national energy certificate data bases for making statistical analysis

In the course of the implementation of the European directive on the energy performance of buildings (EPBD) some European countries are currently establishing national data bases including information on all officially issued energy certificates. The information is either directly collected via energy certification internet tools or data files that are submitted to the central data base for every certified building by the energy consultants or other persons / institutions who issued the certificate. Certainly this is a very good opportunity to attain statistical information on the national building stock, but this task often appears to play only a minor role during the establishment of these data bases. So it can be recommended to check the opportunities and elaborate concepts for getting statistical information on the building stock by analysing the delivered data. Within this it should be checked if all information that would be valuable is actually collected. Generally it can be expected that energy certificates which are based on asset rating will provide more detailed information than those based on operational rating. Of course here – as in all other monitoring approaches – data protection needs must always be kept in mind and cared for.

National energy certificate databases do not exist in every country but often there are other centralised data collection schemes (e.g. collection of samples of energy certificates, data bases on regional level or in the framework of subsidy programmes) which may as well be used for monitoring purposes.

3. Provide the house owners with the complete information about their buildings

Even if there are no national or other energy certificate databases the chances of using energy certificate data for statistical analysis is not completely lost: If the useful data which are collected and calculated during the making of the certificate are transferred to the house owner they will be available in case of future information demand, e.g. when the house owner is asked to fill in a questionnaire of a large-scale survey for monitoring purposes. But it will also be useful for him when the energy certificate is to be updated or in case that refurbishment measures are planned for the building some years after issuing. The information is not necessarily to be provided as an electronic data file but could also be printed on paper. In this case, of course, not all information should be given directly in the Energy Certificate but in a special appendix with standardised structure.

4. Develop concepts for the monitoring of the national building stocks

The collecting, analysing and comparing of data from energy certificates is not an end in itself. What we really need is better information about the energy performance of the building stock so that we can answer questions like: What are the energy saving potentials in the building stock? How much CO_2 do we save in the building stock every year? Is this sufficient to reach the climate protection goals?

To be more precise we can identify three tasks:

- At first we have to get an idea of the structure of the building stock (which types of buildings are there depending on the year of erection? How are they constructed, e.g. which types of walls were built how often in the respective erection period?).
- Secondly we have to know their current state (How many walls, roofs, heating systems et cetera have already been insulated / modernised in the past?).
- And thirdly we have to know the current trends (How many energy saving measures are carried out every year at the walls, roofs, heating systems et cetera?).

To provide this information is no simple task and it will demand for well-tailored statistical concepts. For example it must be assured that the analysis really leads to representative results for the observed building stock. In the next points 5, 6 and 7 we will examine possible approaches in more detail.

5. Develop building typologies

A first step towards monitoring the energy performance of the building stock is to get a systematic overview of its structure: Different types of buildings were erected in different periods, the used building materials and structures also depend on the size (single or multi-family house) and often on the region. The making of a building typology means to classify the building stock in a systematic way: The typology consists of a set of model buildings with characteristic energy related properties (envelope areas, U-values, supply system efficiencies). Each model building represents a certain construction period and a specific building type and size. The number of buildings or the overall living area per type can usually be derived from national statistics so that with the help of the typology a detailed picture of the building stock can be drawn reflecting the different erection periods. Energy certificate data appear as a well suited information source for the definition of building types for example to identify mean values per building type, e.g. the mean wall area per building or mean U-values of buildings in their original state.

Building typologies already exist in some countries (e.g. in Denmark, the Netherlands, Germany) but even in such cases there might be a need for further development e.g. to define the representative model buildings on a better statistical basis. In other countries building typologies would have to be new developed and here we see good perspectives for harmonised approaches on international / European level: If national and regional typologies were structured in a similar way this would be a good basis for comparison and for getting a detailed overview of the building stock in Europe.

6. Carry out representative surveys

The second and third step of monitoring (quantifying the current state and the current trends of building energy performance) will need special attention and well-tailored methods. For example this task can not automatically be solved by collecting and analysing energy performance data of buildings. It must be assured that the analysis really leads to representative results. This is even the case if national data bases for

energy certificate data exist, because as long as there is not an up-to-date energy certificate for every building in the country mean values of the collected data do not necessarily reflect the average state of the whole building stock. So one can expect that energy certificates are often issued for buildings which were recently modernised so that those buildings might be over-represented in the data base[1].

Thus, if there are large energy certificate data bases the question has to be answered, if and how representative results can be attained to certain questions, e.g. by sub-sampling and stratification. Maybe it will turn out that additional surveys are necessary which will anyway be the case if no such national data base exists. Because in the short run not every building will be provided with an energy certificate (and even if: it might not contain all relevant data, see point 3) the certificates hold by the house owners can not serve as the only data source in the survey so that suitable questionnaires might be needed.

7. Monitor the sectors "new buildings" and "rented houses"

Even if apparently not every question can directly be answered by collecting and analysing energy certificate data, there are sub-samples of buildings which are better suited than others: These appear to be the new buildings and the rented houses.

According to EPBD every new building in the EU will be provided with an energy certificate. So here we have a complete covering of the new buildings sector with asset rating data. Collection of this data by central data bases or with the help of representative samples could lead to clear picture of the new buildings sector. Sometimes the new buildings are estimated to be much less relevant for climate protection and energy saving than the existing building stock with its large unused energy saving potentials. But this is not the case if one considers that the existing buildings can not all be modernised overnight. This will take a long time and during this period also the new buildings will accumulate and altogether have a considerable impact to the carbon dioxide emissions. So it will be very important to know how many buildings only keep the national energy saving regulations and how many have a better quality.

As pointed out the analysis of energy certificate data in the existing building stock could be more difficult because energy certificates are not issued for all buildings in the next years. This applies in the first place to owner-occupied houses, mostly single-family houses where energy certificates only need to be issued in case there is a new owner. In the sector of rented buildings the situation is different because the EPBD requires the issuing of certificates in every case of a new rented apartment. So it can be at least assumed that the sector of rented houses (especially larger multi-family houses) will be provided with energy certificates very much quicker than the owner-occupied houses so there might be better conditions for a comprehensive monitoring on basis of energy certificates.

8. Use the opportunity to answer specific questions by monitoring

The previous recommendations concentrated on the monitoring of the complete (e.g. national) building stock. This is of course a central question but there are many others to be faced. The DATAMINE Model Projects showed many exemplary applications of energy certificate monitoring against the background of specific monitoring aims. Here we give some examples of questions which can be answered, there may be others:

- portfolio analysis (e.g. of the building stock of Housing Companies or municipalities);
- monitoring of energy saving support programmes;
- improvement of energy balance methods used for energy certification
  - comparing the calculated energy demand with the measured energy consumption,
  - comparing different methods,

  aiming at an improvement or simplification (and easier application) of the methods;
- quality assurance of energy certificates (applying plausibility tests to the certificates by making use of input and output data, monitoring of energy certificate quality);

[1] In case of deriving basic data about the original state for a building typology this problem has obviously not the same relevance.

Overview of DATAMINE Reports

- **Concepts for Data Collection and Analysis.** First Synthesis Report of the EIE project DATAMINE; Juli 2006

- **Data Collection from Energy Certificates - experiences and analyses.** Second Synthesis Report of the EIE project DATAMINE; March 2008

- **Monitoring by use of Energy Performance Certificates.** Experiences from 12 Model Projects and Conclusions for Energy Performance Monitoring in the European Building Sector; third Synthesis Report of the EIE project DATAMINE; November 2008

- **Model Project Reports**
  - Report Model Project 1 – IWU / Germany (in German + English Summary)
  - Report Model Project 2 – NAPE / Poland (in Polish + English Summary)
  - Report Model Project 3 – ESD / UK (in English)
  - Report Model Project 4 – BuildDesk / The Netherlands (in Dutch + English Summary
  - Report Model Project 5 – DENER / Italy (in Italian + English Summary)
  - Report Model Project 6 – NOA / Greece (in Greek + English Summary)
  - Report Model Project 7 – Vito / Belgium (in Dutch + English Summary)
  - Report Model Project 8 – AEA / Austria (in German + English Summary)
  - Report Model Project 9 – ZRMK / Slovenia (in Slovenian + English Summary)
  - Report Model Project 10 – Ecofys / Spain (in Spanish + English Summary)
  - Report Model Project 11 – Energy Action / Ireland (in English)
  - Report Model Project 12 – SOFENA / Bulgaria (in Bulgarian + English Summary)

All publications are available at the DATAMINE website:

www.meteo.noa.gr/datamine

1 The Foundations of Energy Certificate Data Collection and Evaluation

1.1 Harmonised Data Structure

The common DATAMINE Data Structure, which was elaborated and tested during the DATAMINE project, provided a framework for the data to be collected during the Model Projects. A total of 255 parameters were defined of which a suitable sample may be selected to describe the building´s energy performance, depending on the concrete case and the type of energy certificate.

The Data Structure follows a harmonised approach: The existing version 1.0 was used by all DATAMINE partners in their model projects in the same way.

The Appendix of this report presents the Excel work sheet with all quantities of the DATAMINE data structure. The Excel file can also be downloaded from the project website www.meteo.noa.gr/datamine.

Application of the Data Structure

The data of each model project was collected in a database, which is an EXCEL worksheet. The data of each building was written in a row of the table (data set). The columns of the table describe the building properties. Each column (data field) of the table stands for a well defined quantity (which may be a number, e.g. conditioned floor area of the building in m² or a string indicating special information, e.g. the name of the city where the building is located).

The following sections define in detail the quantities of the data structure. To give a better overview each quantity is written in a row and not (as it will be later the case during the concrete data collection) in a column.

Harmonisation

An important task - especially in the view of the dissemination of the concept - was the harmonisation of the data of the Common Evaluation Data Structure: The quantities are defined in the same way in each of the 12 model projects. This was the basis for the comparison of the model projects' results and experiences and for a later dissemination of the DATAMINE concept. It was also a prerequisite for the application of the software tool which is developed by IWU (Data Analysis Tool, see chapter 5).

Completeness and Practicability

The Data Structure was defined to be as comprehensive as possible, including all relevant quantities. However, it had to be kept as simple as possible to be practicable. Accordingly, there was an effort to reach a compromise between these two aims and a consensus among all project partners.

The Data Structure also accounts for the different types of energy certificates in the EU countries and in the project partners' model projects, as well as the different monitoring aims: For example, the data to be delivered from asset rating (calculation of the energy demand of the building) and from operational rating (measured energy consumption) are very different. The same applies to different types of buildings (certificates of residential and non-residential buildings).

Thus, it is clear that it will not be possible for every model project to deliver all the required input information for all the quantities in the Data Structure. Depending on the properties of the used energy certificates and other circumstances, only parts of the data fields will be filled in and the rest of the data fields will remain empty. Accordingly, the Data Structure is a general framework for different types of projects and it has to be decided from case to case which part of the Data Structure is applicable.

Types of collected data

Different groups of quantities were defined as follows:

A. Energy Certificate Data

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

B. General data of the building

Basic data of the type and size of the building: e.g. location (city), building utilisation, conditioned floor area

C. Building envelope data

Data describing the thermal performance of the building envelope (enclosing the heated part of the building): U-values and area of the elements, window properties

D. System Data

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

E. Calculated Energy Demand (Asset Rating)

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

F. Basic Parameters of Operational Rating

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

G. Summary of Energy Consumption and Energy Generation

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

H. Primary Energy, CO2 Emissions and benchmarks

Primary energy demand and CO_2 emissions for both operational and asset rating

1.2 Methods of Data Collection

Data Collection in the Model Projects

Different sources of energy certificate data were used during the Model Projects: In general there were existing samples or even databases of energy certificate data. But in most of the cases no attempt had been made before DATAMINE to make use of the data to get information about the energy related properties of the respective building stock. This situation – energy certificate data bases installed but not (or only partly) analysed – does not seem to be an exception only. So there might be other comparable applications of the DATAMINE approach in the future. Of special interest is here the fact that some of the EU countries carry out or at least discuss the installation of national energy certificate databases in the framework of EPBD implementation (see Fig. 18). DATAMINE offers the concerned project partners a starting point to discuss the possible opportunities and benefits of monitoring in these cases.

Almost all model projects had to face the fact that the EPBD implementation is delayed. The original date of the introduction of energy certificates had been the 1st January 2006 which was also the starting date of DATAMINE. So in many projects it had been planned to also collect and analyse the new “official” energy certificates. According to the delay this could not be attained in general, but it does not affect the basic project targets. The main aim of DATAMINE was not to accompany or evaluate national EPBD implementation but to examine the general chances and benefits of monitoring the building stock with the help of energy certificates. Rather each Model Project had its own monitoring task widely independent of EPBD implementation.

General Aspects of Data Collection

The first practical step towards monitoring is the collection of energy certificate data in a central data base. This chapter provides a general survey of possible methods, not only considering the DATAMINE model projects.

Depending on the purposes of monitoring and on the types of available energy certificates there are different ways of carrying out the data collection. The following paragraphs present a short overview. Of course, these are only exemplary solutions – in practice there are some more data collection procedures which are partly similar to one or several of the described methods.

Fig. 18: Principle of Energy Certificate Data Collection

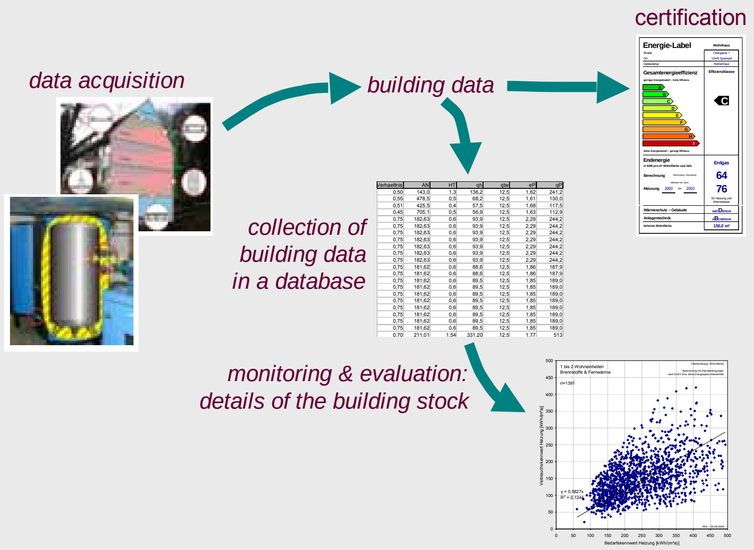


Fig. 18 illustrates the overall principles: The data which are ascertained for making an energy certificate must be also collected in a data base to allow monitoring and evaluation of the considered building stock. The data collection may take place “simultaneously”, that means during the preparation of a certificate (as shown in the figure) or “ex post” (after issuing the certificate).

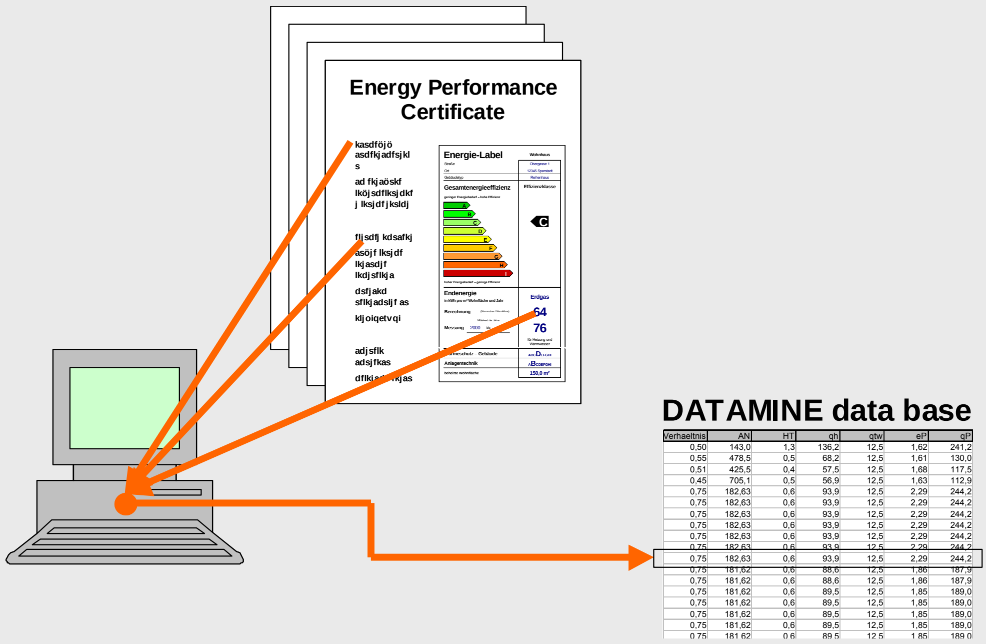
Fig. 19: Status National Energy Certificate Data Collection in European Member States (result of the DATAMINE Expert Workshop on 13th November 2008 in Brussels)

Country	Institutions involved	Type	Level of detail of the collected data	Status of data collection	Status of evaluation	Links
Austria	AEA, gizmocraft	voluntary scheme (upload certificates into webbased database)	high	running	running	www.immozeus.at
Belgium / Flanders	Vito, VEA	central collection official EPC's for residential buildings	medium/high	november 2008 (sale) - 01/01/2009 (renting)	under discussion	www.vea.be
Denmark	SBi	integral part of official certification / local software + data submission	high	running	start in 2000	www.meteo.noa.gr/datamine/5-Wittchen-Denmark-DATAMINE_Workshop-Nov2008.pdf
France	ADEME	planned to be integral part of official certification / local software + data submission	high	start in spring 2009	after spring 2009	www.meteo.noa.gr/datamine/6-Despretz-France-DATAMINE_Workshop-Nov2008.pdf
Germany	dena	voluntary scheme (quality assurance system "dena Gütesiegel") local software + data submission	high	running	pending	www.zukunft-haus.info/de/verbraucher/energieausweis/dena-guetesiegel.html
Greece	Ministry of Development	All EP certificates and audit reports (building energy audits, boilers & heating systems, and air conditioning systems) will be submitted electronically. Mandatory process	High	start in 2009	not yet determined	www.meteo.noa.gr/datamine/HellenicModelProject_Report_EN_Feb08.pdf
Ireland	Sustainable Energy Ireland	integral part of official certification / online certification	medium low (all input data plus only three final rating results)	running	running	www.meteo.noa.gr/datamine/datamineMPie3.03.08v4.pdf
Italy	ENEA - Italian National Agency foe New Technologies, Energy and Environment	EP certificates issued for use of grants and special terms provided by public funds (data submission via web)	medium (a light form is filled out)	running	running	www.efficienzaenergetica.acs.enea.it
Netherlands	SenterNovem	integral part of official certification / local software + data submission	low (file to be sent to central database consists of the full set of input and output parameters but only a limited number of these parameters has a common datastructure. The rest depends on the used software tool)	running	running	www.ep-online.nl www.meteo.noa.gr/datamine/8-Marquart-Netherlands-DATAMINE_Workshop-Nov2008.pdf
Poland		no central register planned				
Portugal	ADENE	integral part of official certification / online certification	high	running	starting	www.meteo.noa.gr/datamine/7-Santos-Portugal-DATAMINE_Workshop-Nov2008.pdf
Slovenia	GI - ZRMK, Ministry for Environment and Spatial Planning, The Surveying and Mapping Authority of the Republic of Slovenia	integral part of official certification / local software + data submission to online application	high	start in January 2009	pending	
UK	Landmark	all EP certificates	high	Running since 2007	Not yet started	https://www.ndepcregister.com/

Manual transfer from energy certificates

A very simple method to get an overview of the certified buildings may be to use the issued certificate itself. The characteristic data given in the certificates are extracted and entered into a data base.

Fig. 20



This way may be of some importance when there are no central data bases with energy certifcate data available. Of course it will be necessary that all relevant information of the building (which is collected during the making of the energy certificate) is actually handed out to the building owner together with the energy certificate (e.g. as an appendix). The manual data transfer from the paper version is of course time-intensive. Sometimes this will be necessary – like in the Irish model project – but in the future and on a larger scale automatic text identifation software might be applied if uniform forms are used for the docmentation of the data.

Assembly and transformation of project files of an energy certificate software

Data processing becomes more convenient, if a specific energy certificate software is used by the certifiers. The project files used by the software can be collected in a single data base. Since the data structure of the energy certificate software usually is not equal to that of DATAMINE a transformation of the different data fields has to be carried out.

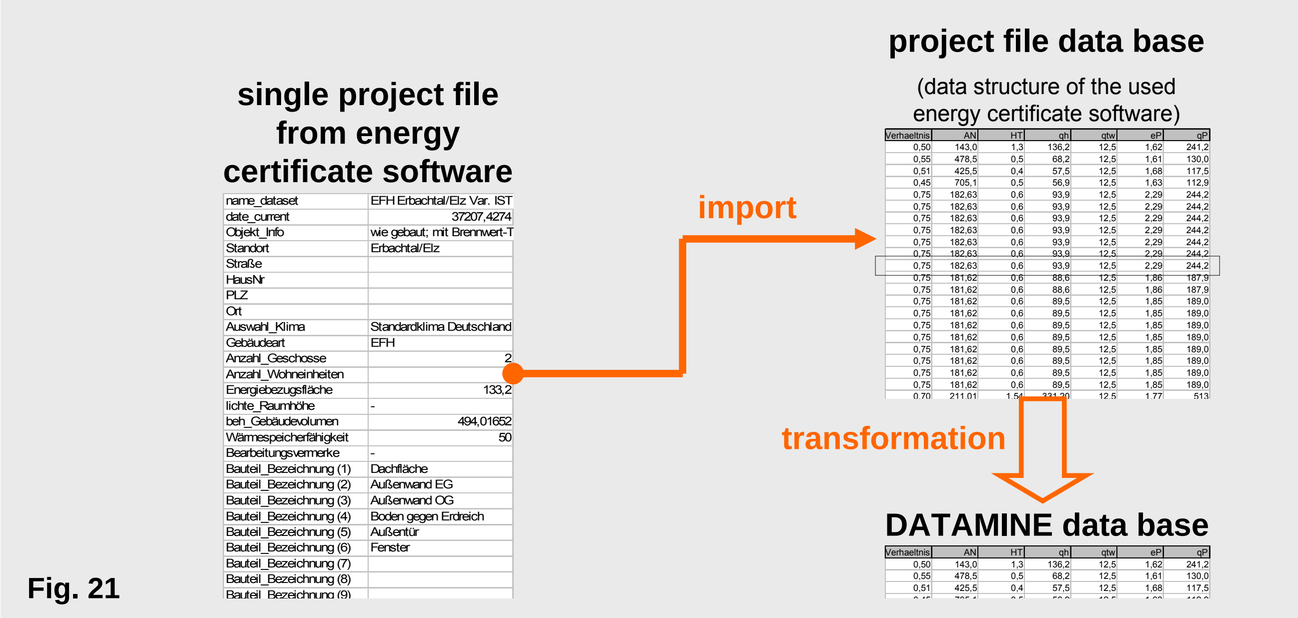


Fig. 21

This way of data collection was applied by most of the DATAMINE model projects: The data of the energy certificates were collected (or had even been collected before DATAMINE) in data bases with an individual structure. During DATAMINE software solutions making a translation of the existing data to the common DATAMINE Data Structure were developed an applied.

Export of single datasets by EPC software and transfer to a central collection point

A future way of handling data collection could be the processing of a DATAMINE export file by the energy certification software itself which is then sent to a monitoring centre by the certifiers. This would require the consideration of the DATAMINE data structure and the integration of a postprocessor in energy certificate software applications.

During DATAMINE this approach was realised in the German model project: A new DATAMINE interface was developed by the providers of two energy certificate software applications.

Another possible solution is that a DATAMINE database is integrated directly into the energy certificate software application. The data of several certifiers could then be analysed by merging their DATAMINE databases.

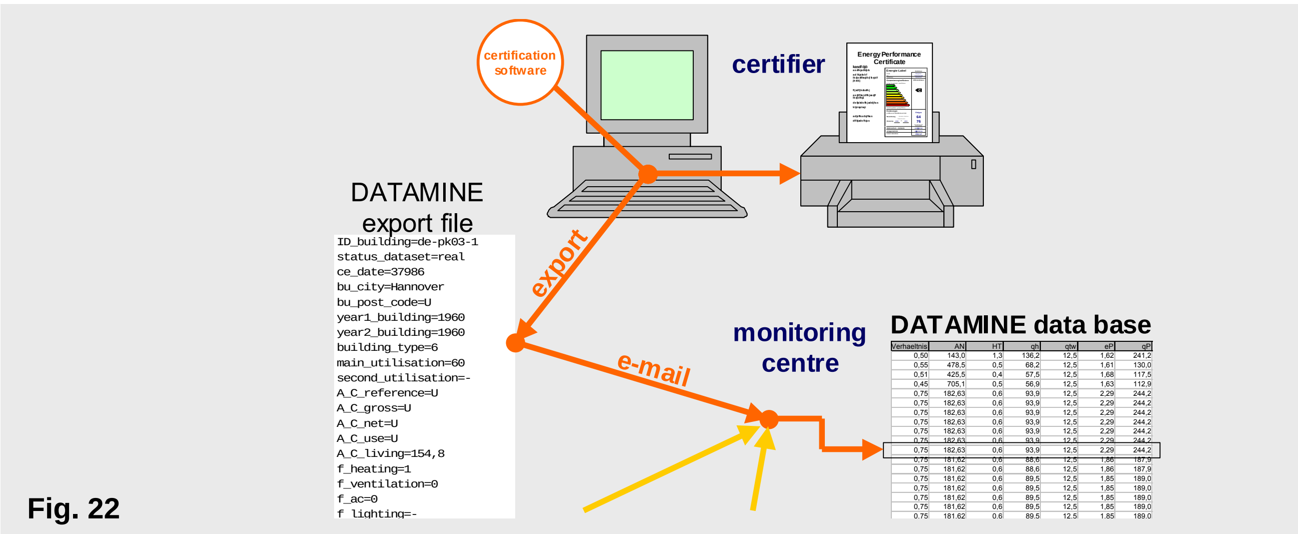


Fig. 22

Online certification with central database

If certification is carried out through the internet this procedure could be realised in an easier way because a direct integration of the harmonised data structure in only one software tool and a direct transfer to the DATAMINE data base could be attained. This kind of data collection was realised in the Austrian and the British Model Project.

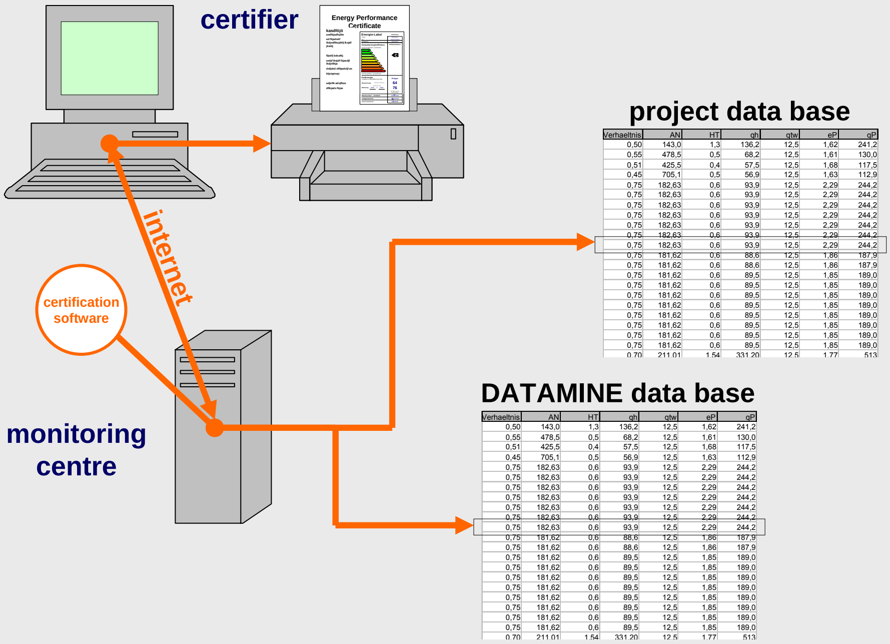


Fig. 23

Empirical inquiries for statistical analysis independent of energy certificates (representative data)

At last there is also the possibility to acquire the data independent of the energy certification – for example, if a statistical survey is carried out using a sample of buildings which are not yet all provided with energy certificates (see also chapter 2). In this case the relevant building data must be included in the questionnaire, which is used for the survey. Duch surveys with questionnaire might often be necessary to answer some fundamental monitoring questions, e.g. the current trends of modernisation measures in the building stock.

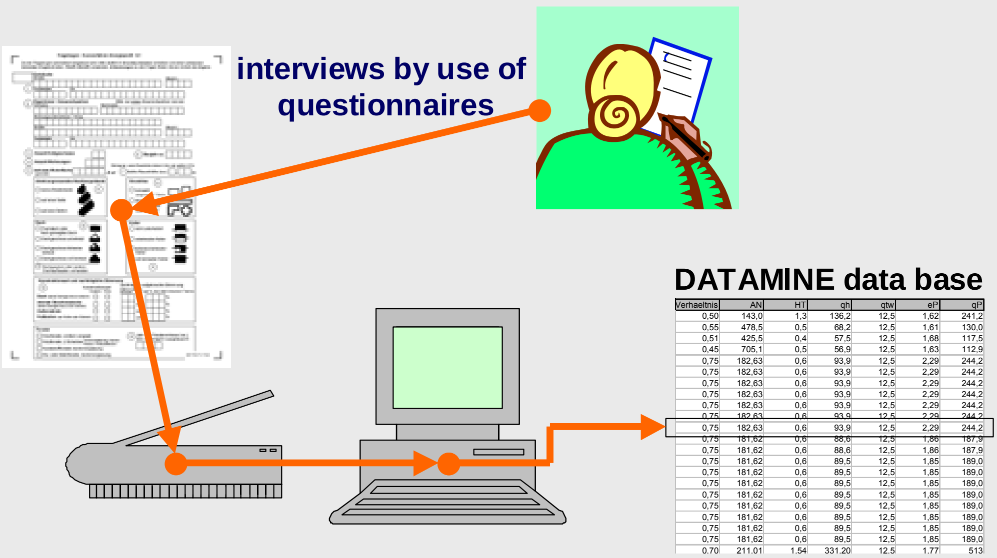


Fig. 24

2 DATAMINE Model Projects

This chapter gives an overview of the aims, the carrying out and the conclusions of the 12 DATAMINE Model Projects.

A detailed description of these regional or national activities can be found in the respective Model Project Reports (download from the DATAMINE website www.meteo.noa.gr/datamine).

2.1 German Model Project

Status of introduction of Energy Performance Certificates in Germany

Since the year 2002 Energy Performance Certificates basing on the primary energy demand for heating and hot water are issued for new buildings in Germany. For existing buildings new regulations came into force in October 2007. In case of renting or sale EP Certificates have to be available: for residential buildings starting from the period July 2008 to January 2009 (depending on building size and age), for non-residential buildings starting from July 2009 (including the presentation in a prominent place for public buildings).

For all existing buildings there is a free choice between asset rating and operational rating – except for small residential buildings (1 to 4 apartments) built before 1977 where only asset rating is allowed.

Fig. 25: Status of Energy Performance Certificate introduction in Germany

Regulations are fixed by government		**yes**	
Coming into force		**October 2007**	
Availability of EP Certificates*	residential buildings	**Jul 2008 / Oct 2008 / Jan 2009****	
	non-residential buildings	**July 2009**	
		Asset Rating	**Operational Rating**
Residential buildings			
new		**yes**	**no**
existing			
small buildings (1 to 4 apartments)	constructed before 1977	**yes**	**no**
	constructed 1977 or later	**yes**	**yes**
large buildings (5 or more apartments)		**yes**	**yes**
Non-residential Buildings			
new		**yes**	**no**
existing		**yes**	**yes**

*) for existing buildings in case of renting or sale (for new buildings already since 2002)

**) depending on building age and building size

The DATAMINE Model Project in Germany

The German DATAMINE model project aimed at the analysis of the energy saving support programme for existing buildings proKima-Altbau which is run in the region of Hannover. The main objective was the calculation of the CO_2 emission reduction which could be achieved by the supported measures. Two main sources with energy certificate data were used during the project:

- Detailed data from 261 energy certificates were provided by Stadtwerke Hannover (the local energy supply company), who also act as energy consultants.
- Simplified data sets from 254 energy certificates. Those datasets, which include only a few data, are collected by proKlima for every supported building.

The 261 datasets from Stadtwerke Hannover provided information of the state of the buildings before modernisation but it was not sure if the distribution of building types (single- or multi-family-buildings) and heat sytem types (especially: type of the used energy carrier) was the same as for the whole support programme, because e.g. the building owners who ordered energy ceritificates by Stadtwerke Hannover might be a special section of all supported building owners. So the calculation of the percentage share of building types and heating system types in the support programme was carried out by analysing the 254 simplified datasets which are more probably a random sample of the buildings which were supported in the programme.

In the recent years the energy certificates of proKlima Hannover were issued according to a scheme which was elaborated by the German Energy Agency (dena) beeing very similar to the official scheme which was introduced in October 2007 .

Main results of the data evaluation

Fig. 26: General statistics of the analysed datasets

Number of collected datasets			**515**
Certificate types		**Utilisation types**	
whole buildings	515	residential buildings	515
building parts	-	offices	-
apartments	-	education	-
Rating types		higher education	-
only asset rating	257	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	258	others	-
Considered energy uses		**Buildings constructed ...**	
heating	515	1900 or earlier	16
hot water	515	from 1901 to 1940	127
cooling / air conditioning	-	from 1941 to 1980	154
lighting	-	from 1981 to 2000	38
others	-	since 2001	-

(analysed data*: total 515 data sets: 261 energy certificates with detailed data, further 254 simplified energy certificate datasets,*

collected and also transferred to the harmonised DATAMINE data structure but not analysed: *2885 simplified datasets from a preceeding period)*

A detailed overview of the state of the funded building stock before modernisation was carried out by analysing the 261 energy certificates of Stadtwerke Hannover. As examples the average U-values of the walls (depending on the age of the building), the frequency of the heat generator types and of the calculated primary energy demand (by energy carrier) are depicted here.

Fig. 27: Mean U-Value of walls, depending on building construction cycle

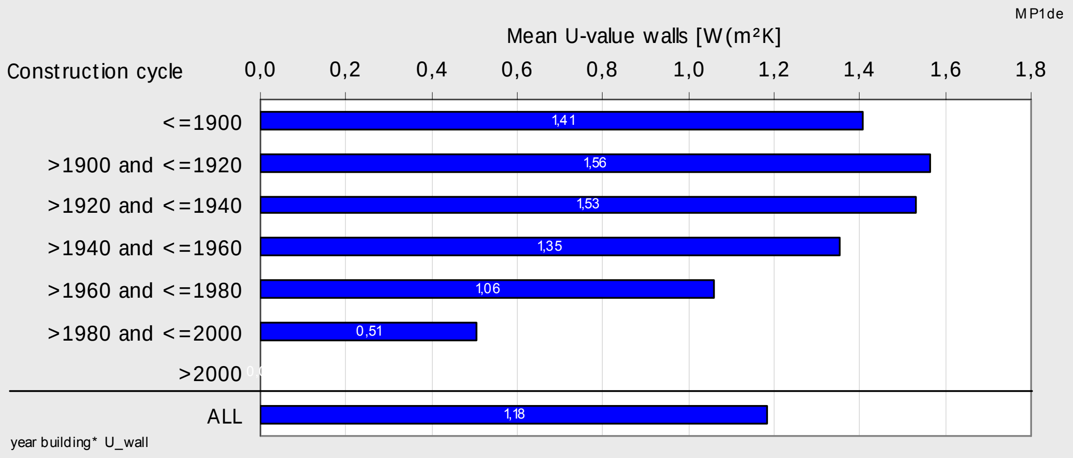


Fig. 28: Frequency of heat generator types for combustion of fuels + respective energy carriers

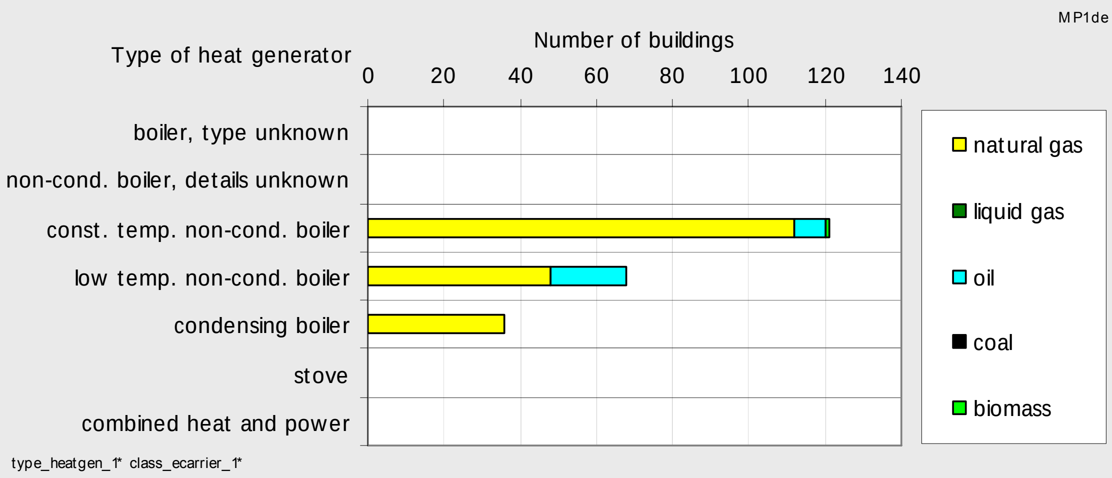
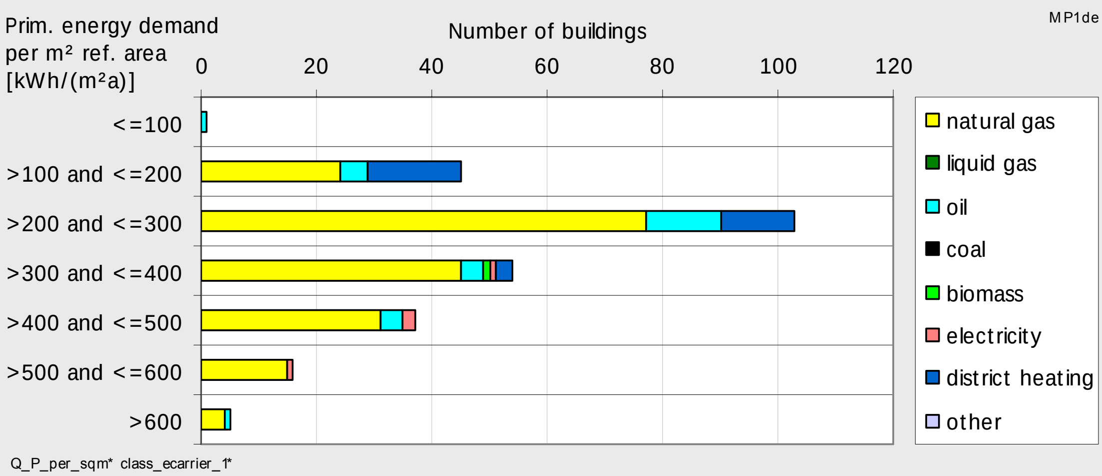


Fig. 29: Frequency distribution of the primary energy demand
(depending on energy carriers used by the main heat generator)



The aim of calculating the CO_2 savings was achieved in three steps:

- By the described analysis of the 261 detailed energy certificates from the Stadtwerke Hannover two "building types" were defined. They reflect an average state of a single-family house and of a multi-family house before modernisation (area and U-values of walls, roofs, windows etc.). Types of heating systems (type and age of the main heat generator depending on the used energy carrier) were accordingly defined.
- The share of building and heat supply system types in the programme was derived from the 254 simplified datasets.
- The number of supported cases for each type of energy saving measures was determined from the programme statistics. By combining this information the energy savings and the CO_2 emission reduction could be calculated with the help of a common energy balance method.

The reduction of CO_2-emissions achieved by the supported measures in 2005 amounts to circa 5150 tons per year. For 2006 the respective number is circa 5350 tons per year.

During the German model project DATAMINE interfaces were implemented in a software product. The interface makes possible a direct transfer of the building data and calculation results to a file in the format of the DATAMINE data structure.

Conclusions

Direct outcome

The German model project demonstrated the application of the general idea of DATAMINE – monitoring with the help of energy certificate data – to a special situation: the analysis of an energy saving support programme.

The 261 available detailed energy certificates made possible a comprehensive analysis of the state of the buildings sample before modernisation which on the one hand delivered valuable data for the monitoring. On the other hand it can also be seen as a successful "test run" of a more general analysis of the existing building stock with the help of data collection from energy certificates using the DATAMINE data structure.

A DATAMINE interface was implemented in an energy consulting software tool. This approach could simplify data collection in the future (not only in Hannover because the tool is not only used there).

Perspectives of the monitoring of the proKlima support programme

The carrying out of the model project showed that the monitoring of the proKlima-Altbau programme could be improved in the future. Especially a direct connection of the data of the building in its original state and the individually energy saving measures could lead to an increased accuracy of the calculation of CO_2 emission reduction. Four alternative concepts of a future continuous monitoring were elaborated in the project. They differ in terms of expenses and accuracy: Three of them are basing on data collection from energy certificates, the last one describes a method of collecting data with the help of a questionnaire to be answered by the house owners (more details are given in the model project report).

In between the conditions of the support programme proKlima have changed: The making of energy certificates is no longer a prerequisite for getting the funding. So the option of an area-covering monitoring with the help of energy certificates does not exist any more and only the fourth approach still appears possible. But during the communication with the key actor proKlima it turned out that this option might cause too much organisational effort. However, now a fifth simplified ap-

proach is also being considered which is similar to the approach of the model project: The typology of buildings and heat supply systems which was developed during DATAMINE could further be used as an rough estimate of the buildings' state before modernisation. As in DATAMINE the frequency of types and the frequency of energy savings could be calculated with the help of the general programme statistics. Apart from that also the results of a new general building typology of the Hannover region could be used (optionally being levelled out with the DATAMINE typology results which were specific for the buildings taking part in the support programme).

Perspectives of national monitoring concepts

Concerning the collection and analysis of energy certificate data on a national level in Germany it must at first be stated that there are some principle obstacles: First there is no central national data base (like it is developed in other European countries in the course of EPBD implementation) and secondly different types of energy certificates are applied in parallel: asset rating as well as operational rating (also within the residential housing sector).

However, while discussing the perspectives of monitoring in the National Datamine Advisory Group, there was a great interest in such concepts by the participants (members of the Federal Office for Building and Regional Planning (BBR), the Hessian ministry of economics, the German energy agency, the city of Frankfurt and proKlima). It was agreed that even if there is no systematic and area-covering national approach of data collection, there will be chances for other ways of collecting and analysing samples of energy certificate data. Subgroups of the building sector with especially good preconditions for monitoring – like the new houses sector with its area-covering asset rating approach - should be identified.

Against that background the new quality control approach for energy certificates which is realised by the German Energy Agency (dena) appears very promising: Energy consultants which issue energy ceritificates for residential buildings can register and take part in the dena quality assurance scheme. Inter alia there is systematic collection of energy certificate data to carry out plausibility tests. In principle the collected energy certificate data can also be used for monitoring purposes. Currently concepts for up-dating IWU's German Building Typology – a systematic scheme for describing the German building stock by more than 40 typical buildings each representing a subset of the German residential buildings – are discussed. The preconditions of using the collected data for monitoring purposes are very good because dena considered the DATAMINE data structure during the development of their list of energy certificate data to be collected.

Besides, in Germany there are now concrete steps taken for improving the knowledge of the building stock, especially to answer the basic questions of which is the actual state of energy performance and which are the dynamics of energy saving modernisation measures. A great need to get more reliable information was identified especially to improve the basis for national climate protection strategies. A study was carried out by Institut Wonen und Umwelt (IWU) and Bremer Energie Institut which described the current state of knowledge, the existing information gaps and the possible measures to close them[1]. The DATAMINE approach of collecting and analysing energy certificates was also considered and measures to develop this concept were proposed. However, the analysis showed that neither in that way nor by combination of other existing data sources all necessary information could be attained in the short run. A new systematic survey of buildings would be necessary.

[1] N. Diefenbach, T. Loga, H. Cischinsky (IWU), K.-D. Clausnitzer (Bremer Energie Institut), A. Vilz (BBR); Grundlagen für die Entwicklung von Klimaschutzmaßnahmen im Gebäudebestand – Untersuchung über die bautechnische Struktur und den Ist-Zustand des Gebäudebestandes in Deutschland; BBR-Online-Publikation 22/2007, www.bbr.bund.de

Meanwhile such a survey project started (carried out by IWU and Bremer Energie-Institut until April 2010, funded by BBR, KfW-Bankengruppe and Hessian Ministry of Economics). It is intended to collect data of a sample of 10.000 residential buildings. This considerably high number is necessary to make possible the quantification of modernisation trends which are expected to be of a magnitude of only about 1% per year (like the annual rate of walls being insulated in Germany) and the break-down of the results to subgroups (e.g. on regional level or for certain building erection periods). Questionnaires will be given to a sample of house owners in about 300 chimney sweeper's districts so that a wide geographic distribution of the survey districts and finally a good representativity of the results will hopefully be attained.

2.2 Polish Model Project

Status of introduction of Energy Performance Certificates in Poland – August 2009

Work on EPBD implementation started four years ago, but due to many governmental changes, Poland noticed delay in the process.

In September 2007 the necessary changes related to the Directive requirements were introduced to the Building Code. The updated Act came into force on 18.X.2007. It states that all buildings mentioned in the Directive – all new residential and public buildings, as well as renting or selling buildings must have valid certificates from 1 January 2009.

Unfortunately, necessary Ordinances introducing methodology are still (August 2008 !!!) under development. What has been decided it is assessment method - for all buildings only asset rating.

Fig. 30: Status of Energy Performance Certificate introduction in Poland

Availability of EP Certificates	residential buildings	**January 2009**	
	non-residential buildings	**January 2009**	
		Asset Rating	**Operational Rating**
Residential buildings			
new		yes	no
existing		yes	no
Non-residential Buildings			
new		yes	no
existing		yes	no

The DATAMINE Model Project in Poland

In co-operation with Ministry of Infrastructure NAPE worked out last year the general frames of EPBD scheme for Poland. Ministry of Infrastructure is a responsible body for legal acts development (Act about Building certification +relevant ordinances) and NAPE serves as main consultant for this process.

So it is obvious that Ministry of Infrastructure is a main group interesting in the project results. Delivered information about existing buildings certification could support the decision makers to improve both – legal and technical solutions adopted during the first phase of EPBD implementation.

As it was mentioned above the Certification Scheme is not ready now in Poland, but Poland has well developed thermomodernisation system, so the data from the energy audits done for the purpose of Thermomodernisation Act will constitute the first data-base for Datamine project. Based on the project of the Ordinances about the methodology we have calculated classes of the buildings and add them to the project base. Some additional calculation presenting

Data required by performance calculation: building envelope, technical systems (heating, hot water), and occupancy. Seasonal heat demand (before and after) based on: U-values for walls, roofs, windows, efficiency of the system, and energy saving measures.

The data-base from existing energy audits is created by NAPE. Calculated data are analysed and compared with statistical data. Recommendation for improvements of the data collecting and evaluation process will be suggested by NAPE experts. Recommendation for futures evaluation and monitoring will be transferred to Certification Secretariat and Ministry of Infrastructure.

Main results of the data evaluation

Fig. 31: General statistics of the analysed datasets

Number of collected datasets			**133**
Certificate types		**Utilisation types**	
whole buildings	133	residential buildings	133
building parts	-	offices	-
apartments	-	education	-
Rating types		higher education	-
only asset rating	133	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	-	others	128
Considered energy uses		**Buildings constructed ...**	
heating	133	1900 or earlier	0
hot water	133	from 1901 to 1940	14
cooling / air conditioning	-	from 1941 to 1980	108
lighting	-	from 1981 to 2000	11
others	-	since 2001	-

Data used in the Model Project came from the energy audits done by NAPE during the period of 2001-2007. More than 400 audits done for the purpose of Thermomodernisation Act contain more than 50 different values describing energy performance of building such as:

input data

- construction year
- total area/cubature
- heating area/cubature
- number of apartments/inhabitants
- coefficient A/V
- envelope construction
- U values (walls, windows, doors, …)
- heating system (fuel-energy carrier, efficiencies)
- ventilation system
- water consumption

output (calculated) data

- energy demand for heating and hot water preparation
- peak demand
- building class as a result of energy consumption

Energy performance of the analysed buildings (expressed at the moment in energy consumption per square meter) is presented on the diagram below.

Fig. 32: Average calculated energy consumption per m² in assessed buildings

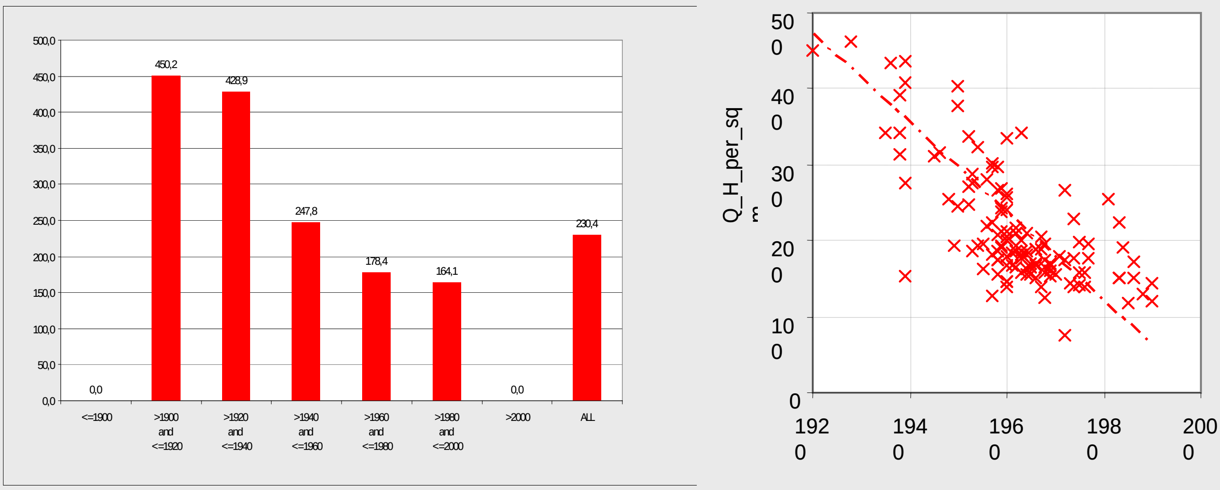


Fig. 33: Average U value for the walls in the assessed buildings

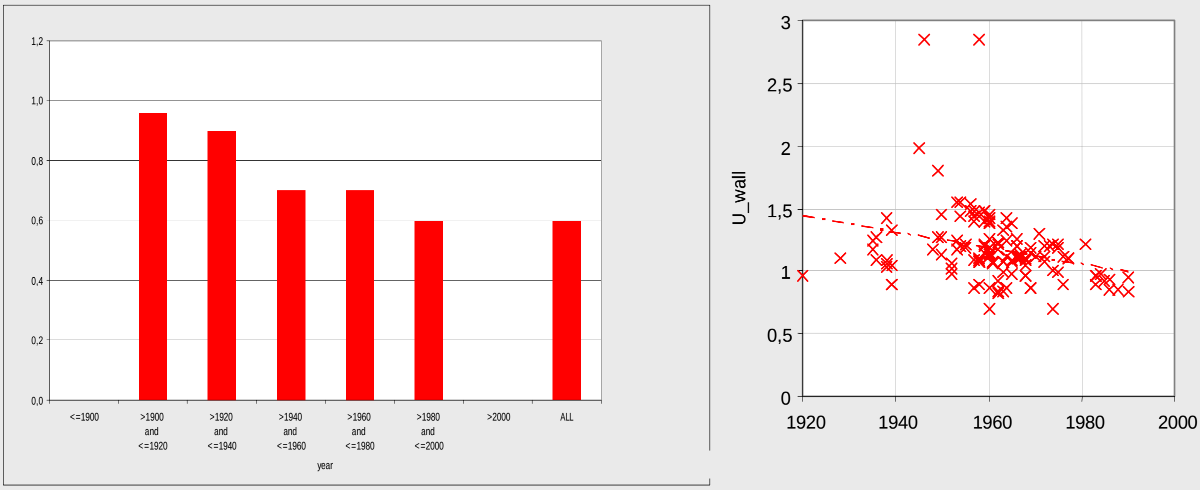
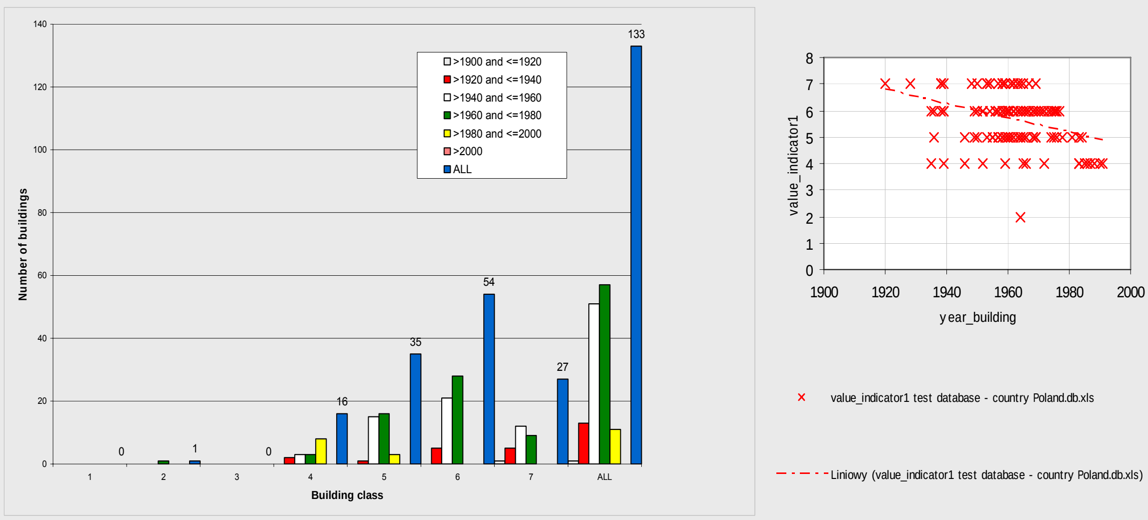


Fig. 34: Number of buildings in defined class categories



In the present version of methodology proposed class categories are as follow:

class	energy consumption (kWh/m2*a for heat and hot water)
1 (A)	up to 120
2 (B)	121-180
3 (C)	181-240
4 (D)	241-300
5 (E)	301-350
6 (F)	351- 450
7 (G)	over 400

Although heat demand per square meter is diminishing each year (see Fig. 32) the general heat consumption is still relatively height. Most of the total assessed building (41%) are in the class 6 (or F), 26 in class 5 (or E) (Fig. 34). Most of the new buildings – constructed after 1980 are in classes 4 and 5 (D and E). Based on the presented results Ministry of Infrastructure decided that the reference building (what means building fulfils minimum of the requirements) will have class D, with the average energy consumption of 240 kWh/m^2*a.

Additionally these results support Ministry in decision of continuation the thermomodernisation programme, since most of the existing buildings still required modernisation and state support could speed up the modernisation processes.

Conclusions

1. In 2006 NAPE chaired the Working Groups established by the Ministry of Infrastructure for the purpose of the adoption of technical solution elaborated by CEN to the Polish condition. Ministry of Infrastructure and Secretariat are the primary target groups of the Project results. Delivered information about existing buildings certification helped them to improve both – legal and technical solutions adopted during the first phase of EPBD implementation.
2. Due to delay in Directive implementation in Poland (to the moment the Ordinances about the methodology in not approved) Polish database comprise of 130 buildings – mainly residential - for which NAPE done energy audits during last 6 years.
3. All of these data cover 150 of 255 data form DATAMINE database.
4. Polish methodology will base only on the asset rating, so there are no data related to the operational rating system.
5. In a consequence of missing methodology at the moment (August 2008) we do not have the database of certified buildings, so at the moment all data from audits into DATAMINE Excel sheet are transferring manually. As soon as database for certification will be ready (it will have place probably after project finalisation) the interface will be developed, which allows to transfer automatically data, what makes all the analysis much more easer.
6. After preliminary DATAMINE analysis and after consultancy with experts (Technical Universities in Warsaw, Poznan and Katowice) Ministry of Infrastructure decided to up-date the Ordinances about Technical Criteria to be met by Buildings and their Localisation, which is an complementary act to methodology.

TYPE	EXISTING REQUIREMENTS	NEW REQUIREMENTS
External walls	0,4 W/m2K (multilayer wall) 0,6 W/m2K (one layer wall)	0,3 W/m2K (all)
Roof ceiling	0,35 W/m2K	0,25 W/m2K
Windows	2,0-2,6 W/m2K	1,8-1,9 W/m2K
Windows, transparent walls	-	Energy transmission coefficient ≤ 0,5, if the area is greater than 50% of total area of external envelope ≤ 0,3

7. Data from energy audits allow defining set of reliable data available for most of the buildings. On the base of this experience it was decided the requirements for new and modernised buildings of usable area over 1000m^2 will refer to:
   - maximal permissible U-value,
   - minimal solar radiation coefficient,
   - minimal shading coefficient for transparent elements,
   - parameters of indoor air quality,
   - minimal efficiency and requirements for elements of heating and cooling installations,
   - maximal permissible capacity of lighting installations for non residential buildings.
8. Statistical analysis showed, that building registered in the database well reflected present situation of the Polish building sector in relation to the age structure, size of buildings and heating systems.
9. Information/dissemination campaign is performed by NAPE (in co-operation with Ministry of Infrastructure) within the educational and information programme called “Friendly house”.

10. Workshops promoting DATMINE project and Directive were organized by NAPE in 7, 8 and 9 July with more than 200 participants.
11. During the period of 2005-2008 two information leaflets about benefits and obligations coming out from Directive implementation have been prepared and published (10 000 copies each). Next edition with 2 mln copies will be issued in the second half of the year and will include preliminary results from the test certificates.
12. For a period 2008-2009 the following actions are agreed with Ministry:
    - Continuation of educational and information campaign within a scope of educational and information program „Dom przyjazny” addressed to:
      - managers and owners and local government administration by the means of leaflets, brochures and posters,
      - notaries, surveyors and real estate agents by the means of leaflets and posters presenting benefits from energy characteristic certificates,
      - designers and construction supervisors by brochures supporting their self education about the erection of energy efficient and passive buildings.
    - Preparation of TV spot to be emitted by governmental TVP,
    - Preparation of information platform on Ministry’s site *www.mi.gov.pl* dedicated to directive including climate databases and calculation software conformed with introduced calculation methodology, and some analysis from DATAMINE project.

2.3 UK Model Project

Status of introduction of Energy Performance Certificates in UK

Fig. 35: Status of Energy Performance Certificate introduction *in UK ex Scotland*

		Asset Rating	Operational Rating
Residential buildings			
new		yes	no
existing			
small buildings (1 to 4 apartments)	constructed before 1977	yes	no
	constructed 1977 or later	yes	no
large buildings (5 or more apartments)		yes	no
Non-residential Buildings			
new		yes	no
existing		yes	no
public buildings		no	yes

Except in Scotland, the UK is using two complementary procedures for quantifying the energy efficiency of a non-residential building:

1. Energy performance certificates (EPCs) which reflect the intrinsic efficiency of a building assuming standard use (the Asset Rating). EPCs are the responsibility of the owner, are based on calculation for heating, hot water, cooling, ventilation and lighting only, and will be required when a building is constructed, sold or let, i.e. as a part of a property transaction.
2. Display Energy Certificates (DECs) which are based on the actual total amount of energy used by a building over a year (the Measured or 'Operational' Rating), and compared with an appropriate benchmark. DECs are required to fulfil EPBD Article 7.3 and must be displayed prominently by all 'Public Buildings' over 1,000 m^2 from 1st October 2008. The penalty for not displaying a DEC and not having an Advisory Report is £1,500.

Objectives of the UK Datamine model project

- Obtaining operational energy performance and CO2 emissions data for large public buildings
- Comparing the collected data with various benchmarks
- Examining how bulk statistical data can be processed to improve knowledge about the energy performance of the existing stock of public buildings

Description of the data collected

The UK Datamine model project used the EPLabel Online web site to collect data on the operational ratings of public buildings. EPLabel was an EC funded demonstration project across 10 countries which examined how energy certificates to be displayed by public buildings might be based on actual measured operational performance. EPLabel Online is a multi-lingual web application allowing users to enter the data needed to calculate the measured energy performance of a building and obtain an energy certificate in line with the applicable CEN Standards. It uses a common methodology for all countries based on a harmonised framework which allows national variations in benchmark values and building categories, building size metrics, energy weighting factors, weather and climate, etc. Since it was launched in May 2007 the data for nearly 500 buildings have been entered (see Figure 2).

EPLabel Online is free to use by anyone who registers their contact details and there is no control on the data that are entered. Examination of the data has found that about 40% of the data sets are incomplete, for example either the building size or its annual energy use have not been entered. This left just over 300 datsets of which 251 or around 85% were for the UK. It was therefore decided to concentrate analysis of the data on the UK datasets. Examination of the 251 complete UK datasets found that about 25% contained data that were not credible, leaving 188 valid UK datasets, of which 111 or about 60% were for offices, 15% were for hospitals, 10% for university buildings and about 5% each for schools, hotels and sports centres.

Fig. 36: General statistics of the analysed datasets

Country	Total	Incomplete	Complete
Total	**493**	**191**	**302**
UK	380	129	251
Greece	27	13	14
Germany	23	16	7
Belgium	18	9	9
France	16	8	8
Ireland	10	7	3
Netherlands	10	4	6
Denmark	3	0	3
Sweden	3	2	1
Finland	1	1	0

UK datasets by Sector		
	Complete	Valid
Total	**251**	**188**
Offices	159	111
Hospitals	34	28
University	22	19
Schools	15	10
Hotels	11	10
Sports centres	10	10

The value which defines the operational energy use of a building is the total weighted energy per m2 of floor area per year – this what the CEN Standards define as the Operational Rating. For the UK datasets this metric was invariably given in terms of associated CO2 emissions using units of kgCO2 per m2 per year. For most buildings the total weighted energy using this metric lies somewhere between 20 - 400 kgCO2/m2, depending on both the uses of the building and its energy efficiency (very energy intensive buildings like data centres may be significantly higher). The value of this metric for the 251 UK datasets is shown in Figure 3.

The operational performance of a building indicating its efficiency can be defined by a dimensionless rating based on the measured energy use divided by a benchmark that represents performance indicative of all buildings of its type. This ranks the building's energy performance by expressing its CO2 emissions as a percentage of a typical value. A building with typical CO2 emissions has an operational rating of 100. The value of this metric for the 251 UK datasets is shown in Figure 4.

Conclusions and recommendations

1. The UK Datamine Model Project used the EPLabel Online web site to collect data on the operational ratings of public buildings. EPLabel was an EC funded demonstration project across 10 countries which examined how energy certificates to be displayed by public buildings might be based on actual measured operational performance.
2. As part of the Datamine project a special user administration system was developed to extract the data from the EPLabel database and transfer it into an Excel spreadsheet. The extracted data comprised 260 data items which constituted the key data needed to describe an operational rating for a non-domestic building.
3. 35 out of the 260 data items in each EPLabel dataset mapped onto a field in the Datamine common data structure and were transformed into the Datamine structure using standard Excel coding.
4. The EPLabel datasets were multi-country and multi-lingual; this created problems in seeking to use pre-defined values for energy carrier types and utilisation (building) types. There was no easy way of using software code to match the values in the EPLabel datasets with the predefined options. As EPLabel preceded Datamine it was not possible to predefine the options in EPLabel in advance so that they would match the descriptions used in Datamine.

5. The same problem occurred with the different building size metrics where EPLabel offered 3 choices per building category per country.
6. It was unfortunate to lose so much of the richness in the EPLabel datasets: only 35 out of 260 data items found a home in the Datamine common data structure. With hindsight it would have been advisable to have had a completely separate database for Operational Ratings. This is the solution that has been adopted by the UK government: there are separate central registers for the data from asset rating and operational rating energy certificates in the UK.
7. Since its launch in May 2007, 493 data sets have been entered into EPLabel Online. 380 of the data sets (77%) were from the UK, around 5% each from Greece and Germany, and the remainder from the other 7 countries represented in EPLabel.
8. Many of the data sets were incomplete, for example either the building size or its annual energy use had not been entered. Of the 113 **non-UK** data sets, 55% (62) were incomplete, leaving just 51 complete data sets. The UK data sets were better with 33% (129) incomplete. This left a total of 302 complete datasets of which 251 or around 85% were for the UK.
9. Further examination of the 251 complete UK datasets found that 63 (or about 25%) contained data that were not credible, leaving 188 'valid' UK datasets. For the Datamine Model Project, it was decided to concentrate analysis of the data on the UK datasets.
10. The breakdown by sector of the 188 'valid' UK datasets found 111 or 60% were for offices, 15% were for hospitals, 10% for university buildings and 5% each for schools, hotels and sports centres.
11. The number of data collected by EPLabel does not provide a statistically significant sample size and is therefore not appropriate for defining new benchmarks. There was also no validation of the quality of the data input, making a small sample size even more problematic from this perspective.
12. Nevertheless, the UK Model Project has demonstrated the principles of collecting datasets for the operational performance of non-domestic buildings and identified many key aspects which should be considered by policy makers when they establish equivalent data collection schemes on a national scale.

Fig. 37: Operational energy use of the 251 buildings in the UK datasets

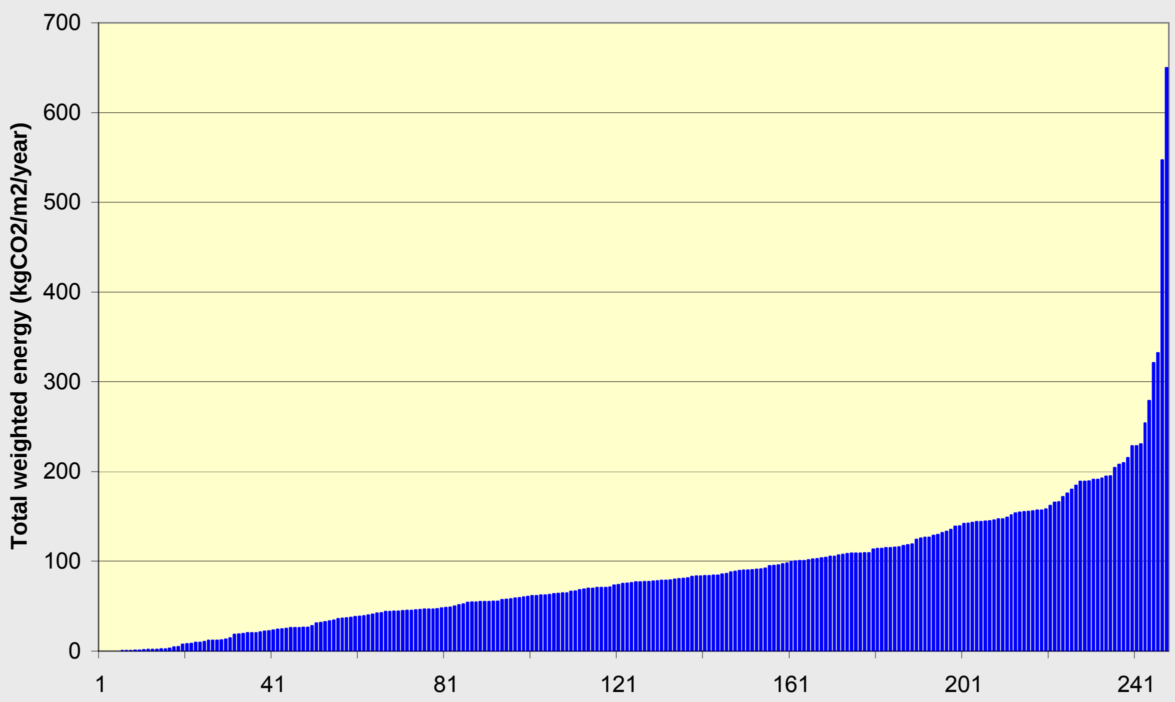
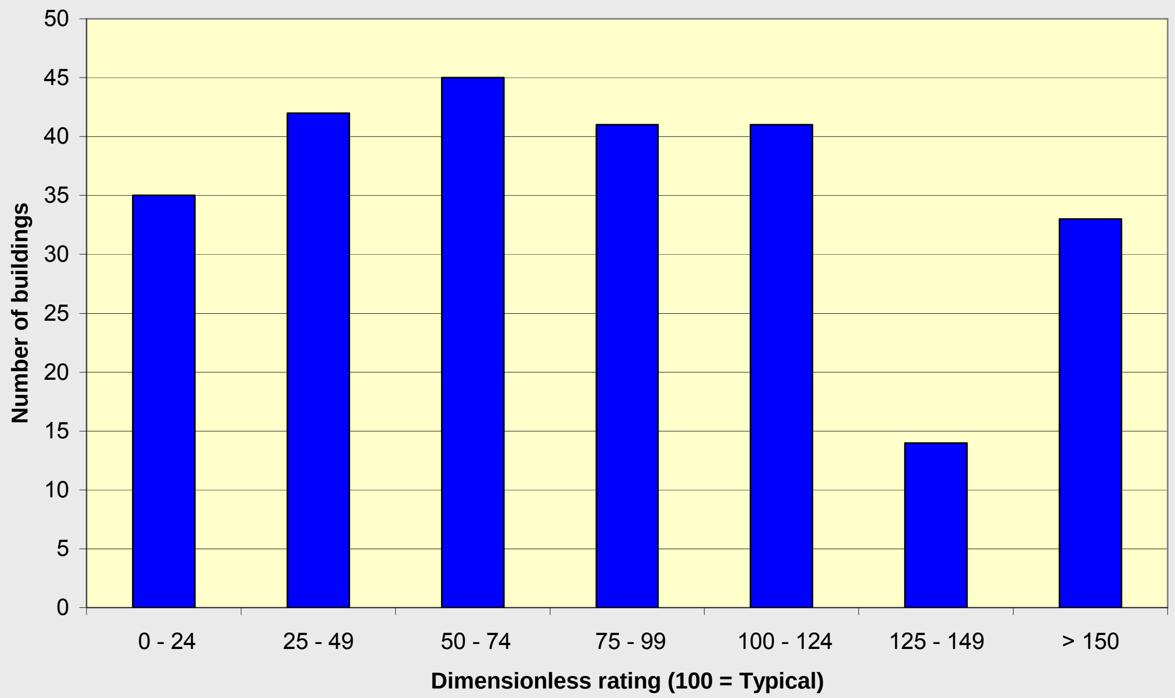


Fig. 38: Operational performance of the 251 buildings in the UK datasets (100 = Typical, < 100 is better than Typical, > 100 is worse than Typical)



2.4 Dutch Model Project

Status of introduction of Energy Performance Certificates in The Netherlands

Energy performance certificates have been legally introduced as of January 2008 for buildings upon construction, rent or sale, see figure 1 for more details (sources: [BEG2006] and [REG2006]).

Fig. 39: Status of Energy Performance Certificate introduction in The Netherlands

Regulations are fixed by government		**yes**	
Coming into force		**1 January 2008**	
Availability of EP Certificates	residential buildings	**1 Jan 2008 / 1 Jan 2009 [1)]**	
	non-residential buildings	**1 January 2008**	
		Asset Rating	**Operational Rating**
Residential buildings			
new [2)]		**yes**	**no**
existing [3),4)]		**yes**	**no**
Non-residential Buildings			
new [5)]		**yes**	**no**
existing [4)]		**yes**	**no**

1) 1 January 2009 in case a housing corporation decides to provide EP certificates for their entire dwellingstock in one go.
2) using a certified calculation of the Energy Performance Coefficient (EPC) according to Dutch Building Code and Dutch Standard NEN5128 - Energy Performance of Residential Buildings as introduced originally in 1995.
3) a certified Energy Performance Advice (EPA) issued between 1 July 2002 and 1 January 2008 is valid as EP certificate.
4) a certified calculation of the Energy Performance Coefficient (EPC) mandatory since 1995 for new buildings according to the Dutch Building Code and not older than 10 years is valid as EP certificate.
5) using a certified calculation of the Energy Performance Coefficient (EPC) according to Dutch Building Code and Dutch Standard NEN2916 - Energy Performance of Non-Residential Buildings as introduced originally in 1995.

The DATAMINE Model Project in The Netherlands

The objectives of the Dutch DATAMINE Model Project

1. to gain improved knowledge on the energy performance of the building stock of housing corporations
2. to integrate energy aspects into the strategic portfolio management of housing corporations
3. to inform policy makers on the value of energy performance certificates to increase the knowledge about the energy performance of the Dutch building stock as a basis for energy policy

The key actors

- Two housing corporations in Tilburg: WonenBreburg and TBV Wonen
- Policy makers involved in energy performance of buildings on local and national level
- BuildDesk, who is managing the EPA-project in Tilburg

Description of the data collection method

In the frame of the Energy Agreement Tilburg the major part of the building stock of the housing corporations WonenBreburg and TBV Wonen has been provided with an Energy Performance Advice (the Dutch elaboration of the energy performance certificate as required by the EPBD). This is the EPA-project in Tilburg which is being managed by BuildDesk (beyond DATAMINE). Data-collection and field surveys have been performed by BuildDesk.

The intake data for the asset rating as required by the Dutch Energy Performance Certificate consist of general building information (like address, building type, year of construction), characteristics of the building envelope and technical systems (including renewable energy sources). Measured energy consumption is not part of the intake.

Main energy performance indicators that have been assessed are U-values of roofs, walls, windows, floors, efficiency of technical systems, calculated energy consumption, CO_2-emission, EI (Energy Index, which is the Dutch elaboration of the energy indicator as required by the EPBD and which has been used as a basis for labelling).

Data sources

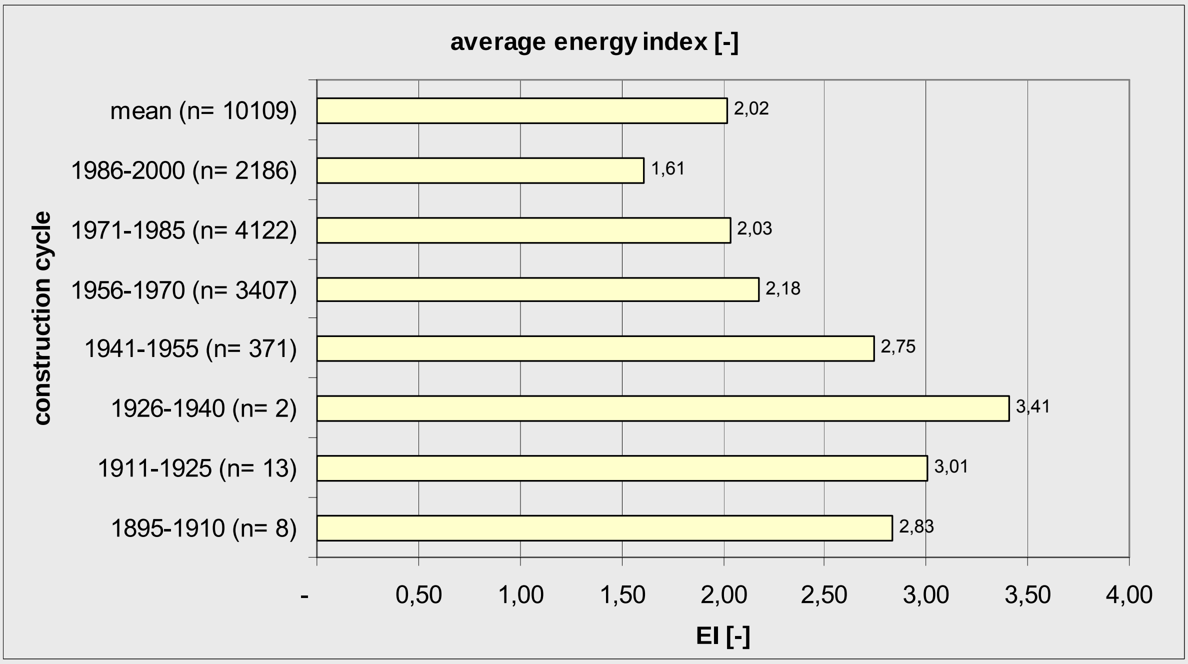
BuildDesk has used existing databases (built up and filled beyond DATAMINE) and made them available for the DATAMINE Evaluation Database. BuildDesk has not collected additional data for DATAMINE only. The certification scheme that has been used is the Epact/W-tool which is a certified tool for energy performance certificates and energy performance advices.

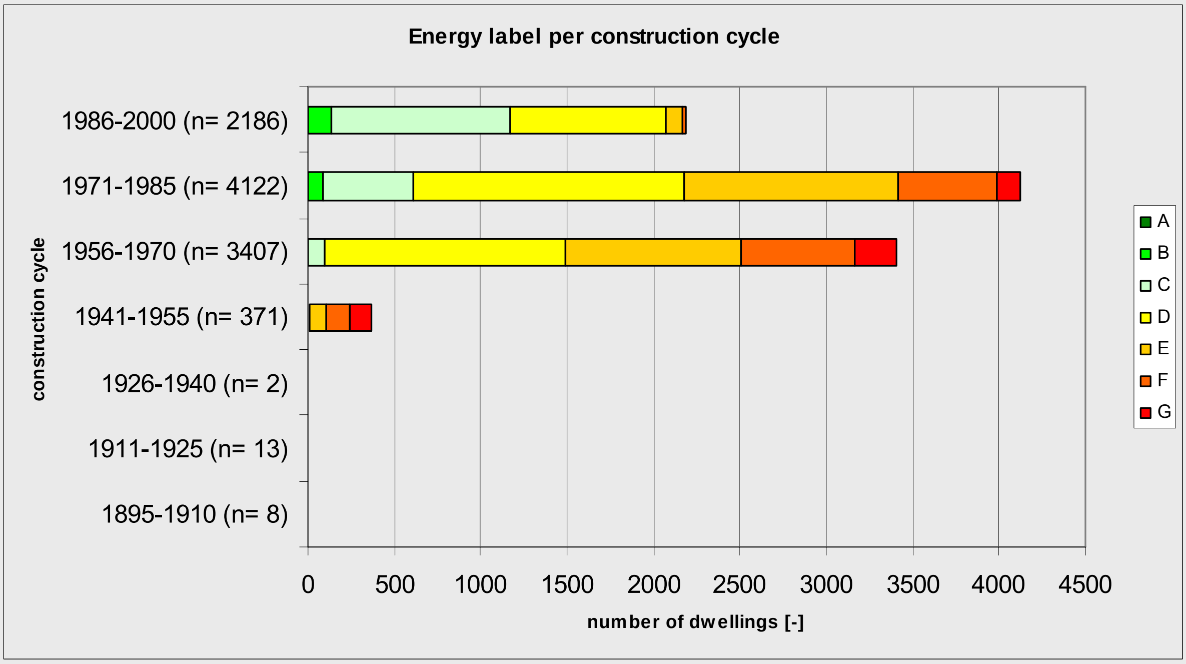
Analysed dwelling stock

Fig. 40: General statistics of the analysed datasets

Number of collected datasets			**10089**
Certificate types		**Utilisation types**	
whole buildings	1945	residential buildings	10089
building parts	-	offices	-
apartments	8164	education	-
Rating types		higher education	-
only asset rating	10089	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	-	others	-
Considered energy uses		**Buildings constructed ...**	
heating	10089	1900 or earlier	5
hot water	10089	from 1901 to 1940	18
cooling / air conditioning	-	from 1941 to 1980	6587
lighting	10089	from 1981 to 2000	3479
others	10089	since 2001	-

Fig. 41: Exemplary results from the analysis of the Dutch data base: average energy indices and of energy labels related to building cycle

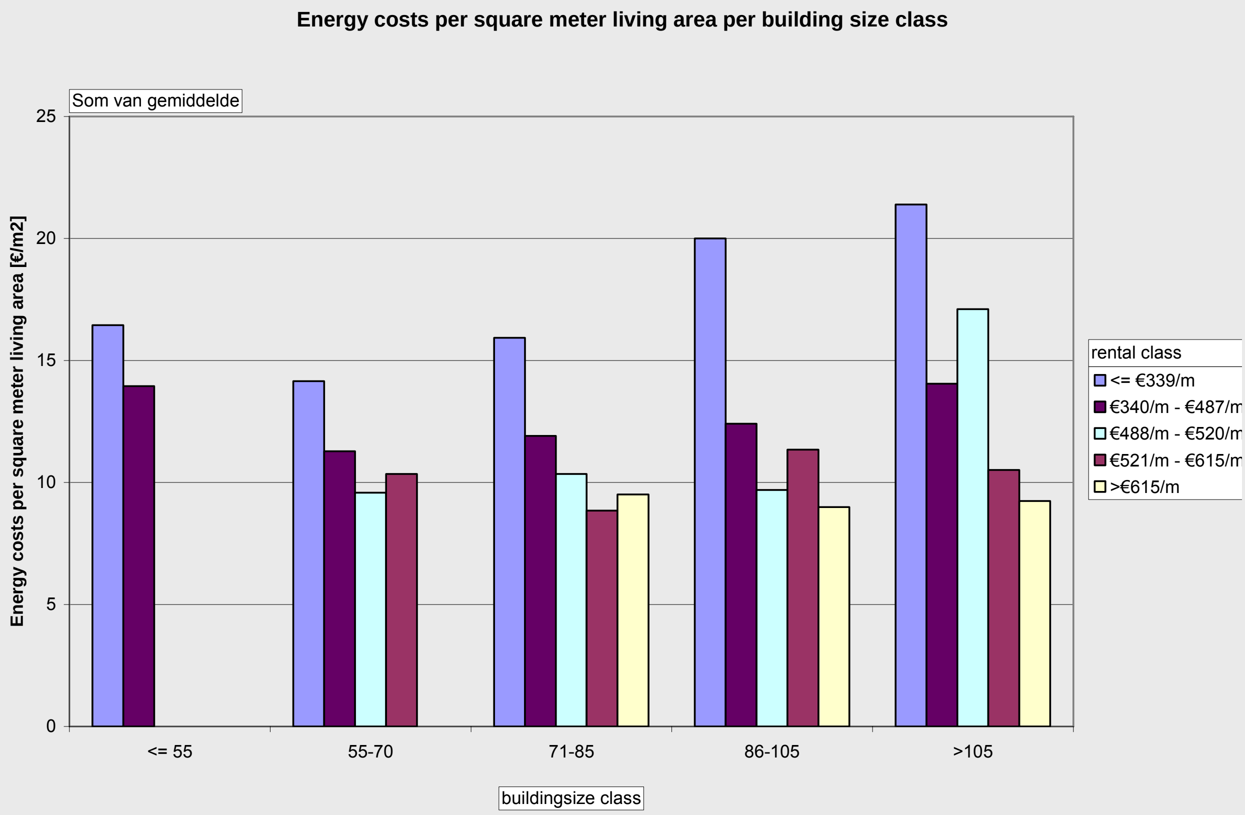




Rent and energy costs (= total cost of living)

The figure below shows the relation between energy costs per m2 living area per year, rental class and building size class. It shows dwellings in the cheapest rental class (rent < € 339/month) have the highest energy costs per m2 living area for all building size classes.

Fig. 42: Break down of energy costs per m2 living area per year related to rental class and building size class



Comparison of two methods to determine the U-value of constructions

The Dutch Energy Performance method uses two different ways for the determination of the U-values of building constructions, depending on the intended use of the U-value: energy performance calculation for either certification or tailored energy advice, [ISSO82-1] and [ISSO82-2].

Extended method

The U-value of a construction is determined by the thickness and heat transmission coefficient of each layer of the construction.

This is the traditional approach. Regarding existing buildings this is also a time-consuming approach. Furthermore in many cases it is not feasible without demolishing a construction, which is usually not desirable. This led to a large variety of U-values for the constructions among different building inspectors. Therefore a more simplified method was developed.

Simplified method

The U-value of a construction is derived from very simple building characteristics: the presence and amount of insulation and the presence of a cavity. If this is not known, the U-value depends on the year of construction.

An analysis for the accuracy of the simplified method when compared to the extended method (for the U-values of glazing, walls, roofs and floors) shows that the simplified method for the determination of the U-value is very accurate for all constructions studied (see the figures below). This is an important result as simplifications are necessary to make an accurate and efficient energy performance method for existing buildings.

Fig. 43: Comparison of elaborate versus simple U-value (glazing and walls)

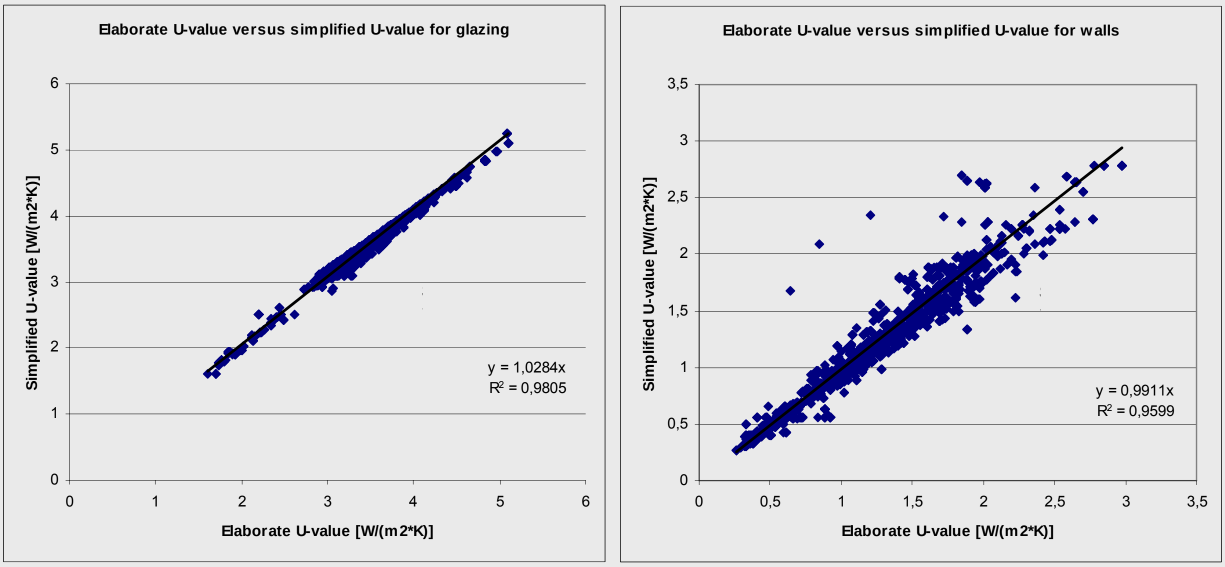


Fig. 44: Comparison of elaborate versus simple U-value (tilted roofs and flat roofs)

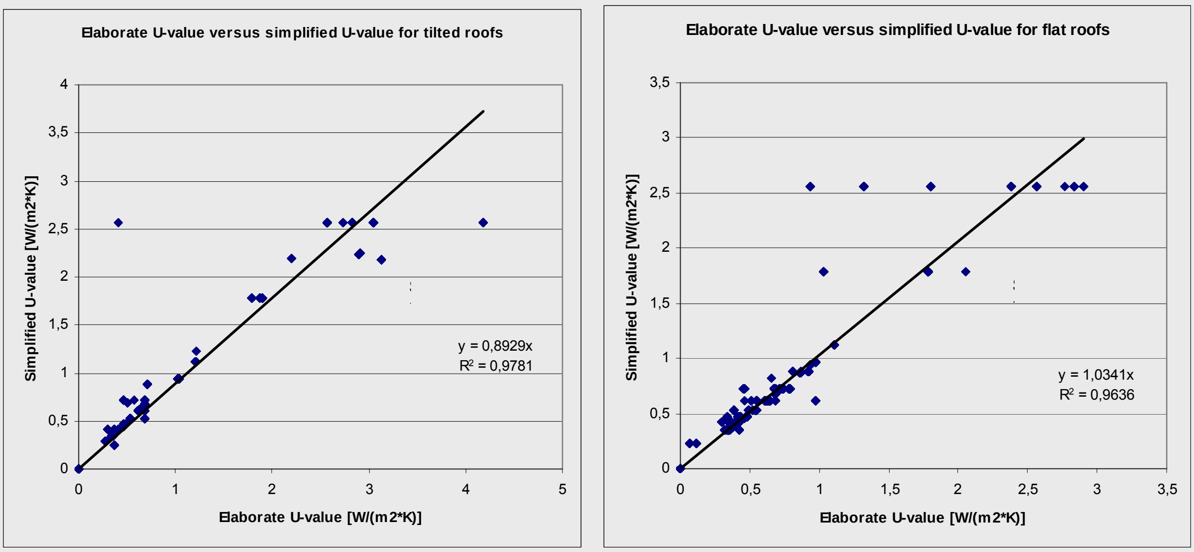
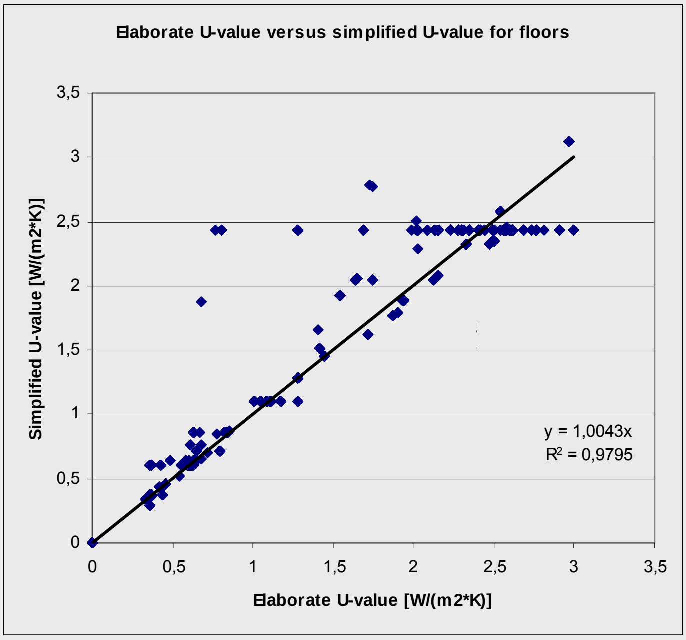


Fig. 45: Comparison of elaborate versus simple U-value (floors)



Conclusions and recommendations

Energy performance of the analysed buildings

1. The major part (65%) of the dwelling stock is connected to district heating, which has a generation efficiency of 1.0 for space heating. This covers up for the rather poor thermal insulation of a large part of the dwelling stock. It is recommended to improve the thermal envelope of the dwellings. A lot of energy can be saved this way.
2. The mean Energy Index for the analysed dwelling stock is slightly better than the indicative mean value of the entire Dutch dwelling stock (2.02 respectively 2.20, see Fig. 41). Possibly this is due to the large number of dwellings with district heating in the dwelling stock of this Model Project.
3. Dwellings in the cheapest rental class (rent < € 339/month) have the highest energy costs per m2 living area for all building size classes. A more elaborate study for the total cost of living of the dwellings is recommended especially since the cheap rental classes will be affected relatively strongly by future rising energy costs.

Data collection method

The Dutch Model Project uses an existing database, so data collection has been performed beyond DATAMINE. As a result not all fields of the DATAMINE data structure could be filled.

Data collection has been performed according to the requirements of the Dutch Energy Performance Advice using desk research as well as a physical inspection of the buildings. To get the most reliable result for existing buildings both information sources are necessary. Particularly in existing buildings it often occurs that not all input necessary for the EP Certificate can be collected. In such cases alternatives have to be found. The Dutch EPA-method and software anticipate on this (e.g. by using key figures based upon year of construction).

Monitoring

1. Consider very carefully what the goal of monitoring of energy performance certificates is. And, when this is clear, then define very carefully which data is to be collected to reach this monitoring goal. Select an approach and tool that optimally serve the monitoring goal.

2. The method of data collection should be very well tuned to the type of building addressed and whether it is a new or existing building.

Perspectives for future monitoring activities

National government

In The Netherlands a national monitoring scheme has already been set up in 2007. Increasing the knowledge on the (existing) building stock is not one of the objectives of the Dutch monitoring database. A restricted number of data is collected in the national monitoring database in a strict format. The value of the collected data is limited as a large part of the data can not be used for analyses, simply because the data, collected from different sources, is not compatible.

The results of DATAMINE have been used to show the power of EP certificates as a source for increasing the knowledge on the existing building stock as a basis for energy policy. As a result policy makers may decide to upgrade the Dutch monitoring database.

Housing corporations

Also policy makers of housing corporations (e.g. building stock managers) have been informed about the power of building stock knowledge based upon energy performance data. This will be particularly linked to energy costs as part of the total cost of living for tenants. Total costs of living become a more and more important issue in the policy of housing corporations. Discussions and studies are ongoing on how building investments (e.g. to improve the energy performance of dwellings) are linked to the total cost of living. Up to now it was hard to compensate for building investments by increasing the rent. However, solutions are tried to be found now to make this possible on a legal basis. For example if a housing corporation invests in the improvement of the energy performance it is allowed to raise the rent as, at the same time, the energy costs will drop. So the total costs of living remain the same for the tenant and the housing corporation will regain, a part, of the investment. This is a hot topic in The Netherlands at the moment and knowledge about the energy performance of building stocks is an important part of it.

2.5 Italian Model Project

Status of introduction of Energy Performance Certificates in Italy

Legislative activity is still underway. Three steps are foreseen:

1. Government provisional regulations have been set up
   - Local certification procedures are still accepted
2. National guidelines on EP certification are being prepared
3. Regions are entrusted to develop their own certification procedures which will substitute the national scheme
   - Lombardia (Milan) and Alto Adige (Bolzano) have already defined their own procedures

According to the government provisional regulations:

- The EP is based on energy primary for space heating
- The EP indicator is expressed in kWh/m² for domestic buildings, in kWh/m³ for non-residential buildings and community residences
- Asset energy rating is used
- As regards the EP assessment methods, CEN and UNI standards are the main reference
- Two different procedures are established:
  a) *Energy Performance Certification*, which is compulsory in the following cases:
     a1) new buildings
     a2) major renovations of existing buildings above 1000 m²
     a3) sale of existing buildings (gradual entry into force)
     a4) use of grants and special terms provided by public funds
     a5) energy service contracts for public buildings
  b) *Energy Performance Qualification*, which can be carried out by a non-independent technician (e.g. designer):
     b1) as a voluntary tool to speed a successive certification
     b2) as a legal document to be made available at the end of the construction process

In the transient phase the Energy Qualification substitutes the Energy Certification.

Fig. 46: Status of Energy Performance Certificate introduction in Italy

Regulations are fixed by government	**yes (provisionally)**
Regulations are fixed by regions	**yes (definitively)**
Coming into force	**February 2007**
Availability of EP Certificates	
new buildings*	**February 2007**
major renovations of large buildings above 1000 m²	**February 2007**
sale of existing buildings	**Jul 2007 / Jul 2008 / Jul 2009****
renting of existing buildings	***
use of grants and special terms by public funds	**February 2007**
energy service contracts for public buildings	**February 2007**

*) if the building permit has been applied for after October 2005
**) depending on building size and on the portion of buidling sold (whole, part)
***) the EP certificate is made available to the tenant only if already produced for other purposes

The DATAMINE Model Project in Italy

The following general objectives were set on evaluation and monitoring:

- get a better knowledge of the features of the building stock
- determine reference values and benchmarks of energy performance for different categories of building
- assessing the effect of possible energy conservation measures
- predicting future energy resource needs on a national scale

The key actors are Social Housing Agency of Torino and Province of Torino. These public bodies have been so far in contact with Politecnico di Torino – DENER, asking for energy diagnosis and certification of their building stocks and making available data sets of energy consumption and buildings for further investigations.

The target groups are public bodies involved in the implementation of the EPBD (ministries, local governments, national and local energy agencies), social housing agencies, technical universities and all the actors involved in building design and management.

In general, the implementation of the Italian model project consisted of:

- comparison of different Italian existing schemes of EP certification in order to identify the most significant parameters;
- correlation between calculated and measured energy use and execution of statistical analyses;
- correlation between the main building geometrical and thermo-physical parameters and execution of statistical analyses;
- specification of additional data to be collected and definition of suitable energy classification of buildings, based on function, size, shape, system typology, kind of energy-ware, use patterns.

The expected outcome of the Italian model project can be summarised as:

- statistics on the features and energy consumptions of the analysed buildings;
- reference values and benchmarks for different kinds of building;
- development of concepts for building data collection, energy monitoring and rating, energy conservation measures;
- study of the impact of the EPBD implementation on the professionals and on the construction market.

Main results of the data evaluation

The data evaluation of the Italian Model Project consisted of the analysis of EP certificates issued both for residential and for commercial buildings. Two different datasets were analysed:

- 138 institutional buildings (mainly high schools) of the Province of Torino (see Fig. 47);
- 50 social multifamily buildings of the Social Housing Energy Agency of Torino (see Fig. 48).

Fig. 47: General statistics of the analysed datasets – Province of Torino

Number of collected datasets			**138**
Certificate types		**Utilisation types**	
whole buildings	138	residential buildings	14
building parts	-	offices	9
apartments	-	education	-
Rating types		higher education	115
only asset rating	-	hospitals	-
only operational rating	138	hotels and restaurants	-
both asset and oper. rating	-	others	-
Considered energy uses		**Buildings constructed ...**	
heating	138	1900 or earlier	-
hot water	-	from 1901 to 1940	-
cooling / air conditioning	-	from 1941 to 1980	-
lighting	-	from 1981 to 2000	-
others	-	since 2001	-

Fig. 48: General statistics of the analysed datasets – Social Housing Energy Agency of Torino

Number of collected datasets			**50**
Certificate types		**Utilisation types**	
whole buildings	50	residential buildings	50
building parts	-	offices	-
apartments	-	education	-
Rating types		higher education	-
only asset rating	-	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	50	others	-
Considered energy uses		**Buildings constructed ...**	
heating	50	1900 or earlier	2
hot water	-	from 1901 to 1940	12
cooling / air conditioning	-	from 1941 to 1980	15
lighting	-	from 1981 to 2000	22
others	-	since 2001	2

For the schools and for the other buildings of the Province of Torino an operational rating was carried out including the collection of typological data on the building envelope and on the heating systems and the used amount of energy-wares.

For the residential buildings both an asset rating and an operational rating were executed, including the collection of data on the building envelope and on the heating system and the used amount of energy-wares.

As regards the schools and the other buildings of the Province of Torino, the data evaluation consisted of the following analyses:

- general statistics of the buildings versus
  - main utilisation
  - volume
  - type of energy carrier
  - degree days
  - specific heat supply
- statistics of the specific heat supply versus
  - main utilisation
  - volume
  - type of energy carrier
  - degree days
- correlation of the specific heat supply versus
  - volume
  - degree days

As regards the residential buildings of the Social Housing Energy Agency of Torino, the data evaluation consisted of the following analyses:

- general statistics of the buildings versus
  - construction cycle
  - conditioned floor area
  - volume
  - energy carrier
  - primary energy demand
- statistics of the specific primary energy demand versus
  - volume
  - energy carrier
- statistics of envelope average thermal transmittance versus building age
- correlation of the specific primary energy demand versus
  - volume
  - average thermal transmittance

<u>Province of Torino</u>

In Fig. 49 the distribution of the buildings as a function of the degree days and of the volume is presented. The sample is not uniformly spread with respect to the two analysed variables: a peak, of about 45 buildings represents the schools with large volume (higher than 20000 m^3) placed in localities having a number of degree days between 2600 and 2800 (mainly in Turin).

Fig. 49: Distribution of the number of buildings as a function of the degree days and of the volume

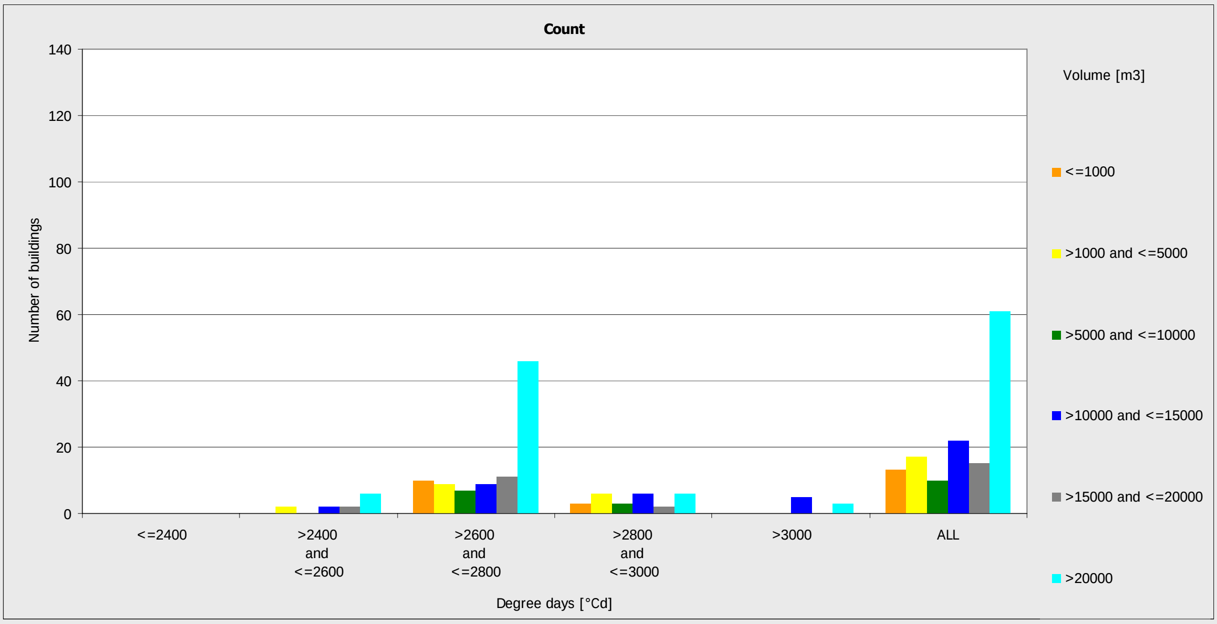
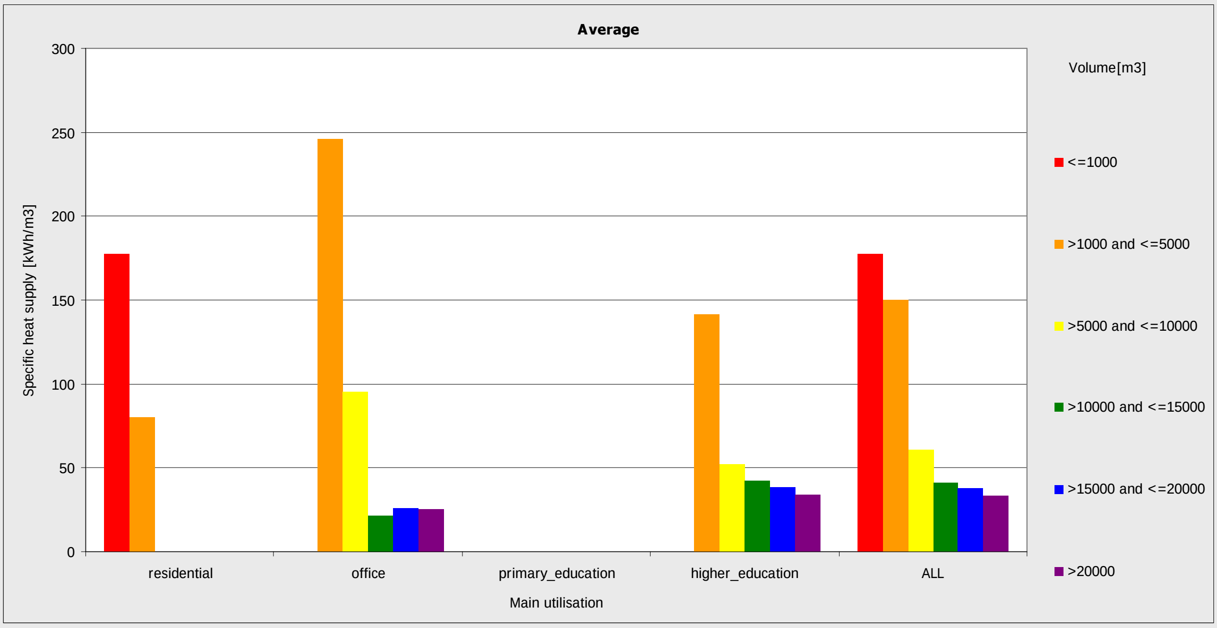


Fig. 50 shows the distribution of the specific heat supply as a function of the main utilisation and of the volume. For the whole sample, the specific consumption tends to decrease for higher volume, as expected. This tendency is verified both for schools and for residential buildings. In office buildings with volumes higher than 10000 m³ the heating consumptions is quite constant.

Fig. 50: Distribution of the specific heat supply as a function of the main utilisation and of the volume

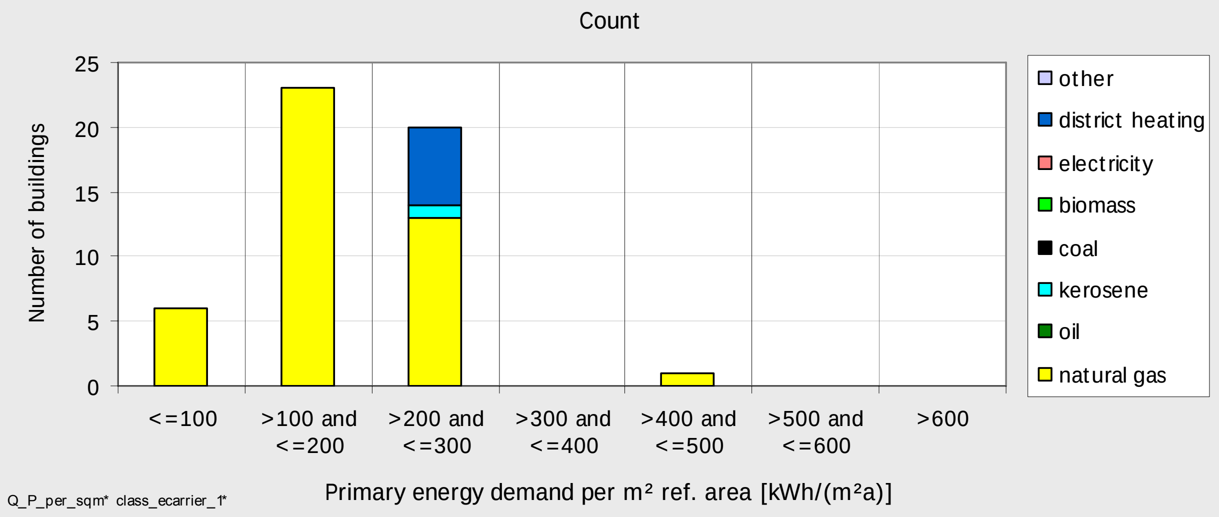


Social Housing Agency of Torino

Fig. 51 shows the frequency distribution of the building sample as a function of the specific primary energy demand for heating, divided by type of fuel. Most buildings have a specific energy demand

lower than 300 kWh/m². The frequency peak is between 100 and 200 kWh/m². District heating feeds the building with energy demand between 200 and 300 kWh/m².

Fig. 51: Distribution of the number of buildings as a function of specific primary energy demand for heating and of the type of fuel



For the buildings of the Province of Torino the frequency distribution analysis of the specific consumption (heat supply per cubic meter) shows that most buildings are in the range between 20 and 40 kWh/m³.

With reference to the ATC residential buildings, their specific primary energy demand is between 100 and 200 kWh/m² . The specific actual energy consumption in mainly lower: the average value is around 100 kWh/m².

The analysis of both the building samples show energy performance indices consistent with space heating consumptions got from in progress studies.

About ongoing and future analyses, a sample of residential multi family buildings (about 30) of the Region of Valle d'Aosta, a sample of single-houses of the Municipality of Livorno Ferraris (about 30) in the Province of Vercelli and a sample of residential and public buildings of the Union of Municipality on Hill around Torino are being studied. Also for these samples an operational rating procedure is applied.

Conclusions

The development of the Italian Model Project highlighted a number of specific topics which are here shown in detail.

Asset rating vs. operational rating

Depending on the different applications, two different kinds of energy assessment are considered: asset rating and operational rating.

According to the Italian experience, both asset and operational are of great importance:

- asset rating represents the intrinsic annual energy use of a building under standardised conditions and is particularly relevant to certification of standard energy performance;
- operational rating is particularly relevant to certification of actual energy performance and for large building stocks.

The following target groups are interested in DATAMINE analyses:

- private bodies, basically interested in asset rating;
- public bodies or big stakeholders, basically interested in operational rating (database of energy consumption for municipalities, local communities, etc.).

The evaluated building samples

The operation rating was applied to both the analysed building samples, while the asset rating was only applied to the residential buildings of the Social Housing Energy Agency (ATC) of Torino.

The examined building sample of Province of Torino consists 138 buildings, mainly high schools (115). The only available data for the energy performance analysis are measured consumptions for space heating.

The ATC building sample consists of 50 buildings, all of them residential and multifamily, most built between 1941 and 2000, that is quite a wide period in terms of construction techniques. As regards the energy performance analysis, the collected data include both energy demand (asset rating) and measured consumption (operational rating) for space heating.

For the buildings of the Province of Torino the energy performance is expressed in terms of ratio of the measured consumption (thermal energy supply by the heat generator) to the building volume. The energy performance indices are corrected for the heating degree-days. The frequency distribution analysis of the specific consumption (heat supply per cubic meter) shows that most buildings are in the range between 20 and 40 kWh/m³.

With reference to the ATC residential buildings, the specific primary energy demand is between 100 and 200 kWh/m² . The specific actual energy consumption is generally lower, with an average value around 100 kWh/m².

Heterogeneity in certification schemes

A considerable heterogeneity among the certification schemes widespread in Italy is highlighted.

Most of the existing certification schemes are based on asset rating and on the use of CEN and UNI standards, but different rules are defined regarding data collection and presentation, calculation assumptions and energy labelling.

DATAMINE represents an opportunity to harmonise the data presented in different certification schemes.

Quality of data

An important aspect refers to the quality of data. This is a key point, especially for existing building analysed through operational rating approach, where data can be supplied by “not-energy expert” persons. A need of rating the quality of data is highlighted.

Little number of data available

In the EP certificates only few data are generally available compared with the large number of data included in DATAMINE data structure. A larger number of data is generally available if the calculation reports, especially for design ratings.

Nevertheless, despite the complexity of DATAMINE data base, it doesn’t matter if only a small part of it can be filled.

As regards the examined samples of buildings, the collected data only partially filled the developed data structure (*Italian Data Structure*). It is important to mention that the Italian data structure is

characterised by a wide number of energy performance parameters related to operational rating procedures.

Climate and user correction in order

In order to make a cross-country comparison, it is necessary to carry out a fitting climate and user correction. As regards the consumption for space heating, the following parameters are taken into account:

- degree days;
- operating hours of the heating plant;
- occupancy schedules.

Climate and user corrections are particularly important for operational rating, when the actual boundary conditions have to be known in detail.

Survey on the determined EP Indicators

The approach used for energy certification/qualification is asset rating:

- only space heating and domestic hot water
- no lighting, no cooling, etc.

The main EP indicators in particular, indicators about:

- net energy demand for heating and cooling [kWh/m^2]
- primary energy demand for space heating [kWh/m^2]
- primary energy demand for DHW [kWh/m^2]
- CO_2 emissions [kg CO_2/m^2]

Anyway a global energy performance indicator should be defined to express the global primary energy demand (all the energy uses), as foreseen in the EPBD and in the DATAMINE approach.

Ongoing and future analyses

The analysis of both the building samples shows energy performance indices consistent with values of space heating consumptions got from in progress studies. About ongoing and future analyses, a sample of residential multi-family buildings (about 30) of the Region of Valle d'Aosta, a sample of single-houses of the Municipality of Livorno Ferraris (about 30) in the Province of Vercelli and a sample of residential and public buildings of the Union of Municipality on Hill around Torino are being studied. Also to these samples an operational rating approach is applied.

Since 2007 the EP certification has been also compulsory in order to get tax reduction or use grants and special terms provided by public funds: that allows to analyse the energy certificates of about 140 existing residential buildings/apartments, based on asset rating.

Generalization of the results

The data collection and evaluation of data on schools and residential buildings represent the first step to create a national database, to be extended in the next future to an European level. From the elaboration of a large number of data it will be possible to obtain not only energy statistical comparisons, but also values to take as references and benchmarks for various building categories.

The next steps for the implementation of a national monitoring concept foresee a cooperation with local public bodies in Piedmont Region (Province of Turin, Mountain Community of 23 Municipalities, Municipality of Turin, …) in order to collect data from energy certificates/diagnosis of existing buildings (public and private).

An important objective is the energy benchmarking. To this purpose it is necessary to enlarge the investigated sample of buildings and to organize the information in a homogenous way.

The necessity of characterizing not only the building typologies but also the different building use categories is stressed. The definition of benchmarks should be then differentiated according to:

- different typologies (single house, multi-family buildings …);
- different categories (dwellings, schools, offices …);
- different climatic zone;
- different uses (heating, cooling, etc.).

A new software tool

Following the implementation of the Italian Model Project, a multi-language web application for data management has been developed, allowing gathering, importing, exporting and collecting of data.

BENDS (Building Energy and eNvironmental Data Structure) realizes the following functions:

- an user friendly data input from an EP certificate or an energy diagnosis report
- the data conversion from/to the Italian data structure and the DATAMINE common data structure.

The objectives of BENDS are to diffuse the DATAMINE approach, to facilitate data collection and to encourage the data comparison between EP certificates and monitoring reports

2.6 Greek Model Project

Status of introduction of energy performance certificates in Greece

Despite the fact that the development of a new regulation for the Energy Performance Assessment of buildings has been underway since 1998, the work has not been finalized yet. A new national law on "Measures for the reduction of energy consumption in buildings and other by-laws (ΦΕΚ 89/A 3661 - 19/5/2008) was recently introduced and passed in May 2008, setting the general national legislative framework for complying with EPBD. Starting in 2009, all buildings (>50 m^2) will need an energy performance certificate - EPC during market transactions (sell or rent), while large new buildings (>1000 m^2) will also need an energy study to obtain their building permit. However, to this date, there is no official energy audit and/or certification methodology/software for the Hellenic buildings.

The DATAMINE model project in Greece

Objectives and key actors

The general objectives of the Model Project in Greece include:

- Evaluation of available data from Hellenic building energy audits, available methodologies and software along with practical information on their implementation.
- Collection of additional up-to-date data using a web platform on the actual energy consumption (based on bills for thermal and electrical energy consumption) of existing Hellenic residential and non-residential (tertiary sector) buildings (no published data is currently available).
- Processing existing and, if any, new data, and integration in the DATAMINE common Evaluation Data Base (EDB) for the extraction of necessary Energy Performance (EP) indicators and comparison for determining current trends and initial benchmarking of Hellenic buildings.
- Evaluation of available methods/software in Greece for building energy audits & issuing EP Certificates using the monitoring results.
- Collection of feedback from key actors on the acceptability of the Energy Performance Building Directive (EPBD) provisions.
- Revision of the draft Hellenic EPBD regulation, which is currently under development. Elaboration of specific recommendations that may be directly incorporated in the national EPBD framework.

The work and outcome of the DATAMINE project is addressed to the following key actors involved in the implementation of the EPBD in Greece:

- The Hellenic Ministry of Development (MD)
- The Hellenic Ministry for the Environment Physical Planning and Public Works (MEPPPW)
- The Technical Chamber of Greece (TEE)
- The Centre for Renewable Energy Sources (CRES)
- The National Observatory of Athens (NOA)
- Engineers, energy consultants.

Fig. 52: Status of Energy Performance Certificate introduction *in Greece*

Regulations are fixed by government		**On-going (drafts available)**	
Coming into force		**2009**	
Availability of EP Certificates*	residential buildings	**start in 2009**	
	non-residential buildings	**start in 2009**	
		Asset Rating	**Operational Rating**
Residential buildings			
new		**YES**	**no ****
existing		**YES**	
Non-residential Buildings			
new		**YES**	**no ****
existing		**YES**	**no ****

*) for new & existing buildings (>50 m^2) in case of renting or sale
**) operational energy consumption will be included on the certificate, but without rating

The EPBD will be implemented by the Hellenic Ministry of Development (MD) and the Hellenic Ministry for the Environment Physical Planning and Public Works (MEPPPW). Priority should be given to the residential sector and public buildings. The Technical Chamber of Greece (TEE) and the Centre for Renewable Energy Sources (CRES) have participated in previous efforts for the national adaptation of EPBD. NOA is a government/public research centre, operating under the auspices of the General Secretariat for Research & Development of the Hellenic Ministry of Development. NOA performed a critical review of the draft Regulation on Rational Use and Energy Conservation in buildings (RRUEC) in the framework of a recently completed study for the MEPPPW on the evaluation and the advancement of the Ministry's policies in relation to the abatement of CO_2 emissions in the residential and tertiary building sectors. NOA is also participating in a joined committee setup by CRES, charged by MD to review all available information and compile the final methods and tools for the national EPBD implementation as of 2009, in accordance to the new national law (ΦΕΚ 89/A 3661 - 19/5/2008). National EPBD implementation is expected to start in 2009.

Description of the data collection method

Currently, there is no energy certification of new or existing buildings in Greece. NOA has participated in several European projects on the development of methodologies and software for building energy audits and the support of the decision-making process for the refurbishment of buildings. Among these methodologies, widely recognised on a European level, EPIQR and INVESTIMMO for residential buildings, TOBUS for office buildings and XENIOS for hotels. More recently, another group of methodologies has been developed for building energy audits and certification, namely: EPA-ED for residential and EPA-NR for tertiary building sector.

In the framework of the DATAMINE Model project in Greece, about 40% of the 250 buildings integrated in the common Energy Data Base (EDB) were available from the above mentioned European methodologies. Additional data were available from energy audits for numerous residential buildings from around the country, a few office buildings and hotels, all major hospitals in Athens, all sports centres and airports in Greece. Additionally, data were supplied from national building audit campaigns. Available data from standard questionnaires and energy audit reports were manually processed and entered in the common EDB. Data underwent suitable quality checks. To

demonstrate future implementation and minimize the time required for data collection, NOA integrated an automated export key for processing the available data from existing audit tools to the common EDB. Furthermore, in the framework of DATAMINE project, NOA set up a web page to solicit additional data on a voluntary basis and to supply the necessary input parameters for the common EDB. This effort did not provide any contributions.

Overall assessment and recommendations for the Hellenic certification code

In the framework of the Hellenic Model project for DATAMINE, NOA evaluated the applicability of existing European methodologies for building audits and energy performance assessment in Greece. The DATAMINE project as well as the available input data collection methodologies has been presented to the key actors and policy makers. NOA made specific recommendations for the elaboration and implementation of the RRUEC in Greece taking into account their feedback.

Recently, NOA participated in a national project for the MEPPPW on the assessment of the energy consumption of the existing Hellenic building stock and the opportunities of different energy conservation measures for all residential and tertiary sector buildings for reaching the national CO_2 emission goals. The cost of different measures, the necessary national policies and other instruments as well as the priorities in terms of specific measures for different buildings and geographic areas were defined. During this project, NOA reviewed the draft RRUEC for compliance with the EPBD and proposed the necessary adaptations to the MEPPPW. During the DATAMINE project, NOA has followed the progress of the preparation of the new draft and made specific recommendations that may be incorporated in the national EPBD framework.

Main results of the data evaluation

In the Hellenic Model project, data from a total of **250 buildings** were incorporated in the common EDB. Emphasis was given on residential buildings, currently representing 76% of the Hellenic building stock. A representative number of tertiary sector buildings for different end-uses are also included in the common EDB. The breakdown of buildings included in the Hellenic Model Project is: 70% **residential buildings**, 12% **airports**, 7% **sports halls**, 4% **hospitals**, 2% **swimming pools**, 2% **offices**, 2% **educational buildings** and 1% **hotels**. The above breakdown is considered to be representative of the Hellenic building stock. As reported by the National Statistics Bureau of Greece [NSBG, 2006] the residential sector represents 77% of the whole building stock whereas the tertiary sector represents the remaining 23%. In the same reference the breakdown of the tertiary sector is reported as: 2.7% office and commercial buildings, 0.46% educational buildings, 0.82% hotels, 0.06 hospitals and 19% other uses (i.e. airports, sports halls etc).

The data included in the Hellenic Model Project were analysed using the DATAMINE analysis tool. Results are reported in graphs illustrating various features of this sample of the Hellenic building stock with regard to its general characteristics, as well as the buildings' thermal envelope and systems. An example of the graphs is given in Fig. 54 and Fig. 55.

Fig. 54 illustrates the average U-values of the buildings classified according to their construction date. The average U-value of the sample is 1.34 W/m^2K. The implementation of the Thermal Insulation Regulation in 1980 is reflected in a decrease of the average U-value for the buildings constructed thereafter.

Fig. 53: General statistics of the analysed datasets

Number of collected datasets			**250**
Certificate types		**Utilisation types**	
whole buildings	246	residential buildings	176
building parts	-	offices	5
apartments	4	education	4
Rating types		higher education	-
only asset rating	72	hospitals	10
only operational rating	178	hotels and restaurants	2
both asset and oper. rating	-	others	53
Considered energy uses		**Buildings constructed ...**	
heating	229	1900 or earlier	3
hot water	204	from 1901 to 1940	3
cooling / air conditioning	174	from 1941 to 1980	143
lighting	218	from 1981 to 2000	95
others	-	since 2001	6

Fig. 54: Mean U-value of walls, dependence on building construction cycle

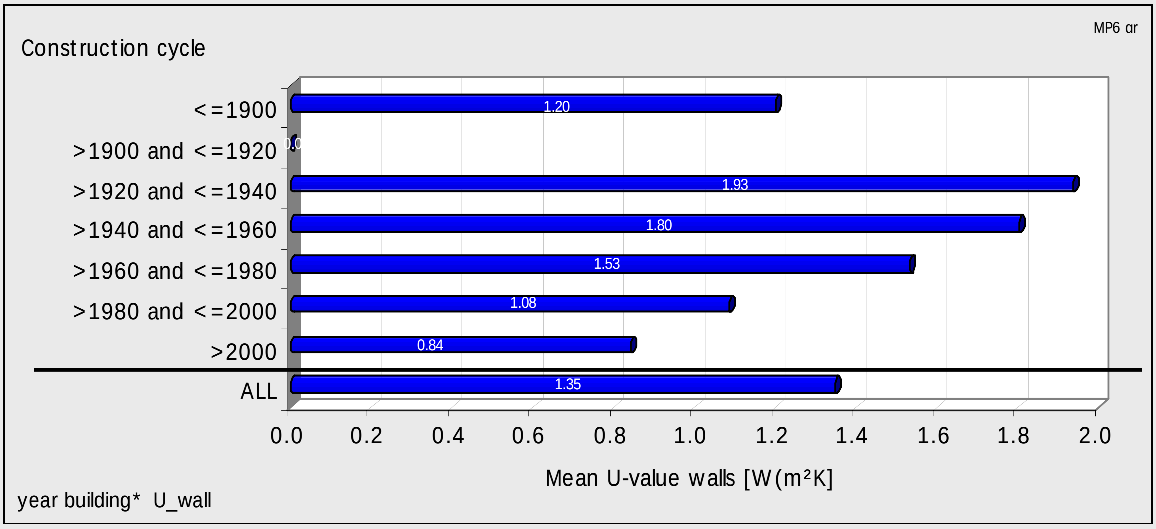
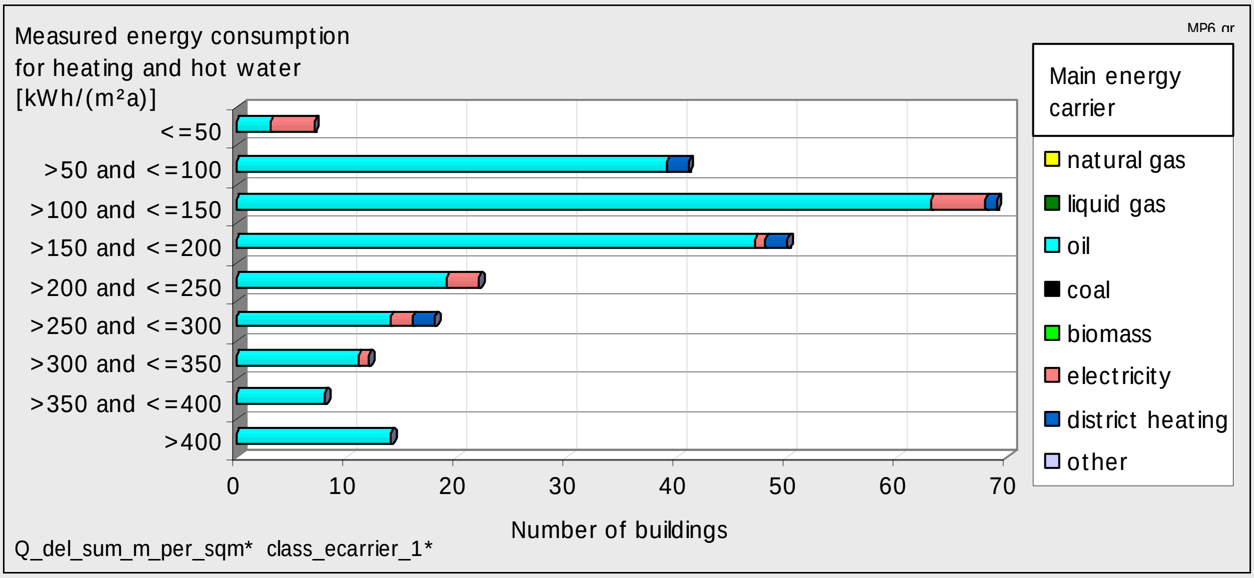


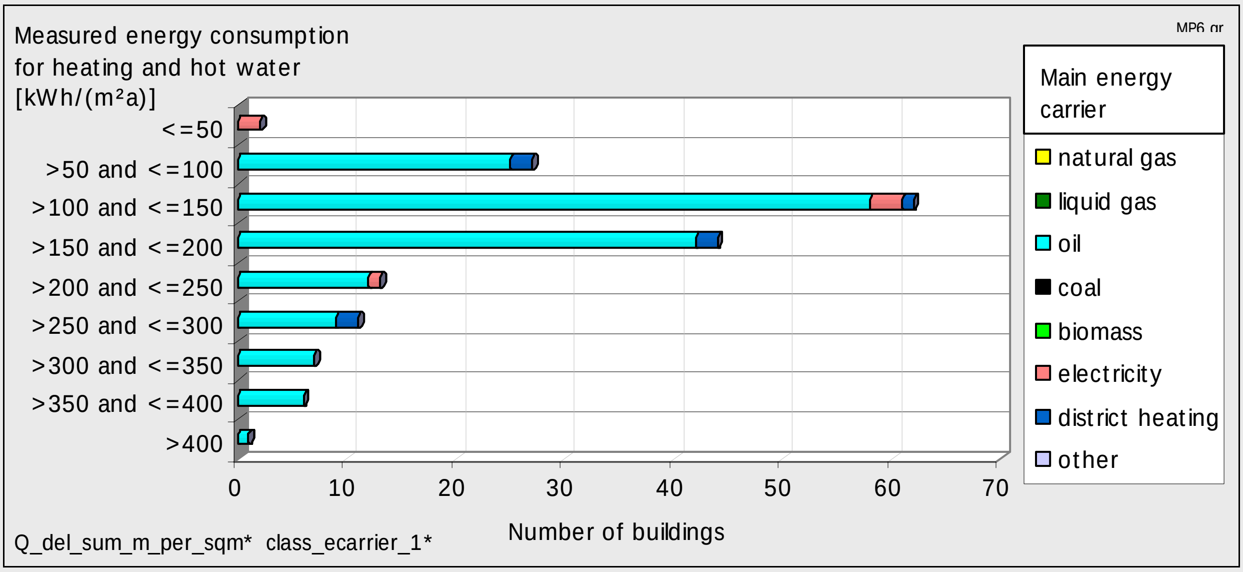
Fig. 55 illustrates the frequency of measured energy consumption (operational data) for heating and hot water production. The majority (87%) of the buildings included in the Hellenic Model project use oil for heating, while 8% and 3% use electricity and district heating respectively. The measured annual thermal energy consumption for heating and hot water production in 78% of the buildings does not exceed 250 kWh/m^2. However, in 6% of the sample the energy consumption exceeds 400 kWh/m^2. These are mainly tertiary sector buildings.

Fig. 55: Frequency of measured energy consumption for heating and hot water



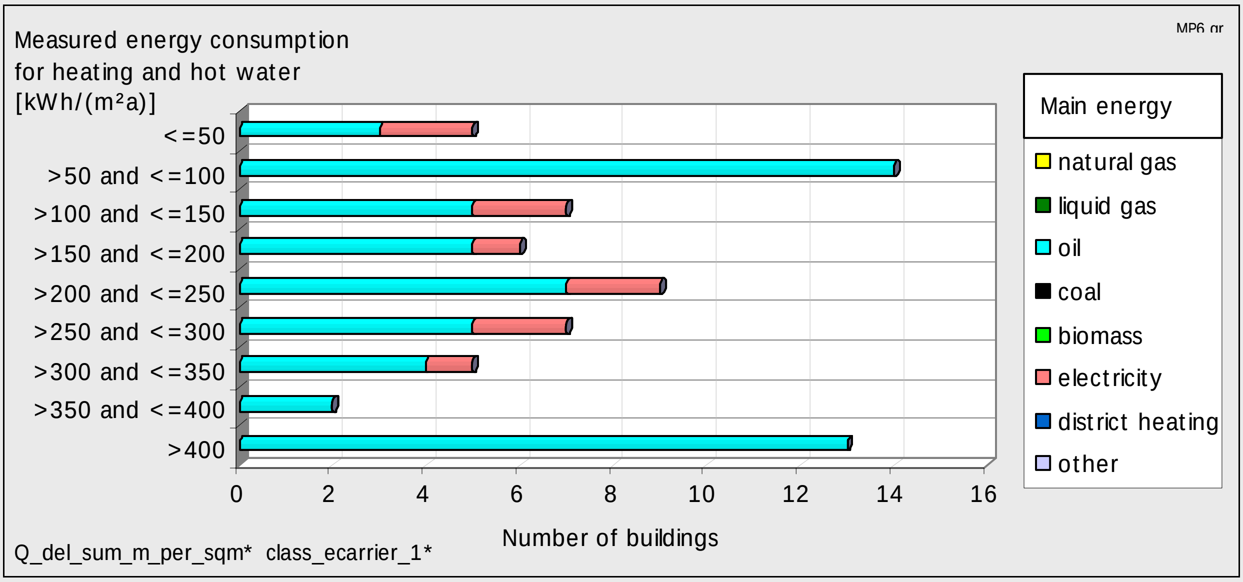
The residential and tertiary sectors differ significantly in terms of building use, sizes, operation hours, heating/cooling systems and set-points. In order to draw more representative conclusions data from buildings belonging to the two sectors were analysed separately. This permits an in-depth analysis of the data taking into account the particular characteristics of the two sectors. Fig. 56 and Fig. 57 are given as an example of this approach. These figures illustrate the frequency distribution of the actual annual energy consumption (operational data) for heating and hot water production per gross area (internal dimensions) in the residential and tertiary sector respectively.

Fig. 56: Frequency of measured energy ware consumption – residential sector
(consumption summarized for all energy carriers, per m2 reference area)



In 72% of the residential buildings included in the Hellenic Model project the annual total thermal energy consumption for heating and hot water production does not exceed 200 kWh/m^2.

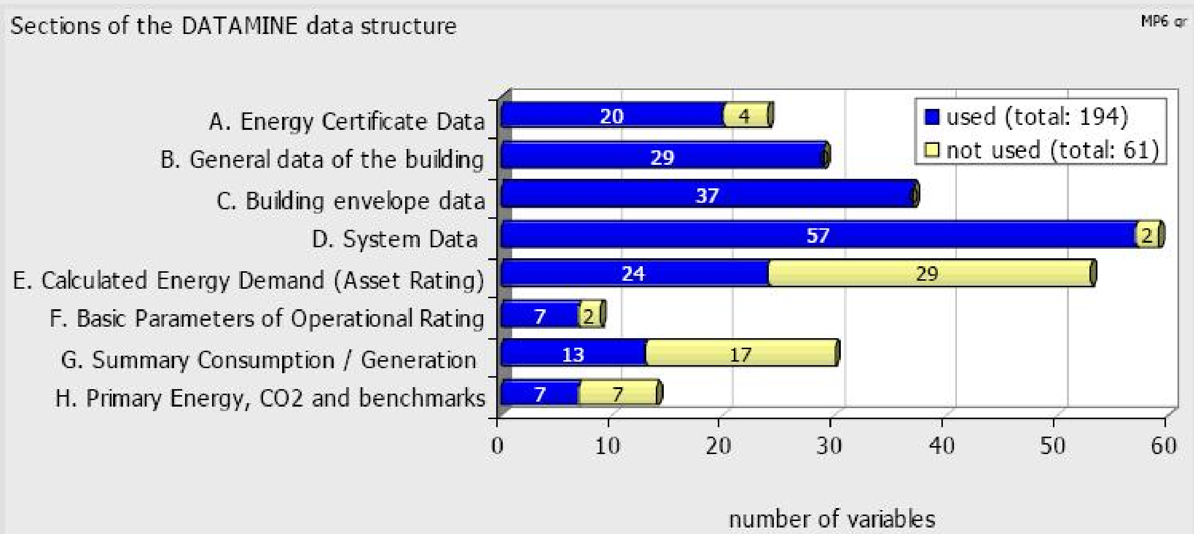
Fig. 57: Frequency of measured energy ware consumption – tertiary sector
(consumption summarized for all energy carriers, per m² reference area)



In 19% of the tertiary sector buildings included in the Hellenic Model project the annual total thermal energy consumption for heating and hot water production exceeds 400 kWh/m². Among the highest energy consuming buildings of this category are hospitals as well as airports operating throughout the year.

The completeness of the common EDB with the Hellenic data is illustrated in Fig. 58, for each of the eight categories. Over 76% of the required entries had at least one entry, while about 24% of the common EDB requested data were not available. The general building data (section B) and the building envelope data (section C) had the highest completeness rates, while the sections with the highest rate of missing data were for asset rating (section E) and the summary of consumption / generation data (section G).

Fig. 58: Completeness of common EDB with Hellenic data.



Specifically, the completeness of the common EDB from the building audit and diagnosis software (EPIQR, TOBUS and XENIOS) are illustrated in Fig. 59. The energy performance assessment software (EPA-ED and EPA-NR) provided a much higher completeness of the common EDB since they are targeted to building energy audits and certification. The EPA tools do not have a commercial interface. Accordingly, the input / output interface can be adapted to include additional parameters requested by the common EDB, thus reaching a potential completeness illustrated by the light green column. The EPA-NR tool is an open source software and may be easily adapted to meet national requirements and characteristics of the common EBD.

Fig. 59: Completeness of common EDB with Hellenic data from diagnosis software (EPIQR for residential, TOBUS for office and XENIOS for hotel buildings).

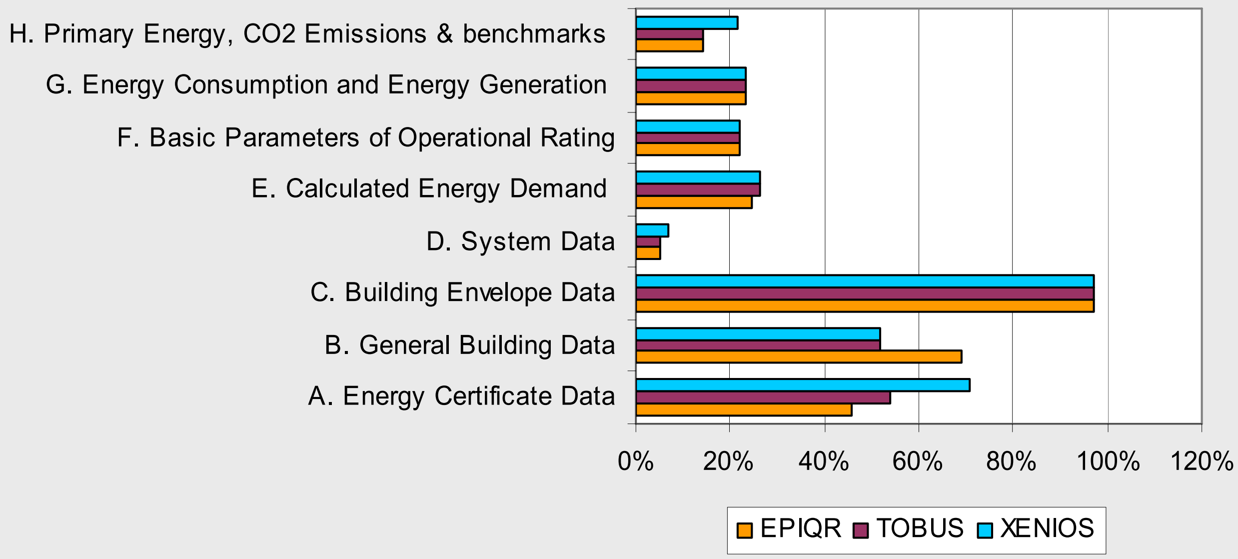
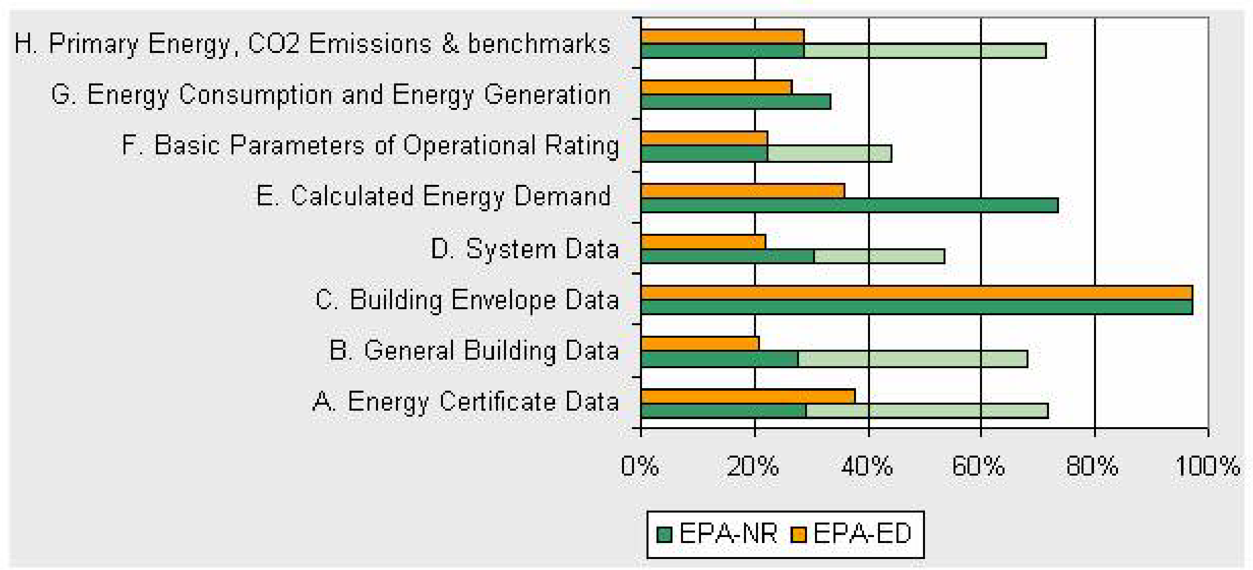


Fig. 60: Completeness of common EDB with Hellenic data from energy performance assessment software (EPA-ED for residential and EPA-NR for non-residential buildings). The light green column represents the potential for additional information that may be easily collected.



Conclusions

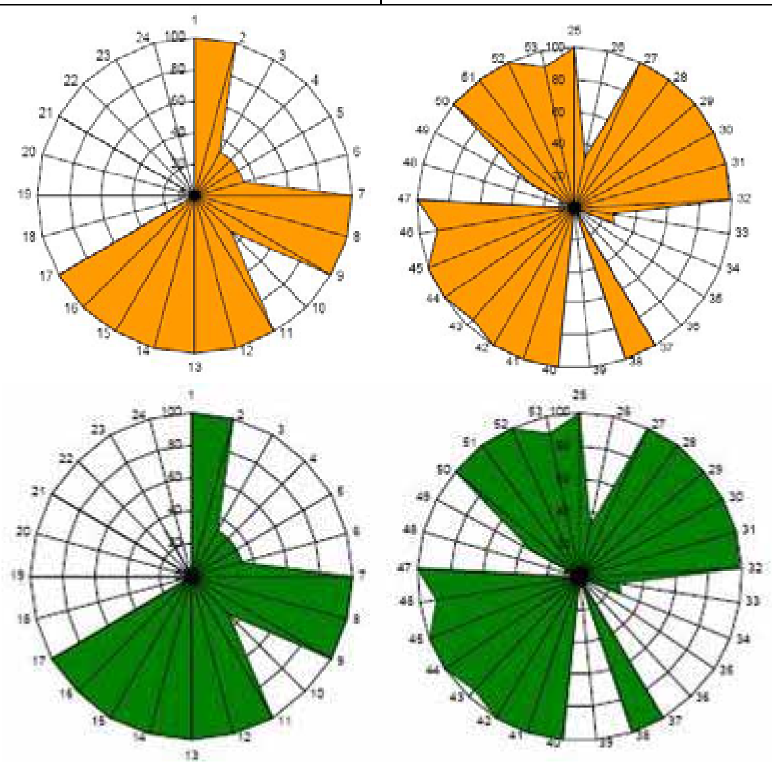
Collection Method

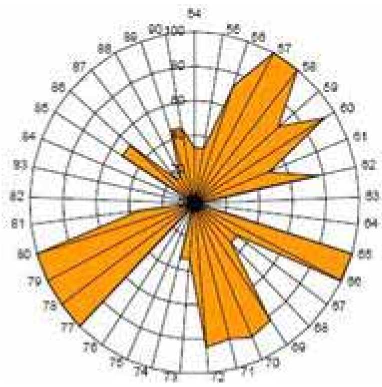
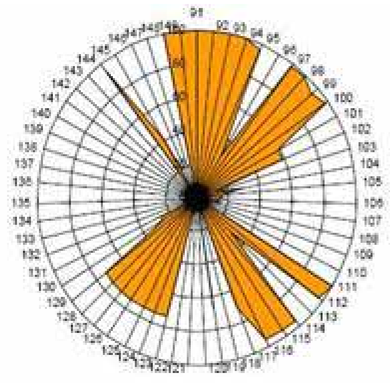
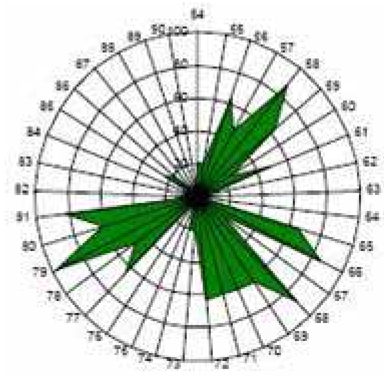
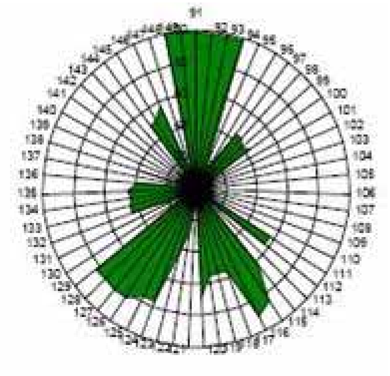
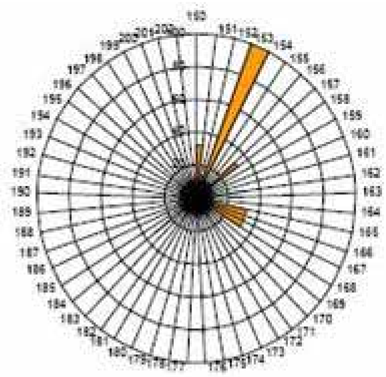
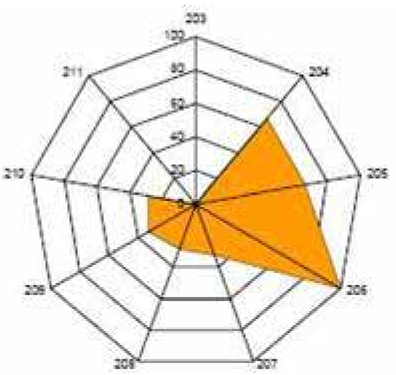
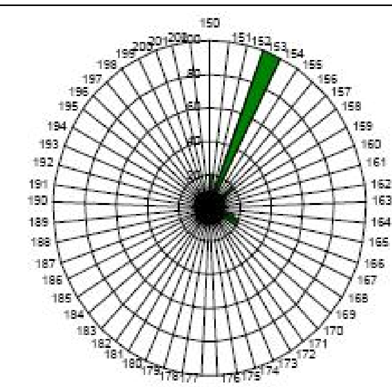
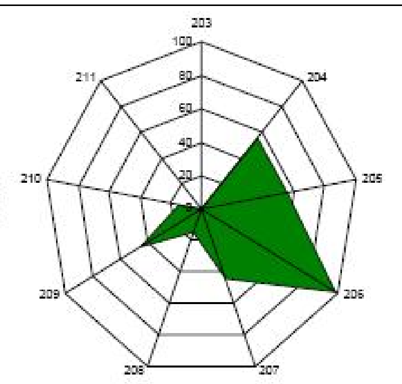
In the absence of an energy certification method in Greece, the data supplied in the Common Evaluation Data Base (EDB) for the Hellenic Model Project came from previous auditing campaigns carried out using available European methodologies in the framework of related European and national projects. These methodologies are: EPIQR and EPA-ED for residential buildings, TOBUS for office buildings, XENIOS for hotels as well as EPA-NR for tertiary sector buildings. Among these methodologies, EPA-ED and EPA-NR are targeted to the energy performance assessment of buildings and provide the user with all necessary tools and guidance throughout the process from inspection to reporting the assessment results. Furthermore, the output of these methods / software includes a large amount of data to choose from for inclusion in the national Energy Performance Certificate. For some of these tools (EPIQR, XENIOS, EPA-NR), NOA integrated in their interface a button through which a user may export the necessary data to the common EDB at the end of each energy audit or building certification, by a simple ‘click’.

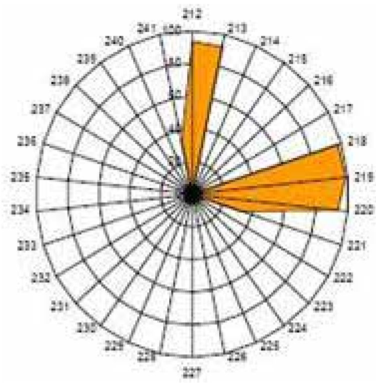
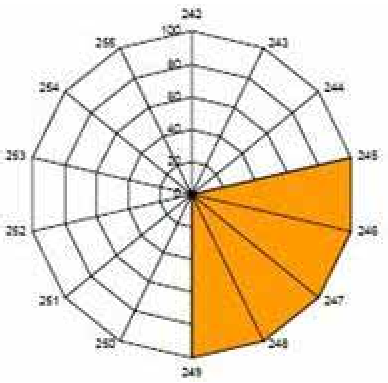
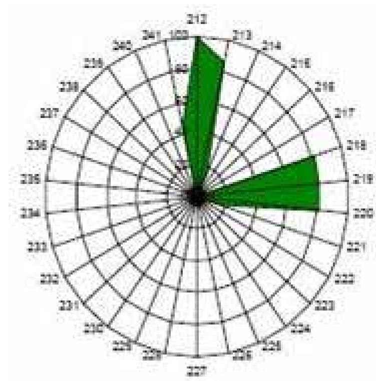
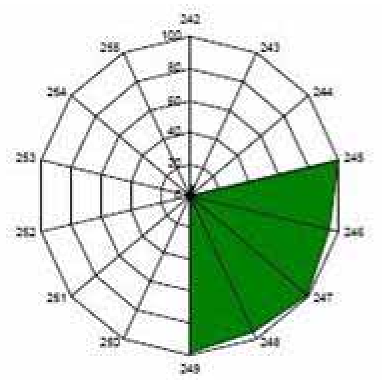
An overview of the available Hellenic data for the eight categories of the common EDB is illustrated in Fig. 61, for the residential (176 buildings) and non-residential (74) buildings. The completeness is illustrated as a percentage for each entry in the corresponding eight categories. Note that for some data entries, information was available from only a few buildings, thus it may be difficult to distinguish.

Fig. 61: Completeness of common EDB with Hellenic data for residential (orange) and non-residential (green) buildings.

A. Energy Certificate	B. General Building



C. Building Envelope	D. System
	
	
E. Asset Rating	**F. Operational Rating**
	
	

G. Energy Consumption	H. Primary Energy, CO_2
	
	

Energy performance of the analysed buildings

A total of 250 buildings were included in the common evaluation database. Among these, 176 buildings were residential and the remaining 74 were tertiary sector buildings. The thermal energy consumption of the residential buildings ranged from 35 kWh/m^2 to 329 kWh/m^2 with an average value of 126 kWh/m^2. The total energy consumption ranged from 41 kWh/m^2 to 409 kWh/m^2 with an average value of 167 kWh/m^2. The thermal energy consumption of the non-residential buildings ranged from 9 Wh/m^2 to 618 kWh/m^2 with an average value of 145 kWh/m^2. The total energy consumption ranged from 17 kWh/m^2 to 792 kWh/m^2 with an average value of 251 kWh/m^2.

The residential buildings incorporated in the Hellenic model project consist of 118 apartment buildings and 58 dwellings. Due to the differences between the apartment buildings and dwellings in terms of size, envelope exposure and operating hours of the heating system these two categories were analysed separately. The average thermal and electrical energy consumption of the apartment buildings is 105 and 44 kWh/m^2 respectively, whereas for dwellings, the corresponding figures are 169 and 51 kWh/m^2 respectively. Further analysis included an investigation of the thermal envelope characteristics and installed systems for the two categories.

The tertiary sector is represented in the Hellenic model project by a variety of different categories of building use. However, the number of buildings per category is rather limited. Consequently, an analysis of the building features and behaviour per category of use would not be statistically acceptable.

Perspectives for future monitoring activities

In the framework of DATAMINE project, NOA has set up a web page through which visitors can voluntarily supply the necessary input parameters for the common EDB.

The national building energy performance certification scheme is under development, in accordance to the general national legislative framework for complying with EPBD (ΦΕΚ 89/Α 3661 - 19/5/2008). Starting in 2009, all buildings (>50 m^2) will need an EPC during market transactions (sell or rent), while large new buildings (>1000 m^2) will also need an energy study to obtain their building permit. A concerted campaign is expected to start thereafter, for monitoring the Hellenic building stock. The related procedures involving data intake, acquisition and inspection will provide an excellent opportunity for extracting all necessary information for the DATAMINE common EDB. NOA has presented to policy makers and key persons charged with the national EPBD implementation the possibilities of the available EPA methodologies. NOA has already demonstrated with available software tools the possibility to integrate an automated processing facility to export collected and calculated data to the Datamine common Evaluation Database.

2.7 Belgian Model Project

Status of introduction of Energy Performance Certificates in Belgium

Belgium is a federal state. Energy is a regionalized matter and energy-related policy are therefore managed by the three regions separately. These three regions are :

- The Flemish region
- The Brussels region
- The Walloon region

This implies that decisions concerning the implementation of the EPBD are concerted between the three regions, but the decisions can be taken independently. At this moment the 3 regions have different approaches, speed and priorities.

Concertation and information exchange between the different communities officially can take place in two groups. First the responsible officials of each region are member of the Belgian representation in the Concerted Action. Furthermore, an official federal body is the ENOVER-forum or CONCERE-forum concerning the coordination of energy-related matters.

In the Flemish region, energy efficiency and energy certification in the building sector is regarded as one of the main policy lines for improving the overall Flemish energy efficiency and for reaching the Kyoto targets. Belgium has set its Kyoto target to diminish the greenhouse gas emissions by 2012 with 7,5% compared to the situation in 1990. The energy certification in the Flemish Region will be implemented progressively. New building regulations and energy certification is obligatory since 1/01/2006, since the Energy Performance and Indoor Climate (~EPB) Decree. Energy certification for existing buildings in case of sale will be enforced in the year 2008. In case of rental transactions, energy certificates will be necessary from 2009 onwards.

The table below gives an overview of the situation in the Flemish Region:

Fig. 62: Status of Energy Performance Certificate introduction in the Flemish Region

Legal framework fixed by Flemish government (EPB)		**22/12/2006**
Coming into force - progressive scheme		**22/07/2005**
Availability of EP Certificates	new buildings	**2006**
	public buildings	**2009**
	residential buildings	**2008 (sale) / 2009 (renting)**
	non-residential buildings	**2009 (sale) / 2009 (renting)**

	Asset Rating	Operational Rating
New buildings	**yes**	**no**
Public buildings	**no**	**yes**
Residential buildings	**yes**	**no**
Non-residential buildings	**yes**	**no**

In the Walloon region, the administration has a long time experience with auditing of private dwellings. There was no structured procedure, but a lot of experience has been gathered. The Walloon region wants to build on this experience to introduce auditing on a broader scale, still on a volun-

tary basis. On 19/04/2007 the Walloon Region approved a new building Decree to fix a legal framework on the implementation of the EPBD (the so-called CWATUP-E).
The table below gives an overview of the situation in the Walloon Region:

Fig. 63: Status of Energy Performance Certificate introduction in the Walloon Region

Legal framework fixed by Walloon government (PEB)		**19/04/2007**	
Coming into force - progressive scheme		**Yes**	
Availability of EP Certificates	new buildings	**2008 / 2009**	
	public buildings		
	residential buildings	**2009 (sale) / 2010 (renting)**	
	non-residential buildings		
		Asset Rating	**Operational Rating**
New buildings		**yes**	**no**
Public buildings			
Residential buildings		**yes**	**no**
Non-residential buildings			

The Brussels Capital Region also has a new Ordinance on energy certification and energy efficiency in buildings since 07/06/2007.
The table below gives an overview of the situation in the Brussels Capital Region:

Fig. 64: Status of Energy Performance Certificate introduction in the Brussels Capital Region

Legal framework fixed by Brussels Capital Region		**7/06/2007**	
Coming into force - progressive scheme		**Yes**	
Availability of EP Certificates	new buildings	**as of August 2008**	
	public buildings		
	residential buildings		
	non-residential buildings		
		Asset Rating	**Operational Rating**
New buildings		**yes**	**no**
Public buildings		**no**	**yes**
Residential buildings		**yes**	**no**
Non-residential buildings		**yes**	**no**

The DATAMINE Model Project in Belgium

For the Belgian Model Project the data collection is carried out beyond the DATAMINE project.

Since 01/10/2005 energy performance data are collected in the Flemish Region by ‘certified’ energy experts (type B) using an auditing procedure for existing single family dwellings (the Energy Advice Procedure, briefly EAP). This auditing procedure is a procedure, appropriate for the Belgian situation, that was commissioned by the three Belgian regions. Research on the procedure started in 1996 (parallel with the development of the EPBD!). Consequently, the procedure was not found in conformity with the EPBD over the whole line.

EAP-audits are performed on a voluntary basis by order of the occupants. The occupants receive an “evaluation” of the actual situation in terms of labels. Energy “advice” consists in separated calculation of yearly energy savings (expressed in MJ, %, in EUR) for each recommendation, including technical advice about the renovation of the construction. Financial support is available on a federal level (tax reduction of 40% of the audit price). Official audits are uploaded to the central server of each region.

The EAP-database on the central server of the Flemish Region was the starting point for the Belgian Model Project. Because the ‘certified training programs’ only started in the middle of 2006 in the Walloon Region, data gathering started here at the end of 2006. In the Walloon Region occupants receive an additional grant of 60% of the audit price, with a maximum of € 360. For the Brussels Region, ‘certified training programs’ started in 2008.

Recent developments in relation to the EPBD: In Flanders EAP will only be applied as a voluntary procedure, delivering tailored energy advice (down) to size for occupants of existing dwellings. Regarding the mandatory procedure, the Flemish Region opted for a licence-acquisition of Dutch software. On the other hand, the Walloon Region is working on the extension of the existing EAP-procedure for existing single family dwellings towards a procedure applicable for apartments and for conversion of the “evaluation” and “advice” tool into a “certification” tool.

Fig. 65: General statistics of the analysed datasets

Number of collected datasets			**113**
Evaluation types * (≠ Certification)		**Utilisation types**	
whole buildings **	113	residential buildings **	113
building parts		offices	
apartments		education	
Rating types		higher education	
only asset rating		hospitals	
only operational rating		hotels and restaurants	
both asset and oper. Rating ***	113	others	
Considered energy uses		**Buildings constructed ...**	
heating	113	1900 or earlier	3
hot water	113	from 1901 to 1940	23
cooling / air conditioning		from 1941 to 1980	51
lighting		from 1981 to 2000	26
others ****	113	since 2001	9

*) *EAP does deliver an evaluation of the building, but doesn’t deliver certificates.*

**) *EAP is only available for single family dwellings.*
EAP is not applicable for apartments.
EAP is not applicable for mixed buildings (mixture of functions).

***) *Asset rating including measured consumption, if available.*

****) Additionally, an estimation of indoor climate, overheating, summer condition and ventilation requirements can be considered.

As the Flemish authorities were involved as source of data, they are first beneficiary of the results of the project. Secondly, a comparison was drawn with existing statistical data of the residential sector in Flanders. The institution involved with setting up the Flemish energy Balance will be addressed too. Because this auditing procedure only started on 01/10/2005 in Flanders and therefore in its introductory phase, follow-up and quality-control were essential. VITO performed quality-control of 10 audits in the database. Next to the authorities, auditors will be informed of the results.

Main results of the data evaluation

The database can be compared with polls of 2003 and 2005. These comparisons improve that the methodology, developed in specific for the official audit procedure, gives good results and that the database is 'relevant' for the Flemish housing stock, despite its limited size.

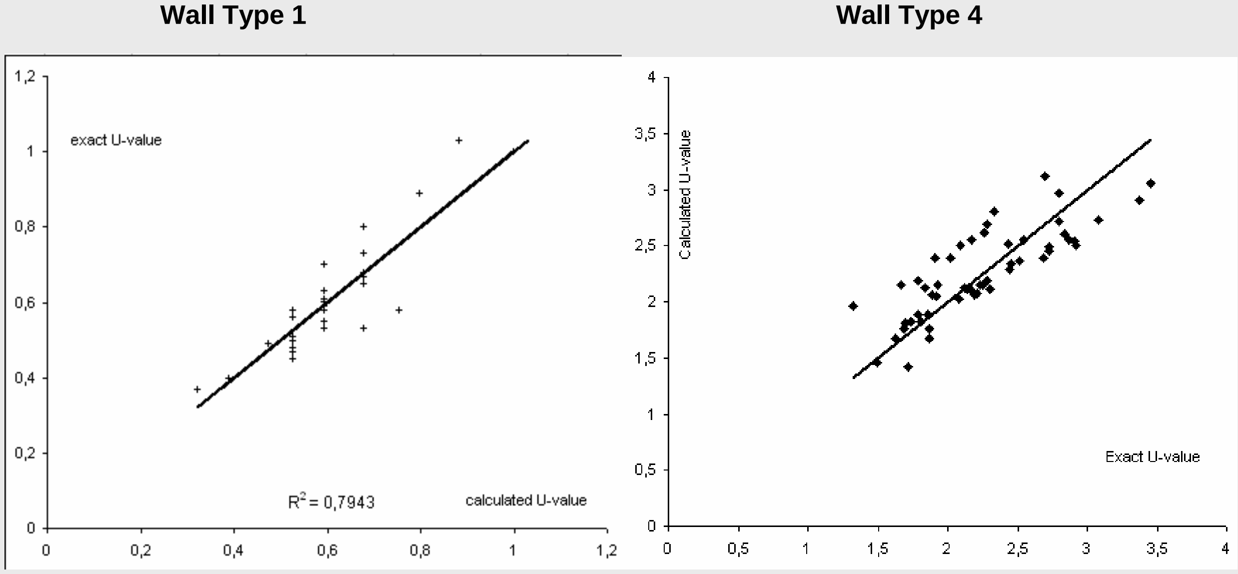
The analyses demonstrate that the official database contains inaccurate data. Inaccurate data are extreme points on graphics. In view of refined software, a "control-function" could lead to detect inaccurate data automatically before uploading to the central server and quality will improve.

The main target was the making of a "typology" of building elements in order to simplify energy auditing that means to save time and costs. A procedure for the estimation of the U-value of a wall was developed. To find a formula for general use for calculation of the U-value depending on maximum twosome parameters, the walls in the database were first realigned into 4 types of walls:

- Wall-type 1 : Walls with a cavity layer partially filled with insulation;
- Wall-type 2 : Walls with a cavity layer and no insulation;
- Wall-type 3 : Walls whom 's cavity is completely filled with insulation;
- Wall-type 4 : Walls without cavity, without insulation.

Possible parameters in the formula [U = C1.parameter1 + C2. parameter2] are the erection year, the insulation layer thickness, the cavity layer thickness and the brick thickness. Given these basic assumptions, calculated U-values (using the formula above) are shown as function of the exact U-values in the appropriate interval. Thus the formula with the slightest deviation was determined for each of the types of walls. The following figures illustrates the approach.

Fig. 66: Deviation between calculated and exact U-value for wall-type 1 (left) and wall type 4 (right)
wall type 1: U = 1,6764 – 0,29398 x Ln (insulation layer thickness)
wall type 4: U = 0,0017415 x erection year – 0,0043104 x brick thickness



Conclusions

In Belgium the currently developed software tools to evaluate (and improve) the energy performance of buildings are all web based with direct connection for the energy experts. This means that only the software proposed by the government is applicable and all results are requested to be sent to the administration. This has several advantages, especially with respect to data mining of the building data. Following issues need further development in the future:

Technical procedure and software

Following improvements are necessary:

- Improvement of easiness of use of the software (including some small technical errors)
- For existing dwellings a simplified (meaning less costly) procedure needs to be developed with focus on the balance accuracy/cost and reproducibility.
- Harmonisation of different calculation procedures/methodologies for new and for existing buildings.

Training and experts

- Occupants require experts with technically added value and working according to quality requirements, nevertheless this is difficult to combine with the expectations towards lower cost.
- Random check ups show that quality of the experts can be improved. Checking the quality of the training centres may be one of the possible solutions for this.
- Interactive websites with opportunities for FAQ and webplaces for direct input of energy certificate results is a positive initiative which has a growing value.

Financial support

- For existing buildings the voluntary scheme is being supported by tax reduction both on the audit as on the measures. It is however for the moment not yet clear to which extent this will lead to significantly increased number of applied measures. As mentioned previous further investigation on other possibilities for tax reduction and loans/mortgages is necessary.

Data mining

The opportunities offered by data mining are large:

- It is possible for the government to check the quality of the uploaded data automatically. A simple check, comparison to likely values, could in the future lead to a quality check on the performance of the auditors and to a selection of on-site controls.
- Definition of more accurate default values for building energy characteristics and building typology or even revision of defined energy classes.
- Follow up and reporting of the implementation of the EPBD and evaluation of implemented policy measures.
- Further experience with large number of data has to be built up in order to evaluate the full capacities of this data mining.
- Issues to be dealt with are privacy of data and efficiency of data processing and reporting.

The implementation of this kind of on-line data mining of course requires quite some efforts (people working on the data processing and interpretation).

Follow-up and perspectives

The data mining of EP certificates could be linked to other activities of energy agencies and research institutes:

- Harmonisation with 'other' collected data related to EPBD → art 8 from chimney-sweepers (new regulation 2006) – more detailed information available about boiler type (power, type, annual charge, measurement of combustion efficiency) → in Belgium : typical problem is oversized boilers in domestic region (surveys : average charge = 10 à 15 %).
- 'Energy Renovation Programme 2020' Action – Flemish Region : Decrease Energy consumption 20% building sector Lack of information about existing building stock; success of measurements, subsidy schemes, potentials,….; modelling – prognoses; necessity to have information about 'real consumption' before/after renovation and about costs of measurements. Policy: information campaign / 2 priorities / different scenarios www.energiesparen.be/2020
- link with SuFiQuaD-project (= project for **Su**stainable, **Fi**nancial and **Qua**lity evaluation of **D**wellings) First results in June 2008; Publications autumn 2008; Belgian project with federal support. Next step – selection representative dwelling types. Aim: implementing the developed tool on representative dwelling types
- Monitoring the implementation and the objectives of the energy end-use efficiency and energy services directive ESD in the MS

The DATAMINE concept certainly draws the attention of the local instances from the three regions in a positive way. The Flemish Energy Agency asked VITO to do a new evaluation of the EAP-database (>600 data sets) using the DATAMINE analysis tool and philosophy and so can be seen as a continuation of the Model Project. Conclusions drawn from this exercise will directly be used in the current discussion about the use and evaluation of the new EPC-database, which soon will contain data sets on a large scale. The efficient use of this large database can directly be coupled to the different issues previously described. The importance of correct/reliable data leads to the fact that VITO will take its first steps in the development of an automatic quality control via the use of a programmed module/macro.

Possible opportunities for researchers:

The future availability of EP data opens opportunities to exchange information with policy-related research fields:

- Energy Balance
- Life Cycle Cost/Assessment
- Modelling future energy consumption
- Calculating the impact of energy saving measures

2.8 Austrian Model Project

Status of introduction of Energy Performance Certificates in Austria

Fig. 67: Status of Energy Performance Certificate introduction *in Austria*

Regulations are fixed by government		yes*	
Coming into force		**2008**	
Availability of EP Certificates	residential buildings	partly**	
	non-residential buildings	partly**	
		Asset Rating	**Operational Rating**
Residential buildings			
new		yes	no
existing		yes	no
Non-residential Buildings			
new		yes	no
existing		yes	no

*) obligation to present an EPC on national level, energy benchmarks on regional level
**) the EPC according to housing subsidy sheme was precondition to receive public subsidy

In Austria, the submission of the Energy Performance Certificates (EPC) has been the precondition to receive public subsidy for construction or renovation of residential buildings since many years. Although these EPCs differ slightly from the EPC concept of the energy performance certificate according to EPBD EU-Directive 2002/91/EC, the EPCs provide interesting information. In Austria, the implementation process of the EPBD 2002/91/EC will be completed in the second half of 2008. The implementation takes place partly on the level of the Austrian provinces (energy benchmarks are part of regional building code) and partly on the federal level (obligation to present the EPC[2]). After transposition of the EPBD in the provinces, EPCs according to EPBD are used to apply for social housing subsidies. In Carinthia, the process of EPBD 2002/91/EC implementation was only completed on 12th of march 2008, and the Austrian Model Project started in 2007. Therefore the Carinthian EPCs according to public subsidy regulations were used for the Austrian Model Project.

In Carinthia, the software programs used for the calculation of EPCs in the last years were "GEQ", by company Zehentmayer, and software "Ecotech", by company Ecotech. These calculation programs provide updates to comply with the new rules according to EPBD 2002/91/EC implementation.

In some Austrian Provinces, a software called "ZEUS" is used for the electronic data management of EPCs. ZEUS is a product of the company "gizmocraft". The development of ZEUS was initiated by the province Salzburg and has been further developed in cooperation with other Austrian provinces. ZEUS (http://www.energieausweise.net/) is an internet-software, which transforms the EPCs (after they have been compiled with one of the existing calculation programs) automatically into the internet. ZEUS can be used by consultants, building owners, and public bodies to process energy certificates and to store them. Public bodies have the opportunity to evaluate data provided in the course of EPC calculation such as decrease of heating energy demand or increase of thermal quality of building envelope during a defined period of time. With the adoption of the requirements of EPBD 2002/91/EC implementation even more information will be available.

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[2] "Energieausweis-Vorlage-Gesetz – EAVG", came into force on January 1st, 2008 for every building to be sold or rented with building license dated later than January 1st 2006; for building licenses earlier the EPC is obligatory from January 1st 2009.

The DATAMINE Model Project in Austria

It was the objective of the Austrian DATAMINE Model Project to incorporate data of Austrian Energy Performance Building Certificates into the European DATAMINE project. The DATAMINE data entry provides a defined interface for data collection and data evaluation. It was the task to collect Austrian EPC data and process them in a way so that they can be incorporated into the DATAMINE project via interface.

It was decided to use the data of the Austrian province Carinthia for the project, because the regional energy agency "Energie:bewusst Kärnten" has compiled the EPCs according to social housing subsidy scheme since the year 2000.

Key actors of the Austrian Model project

Key actor #1: "Energie:bewusst Kärnten" provided the existing compilation of EPCs.
Key actor #2: the Austrian Energy Agency represented the interface with the DATAMINE project.
Key actor #3: Zehentmayer software company prepared the datasets calculated with their software programme "GEQ" for input into ZEUS internet software.
Key actor #4: "gizmocraft" internet agency (developer of the ZEUS database) imported the adapted data into the ZEUS online database and created the DATAMINE export file.

The data collection method in Austria

At the beginning of the DATAMINE project, stock data were available in the form of paper copy and data copy, in then current software-version. Stock data are managed by the regional energy agency "Energie:bewusst Kärnten". Their local access-database contains far more than 7,000 EPCs (including new and existing buildings) from the years 2000 to 2007.

It was the challenge to upgrade the old stock data to make them useable for ZEUS, in order to automatically export them into the DATAMINE project. To achieve this, the following tasks were carried out:

- The local database was transferred to the software companies Zehentmayer und Ecotech.
- They upgraded the stock data for ZEUS using the recent version of their program already supporting ZEUS.
- These calculation software tools generate as well a pdf-file for viewing as well as a XML-file which includes all relevant calculation data needed for evaluation procedures.
- The upgraded database was handed over to gizmocraft.
- gizmocraft was responsible for the input of this data into ZEUS-internet software.
- ZEUS-internet software made the Carinthian EPCs visible at http://ktn.energieausweise.net.
- gizmocraft created an automated export of this database for DATAMINE.

Results

Existing EPCs are stored in the ZEUS online database for further handling and reporting. Any reports and statistics can be generated based on the stored data (real-time).The DATAMINE export is created as an MS Excel/CSV file to be used for further purposes.

For the Austrian Model Project the EPCs of the years 2003 to 2007 were used for the interface to DATAMINE: 5,229 EPCs of new buildings and 1,486 EPCs of reconstructed buildings.

The whole report is to be found on: http://env.meteo.noa.gr/datamine/Datamine_MKG_rp_2008-03-06.pdf (English version) and http://env.meteo.noa.gr/datamine/Bericht_mkg_2008-03-27_AEA.pdf (German version).

Lessons learned and possible improvements

In the past EPC data was collected fragmentarily, and so there is a lack of experience and lack of standards regarding smooth and continuous data collection. However, many Austrian institutions and associations have integrated the EPCs in their workflows and have started their own data collections. Now it is necessary to implement a standard or pseudo-standard, so that all energy certificates can be stored in databases and can be compared to each other. The online database ZEUS and its interfaces to the Austrian calculation software programs is a step towards the right direction and fulfils its purpose even if it is not based on an official standardisation. However, one common database and one common standard for all over Austria (or even EU) is desirable. Therefore the Austrian Energy Agency still discusses with the Austrian provinces to enlarge the use of ZEUS.

During the model project we detected some problems regarding data allocation which were solved for DATAMINE interface. In addition, the internet agency gizmocraft updated ZEUS for solving these problems, e.g. they have created the technical pre-condition to mark the building as "new" or "refurbishment", for the new projects to be stored in ZEUS, as well as for the already existing EPC´s. This means that 6,715 datasets have to be checked again.

Main results of the Austrian data evaluation

Fig. 68: General statistics of the analysed datasets (2003-2007)

Number of collected datasets			**6715**
number of new buildings			5229
number of existing buildings			1486
Certificate types		**Utilisation types**	
whole buildings	6715	residential buildings	6380
building parts	-	offices	11
apartments	-	education	147
Rating types		higher education	-
only asset rating	6715	hospitals	6
only operational rating	-	hotels and restaurants	-
Both asset and oper. Rating	-	others	171
Considered energy uses		**Buildings constructed …**	
heating	6715	1900 or earlier	125
hot water	-	from 1901 to 1940	123
cooling/air conditioning	-	from 1941 to 1980	1433
lighting	-	from 1981 to 2000	185
others	-	since 2001	4236

Austrian main results

- 6,715 EPCs were analysed in the DATAMINE project. The analysed certificates represent the majority of the EPCs issued in the federal state of Carinthia between 2003 and 2007.
- 5,229 certificates of new buildings are available from the years 2003 until 2007.
- 1,486 certificates of existing buildings are available from the years 2005 until 2007, presumably due to specific subsidies granted for renovation projects from 2005 on.
- 6,380 of these EPCs were made for residential buildings.
- Data concerning the building envelope is rather far developed. In contrast there are lacks and inconsistencies concerning the data and values for single building components.
- There is a severe lack of data regarding building services and final energy demand. These facts have only been integrated into the new Austrian energy certification according to EPBD 2002/91/EC from 2008 on.

Fig. 69: Number of new buildings ("Neubau"): 5,229

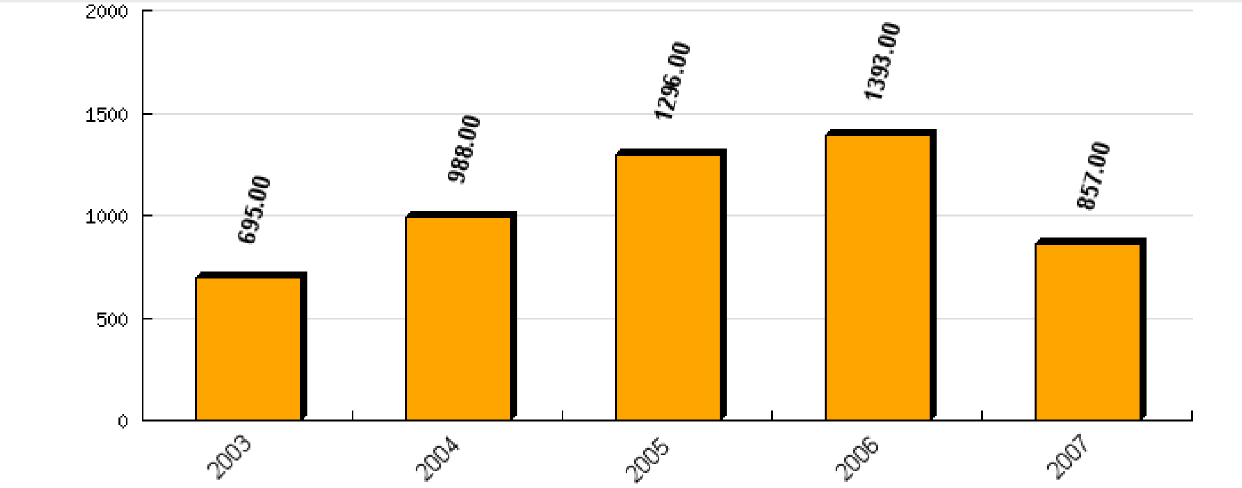
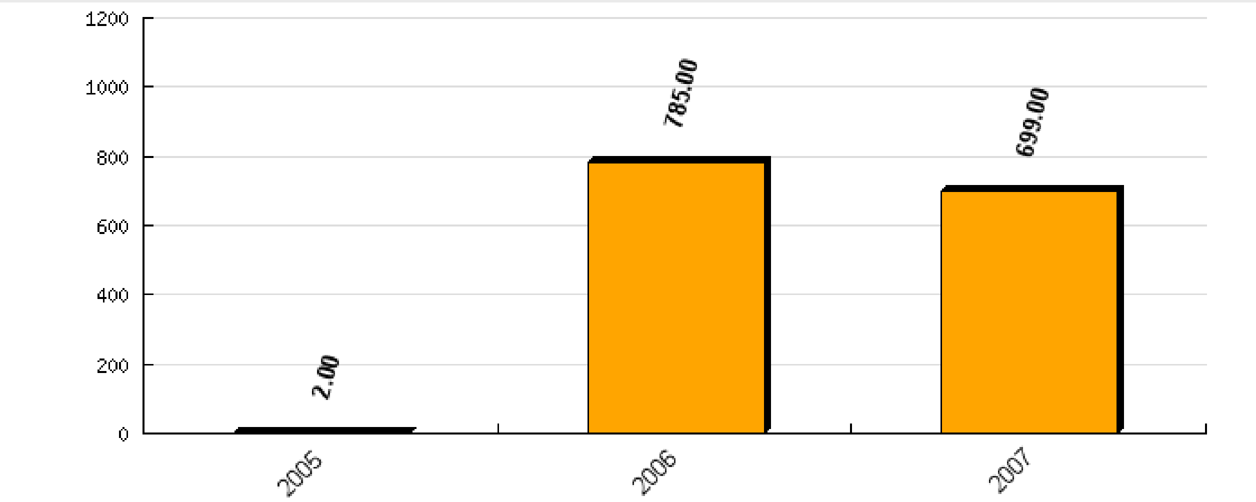


Fig. 70: Number of existing buildings ("Sanierung"): 1,486



Conclusions

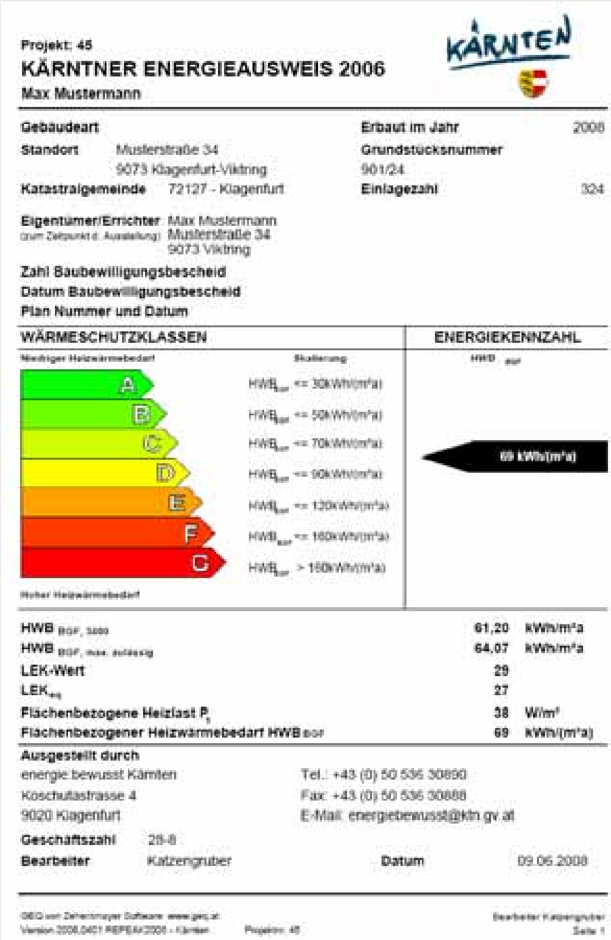
The collection process of Austrian EPC data for the DATAMINE model project was complex and of long duration. Existing EPC data differ strongly in quantity and quality which influences the technical feasibility of a centralised data collection.

The new rules according to EPBD 2002/91/EC will guarantee quality assurance as regards EPC content, additionally a technical quality control of data format has to be implemented. Technical standards like XML-formats might be considered.

Based on a standard data format centralised databases facilitate the collection of EPC data, as the internet software ZEUS does in Austria. Online databases are especially suitable as they lead to real-time global data collections regardless where or on which purpose the EPC data is calculated. Internet technology has led to wide-spread standards, therefore the implementation of online interfaces in existing EPC calculation software should be enhanced.

Since January 1st 2008 the EPC has to be made for new buildings[3] in Austria, so the ZEUS database will be enlarged in the next years. To demonstrate the consequences of the new regulations in Carinthia the following example shows the differences between the previous EPC according to social housing subsidy scheme (see Fig. 71, below) and the "new" EPC according to the EPBD 2002/91/EC implementation (see Fig. 72, below). Both EPCs were calculated for the same building.

Fig. 71: The previous energy performance certificate according to social housing subsidy scheme in Carinthia



Projekt: 45

KÄRNTNER ENERGIEAUSWEIS 2006

Max Mustermann

Gebäudeart | **Erbaut im Jahr** 2008

Standort Musterstraße 34, 9073 Klagenfurt-Viktring | **Grundstücksnummer** 901/24

Katastralgemeinde 72127 - Klagenfurt | **Einlagezahl** 324

Eigentümer/Errichter (zum Zeitpunkt d. Ausstellung) Max Mustermann, Musterstraße 34, 9073 Viktring

Zahl Baubewilligungsbescheid

Datum Baubewilligungsbescheid

Plan Nummer und Datum

WÄRMESCHUTZKLASSEN | **ENERGIEKENNZAHL**

HWB BGF, 3400	61,20	kWh/m²a
HWB BGF, max. zulässig	64,07	kWh/m²a
LEK-Wert	29	
LEK_{eq}	27	
Flächenbezogene Heizlast P_1	38	W/m²
Flächenbezogener Heizwärmebedarf HWB BGF	69	kWh/(m²a)

Ausgestellt durch

energie:bewusst Kärnten, Koschutastrasse 4, 9020 Klagenfurt

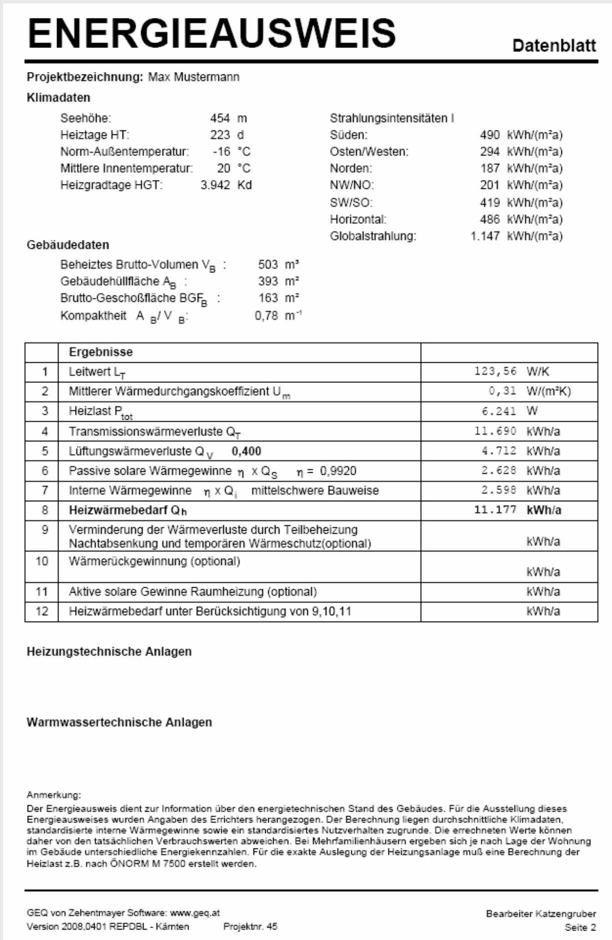
Tel.: +43 (0) 50 536 30890

Fax: +43 (0) 50 536 30888

E-Mail: energiebewusst@ktn.gv.at

Geschäftszahl 28-8

Bearbeiter Katzengruber **Datum** 09.06.2008



ENERGIEAUSWEIS **Datenblatt**

Projektbezeichnung: Max Mustermann

Klimadaten

Seehöhe:	454	m
Heiztage HT:	223	d
Norm-Außentemperatur:	-16	°C
Mittlere Innentemperatur:	20	°C
Heizgradtage HGT:	3.942	Kd

Strahlungsintensitäten I		
Süden:	490	kWh/(m²a)
Osten/Westen:	294	kWh/(m²a)
Norden:	187	kWh/(m²a)
NW/NO:	201	kWh/(m²a)
SW/SO:	419	kWh/(m²a)
Horizontal:	486	kWh/(m²a)
Globalstrahlung:	1.147	kWh/(m²a)

Gebäudedaten

Beheiztes Brutto-Volumen V_B :	503	m³
Gebäudehüllfläche A_B :	393	m²
Brutto-Geschoßfläche BGF_B :	163	m²
Kompaktheit A_B / V_B:	0,78	m^{-1}

	Ergebnisse	
1	Leitwert L_T	123,56 W/K
2	Mittlerer Wärmedurchgangskoeffizient U_m	0,31 W/(m²K)
3	Heizlast P_{tot}	6.241 W
4	Transmissionswärmeverluste Q_T	11.690 kWh/a
5	Lüftungswärmeverluste Q_V **0,400**	4.712 kWh/a
6	Passive solare Wärmegewinne $\eta \times Q_S$ η = 0,9920	2.628 kWh/a
7	Interne Wärmegewinne $\eta \times Q_i$ mittelschwere Bauweise	2.598 kWh/a
8	**Heizwärmebedarf Q_h**	**11.177 kWh/a**
9	Verminderung der Wärmeverluste durch Teilbeheizung Nachtabsenkung und temporären Wärmeschutz(optional)	kWh/a
10	Wärmerückgewinnung (optional)	kWh/a
11	Aktive solare Gewinne Raumheizung (optional)	kWh/a
12	Heizwärmebedarf unter Berücksichtigung von 9,10,11	kWh/a

Heizungstechnische Anlagen

Warmwassertechnische Anlagen

Anmerkung:

Der Energieausweis dient zur Information über den energietechnischen Stand des Gebäudes. Für die Ausstellung dieses Energieausweises wurden Angaben des Errichters herangezogen. Der Berechnung liegen durchschnittliche Klimadaten, standardisierte interne Wärmegewinne sowie ein standardisiertes Nutzverhalten zugrunde. Die errechneten Werte können daher von den tatsächlichen Verbrauchswerten abweichen. Bei Mehrfamilienhäusern ergeben sich je nach Lage der Wohnung im Gebäude unterschiedliche Energiekennzahlen. Für die exakte Auslegung der Heizungsanlage muß eine Berechnung der Heizlast z.B. nach ÖNORM M 7500 erstellt werden.

GEQ von Zehentmayer Software: www.geq.at

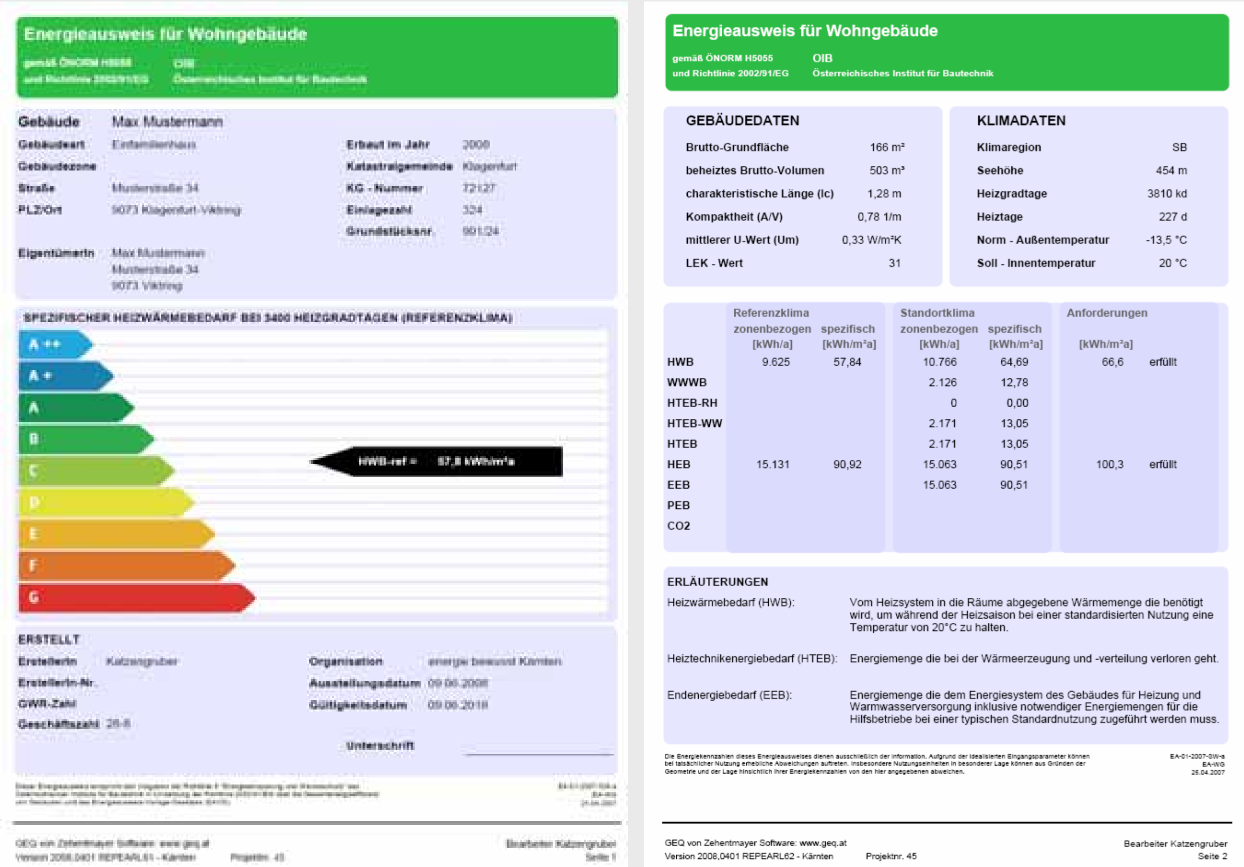
Version 2008,0401 REPDBL - Kärnten Projektnr. 45

Bearbeiter Katzengruber

Seite 2

[3] "Energieausweis-Vorlage-Gesetz – EAVG", came into force on January 1st, 2008; obligatory of EPC for every building to be sold or rented with building license dated later than January 1st 2006; for building licenses earlier the EPC is obligatory from January 1st 2009 on;

Fig. 72: The new EPC according to national regulations according to EPBD 2002/91/EC, implemented by national “OIB-Richtlinie 6” (Austria-wide standardised monthly energy balance method)


Energieausweis für Wohngebäude

gemäß ÖNORM H5055 und Richtlinie 2002/91/EG — OIB Österreichisches Institut für Bautechnik

Gebäude: Max Mustermann
Gebäudeart: Einfamilienhaus — Erbaut im Jahr: 2000
Gebäudezone — Katastralgemeinde: Klagenfurt
Straße: Musterstraße 34 — KG-Nummer: 72127
PLZ/Ort: 9073 Klagenfurt-Viktring — Einlagezahl: 324
Grundstücksnr.: 901/24
Eigentümerin: Max Mustermann, Musterstraße 34, 9073 Viktring

SPEZIFISCHER HEIZWÄRMEBEDARF BEI 3400 HEIZGRADTAGEN (REFERENZKLIMA)

A ++, A +, A, B, C, D, E, F, G

HWB-ref = 57,8 kWh/m²a

ERSTELLT
ErstellerIn: Katzengruber — Organisation: energie bewusst Kärnten
ErstellerIn-Nr. — Ausstellungsdatum: 09.06.2008
GWR-Zahl — Gültigkeitsdatum: 09.06.2018
Geschäftszahl: 26-8
Unterschrift

GEQ von Zehentmayer Software www.geq.at
Version 2008.0401 REPEARL61 - Kärnten — Projektnr. 45
Bearbeiter Katzengruber — Seite 1

Energieausweis für Wohngebäude

gemäß ÖNORM H5055 und Richtlinie 2002/91/EG — OIB Österreichisches Institut für Bautechnik

GEBÄUDEDATEN		KLIMADATEN	
Brutto-Grundfläche	166 m²	Klimaregion	SB
beheiztes Brutto-Volumen	503 m³	Seehöhe	454 m
charakteristische Länge (lc)	1,28 m	Heizgradtage	3810 kd
Kompaktheit (A/V)	0,78 1/m	Heiztage	227 d
mittlerer U-Wert (Um)	0,33 W/m²K	Norm - Außentemperatur	-13,5 °C
LEK - Wert	31	Soll - Innentemperatur	20 °C

	Referenzklima zonenbezogen [kWh/a]	Referenzklima spezifisch [kWh/m²a]	Standortklima zonenbezogen [kWh/a]	Standortklima spezifisch [kWh/m²a]	Anforderungen [kWh/m²a]	
HWB	9.625	57,84	10.766	64,69	66,6	erfüllt
WWWB			2.126	12,78		
HTEB-RH			0	0,00		
HTEB-WW			2.171	13,05		
HTEB			2.171	13,05		
HEB	15.131	90,92	15.063	90,51	100,3	erfüllt
EEB			15.063	90,51		
PEB						
CO2						

ERLÄUTERUNGEN
Heizwärmebedarf (HWB): Vom Heizsystem in die Räume abgegebene Wärmemenge die benötigt wird, um während der Heizsaison bei einer standardisierten Nutzung eine Temperatur von 20°C zu halten.
Heiztechnikenergiebedarf (HTEB): Energiemenge die bei der Wärmeerzeugung und -verteilung verloren geht.
Endenergiebedarf (EEB): Energiemenge die dem Energiesystem des Gebäudes für Heizung und Warmwasserversorgung inklusive notwendiger Energiemengen für die Hilfsbetriebe bei einer typischen Standardnutzung zugeführt werden muss.

GEQ von Zehentmayer Software: www.geq.at
Version 2008.0401 REPEARL62 - Kärnten — Projektnr. 45
Bearbeiter Katzengruber — Seite 2

The new EPCs contain more detailed information, especially regarding the technical equipment of the buildings.

Referring to the DATAMINE category D “system data” there are about 50 fields to be filled with information like “year_of_heatgen” or “effectivity_of_pump” which could not be filled in by the previous EPCs, the same with information about hot water, ventilation and electric configuration. But with the information from the new EPCs according to EPBD it be possible to fill these fields. So the data availability in Austria will substantially increased.

The Austrian Model Project has successfully proven that existing EPC data can be transferred into the database years after their calculation and it does not matter if the EPCs were stored in paper copies (and this is the vast majority) or in older versions of the different calculation programs.

The advantage of ZEUS internet platform is the integration of data from previous EPCs and data from new ones. As there are some important figures which were given in the previous ones and in the new ones (like heat energy demand) it is possible to show e.g. that the reduction of heat energy demand is linked directly with grants like social housing subsidy for thermal insulation. And this is what the Provinces wanted to achieve. So the analysis is a good-working instrument to support political instruments and show the Provinces where their aims already have been achieved and where it is necessary to give more grants on special fields, e. g. exchange of heating systems and refurbishment in general.

The DATAMINE Model Project is completed, however work will continue in Austria. The next steps will be to integrate Austria-wide the changes caused by the implementation of the EPBD, the amplification of categorisation possibilities in ZEUS, and the enlarging of the ZEUS platform as well as creating further database-links.

The Austrian Energy Agency has created an own database access called “Immo-ZEUS” (www.immozeus.at) to collect information concerning the Austrian building stock. The first company who uses this platform is conwert SE which owns about 150 buildings in Vienna.

The status quo is that asset rating (out of energy performance certificates) is collected in the provinces by different agencies, the target is to combine these results with the results from operational rating (including life-cycle-costs). Furthermore interfaces to other existing building certification databases, to the “TQB” (Total Quality Building) -tool as well as towards LCC calculation tools and to the official database of “Statistik Austria” are planned.

On the one hand this is planned for quality control of EPCs, on the other hand to launch measures addressing user behaviour for better support in energy efficiency.

On the building level this ought to improve energy efficiency from the planning phase on. On the aggregated level the assessment of anonymous data pools supports the Austrian Energy Agency to give advices for the development of policy instruments in Austria. For example it could be used to support energy advisers in their work. Especially the refurbishment has to be increased in Austria to achieve the reduction of CO_2-emissions in (and addition to) the Kyoto-period. So the detailed analysis of EPC data is seen as a support for the ongoing of CO_2-emission reduction in Austria.

2.9 Slovenian Model Project

Status of introduction of Energy Performance Certificates in Slovenia

In Slovenia EPBD is being transposed with Building Construction Act (art. 3, 4, 5.1, 6), Energy Act and its amendment (art. 5.2, 7, 9, 10) and Environmental Protection Act (art. 8, 10).

The amended Energy Act (Official journal nr.118, Nov. 17, 2006) defined the framework conditions for the implementation of energy performance certificates as well as independent experts. The act defined that issuing of certificates for new buildings and public buildings is obligatory since Jan. 1, 2008 (large public buildings have to provide EPCs and public placement by Dec. 2010 latest). EPCs for existing buildings (sold or rented out) are obligatory since Jan. 1, 2009. The EPC in Slovenia shall have a status of official public document, so it can only be issued by authorized companies and elaborated by licensed experts (license is subject to prior obligatory training course and exam). Based on the experiences from EIE BUDI and CA EPBD the national regulation on EPC was drafted (2007), where calculated indicators are planned for new buildings and for existing residential buildings, while non-residential (sold, rented) and public buildings are planned to be certified on a basis of operational rating. The draft calculation methodology allows calculation of heating and cooling needs, delivered energy, as well as primary energy and CO_2 emissions, (promulgation expected in March 2008). The methodology has already been used for calculation of test energy certificates since 2006.

Fig. 73: Status of Energy Performance Certificate introduction in Slovenia

Regulations are fixed by government		**no (final draft ready)**	
Coming into force		**(expected) March 2008**	
Availability of EP Certificates	residential buildings	**Jan. 2008 new buildings, Jan 2009 existing**	
	non-residential buildings	**Jan. 2008 new buildings, Jan 2009 existing**	
		Asset Rating	**Operational Rating**
Residential buildings			
new		**yes**	**no**
existing		**yes**	**no**
Non-residential Buildings			
new		**yes**	**no**
existing		**no**	**yes**

The DATAMINE Model Project in Slovenia

General objectives:

The following general objectives can be defined in Slovenian model project,

- to learn about the energy and CO_2 indicators in the building stock an its sub-sectors,
- to provide the energy benchmarks for different type/age of buildings and consequently the estimation of energy saving potential,
- to establish a data base based on EPCs and integral energy indicators in Slovenia,

- to show the ministry responsible for EPBD the benefits of using DATAMINE tool (by Amended energy law (Nov. 2006) – the ministry is responsible for EPCs' database and for licences of experts data base),
- to provide a support to the government by making available DATAMINE results to national and/or local authorities, when developing the incentives, setting minimum requirements for different type of buildings and when in monitoring of the impacts,
- to control and guaranty the reliability and coherence of the data collected in EPCs,
- to focus on extension of database (other building types) and establish the monitoring of indicators beyond the project.

Key actors for Slovenian Model Project are:

- Municipal Housing Funds, moreover MHF of Ljubljana, a municipal public fund responsible provision of social housing in Ljubljana and oriented to implementation of various projects from energy auditing to pilot energy certification of their apartment buildings and passive house renovation, acting also as a best practice for other municipal funds in Slovenia.
- The Ministry of Environment and Spatial Planning is responsible for EPBD transposition and for monitoring of impacts of certification scheme as well as for the transposition of ESD (new RES and RUE targets) .
- National and local authorities – involved in the discussion regarding the concept of implementation of a monitoring system as one of the outcomes of this project, (i.e. Jesenice municipality, utility).

Description of the data collection method

In Slovenia the procedure about EPBD energy performance certification is still in progress, but on the other hand many EPC pilot projects were going on since 2002 to support the development of obligatory scheme under EPBD. The following EPC related data sources and corresponding collection methods were applied:

1 – 23 voluntary energy certificates following the EPC methodology from pilot project OPET Slovenia, FP5, in use since 2002 by ZRMK mostly for residential buildings; data were collected manually based on input data records and EPCs themselves (design certificates, heat demand, classes A-G)

2 – 15 pilot EPBD energy certificates, prepared within the EIE BUDI project, between 2005 – 2007, CEN EPBD based national calculation methodology – draft and EPCs by EIE BUDI methodology as proposed for the national obligatory scheme in 2007 was used, a post processor was developed to transfer the needed set of data from the calculation tool to DATAMINE database form (asset certificates, heat demand, final energy for heating and DHW, classes A-G, CO2 indicator)

3 – 40 pilot EPBD energy certificates, prepared in EIE EffCoBuild project, based on the above EIE BUDI methodology for certification, using draft final calculation methodology and minimum requirements, background information from energy audit; audits results - residential buildings in municipality Jesenice; a post processor was used transfer the needed set of data from the calculation tool to DATAMINE database form (energy audit; combined operational and asset approach certificates, heat demand, final energy for heating and DHW, classes A-G, CO2 indicator, final energy for heating measured)

4 – 22 brief energy audits results for selected apartment buildings of Housing Fund of Ljubljana, calculation based on seasonal method from existing 2002 regulation, data were electronically transferred from existing data base (audit – asset approach, heat demand calculated)

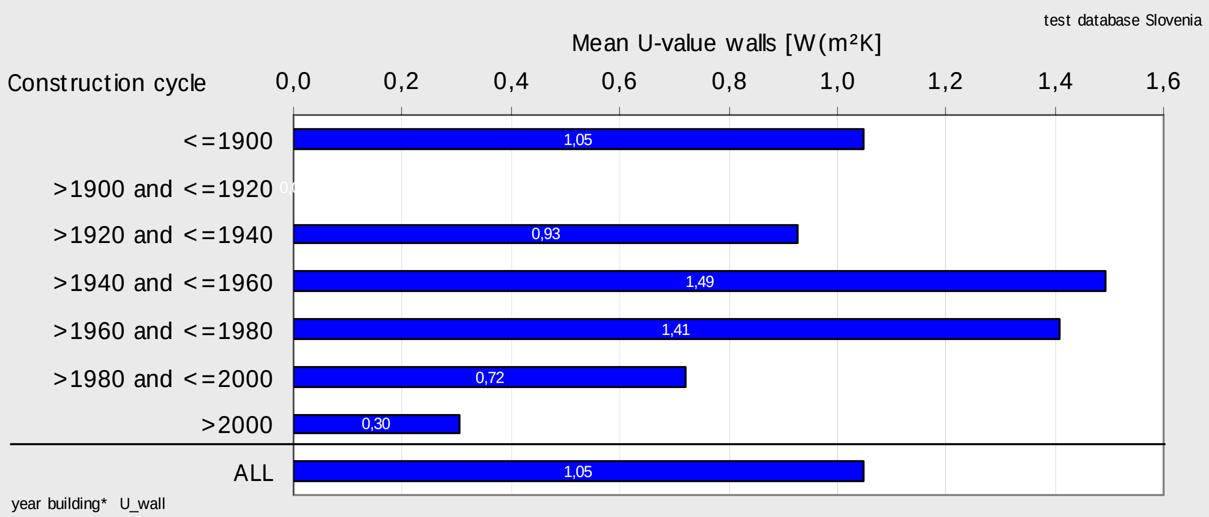
Main results of the data evaluation

Fig. 74: General statistics of the analysed datasets

Number of collected datasets			**100**
Certificate types		**Utilisation types**	
whole buildings	100	residential buildings	86
building parts	-	offices	7
apartments	-	education	-
Rating types		higher education	-
only asset rating	100	hospitals	-
only operational rating	-	hotels and restaurants	2
both asset and oper. rating	-	others	5
Considered energy uses		**Buildings constructed ...**	
heating	100	1900 or earlier	2
hot water	77	from 1901 to 1940	15
cooling / air conditioning	-	from 1941 to 1980	58
lighting	-	from 1981 to 2000	13
others	-	since 2001	23

The analysed data base is focused on post WW2 buildings with the biggest energy saving potential. More recent residential buildings show the thermal quality of existing buildings on the market, where energy efficiency is in focus.

Fig. 75: Mean U-Value of walls, dependence on building construction cycle



There has been significant improvement in overall thermal insulation of the buildings in the last millennium.

Fig. 76: Transmission losses per m² envelope (similar to mean U-Value of the envelope), dependence on building construction cycle

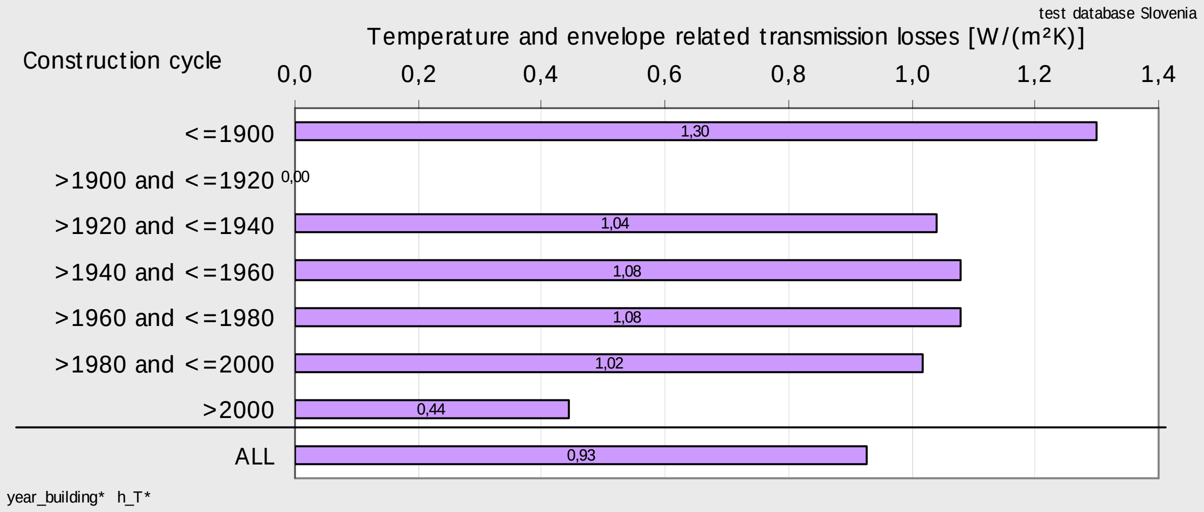
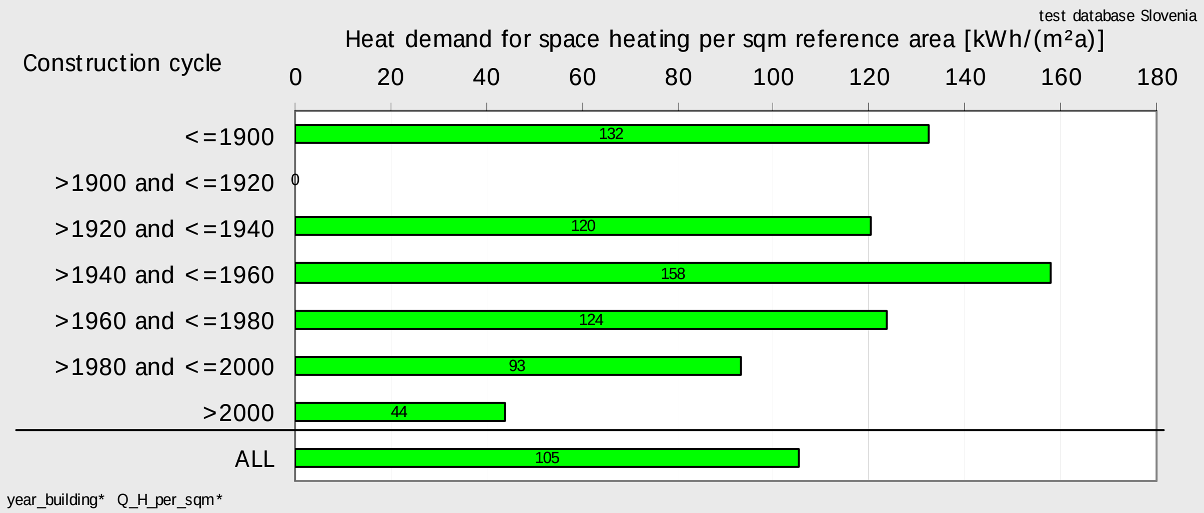
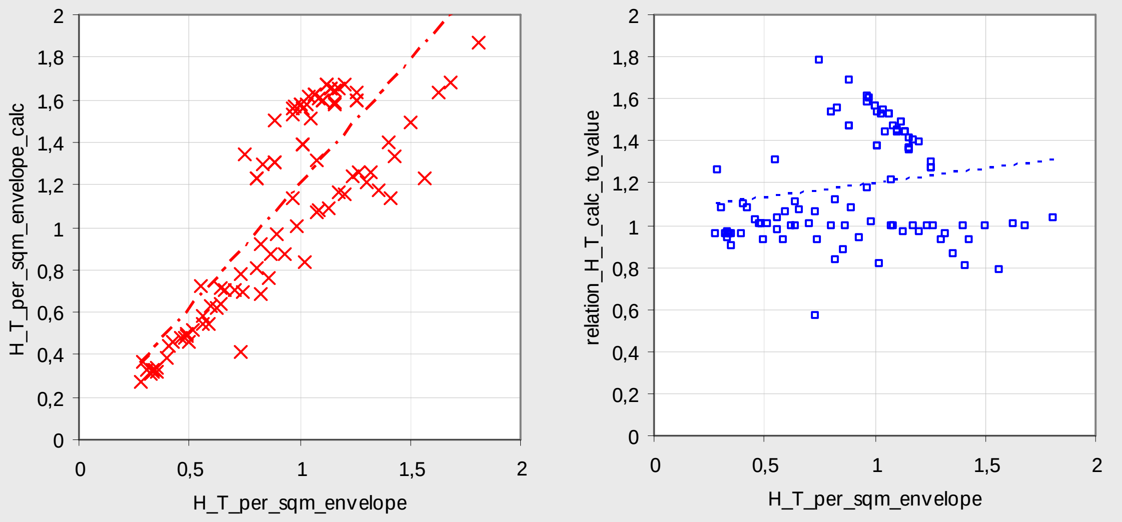


Fig. 77: Mean values for the calculated useful energy demand for space heating – dependence on building construction cycle



The net heat demand indicators are in relation up to 7 : 1 (existing : new).

Fig. 78: Plausibility check for the transmission heat losses
transmission losses related to the temperature difference and the envelope area
comparison of the values calculated by the energy certificate programme (DATAMINE output) with the value calculated by the exported U-values and areas



The above plausibility check identified an error in the database. The software that was used to export results from a calculation of the energy demand had an error. Only one group of buildings was affected what is well displayed in the above chart.

Conclusions

Slovenian Model Project

Collection Method: In the Slovenian Model project the data from pilot energy certificates were used, based on the voluntary and draft EPBD national certification scheme. Data were collected partly manually (in 23 cases) partly the data were electronically transferred (in 22 cases). In more recent pilot EPBD certificates (draft national method) a post processor was developed and used to transfer data from draft EPC calculation tool (in 55 cases). Further automatic transfer of future obligatory EPC data is thus possible.

Energy performance of the analysed buildings demonstrate that the calculated heat demand in post WW2 buildings is up to 7-times higher than in today's buildings. Thermal building envelope average U value of old existing buildings (slightly above 1,0 W/m^2K) is reduced to 0,44 W/m^2K after the year 2000. In spite of the incomplete data due to the variances in EPC methodologies used, many interesting descriptions of the data from Slovenian model project were done.

Plausibility check has shown an error in the database, where a group of datasets had wrong values due to the mistake in the post processor for data transfer.

The DATAMINE tool offers a good opportunity for future monitoring and analysis of data from the obligatory energy certification scheme in Slovenia. In future there will be better opportunities to collect metered as well as calculated data (EPCs in existing buildings), what will allow better understanding of energy consumption rules in buildings.

Future national monitoring of EPC

Implementation of DATAMINE tool is a challenge in Slovenia – since the monitoring procedures of certification scheme haven't been fully defined yet. Current final draft of the methodology for the calculation of the energy performance indicators of buildings has over 400 equitations so for the end user a software solution is needed. Ministry responsible for the implementation of the EPBD will prepare the calculation core of the software, which will then be available for the commercial developers to add input and output interference.

Since the ministry is also responsible for the monitoring of impacts of certification scheme we have proposed, based on a DATAMINE experiences, a national monitoring project of EPC. Our proposal is linked to the software supporting the calculation, from which we could export all the intermediate and final outputs of the calculation of the energy performance factors.

The output file would be of the xml format and transferred to the nation database which is held at the Geodetska uprava Republike Slovenije (The Surveying and Mapping Authority of the Republic of Slovenia).

Besides that Datamine tool offers an analyzing solution that could be used in the future to analyze energy performance indicators collected in Slovenian database and by that we could:

- perform evaluation of energy and CO_2 indicators in the building stock an its sub-sectors
- set of energy benchmarks for different type/age of buildings and consequently the estimation of energy saving potential,
- control quality of EPCs, especially the reliability and coherence of the data collected in EPCs
- set future minimum requirements
- revise nation calculation methodology, propose new default values, etc.

Further on the DATAMINE tool and data structure will be used as a monitoring and analyzing tool to develop national building typology.

Monitoring of local communities building stock

On the other hand using a tool like DATAMINE would have proven to be very useful for municipal public founds and local authorities, who could obtain better knowledge about their building stock and easier renovation decision making. This was demonstrated on a group of apartment buildings (municipality Jesenice) where the utility tends to stimulate the energy efficiency of their customers' buildings by comparing the energy indicators. In this respect DATAMINE tool can play also an important role in developing the information activities of utilities under the Energy service directive.

Because the reasons stated we have approached other municipalities with a suggestion on monitoring program of their building stock. After such a program would be adopted local authorities will have a better insight on local energy consumption in building sector, on local construction and refurbishment trends thus better decision making on:

- local subsidies
- large scale renovations of municipal public buildings
- setting energy priorities
-

Monitoring of GI ZRMK activities

One of the outcomes of the Datamine project is a database witch at the moment consists of 100 datasets. We will expend this database with our available data from other projects. This will give us an opportunity to evaluate our activities.

In the year 2008 a new obligatory training course and exam for licensed experts (they will elaborate the EPCs) is coming into force. GI ZRMK will be applying as a training institution. Part of our

training scheme will be a ZRMK quality control label which will be awarded to the expert who will undergo our training program and will constantly send us feedback of his elaborated EPCs. We will store this data in a Datamine structures database and with analyzing tool:

- evaluate the coherence of results,
- perform plausibility checks and
- monitor individual expert’s performance.

2.10 Spanish Model Project

Status of introduction of Energy Performance Certificates in Spain

Last 17th January 2007 the Royal Decree on the Basic Procedure for Energy Performance Certification of **new buildings**, was approved by the Council of Ministers and was officially published on 31st January 2007.

The certification scheme, responsibility of the Ministry of Industry, Tourisms and Trade, came into force six moths later, so from the 31st October 2007 EP Certification is mandatory for new buildings to obtain a building permit.

As it is published as a 'Basic procedure', the 17 Autonomous Communities, have he right to regulate and complete the National scheme giving more detailed provisions of control and inspections. These regional governments in general play an important role in the construction, exploitation, renovation and maintenance of (social) housing in Spain.

There are two options to obtain an EP certificate:

1. a simplified one (prescriptive with different settings in 12 climate zones)
2. a more complex one named General Option that requires the use of an official simulation software tool, called CALENER.

It still has to be defined how Spanish authorities are going to handle the EP certification of **existing buildings**, however a "Basic Procedure" is expected to be ready and mandatory from 2009.

Fig. 79: Status of Energy Performance Certificate introduction *in Spain*

Availability of EP Certificates	New Buildings*	**Nobember 2007**	
	Existing Buildings	**2009****	
		Asset Rating	**Operational Rating**
Residential buildings			
new		yes	yes
existing		?	?
Non-residential Buildings			
new		yes	no
existing		?	?

*) Both residential and non-residential
**) "Basic Procedure" still to be defined by national authorities

The DATAMINE Model Project in Spain

Datamine and its results are an attempt to support and assist Spanish certification responsible administrations to be ready to deal with the possible barriers that can be encountered during the whole EP certification process, by establishing a stable framework for all involved actors (end users as well as authorities) in the certification scheme to ensure the process success.

Main objectives of the Spanish model project are:

- General overview on the quality or energy performance of the evaluated buildings
- Definition of the main building energy performance indicators and their dependency to other factors
- Creation of a database to store and analyse the main EP indicators related to the built environment.
- Accurate information for the decision-making processes regarding energy saving measures to be realized
- Recommendations for the development of a monitoring scheme according to the results obtained from the energy performance building certification

The Datamine Project is mainly addressed to public authorities, responsible for the implementation of the EP building certification scheme, so key actors are the 17 Autonomous Communities.

Other possible target groups are public housing associations, retrofit companies, big project developers and real estate asset managers. They can take advantage of the Datamine benefits to manage their building portfolio from the energy point of view.

Data collection method

The project's first step was to determine the whole data collection process required for the EP building certification. This data must be further transferred into the Datamine's database.

Several collection methods have been analysed, and finally a tailor-made tool to transfer all relevant data automatically was developed and used by Ecofys.

Main results of the data evaluation

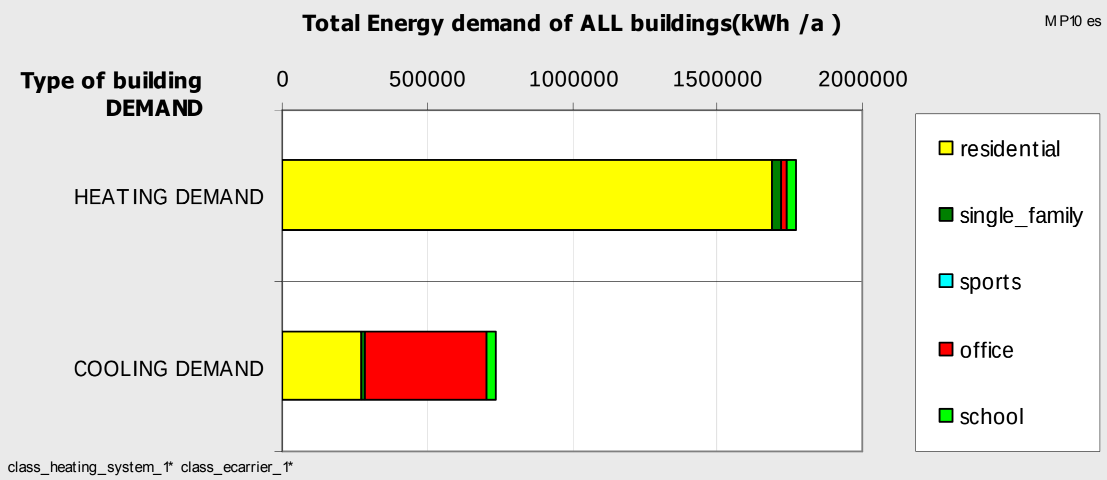
For the Spanish Model Project, a sample of 50 building EP certificates simulated by CALENER was used. These are mainly existing residential buildings, although CALENER was developed for new buildings.

Fig. 80: General statistics of the analysed datasets

Number of collected datasets			**50**
Certificate types		**Utilisation types**	
whole buildings	50	residential buildings	45
building parts	-	offices	3
apartments	-	education	1
Rating types		higher education	-
only asset rating	50	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	-	others	1
Considered energy uses		**Buildings constructed ...**	
heating	49	1900 or earlier	-
hot water	47	from 1901 to 1940	-
cooling / air conditioning	48	from 1941 to 1980	10
lighting	5	from 1981 to 2000	22
others	-	since 2001	18

For analysed buildings, almost all the heating demand is required by residential buildings while for space cooling, office buildings require much more demand than the rest of buildings.

Fig. 81



Conclusions

The Spanish certification scheme came into force early 2007 for new buildings. Since then, some problems appeared regarding the selected approach to implement it.

Main barriers are:

- The complex hourly simulation tool still under development,
- The tool is not flexible (unable to include new and efficient developments/measures),
- The tool is not robust (different results depending on the user, version),
- Regional authorities have the responsibility to implement the process although they didn't participate in its development (lack of knowledge and expertise). As a result, they still haven't developed a certification control scheme that guarantees all new buildings are well certified according to the new mandatory building regulations in Spain.

Consequently, all involved parties from end-users to regional authorities are experiencing difficulties, which makes them pessimistic about the success of the certification process.

The Spanish Datamine approach aims to give a boost to the current state of implementation of the national certification scheme, providing solutions to increase the commitment of all involved parties to reach a common objective: save energy by the success of the building energy performance certification scheme.

The DATAMINE model project approach for Spain is based on the following tasks:

1. Data collection from the energy performance certificates.
2. Transfer of the collected data to a central structured database.
3. Analysis of that central database.

The optimization of these three concepts or tasks is a flexible and powerful approach to provide solutions to deal with the detected barriers of the certification process which were mentioned before.

1. **Data collection from the energy performance certificates.**

Spanish Energy Performance Certificates outcome information is only related to energy (energy demand, consumption and CO_2 emissions), so they do not include any description about the characteristics of the building. In order to develop further evaluations of the certification process, it is necessary to analyse the relation between building characteristics and the energy results given by the EP certificate.

It is strongly recommended to collect input and output CALENER files (simulation files) in order to obtain missing information about the building characteristics, as this boundary conditions will determine the certificate result.

2. **Transfer collected data to a central structured Database.**

Data gathered in phase 1 must be stored into a central database with a common structure that could facilitate the analysis and comparison between different buildings, so the data transfer from a certificate to a central database.

After considering both manual and automatic data collection and transfer methods, it appeared that automatic data collection from all generated CALENER files is the best monitoring option for time and accuracy reasons.

It is strongly recommended to use the DATAMINE database or similar, as it has a common EU structure that allows to:

- Compare results between different countries, regions, cities, etc.

- Compare results between buildings located at regions with the same or similar climate conditions.

3. **Analysis of the EP certificates database.**

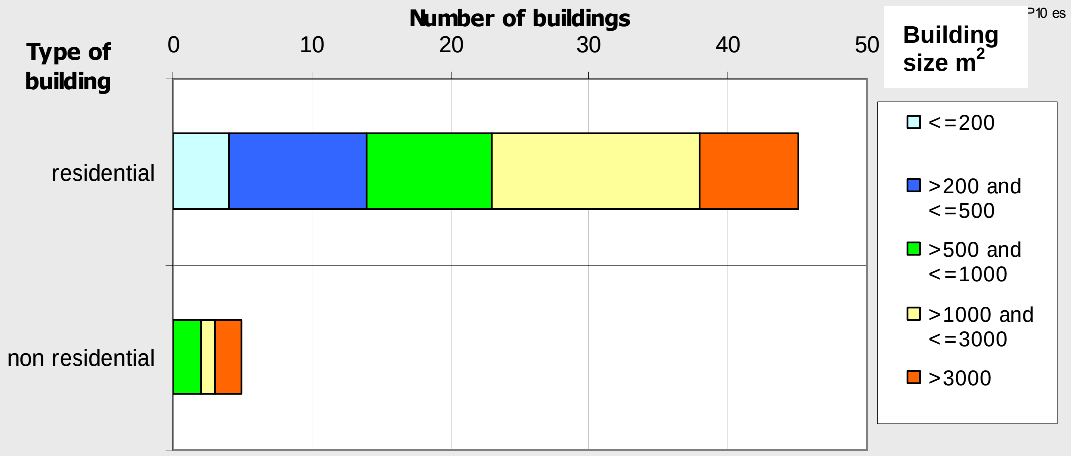
Once a standard automated collection method to transfer and store EP certification results to a database is defined, an analysing tool of this database will significantly improve the control and monitoring process for the public administration in charge: higher quality and less time or expert knowledge needed.

There are lots of possible analysis that could provide useful information to the public administrations in charge of the implementation of the certification scheme.

Below a list is given of possible objectives that could be reached analysing the central EP certificates database:

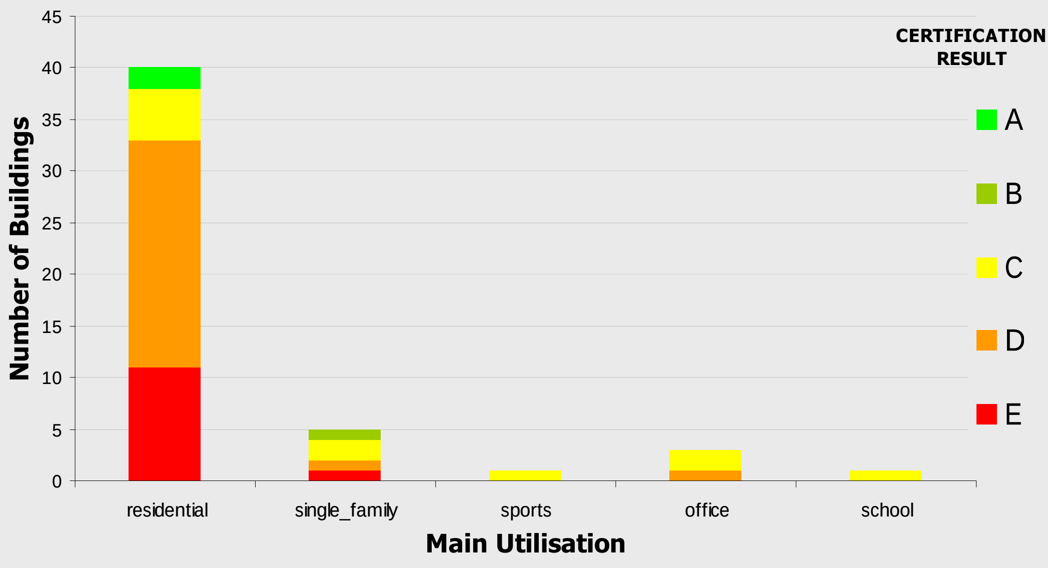
- Monitor the Spanish building sector, providing information about the new building stock that could complete current information available. (very poor)

Fig. 82: Frequency of building size classes depending on the main utilisation



- Control and monitor the national/regional implementation of the building certification scheme. It is recommended to setup and implement the scheme on a national/regional level. Below, an example is given of a Datamine database analysis. Here the certification process can be monitored, having information on the number of buildings certificated for each type of building, and its EP Label class frequency distribution.

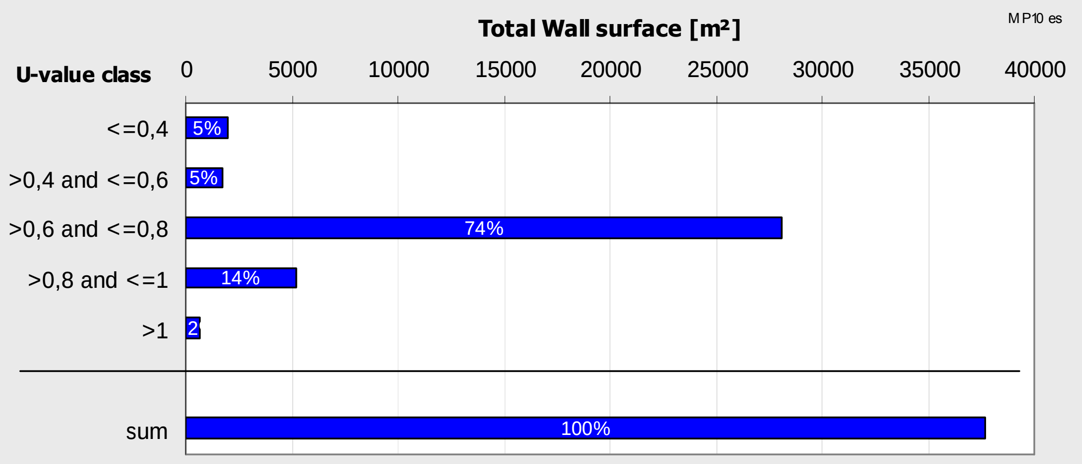
Fig. 83



- Planning tool for authorities to control and follow building improvements plans. It is recommended to implement it for this purpose on a national, regional and local level.

  For example, the figure below shows the impact analysis of measures regarding the thermal improvement of external walls. In this case, 75% of the analysed buildings could achieve significant energy savings by reducing the U-values from 0,8 to 0,4.

Fig. 84



- Detect failures on the certification scheme approach, methodology and calculations, especially all problems regarding the software calculation tool.

- Solve detected errors on previous versions of the software tool. With the use of extrapolation techniques, it is possible to estimate the right values that should have been calculated by the simulation tool.

- Control and monitor the subsidy scheme for building certification.

  Each regional government has a budged to subsidize actuations related to EP certification of new buildings. Datamine can support the subsidy scheme: setting up baselines as well as the minimum energy performance objectives to be subsidized, and helping in the necessary control and inspection that guarantee the efficiency of the subsidy process.

- Detect end-user frauds.

To conclude, a standard automated collection method to transfer and store results to a database, and the analysing tool of the database, would significantly improve the control and monitoring process for the public administration in charge: higher quality, less time and expert knowledge needed.

2.11 Irish Model Project

Status of introduction of Energy Performance Certificates in Ireland

The requirement for Energy Performance Certificates for new dwellings based on the primary energy demand for heating and hot water came into effect on 1st January 2007. This applied only to new dwellings for which planning permission was applied for or a planning notice was published on or after 1st January 2007, and where substantial work is completed by 30 June 2008.

The requirement for Energy Performance Certificates for new non-residential buildings will come into effect on 1st July 2008. This will not apply to buildings, other than dwellings, for which planning permission is applied for or a planning notice is published on or before 30th June 2008 and where substantial work is completed by 30th June 2010, except when such building is offered for a second or subsequent sale or letting.

For existing buildings of any class in existence at 1 January 2009, an Energy Performance Certificate will be required when the building is offered for sale or letting.

Fig. 85: Status of Energy Performance Certificate introduction in Ireland

	Dates for Implementation of EPBD
Residential dwellings* (asset only)	
new dwellings**	1st January 2007
existing dwellings when sold or rented	1st January 2009
Non-residential Buildings***	
new buildings****	1st July 2008
existing buildings	1st January 2009

*) apartments are treated on an individual basis
**) where planning application made on or after 01.01.2007
***) operational for public buildings, asset-based for others
****) where planning application made on or after 01.07.2008

The DATAMINE Model Project in Ireland

Objectives

The objectives of the Datamine model project in Ireland are:

- to demonstrate how Datamine can record key building energy rating (BER) data for a large population of BER certificates
- to highlight practical issues arising in populating the Datamine database (or similar databases) with BER certificate data
- to show the range of analytical facilities that Datamine can provide for large populations of BER certificates
- to monitor the improvement in energy performance (energy rating score, annual heating costs and CO_2 output) pre and post installation of energy saving measures
- to inform Sustainable Energy Ireland (responsible for EPBD implementation in Ireland) and relevant Government Departments of the benefits and learnings arising from the Datamine project
- to advise Dublin City Council and other Local Authorities with large stocks of housing of the merits of the Datamine database and analytical tool for management of BER certificate data, housing stock analysis and strategic planning input.

Key Actors

The key actors are Dublin City Council, other Local Authorities with large stocks of houses, Sustainable Energy Ireland, The Department of the Environment, Heritage and Local Government, the Department of Communications and Energy, and, energy surveyors/ energy consultants.

The Data Collection Method

Energy Action has conducted many major studies on existing Irish housing stock over the last 10 years and so has a large database of private sector produced energy rating certificates. As work on the Irish model project preceded EPBD implementation for new dwellings in 2007 and that for existing dwellings in 2009, the data being used for the Datamine project was initially taken from pre-2007 energy rating certificates prepared using the Irish Home Energy Rating (IHER) method.

The Irish Home Energy Rating method was developed under a technology transfer project in 1999 funded under an EU SAVE Programme by a partnership involving National Energy Services, (UK), Energy Action Limited, Dublin, the Energy Research Group, University College Dublin and Alembic Research (Scotland). The IHER software is based on a derivation of the UK National Home Energy Rating (NHER) method adapted to Irish conditions. As NHER is SAP-based, the IHER method is also UK SAP-based.

In implementing the EPBD in Ireland, Sustainable Energy Ireland decided to adapt the latest UK SAP method to Irish conditions leading to the launch of the Dwelling Energy Assessment

Procedure (DEAP) method in late 2006. Some different adaptations were made when creating DEAP to those made when the IHER method was originally developed. The launch of the DEAP software in Ireland in April 2007 has allowed the original data used in the IHER energy ratings to be entered into the DEAP software program. While the DEAP method for existing dwellings will only be available from July 2008 approx., it has been possible to produce DEAP BER ratings for existing dwellings by combining IHER default U-value data for building fabric with the DEAP software for new dwellings. The DEAP method provides a BER label ranging from A to G based on primary energy demand, i.e. $kWk/m^2/year$. DEAP is based on a single climate for all of the Republic of Ireland and does not take account of height above sea level or wind speed data. The IHER

method scores a dwelling on a scales of 1 to 10, where 10 is the most energy efficient and is based on energy costs (€)/m^2/year. IHER take account of geographical location, height above sea level and wind speed data.

The Irish Datamine project has been conducted in two phases. The first phase involved analysis of the data from 126 dwellings originally audited using the IHER method. This data was also entered into the DEAP software to calculate the various energy performance parameters. All 126 BER rating data produced by the DEAP software have been entered into the Datamine database in phase 1 to produce a wide range of analysis charts.

The second phase involved adding a further 60 dwelling audits giving 186 in total. Energy audits numbered 107 to 186 formed part of a pilot refurbishment programme of dwellings in the Dublin City area. All dwellings were audited before and after the refurbishment measures to check for the improvement in energy rating scores and reduction in primary energy and primary CO_2 emissions. The refurbishment measures included the fitting of gas condensing boilers, 130 litre hot water cylinders with 50mm of factory-fitted foam insulation, a central heating programmer, cylinder thermostat, room thermostat, roof insulation to a minimum of 200mm, draught proofing of doors and windows, cavity wall insulation where possible and the fitting of CFLs.

Main results of the data evaluation

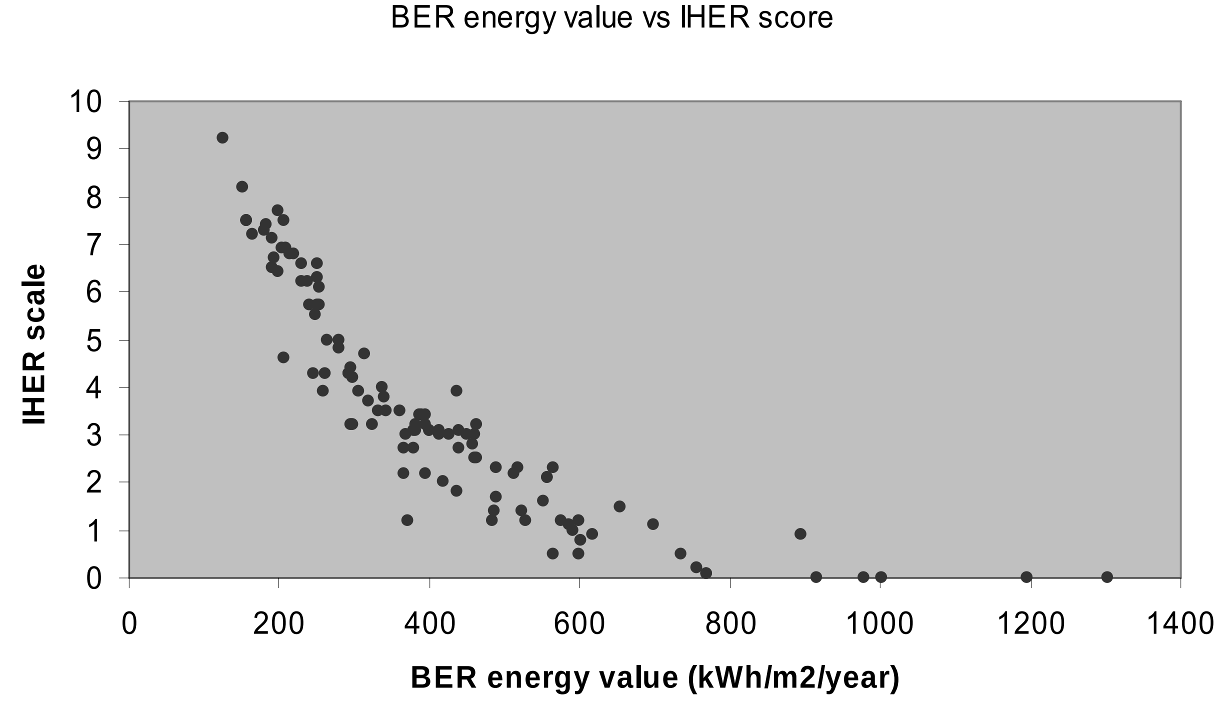
126 datasets were analysed in phase 1. All datasets were from existing dwellings including houses and apartments. In Ireland, each individual apartment is treated as a separate dwelling. The common areas in apartment buildings will be evaluated as non-residential buildings under the EPBD.

Fig. 86: General Statistics of the analysed datasets

Number of collected datasets			**126**
Certificate types		**Utilisation types**	
whole buildings	126	residential buildings	126
building parts	-	offices	-
apartments	-	education	-
Rating types		higher education	-
only asset rating	126	hospitals	-
only operational rating	-	hotels and restaurants	-
both asset and oper. rating	-	others	-
Considered energy uses		**Buildings constructed ...**	
heating	126	1900 or earlier	4
hot water	126	from 1901 to 1940	17
cooling / air conditioning	-	from 1941 to 1980	57
lighting	-	from 1981 to 2000	29
others	-	since 2001	19

In Phase 1, all 126 dwellings were analysed using both the original IHER method and the new DEAP method introduced as part of EPBD implementation in Ireland in January 2007. As well as conducting a wide range of analysis charts similar to the work of other partners, a close correlation between the IHER score and the BER energy value (kWh/m^2/year) was demonstrated. This result was expected as both methods are based on the UK BREDEM method.

Fig. 87: BER energy value (kWh/m^2/year) Vs IHER score



In phase 2, some interesting results were produced doing a before and after analysis of the 78 dwellings that had measures installed. (2 of the dwellings in the 107-186 dataset withdrew from the refurbishment scheme). The summary results are provided in Fig. 88.

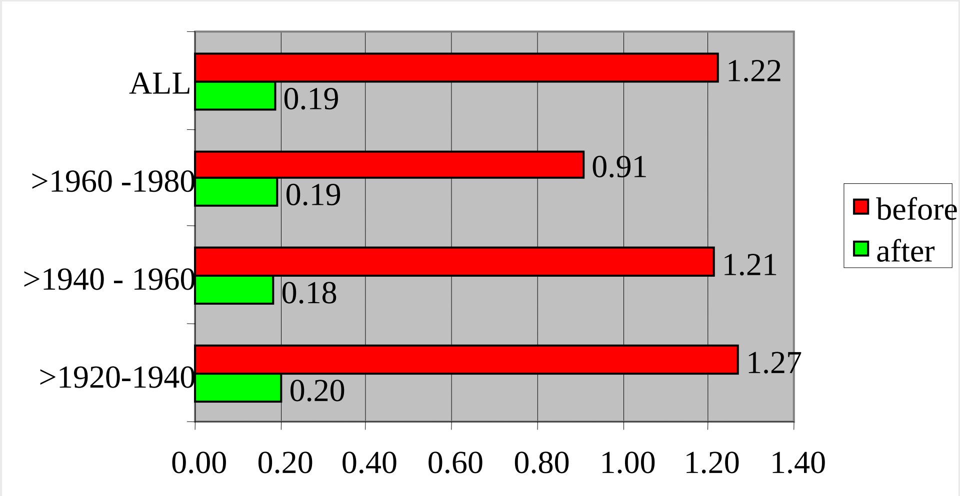
Fig. 88: Average Scores Before and After Refurbishment

Average	Before	After
Energy Value (kWh/m^2/yr)	486	237
Building Energy Rating	G	D1
CO_2 (kg/year)	9005	4108
Running costs (€)	1571	920

The Datamine analysis tool was then used to provide more detailed analysis and highlight where the reductions were apportioned.

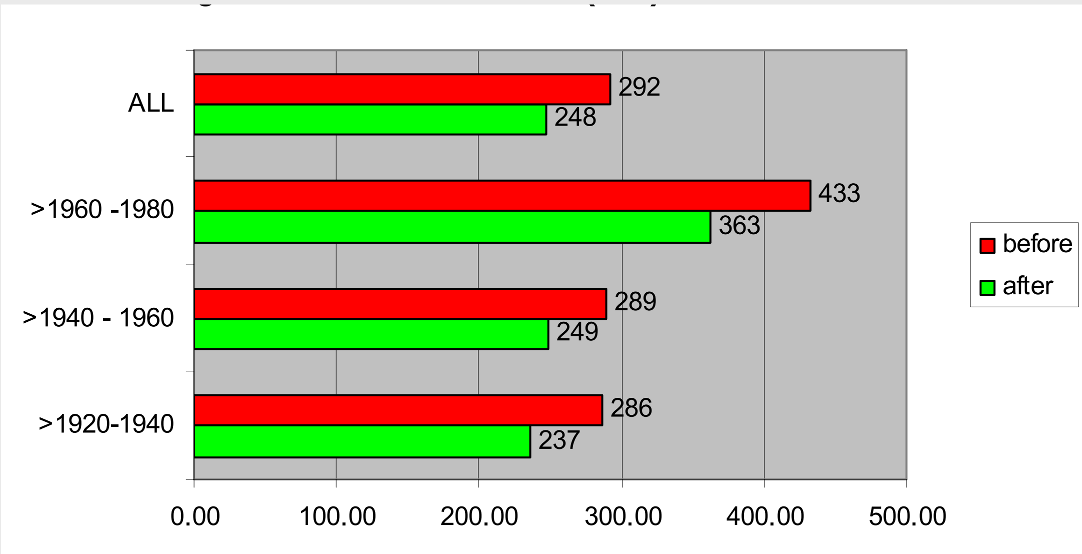
Almost all 78 dwellings had roof insulation increased to a minimum of 200 mm so the average U values of roofs dropped from a U value of 1.22 to 0.19 as shown in Fig. 89.

Fig. 89: U Roof Before and After



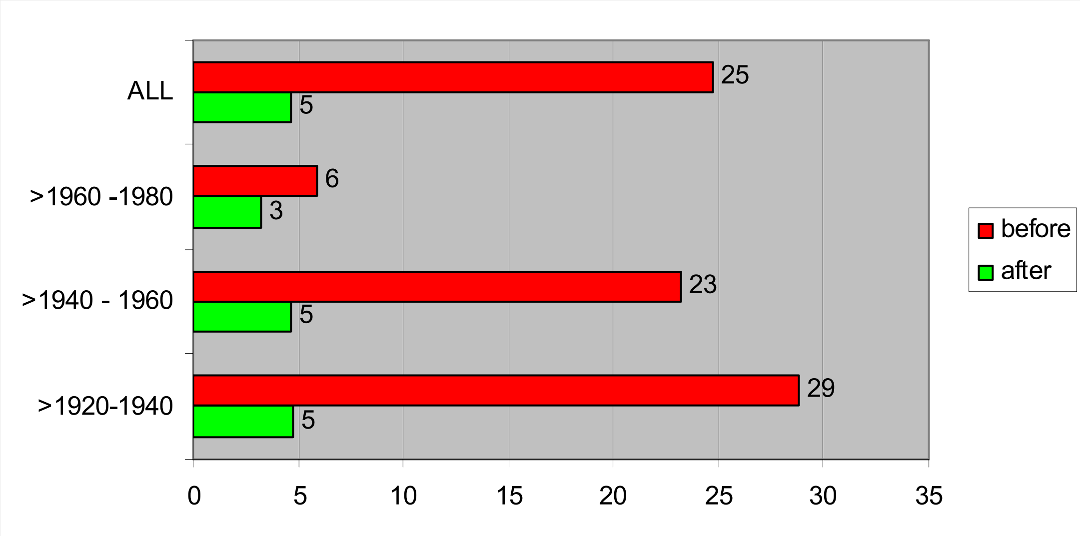
However, as none of the dwellings had wall or floor insulation added, the total transmission losses only decreased slightly from 292 W/K to 248W/K. The fabric losses for the 1960-1980 set of dwellings were higher because of introduction of hollow block wall construction at that time.

Fig. 90: Total Fabric Losses (W/K) / Before and After



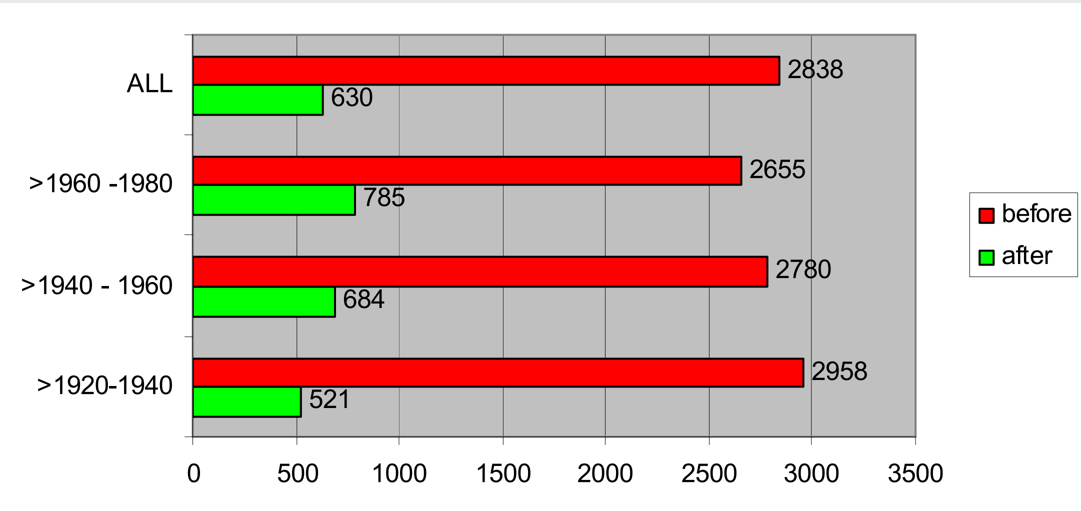
The introduction of factory insulated hot water cylinders had a notable effect in reducing hot water losses (see Fig. 91 below).

Fig. 91: Hot Water Storage Losses (kWh/(m²/year)



Also, the addition of modern heating controls for both hot water and space heating systems resulted in a notable decrease in additional heat emissions due to non-ideal controls and heating system responsiveness (Fig. 92).

Fig. 92: Additional Heat due to non-ideal controls % responsiveness (kWh/m²/year)



When the dramatically improved efficiencies of the heat generators for space and water heating were factored in, the delivered energy and the primary energy were shown to be reduced by more than 50% on average, though much less noticeably for the 1960-1980 housing group due to the prevalence of hollow block walls at that time (Fig. 93).

Fig. 93: Primary Energy: Main Heating System (kWh/year)

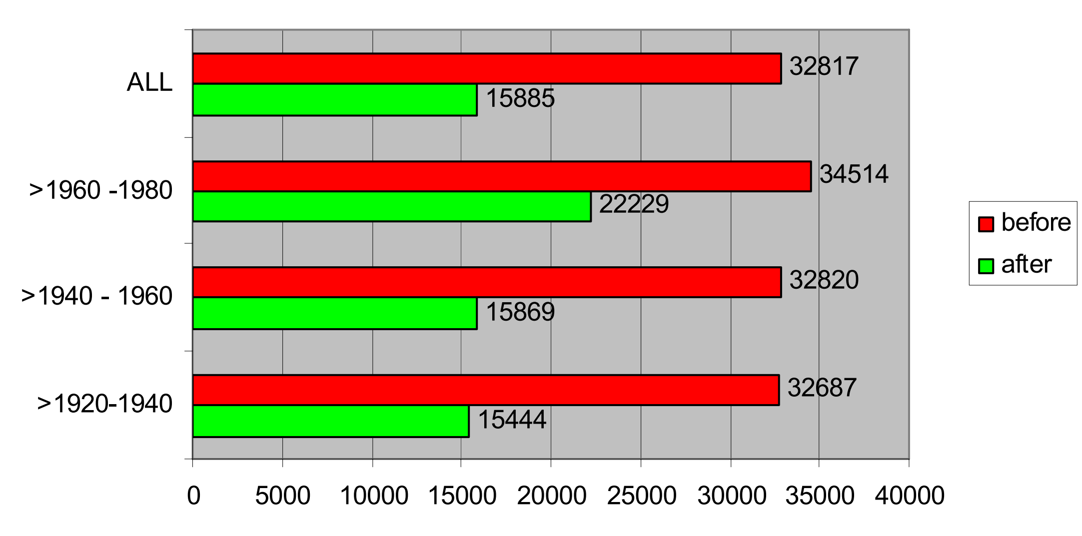
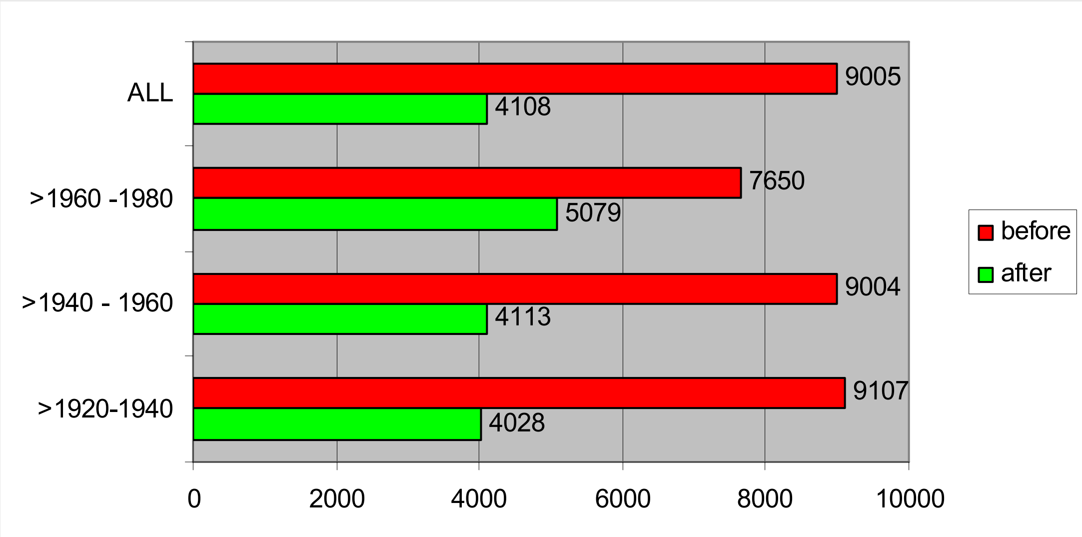


Fig. 94 shows the Carbon dioxide emissions before and after, matching those shown in Fig. 93.

Fig. 94: Carbon Dioxide Emissions (kg/year)



Conclusions

Collection Method

To date, BER certificate data has been analysed for 186 dwellings using both the IHER method and the new DEAP method, 78 of these for both 'before and after' energy efficiency improvement measures.

The DEAP BER data was entered manually into the Datamine database as the DEAP xml file does not contain much of the essential energy performance data that is required for creation of a straightforward export tool. Currently, the xml data stream within the DEAP software only contains the input data and the final calculated primary energy value and primary CO2 emissions. It does not contain any of the calculated energy outputs that would be essential for data analysis in Datamine or elsewhere.

SEI was notified of this in 2007 and in early 2008. More formal discussions took place in April 2008 before the next stage of DEAP software revisions got underway. The response from SEI has been that the addition of intermediate calculated values to the xml file cannot be accommodated in the latest specification for software revision owing to other demands that have higher priority.

However, the merits of the Datamine model are well known to SEI and it is hoped that other technical solutions will be found in the near future to permit datamining of key energy rating certificate data on a significant scale.

Energy Performance of the Analysed Buildings

The initial analysis of the datasets focussed on comparing for the first time the correlation between the IHER method and the DEAP method for the available dataset of 126 dwellings. The results show that there is reasonably close correlation apart from water heating energy values.

Given our long experience with IHER over the last 10 years and our short experience of the new DEAP method, it was important to understand the relation between the calculations behind both methods before undertaking more comprehensive data analysis of 126 datasets under one or other method.

The data analysis conducted in phase 2 of the Irish project showed how valuable Datamine can be in demonstrating the impact of energy savings schemes both in a detailed and clear format that can be understood by technical experts, housing managers and the general public at large. A summary of the Irish Datamine project and the analysis and results from phases 1 and 2 was presented to an audience of more than 100 housing managers and designers belonging to local authorities in Ireland on 5th June 2008. The feedback from the Datamine presentation at the Irish "Housing in a Changing Climate" Conference on 5th June 2008 was very positive and there was a very strong interest from several local authorities in adopting the Datamine approach for BER data collection and analysis.

The same presentation was also made to officials of the Department of Environment, Heritage and Local Government who are partly funding the refurbishment scheme. Again, the response was very positive and the benefits of using Datamine for detailed building energy analysis was highly praised and appreciated.

The Irish project has shown that Datamine has the added benefit of demystifying the science of building energy performance and providing important information to analysts, strategists and policy makers.

Perspectives for Future Monitoring Activities

As indicated above, the DEAP xml file does not contain any of the intermediate calculated energy values that would be essential for the creation of a straightforward export tool. While the creation of a larger xml file may not now be addressed in the short term, other technical solutions will now be explored. This needs to be addressed so that the National Administration body, Governments Departments and organisations with various sizes of housing stocks can avail of data collection and analysis tools.

Energy Action proposes to immediately investigate other technical solutions to developing an export tool in the absence of an expanded xml file in response to stated need of housing managers nationally for such a facility. Housing Managers are aware that they are facing a significant new area of responsibility in the near future, especially from 1st January 2009, and that they need to also make best use of the huge volume of building data that they will gather. Thus, Datamine, and future updates of Datamine, can be expected to feature strongly as a data collection and analysis tool for housing managers and building energy experts in Ireland.

Energy Action will also continue to liaise with SEI on possible opportunities to incorporate the learnings from Datamine within the National Database.

2.12 Bulgarian Model Project

Status of introduction of Energy Performance Certificates in Bulgaria

Since the year 2004 Official Energy Performance Certificates are being issued in accordance with Bulgarian Energy Efficiency Act (EEA). According to the Act every project for construction, reconstruction and rehabilitation of sites shall be subject of energy efficiency assessment. Every building may be certified by the order of an ordinance for certification of the buildings and each commissioned site – state or municipal property, with gross floor area above 1000 sq m shall be subject to certification with some exceptions i.e. cultural monuments, places of worship and others.

General statistics of the audited and certified sites is presented below:

Fig. 95

Buildings	*Year*			*Total number*
	2005	*2006*	*2007*	
Audited	38	521	780	1339
"A" certified	31	229	656	916
"B" certified	4	10	20	34
With prescribed energy saving measures	3	282	104	389

The certification categories are of type "A" and "B". "A" corresponds to the current requirements for energy efficiency of buildings (as of 2004) and "B" corresponds to the regulations in force in the year of the construction of the building.

Currently the EEA and the adjacent regulations are being updated for closer correspondence with the Energy Performance of Buildings Directive of the EU.

The DATAMINE Model Project in Bulgaria

The national project that is being carried out by SOFENA Agency aims at collection, analysis and monitoring of the energy performance indicators of the municipal buildings in Bulgaria – schools, kindergartens, social and office buildings, etc. The scope and specific targets of the model project are connected with evaluation of the energy performance of as large number as possible of municipal buildings throughout Bulgaria, analysis of the methods for energy certification and monitoring, evaluation of the major energy performance indicators, expertise on the energy state of the building sector, calculation of the ecological benefits and analysis of the energy efficiency measures – by type, effectiveness, price, popularity, etc.

The main prerequisites for a successful results of the project are connected with the Bulgarian energy efficiency legislation in force, big potential for performance of energy audits and monitoring of the energy performance of the building stock, as well as the good practices, know-how, experience and ideas of the Agency. SOFENA is in close cooperation and receives support from the State Energy Efficiency Agency, municipal authorities and others.

The initial aim of the Model Project 12 was to gather asset rating and detailed information of about 50 to 100 officially certified municipal buildings throughout Bulgaria. These buildings were meant to be included in a pilot data base, to be evaluated and analyzed.

By reason of number of obstacles, the process of official energy certification of the municipal buildings is not being carried out with the desired speed. This fact changed the initial ideas of processing the project. The current information is operational and is being gathered by various methods –

by means of questionnaires, communication with responsible people from local authorities and private auditing companies, as well as by using the existing information in SOFENA on the municipal building sector. These various methods for data collection lead to the presence of lack of different energy performance indicators for the different data bases or buildings.

Fig. 96: General Statistics of the analysed datasets

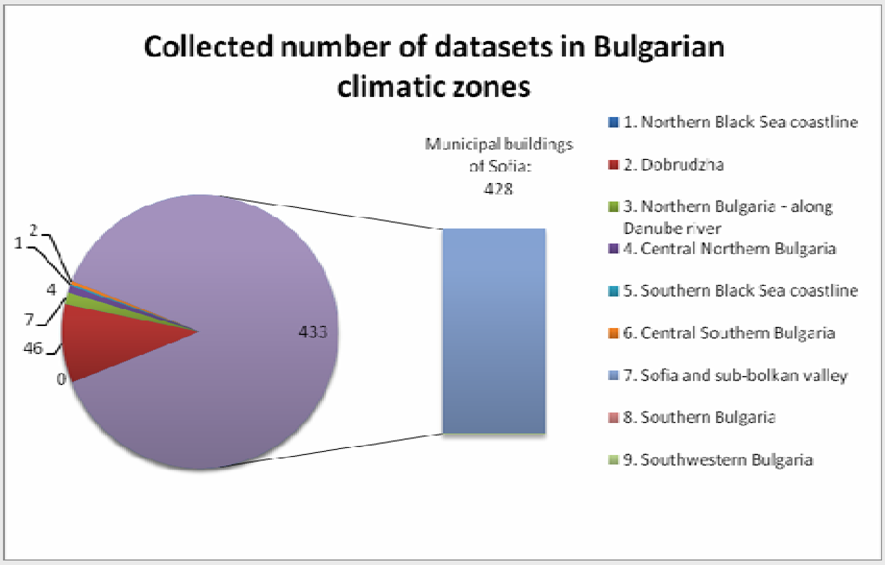
Number of collected datasets			**494**
Certificate types		**Utilisation types**	
whole buildings	494	residential buildings	-
building parts	-	offices	21
apartments	-	education	445
Rating types		higher education	-
only asset rating	-	hospitals	18
only operational rating	494	hotels and restaurants	-
both asset and oper. rating	-	others	10
Considered energy uses		**Buildings constructed ...**	
heating	494	1900 or earlier	
hot water	358	from 1901 to 1940	
cooling / air conditioning	-	from 1941 to 1980	
lighting	-	from 1981 to 2000	
others	-	since 2001	

Main results of the data evaluation

The collected information at present is for 493 buildings and the total number of datasets is 494. There is only one kindergarten with two datasets – one real at the moment of energy audit and one theoretical after the prescribed energy efficiency measures which are in process of implementation.

One of the purposes of the study is to gather as much data as possible from the energy performance of the municipal buildings in the different climatic regions of Bulgaria. Currently the segmentation is as follows:

Fig. 97



The overall database was split into 4 sub-bases and analyzed in Microsoft Excel environment. The four databases that were formed include:

I. Sofia municipal buildings with local heat energy supply

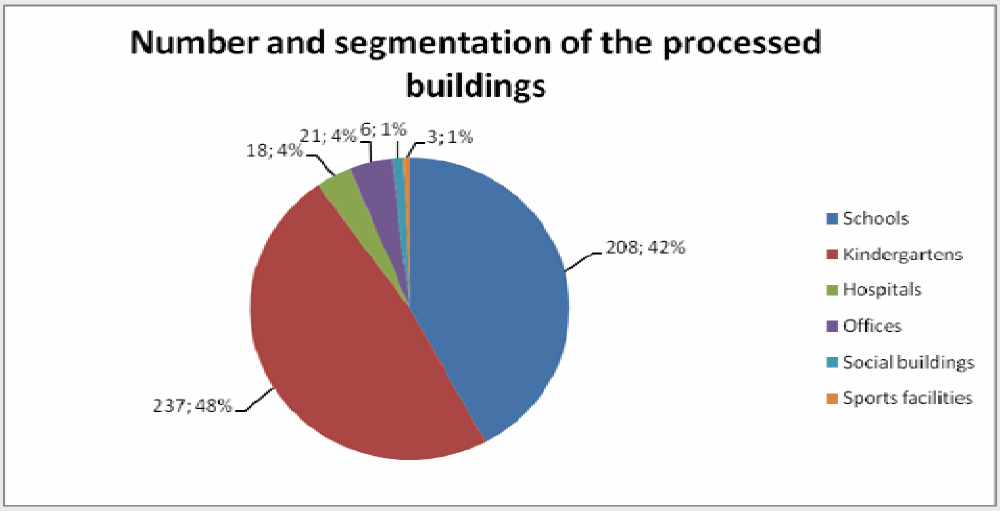
II. Sofia municipal buildings with district heating supply

III. Other municipal buildings outside Sofia municipality

IV. All buildings

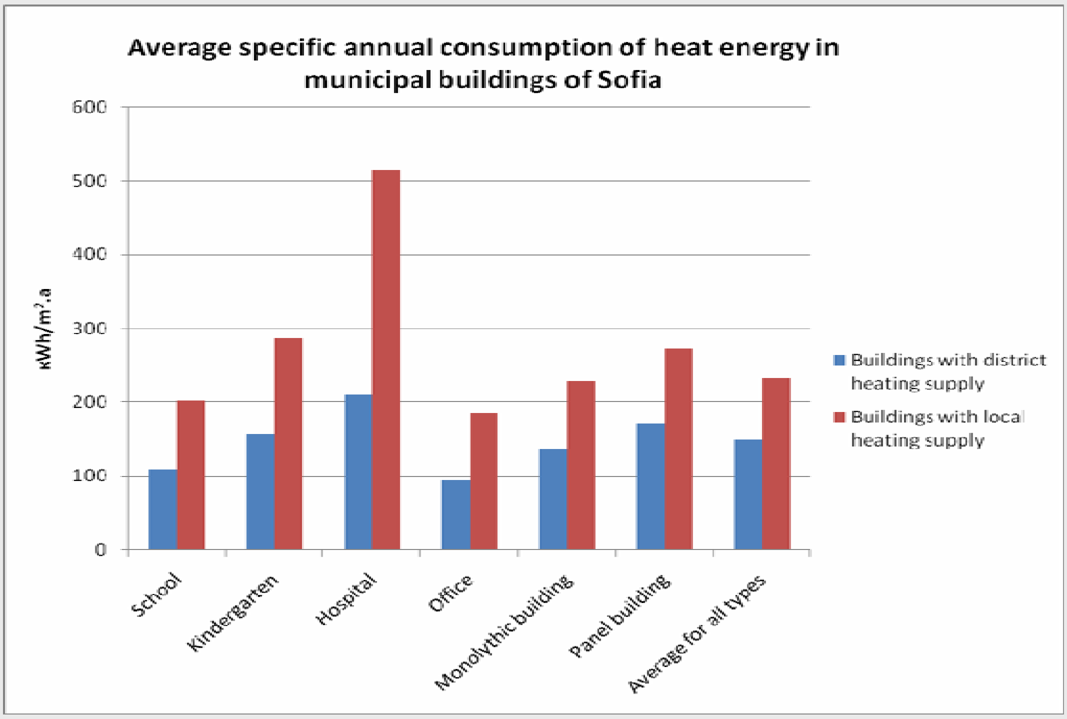
The percentage segmentation of the buildings according to their use is presented on the figure below:

Fig. 98



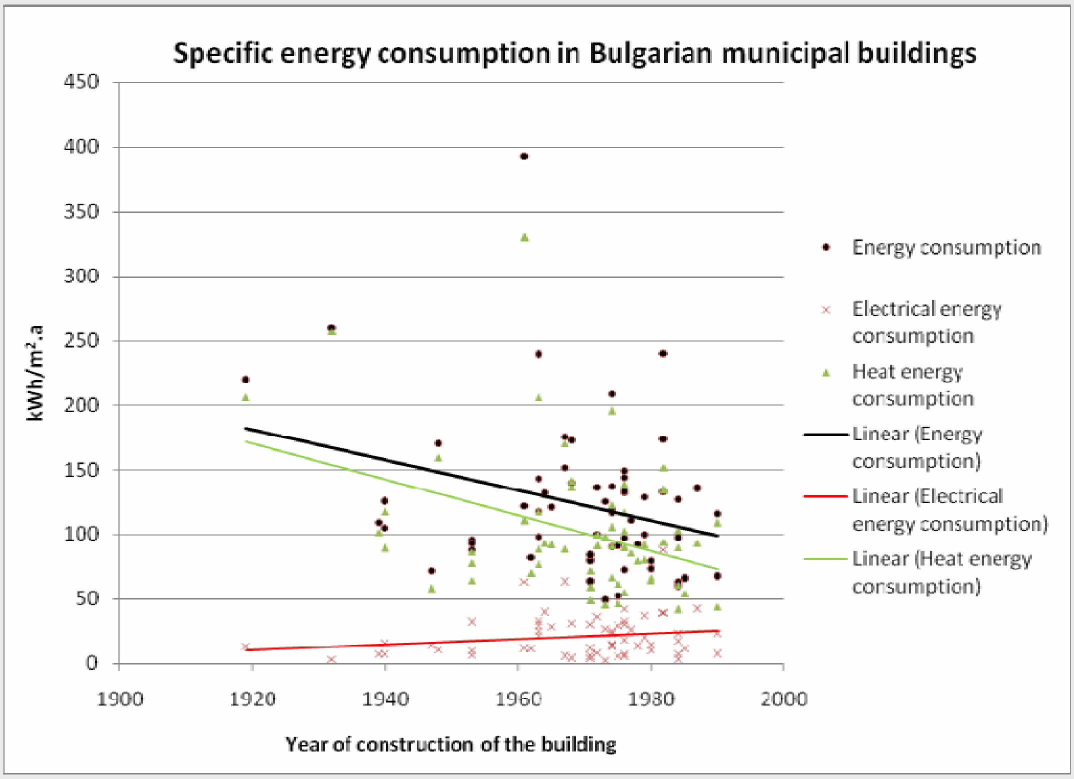
Municipal Buildings of Sofia represent 87% of the total number of collected datasets. Major results of their energy performance is indicated on the following figure:

Fig. 99



The overall analysis of the gathered data leads to the following results:

Fig. 100



Results of the analysis of the heat transfer coefficients of the building envelope elements and general energy performance indicators are presented in the next tables:

Fig. 101

Element	Average heat transfer coefficient in the examined buildings, kWh/m^2K	Legislative requirements for the heat transfer coefficients in case of building refurbishment, kWh/m^2K
External walls	1,43	0,35 ÷ 0,45
Windows	3,22	1,80 ÷ 2,20
Roof	0,84	0,25 ÷ 0,30
Floor	0,59	0,40 ÷0,50

Fig. 102

Site:	*kWh/a*	*$kWh/m^2.a$*	*kWh/user.a*	*$kgCO_{2heat}/г$*	*$kgCO_{2heat}/m^2.г$*
School	546 701	136	1 095	146 183	36
Kindergarten	294 820	171	2 118	77 400	45
Hospital	1 345 095	363	4 017	365 105	99
Admin. building	211 882	110	1 367	62 137	32
Social building	588 046	113	4 400	116 407	22
Average for all types of buildings	*597 307*	*179*	*2 599*	*153 446*	*47*

Conclusions

Compared to the standard numbers, the results show that the energy consumption in the municipal buildings is high and there is a significant potential for its decrease. Most of the buildings exceed the overall standard energy consumption of the building only by their consumption of heat energy for space heating and domestic hot water. By means of the calculations made there can be paid priority attention to certain sites – for example the ones with local heat generator or hospitals, or the ones with highest specific energy consumptions, etc. About 85% of the examined buildings are exceeding 1000 m^2 of useful area and are liable for obligatory energy auditing and certification.

Most energy conserving measures for reduction of energy consumption and CO_2 emissions would be the refurbishment of the building envelope, increase the efficiency of the installations, change of the energy carrier.

The above mentioned energy efficiency measures would not be successful enough without combining it with organizational, control and monitoring procedures concerning the energy performance of the buildings. Part of the measures is also related to the collection and access to information about the energy performance of the building stock and further engagement of the responsible authorities in this up-to-date problem.

In the pilot run within DATAMINE project it was possible to collect general data about the energy performance of the sites, i.e. annual energy consumption of heat energy, heated area, number of users, type and output of the heat source, annual emissions of CO_2 etc. It proved to be successful and very useful. Further data collection and more in-depth analysis and monitoring will be proposed to interested parties.

Conclusions for National Monitoring Concepts

Bulgaria is the first European country (even not member state that time) where the Building directive has been applied. Since the year of 2005 Official Energy Performance Certificates are being issued in accordance with Bulgarian Energy Efficiency Act (EEA) and Ordinance for certification. Every building may be certified by the order of the owner and each commissioned site – state or municipal property, with gross floor area above 1000 sq m shall be subject to certification with some exceptions i.e. cultural monuments, places of worship and others. By the end of 2007 the number of audited buildings reached 1339.

Meanwhile the Energy Efficiency Act has been changed with the amendments of July 2007 when the benefits (tax reduction) for certified building have been restricted while the significance of RES use has been increased. The complete correspondence with EPBD has been achieved with the amendments in the sub-law normative acts in April 2008 concerning the auditing process and authorized companies with rights to perform energy audits.

The results from the implementation of the Bulgarian Model Project show that:

- There is a great potential for realization of energy efficiency measures in the municipal building sector. Energy consumption can be decreased by 30-40% average. So far mainly sites with local heating systems have been preferred where the energy-saving and CO2 emissions reduction potential are high.
- The energy efficiency measures would not be successful enough without combining it with organizational, control and monitoring procedures concerning the energy performance of the buildings.
- Further data collection and more in-depth analysis can be performed for more precise and complete results.
- Engagement of local authorities is vital for further development of the monitoring concepts. Bulgarian model project results are a good basis to start from.

The main conclusion is that the Bulgarian Model Project gives a good picture of the certification process in Bulgaria and could be used successfully for further data collection and in-depth analysis. Something more – the development of monitoring concepts is essential for the quality of energy efficiency measures and their success.

The implementation of national building efficiency monitoring could be possible in Bulgaria with the new Energy Efficiency Act to be adopted by the National Assembly by the end of October 2008. The needs for new Act aroused by the Energy Service Directive but with this law new roles of the owners of buildings with gross floor area above 1000 sq m have been assigned: the owner

- has to implement energy efficiency management;
- is responsible for planning and implementation of EE measures;
- has to record the energy consumption and to report the data to the state Energy Efficiency Agency;
- has to assign assigning a person responsible for the above mentioned tasks.

For the success of the ideas for reporting, collecting and analysing of information the process has to be unified and to collect carefully defined performance indicators that allow further analyzing of the data. It is necessary to have also decentralised reporting and analyzing – at municipal level, at ministry level (for state owned buildings) and finally at the Energy Efficiency Agency. At the moment the main problems are related to the difficulties for access and collection of data. The assignment of a person responsible for collection of information and ensuring of data quality is a good step toward solving these problems. It is also important to ensure qualified personnel at municipal level and to raise the awareness within the building owners on the new legislative requirements, environmental and energy concerns and the small but important contribution of each building.

3 Cross-Country Comparison of the Collected Data

3.1 Summary

The Common Data Structure laid the basis for the cross-country comparison of the data of the 12 Model Projects. The realisation of this turned out to be relatively simple. This is due to the fact that the datasets were collected using a harmonised data structure in all Model Projects. The study inter alia comprises cross-country comparisons for U-values, envelope areas, supply system types, calculated and measured consumptions. Furthermore a simple typology of residential buildings was derived by classifying the Model Project databases. Each building type is represented by an “average building”, a dataset determined by averaging the specific envelope areas, the U-values and the energy need for heating.

In summary the DATAMINE data structure proved to be a suitable approach for information exchange between countries and for harmonised monitoring activities on EU level. The survey analysis shows that suitable information about trends and characteristics in the building sector can be attained by the proposed indicators and by the data analysis concept.

3.2 Proceeding

Data analysis

According to the workplan of the DATAMINE project the cross-country comparison was performed by IWU. Each DATAMINE partner sent an Excel sheet with the datasets collected during the runtime of the DATAMINE Model Projects. For each database the datasets are arranged in rows, the names of the DATAMINE datafields (variables) are located in the first row.

The analysis was performed for 11 Model Project databases[4]. Fig. 103 gives an overview of the dataset numbers of each database and shows the frequencies of buildings types and construction years.

[4] At the time when the analysis was performed the database from UK was not yet available.

Fig. 103: General statistics of the analysed data bases

Total number of collected datasets	**18793**		
Certificate types		**Utilisation types**	
whole buildings	10625	residential buildings	17727
building parts	0	offices	56
apartments	8168	education	597
Rating types		higher education	115
only asset rating	17542	hospitals	34
only operational rating	810	hotels and restaurants	4
both asset and oper. rating	421	others	368
Considered energy uses		**Buildings constructed ...**	
heating	18751	1900 or earlier	160
hot water	18377	from 1901 to 1940	352
cooling / air conditioning	222	from 1941 to 1980	8616
lighting	10312	from 1981 to 2000	3920
others	10202	since 2001	4313
Contribution of the Model Projects			
MP 1 Germany	515	MP 7 Belgium	113
MP 2 Poland	133	MP 8 Austria	6715
MP 3 United Kingdom	0	MP 9 Slovenia	100
MP 4 The Netherlands	10109	MP 10 Spain	50
MP 5 Italy	188	MP 11 Ireland	126
MP 6 Greece	250	MP 12 Bulgaria	494

The result of the cross-country comparison of different energy related quantities are documented in the next chapters in form of charts. At the bottom of each chart the used variables are explicitly displayed. Some of these variables are the original DATAMINE datafields, which are defined in the DATAMINE data structure [DATAMINE SR1]. Others are composed of DATAMINE datafields and marked with a * in the charts. In the Appendix you find the corresponding definitions of theses quantities (the formulas are copied from the DATAMINE Analysis Tool).

Reference area

In order to compare different energy performance indicators it is convenient to relate quantities to a quantity representing the size of the building, usually the floor area or the volume of the buildings. However, different types of reference areas or volumes are used in the countries and there is no type which is available for all countries. Therefore a reference area is defined which is used for the purpose of cross-country comparison and which is derived from the available reference quantities.

The DATAMINE data structure contains the following types of floor areas (see [DATAMINE SR1]):

Fig. 104: Definition of different reference quantity according to the DATAMINE data structure [DATAMINE SR1]

Quantity	Data field name	Unit	Description
conditioned gross floor area	**A_C_extdim**	m²	conditioned floor area calculated on the basis of external dimensions (measured to the outside surface of external walls)
conditioned floor area	**A_C_intdim**	m²	conditioned floor area calculated on the basis of internal dimensions (measured to the inside surface of external walls) The floor area may be the gross internal area (= total building area measured inside external walls) or the net internal area (= total building area measured inside external and internal walls) - since the difference is small we don't distinguish between both. The conditioned area is generally equal with the heated area or with the air-conditioned area, dependend of which is the bigger one.
conditioned useful floor area	**A_C_use**	m²	section of the conditioned net floor area primarily dedicated to the utilisation of the building, excluding functional and circulation areas (excluding e.g. stair cases in all buildings, corridors in non-residential buildings). In office buildings the conditioned useful floor area is equivalent to the net lettable area.
conditioned living area	**A_C_living**	m²	section of the conditioned net floor area inside of the apartments of the building (only to be filled in for buildings which are completely or at least partly used as residential buildings)
conditioned building volume	**V_C**	m³	conditioned volume of the building (external dimensions)

In the following analysis the reference area used for comparison is labelled A_C_ref. It is in principle defined as the conditioned floor area based on internal dimensions.[5] In consequence, if this area is available for a building A_C_ref will be derived directly from A_C_intdim. If it is not available, A_C_ref is estimated by use of the available reference quantities using the following adaptation factors (and the given sequence of queries):

[5] The reason for the choice of A_C_intdim as reference area is that the values are typically between A_C_extdim and A_C_use or A_C_living. In consequence the area related energy performance indicators calculated in this analysis are closer to those which are known in the different countries and can therefore easier compared with well-known values without converting.

Fig. 105: Derivation of the reference area used for cross-country comparison

available quantity	A_C_ref
conditioned floor area based on internal dimensions	= A_C_intdim
conditioned floor area based on external dimensions	= 0,85 · A_C_extdim
conditioned living area	= 1,1 · A_C_living
conditioned useful floor area	=1,4 · A_C_use
conditioned building volume	= 0.85/3.0 · V_C = 0,283 · V_C

Specific envelope areas

For the analysis of the surface areas of the building specific envelope areas where defined (see Fig. 106). Theses definitions are based on a study in which a method for the estimation of the envelope area was developed by statistical and analytical deductions (Simplified Energy Profile Procedure[6] [IWU 2005]).

Fig. 106: Derivation of the specific envelope areas

Composed variable	Formula	Explanation
n_storey_eff	=n_storey +if(attic_cond="c",0.75,0) +if(attic_cond="p",0.75*0.5,0) +if(cellar_cond="c",1,0) +if(cellar_cond="p",0.5,0)	effective number of storeys: full storeys (above ground without attic) + fraction representing attic, if conditioned + fraction representing cellar, if conditioned
A_C_storey	=A_C_ref/n_storey_eff	conditioned floor area per effective storey
A_facade	=A_wall+A_window	facade area
A_facade_per_sqm_A_C_ref	=A_facade/A_C_ref	specific facade area
A_window_per_sqm_A_C_ref	=A_window/A_C_ref	specific window area
A_roof_per_sqm_A_C_storey	=A_roof/A_C_storey	specific roof area
A_basement_per_sqm_ A_C_storey	=A_basement/A_C_storey	specific basement area

6 (see http://www.iwu.de/fileadmin/user_upload/dateien/energie/werkzeuge/kvep-abstract_english.pdf)

Pre-check of databases

In a pre-check the format and the contents of the Model Project databases were verified. The result was that in general the databases had already a high quality. Only a few errors or implausible relations were identified and corrected before performing the cross-country comparison, e.g.:

- single datafield names were not correct (e.g. additional blank after the label)
- predefined values: In a few cases deviations from the DATAMINE codes occurred, e.g. “single family” instead of “single_family”
- heat demand / consumption: In two cases the heat was accidentally given in MJ instead of kWh
- envelope areas: In some cases the sum of the detailed envelope areas was not equal to the global values

In future it would be useful to have a software application for automatically checking the following features of a DATAMINE database:

- correctness of datafield names
- completeness of datafields (minimum requirements)
- format of numbers
- correctness of codes / predefined values
- plausibility checks: limit values, relations between quantities

DATAMINE Analysis Tool

The cross-country analysis was performed by use of the DATAMINE Analysis Tool, an MS Excel Workbook which was designed for the analysis of data sheets with DATAMINE data structure (see [DATAMINE SR1], download of the tool and the user guide: www.env.meteo.noa.gr/datamine).

The experience was that the tool was very well suited to this type of comparison analysis. The only restraint was that the loading of the two large databases from the Netherlands and from Austria took some time (about half an hour). However databases with some 100 datasets were loaded in about 10 seconds. However the loading of the databases needed to be done only one time. After the loading the time for analysing was acceptable, even for the large databases.

For future applications it would be helpful to programme an express loading feature which would abstain from the time consuming single value checks (by importing complete columns from the DATAMINE databases).

3.3 General Statistics

Utilisation types and building age classes

Due to the different monitoring approaches of the DATAMINE Model Projects the structure of the analysed buildings stocks is not homogeneous. Most of the Model Projects focussed on residential buildings (Fig. 107). However the Italian and the Bulgarian projects had a considerable number of educational buildings. the Greek database contains also a number of sports facilities as well as buildings which were classified as “others” (in this case: airport buildings). Furthermore office buildings were available in the Italian, Greek, Slovenian, Spanish and Bulgarian database.

Regarding the construction year the German, the Polish, the Italian, the Belgian and the Irish database contain buildings of nearly all ages. In contrast the Dutch, the Austrian, the Spanish and the Bulgarian database focus on buildings which were built after 1960. In the Austrian database there is a very high fraction of new buildings (built after 2000). In some cases the sum of the percentages don’t equal 100%. The reason is that the information about the construction year was not available for all datasets.

More details about the databases can be found in the single country reports (summary in [DATAMINE SR2], download of the synthesis report and of all available country reports: www.env.meteo.noa.gr/datamine).

Fig. 107: Frequency of utilisation types (part 1)

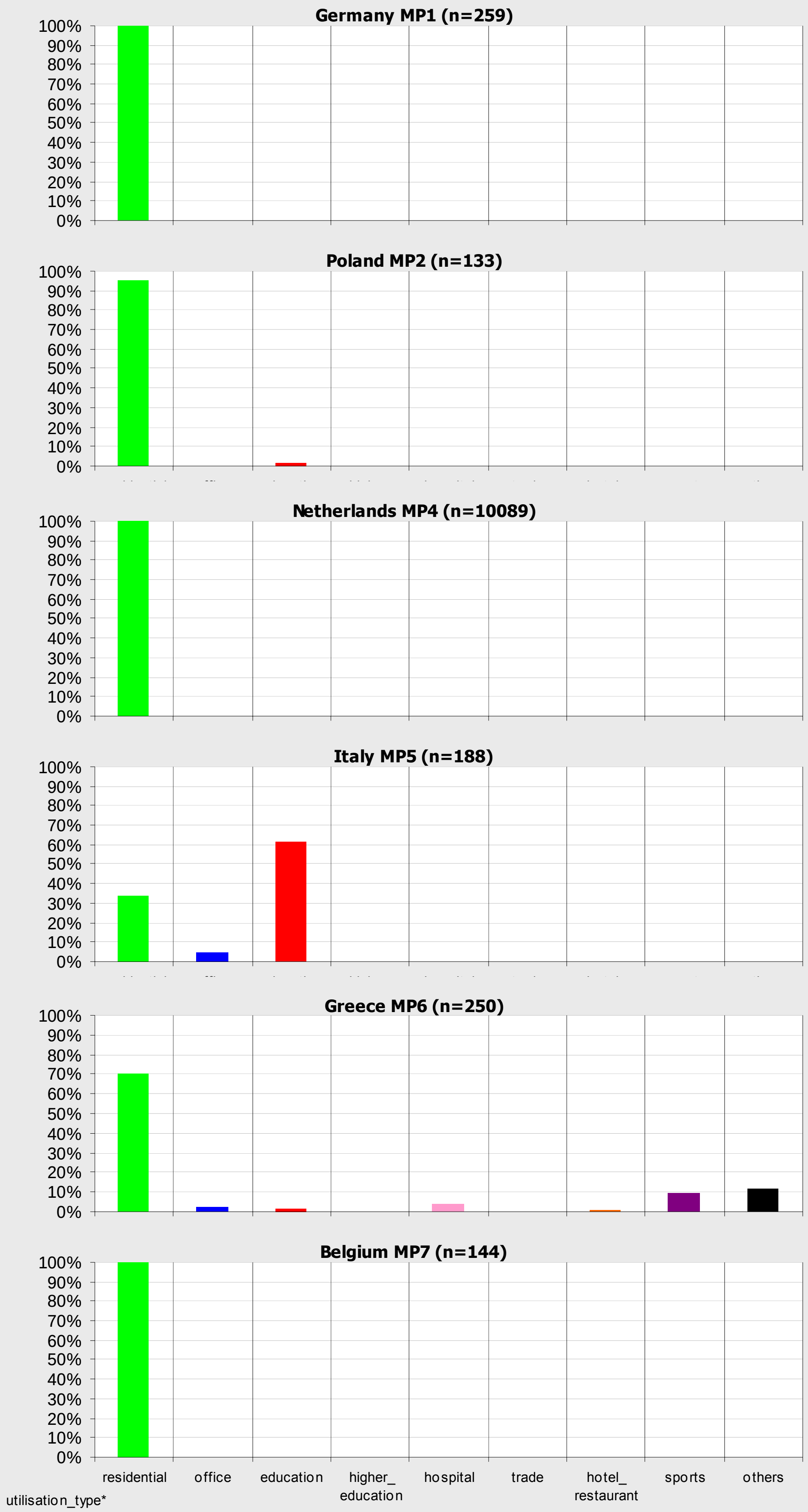


Fig. 108: Frequency of utilisation types (part 2)

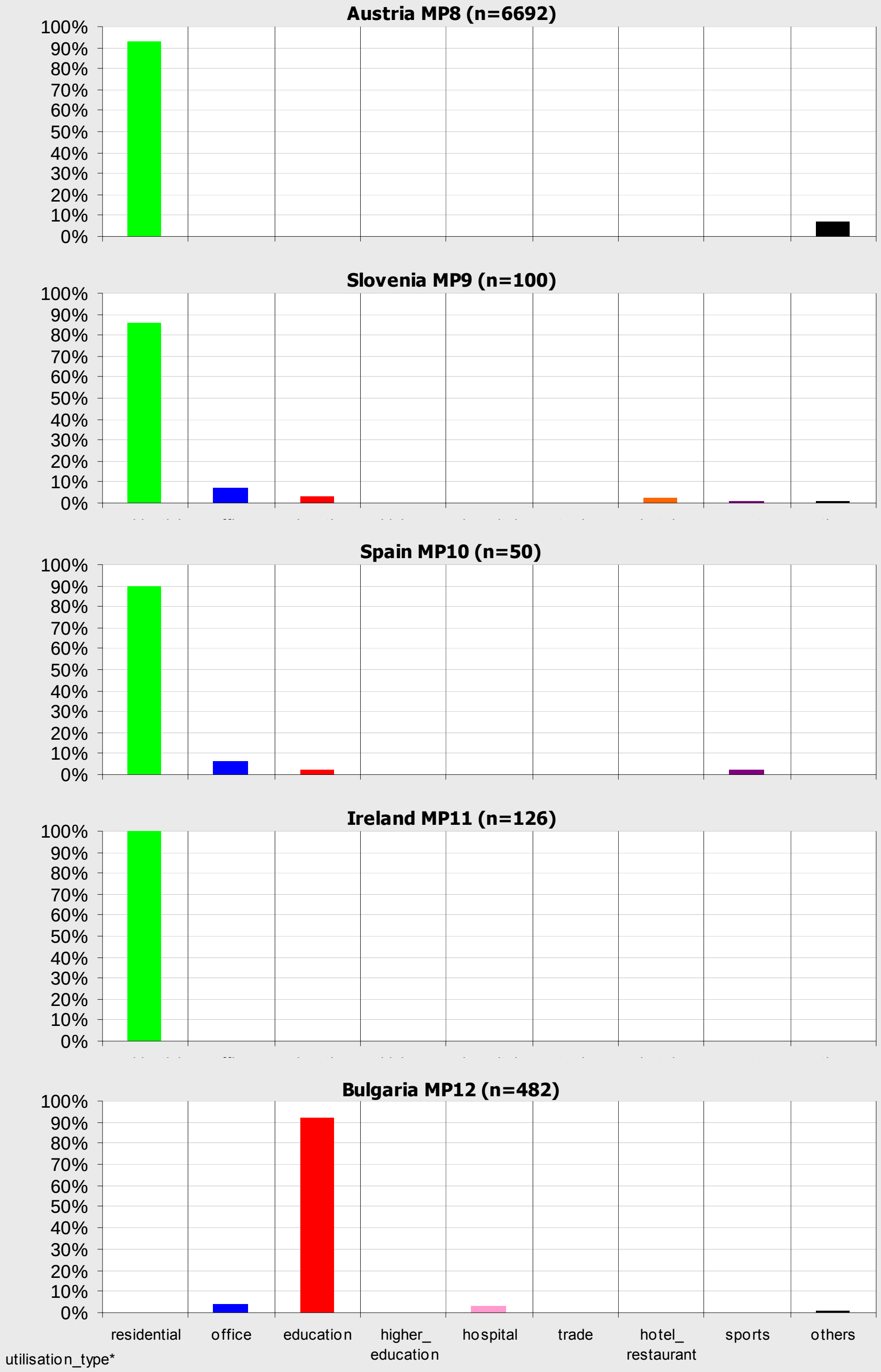


Fig. 109: Frequency of building age classes (part 1)

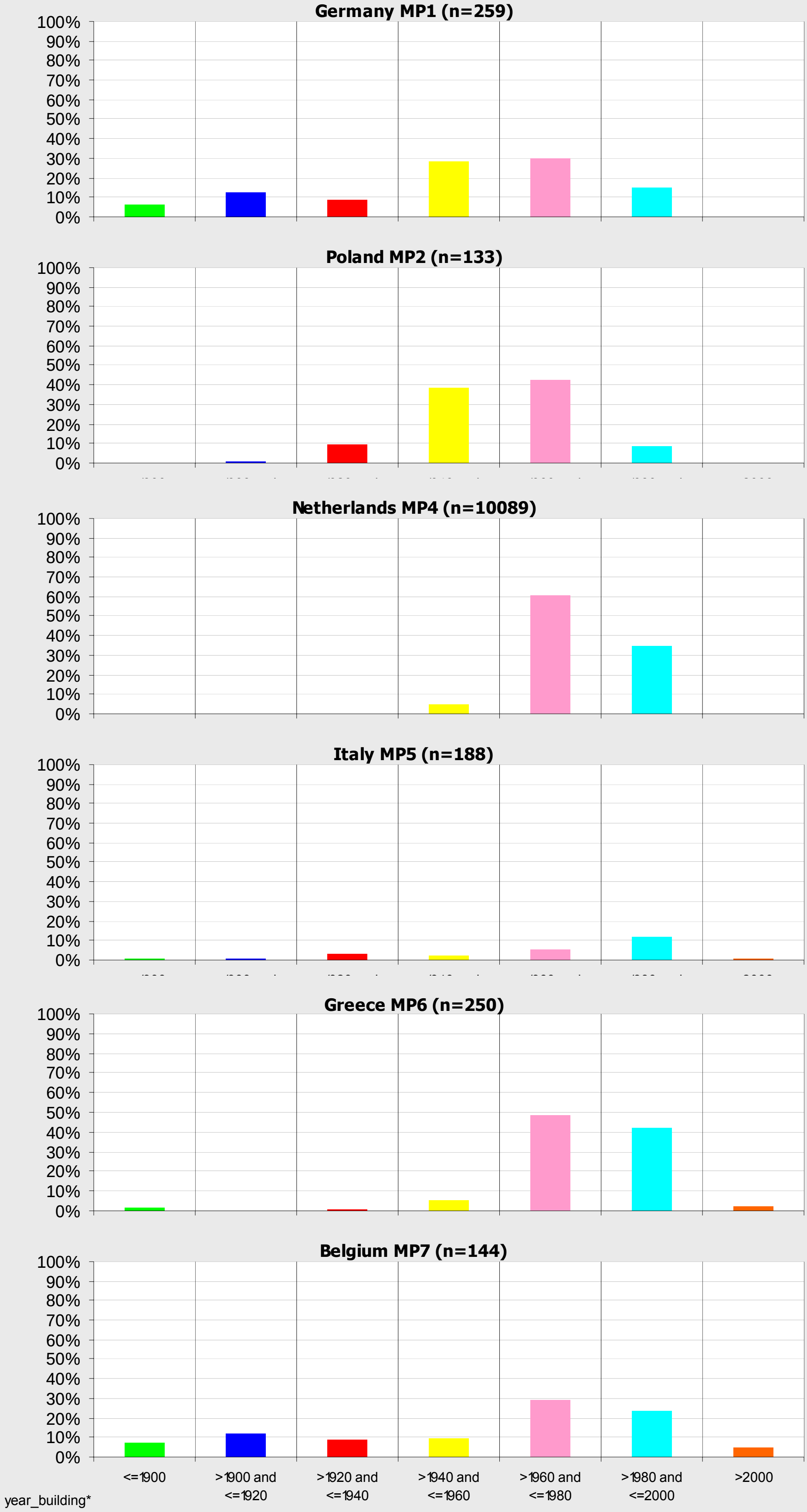
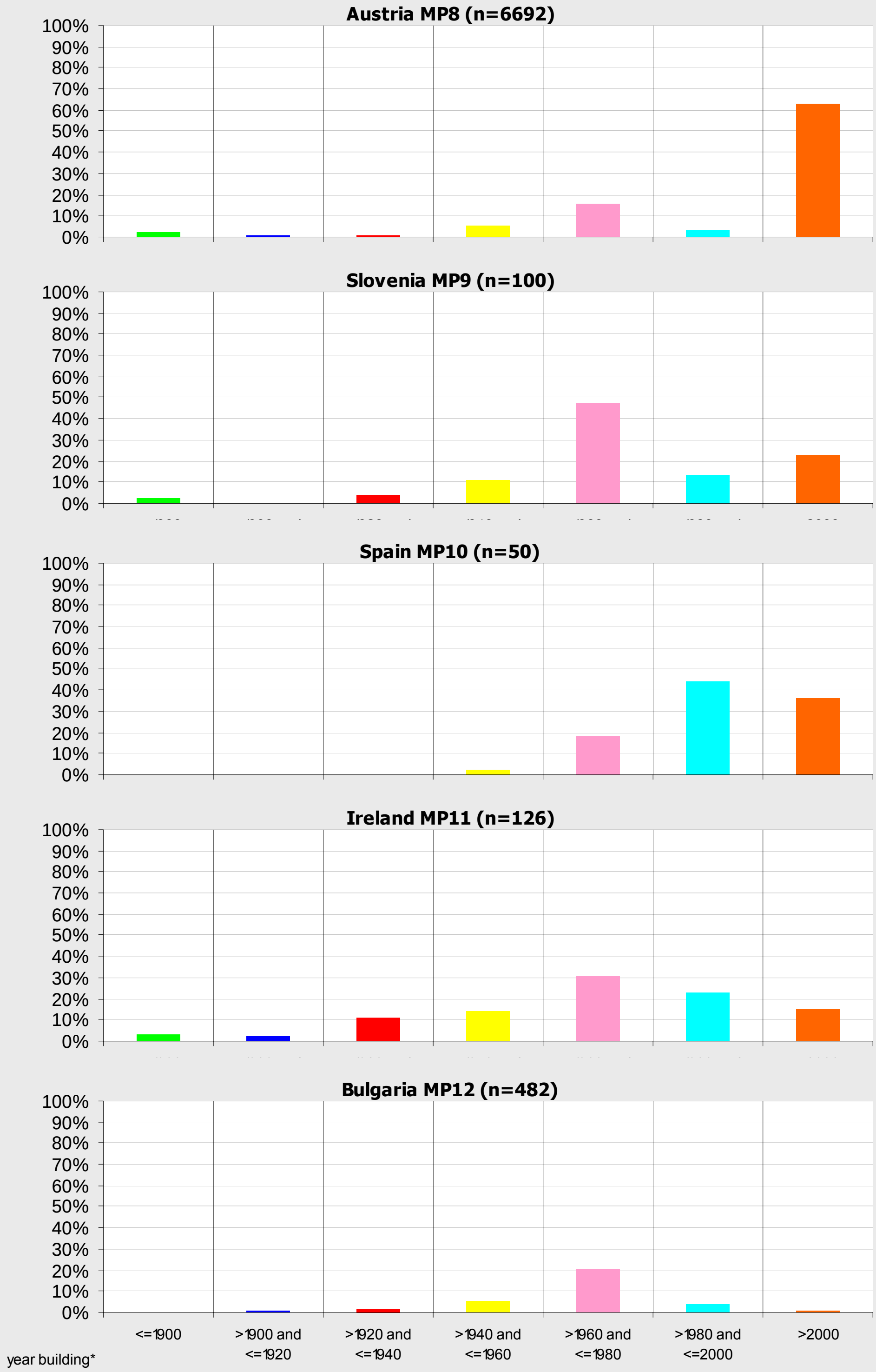


Fig. 110: Frequency of building age classes (part 2)



3.4 Thermal envelope

U-values

The comparison of the average U-values gives an impression of the improvement of the quality of the thermal envelope during the last 100 years. Whereas the U-values only slightly decreased until the seventies a considerable drop occurs in the last two decades of the 20th century. This fact is evident in the charts representing the walls (Fig. 111) and roofs (Fig. 117). In case of the basement the drop is not so dramatic in some countries (Fig. 120). In case of the windows the dependence is rather low for all countries (Fig. 114). A reason for this might be the fact that – due to the lower durability of windows in comparison to other envelope components – a larger part of windows has already been renovated or replaced in the last decades.

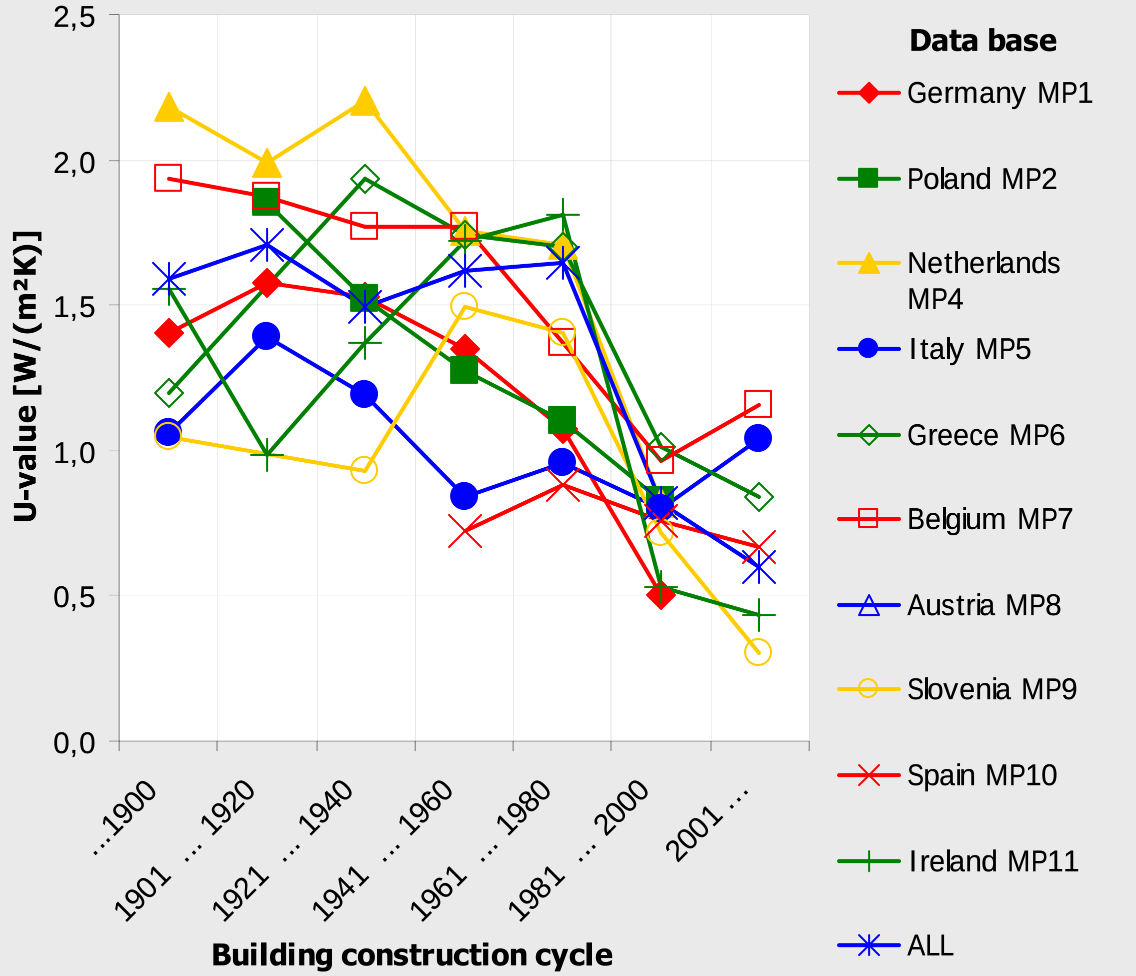
The frequency distribution of U-values gives hints which fraction of walls, roofs and basement areas already have a good thermal insulation. Regarding the walls for example in some databases only a small range of U-values occurs (Poland, Spain, see Fig. 112 and Fig. 113). In others there is a broad spectrum which in many cases has two peaks (Germany, Netherlands, Greece, Belgium, Ireland). The two peaks may be caused by the fact that there are mainly two types of walls: with and without insulation. Since insulation is practiced with a certain minimum thickness there is a range of U-values which is not so common. The two peaks are not so evident for roofs since in many countries low level insulation was practiced earlier than in case of walls (Fig. 118 / Fig. 119). This is also true for the basement (Fig. 121 / Fig. 122).

The frequency distribution of windows clearly shows that in the Italian, Greek, Spanish and Irish databases single glazing is still present (Fig. 115 / Fig. 116). A considerable fraction of low-e glazing with U-values below 1,5 can only be found in the Slovenian database which contains a relative large number of buildings where energy refurbishments were recently performed (that can also be seen by the fraction of high quality wall and roof insulation).

It has to be pointed out that these evaluations do not always give information about the actual thermal quality of the envelopes but only of the assessment by the energy consultant. In some cases U-values were calculated on the basis of detailed information of layer thickness and conductivity, in other cases default U-values were used which are typical for specific construction types and building ages. Therefore the differences between the countries reflect at the same time different construction types as well as different assessment procedures – effect of both can not be separated.

U-values of walls

Fig. 111: U-values of walls – average values depending on building age class



year_building* U_wall

Fig. 112: U-values of walls – frequency distribution (part 1)

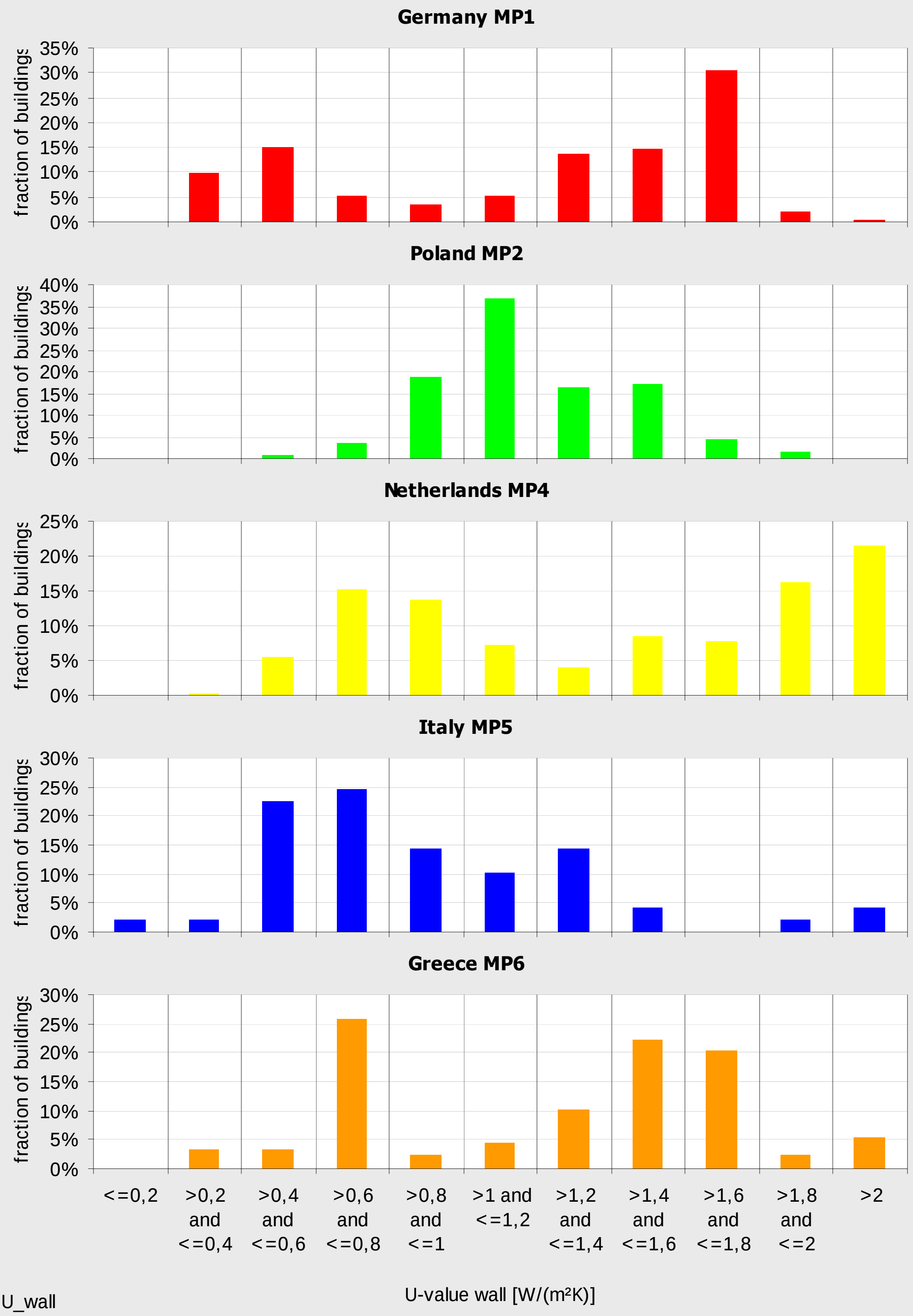
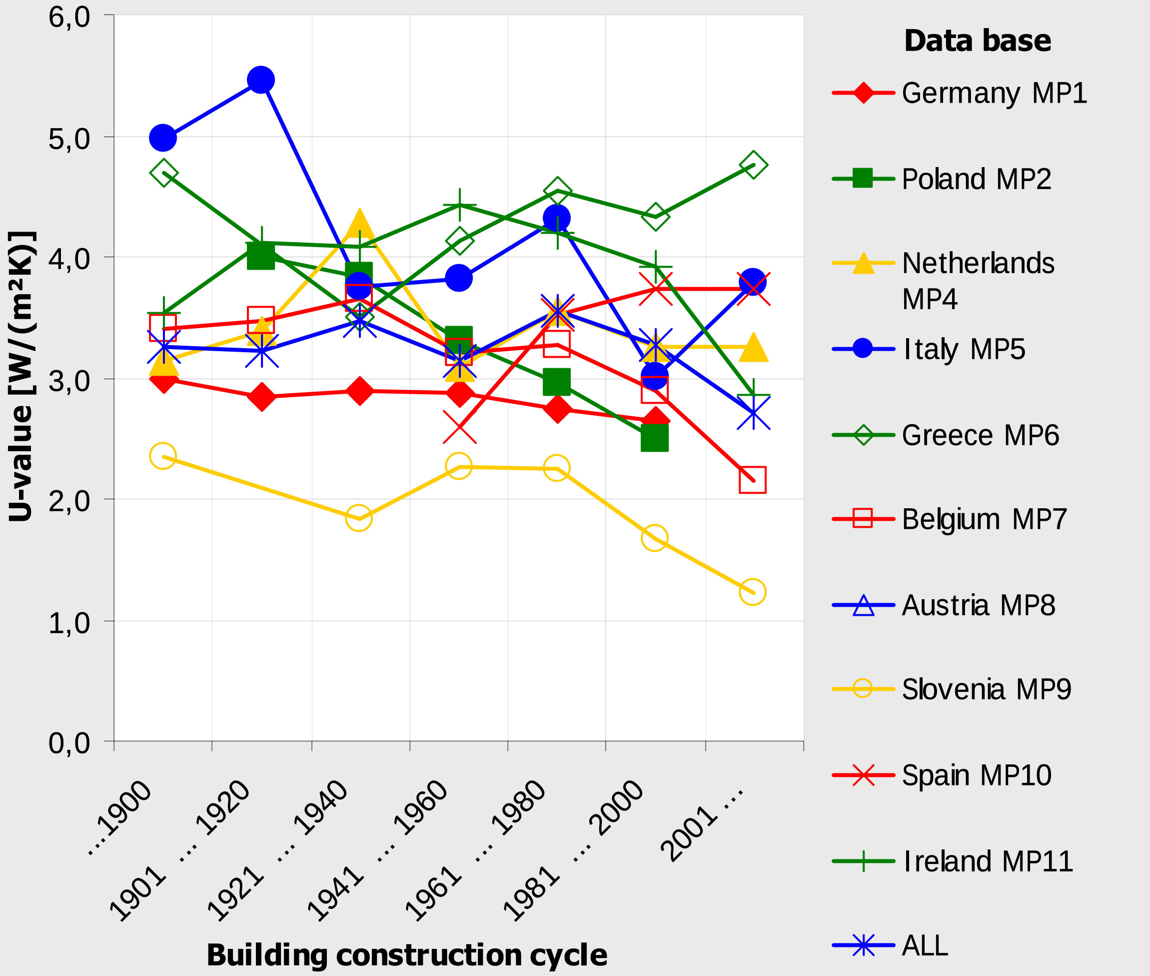


Fig. 113: U-values of walls – frequency distribution (part 2)

U-values of windows

Fig. 114: U-values of windows – average values depending on building age class



year_building* U_window

Fig. 115: U-values of windows – frequency distribution (part 1)

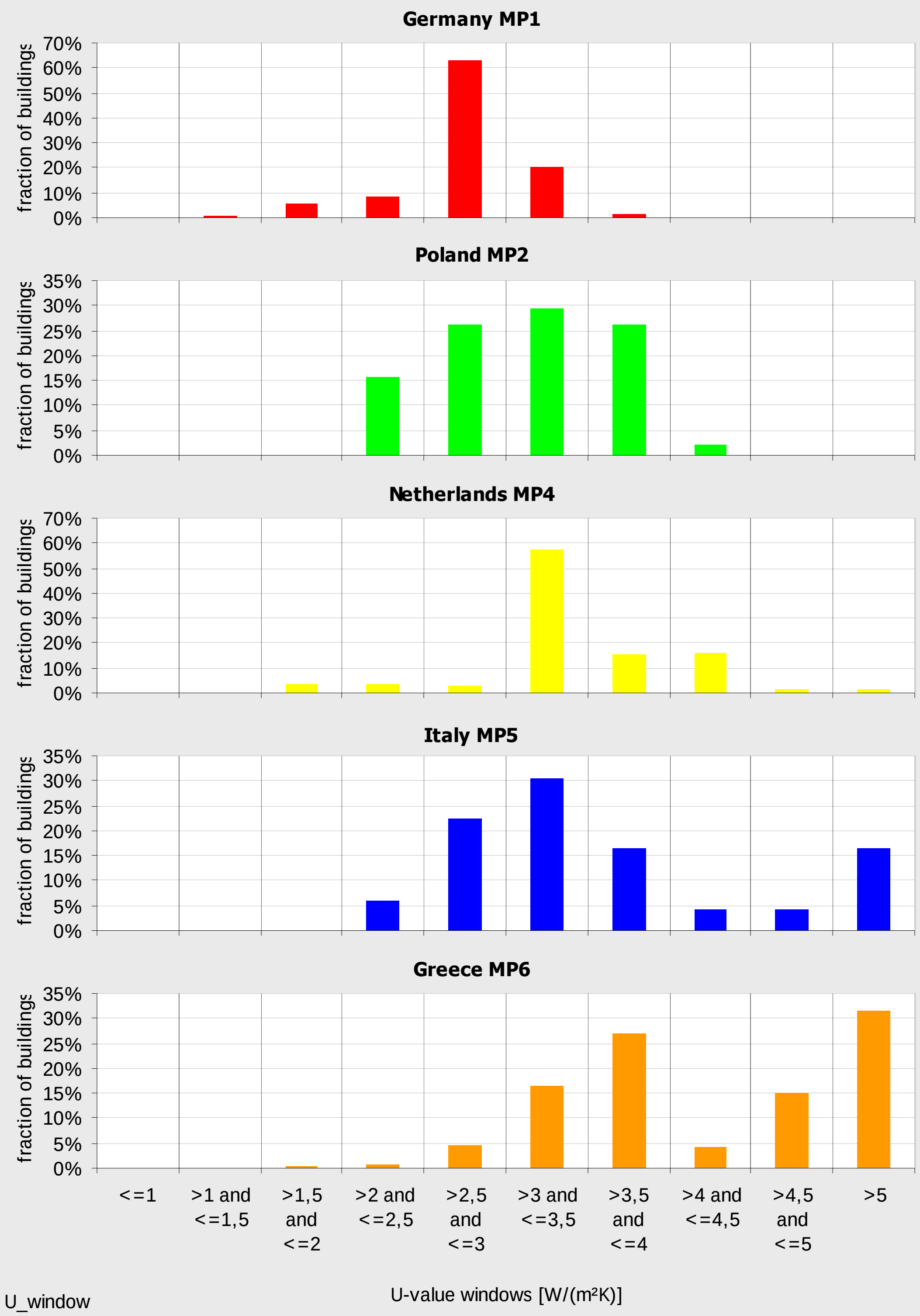
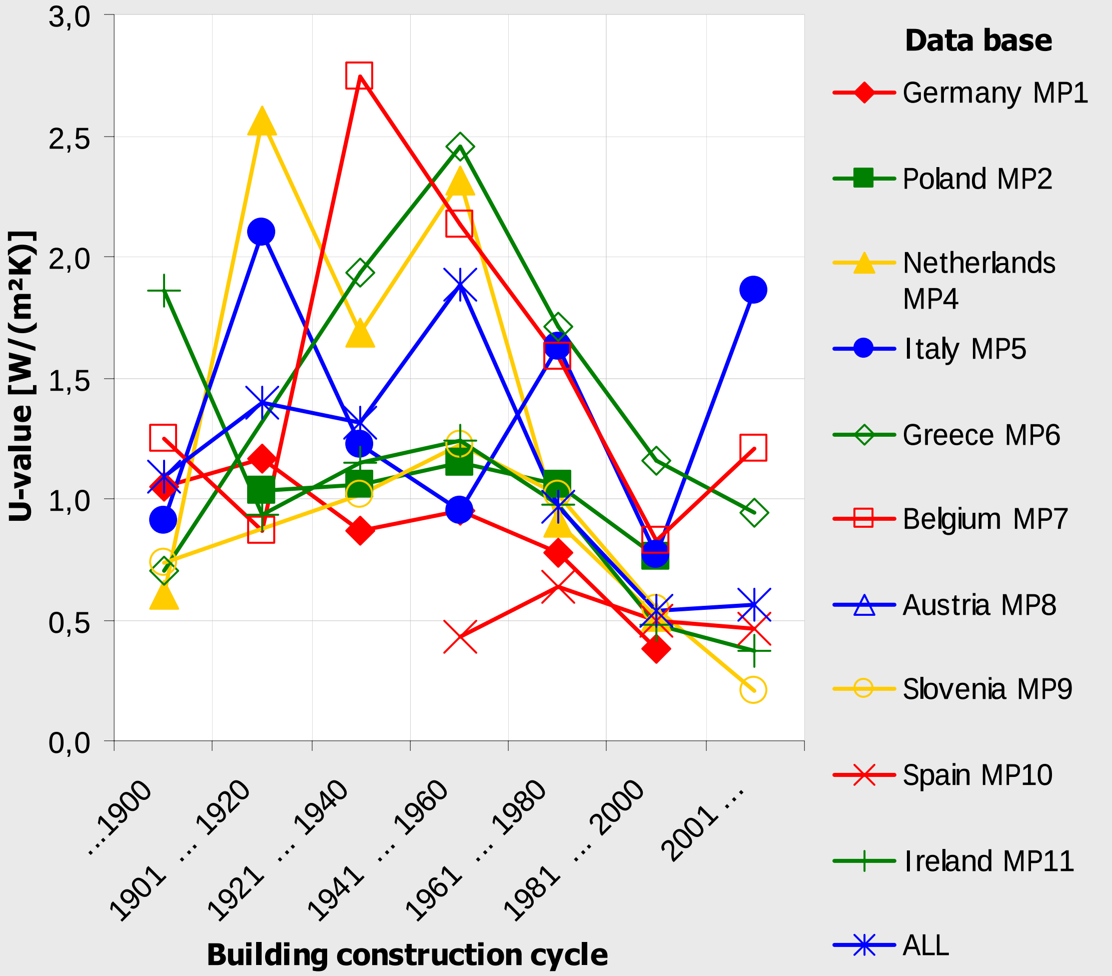


Fig. 116: U-values of windows – frequency distribution (part 2)

U-values of roofs

Fig. 117: U-values of roofs or top ceilings
– average values depending on building age class



year_building* U_roof

Fig. 118: U-values of roofs or top ceilings – frequency distribution (part 1)

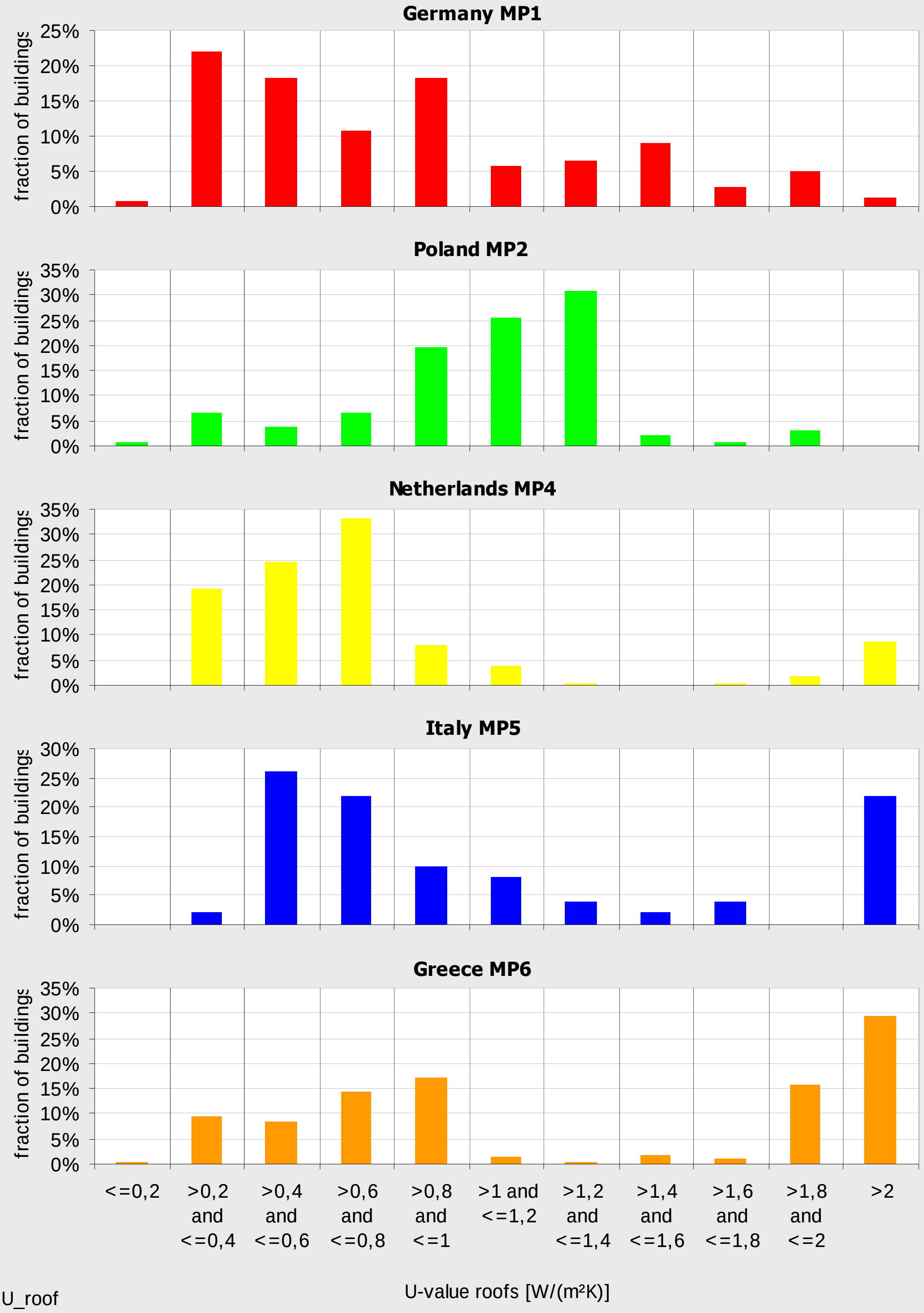
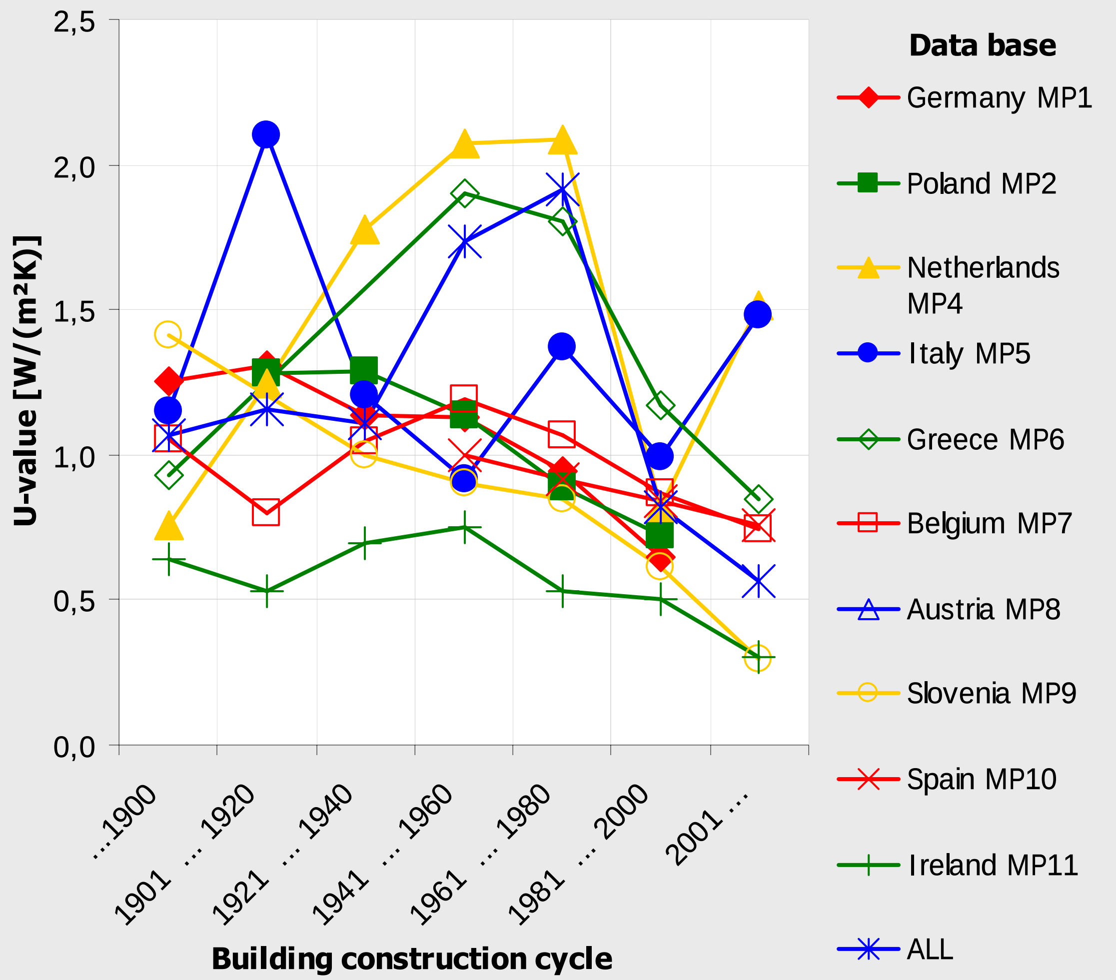


Fig. 119: U-values of roofs or top ceilings – frequency distribution (part 2)

U-values of basement areas

Fig. 120: U-values of basement (floor of bottom conditioned storey over cellar or soil) – average values depending on building age class



year_building* U_basement

Fig. 121: U-values of basement (floor of bottom conditioned storey over cellar or soil) – frequency distribution (part 1)

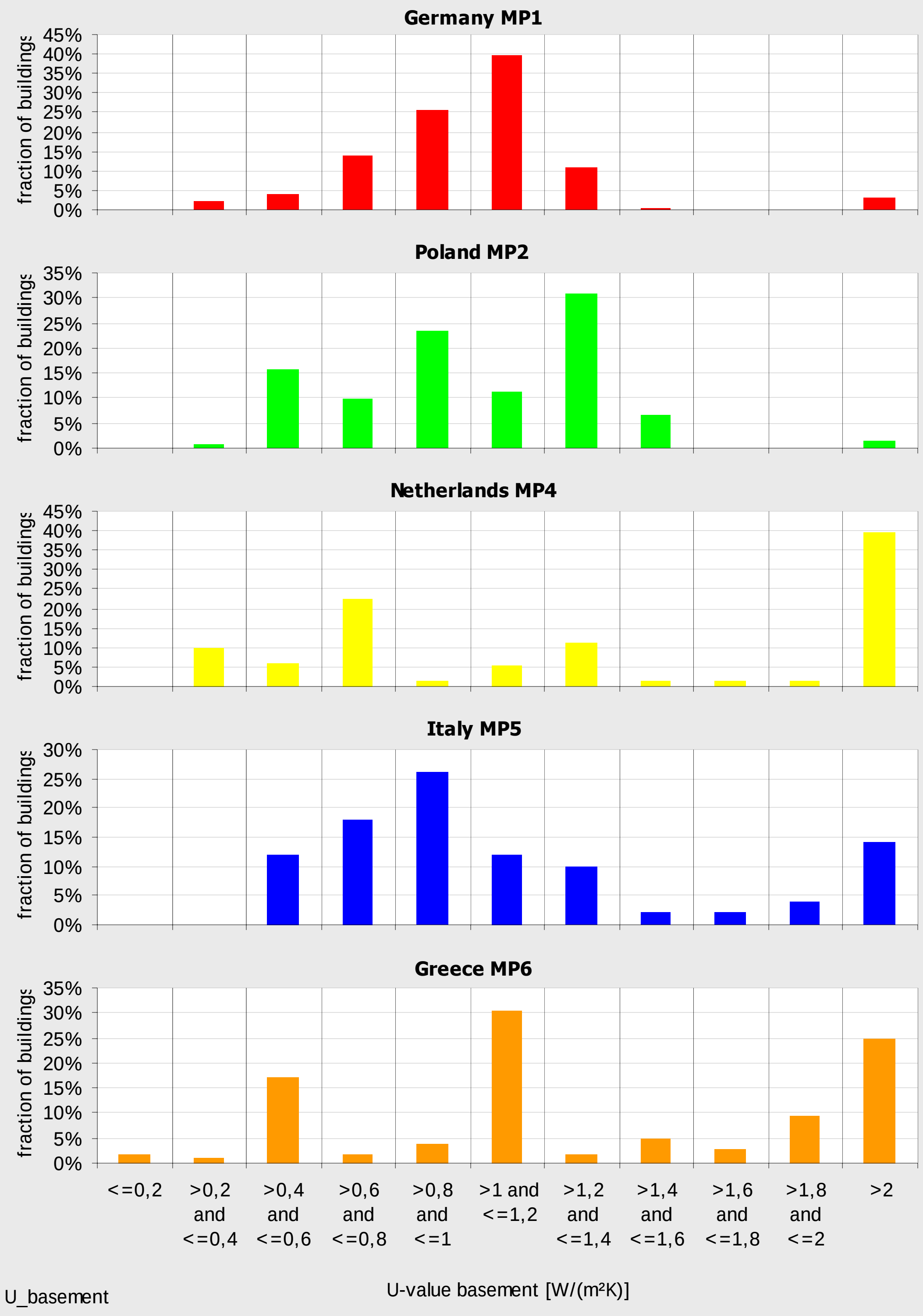


Fig. 122: U-values of basement (floor of bottom conditioned storey over cellar or soil) – frequency distribution (part 2)

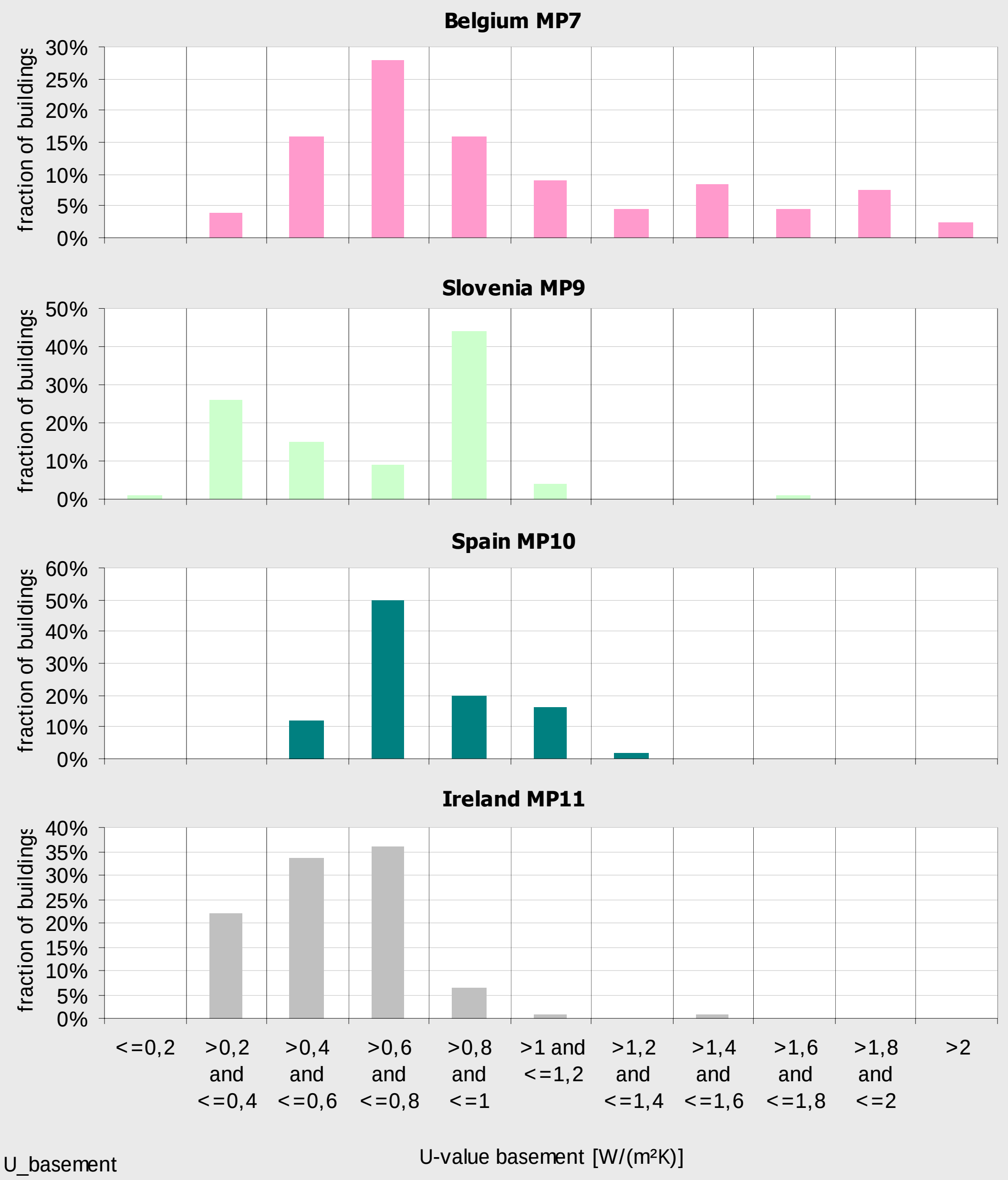
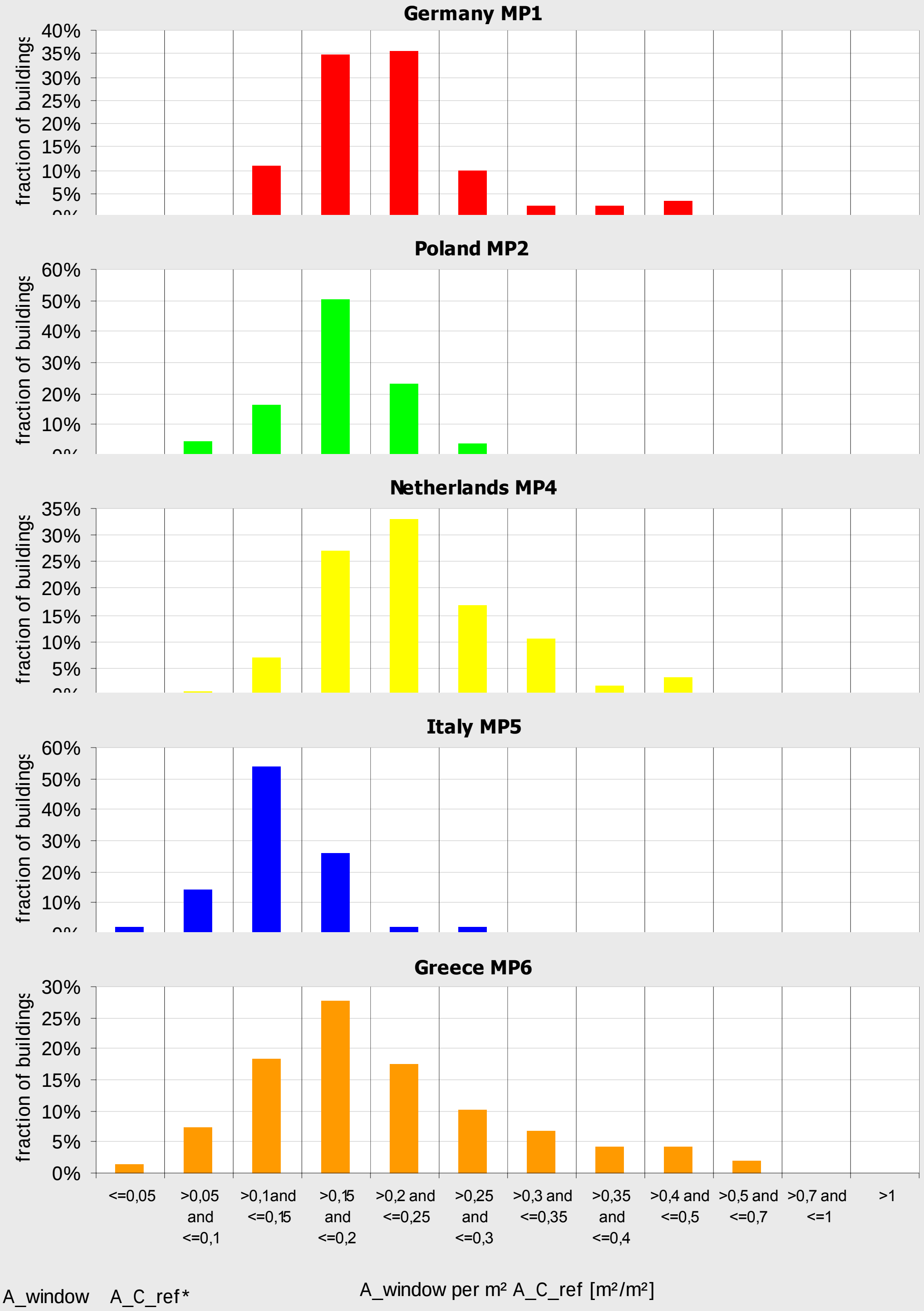


Fig. 123: Frequency of specific window area (part 1)
(window area related to reference floor area)



Envelope areas

The envelope areas were investigated using the specific quantities defined in the appendix. This analysis was already used in the plausibility pre-check and resulted in the finding of a number of errors (e.g. it turned out that in one database envelope areas based on internal dimensions were inserted without transformation to external dimensions, which is required by DATAMINE).

Typically the specific window area (window area per m² reference area) lies in a range of 0.15 to 0.25 (Fig. 123/**Error! Not a valid bookmark self-reference.**. There are databases where we find a broad distribution (Greece, Belgium, Ireland) and others with a very small band (Poland, Italy, Spain). The specific distribution may not only represent a national construction tradition but also a characteristic feature of the building sample (utilisation type, building size and building age). For the specific areas of façade, roof and basement similar frequency distributions can be found (Fig. 125/Fig. 128). Especially for the roof and the basement the distributions tend to be very small.

**Fig. 124: Frequency of specific window area (part 2)
(window area related to reference floor area)**

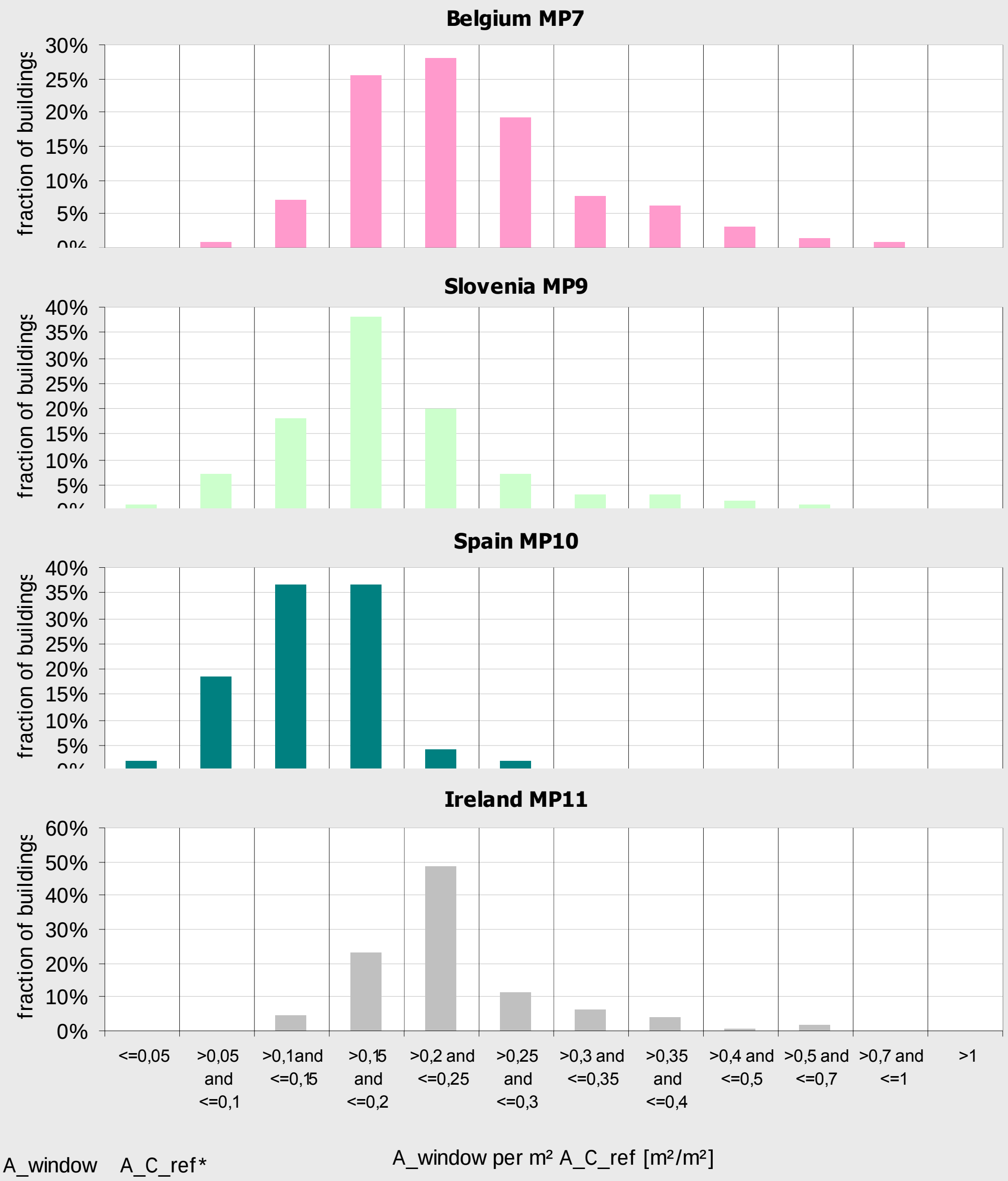


Fig. 125: Frequency of specific façade area (part 1)
(façade area related to reference floor area)

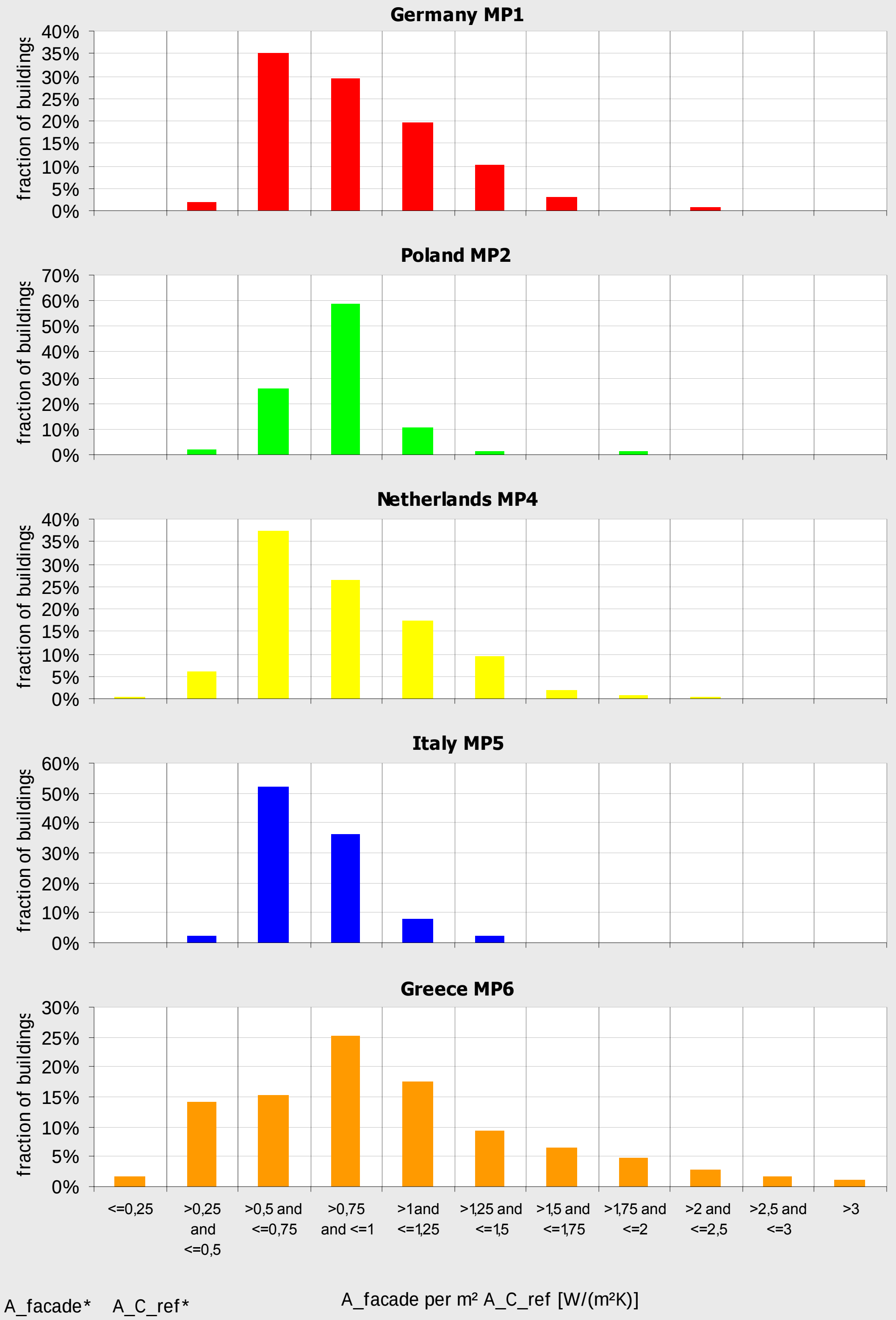


Fig. 126: Frequency of specific façade area (part 2)
(façade area related to reference floor area)

Fig. 127: Frequency of specific roof area
(roof or top ceiling area related to reference floor area per conditioned storey)

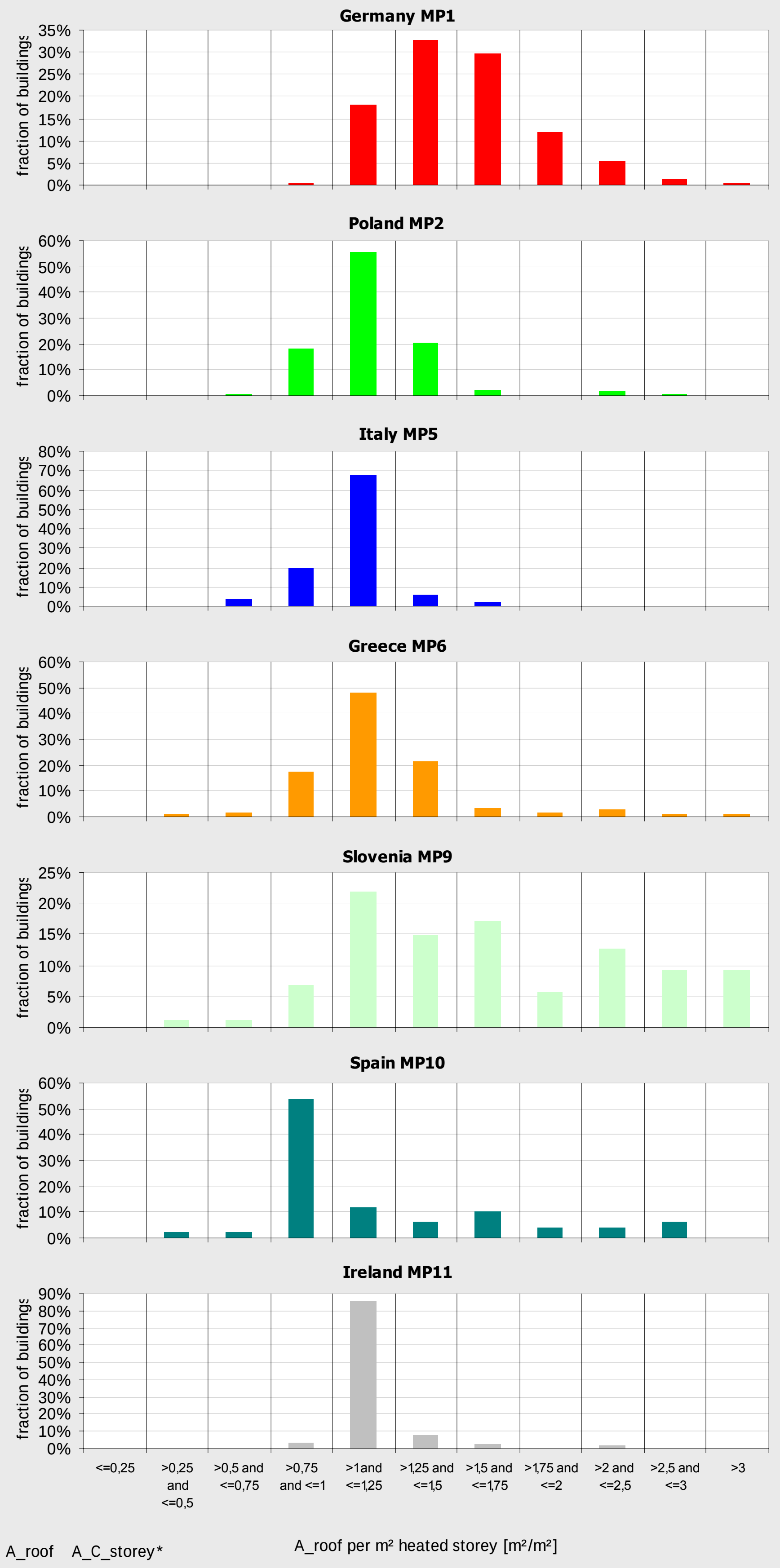
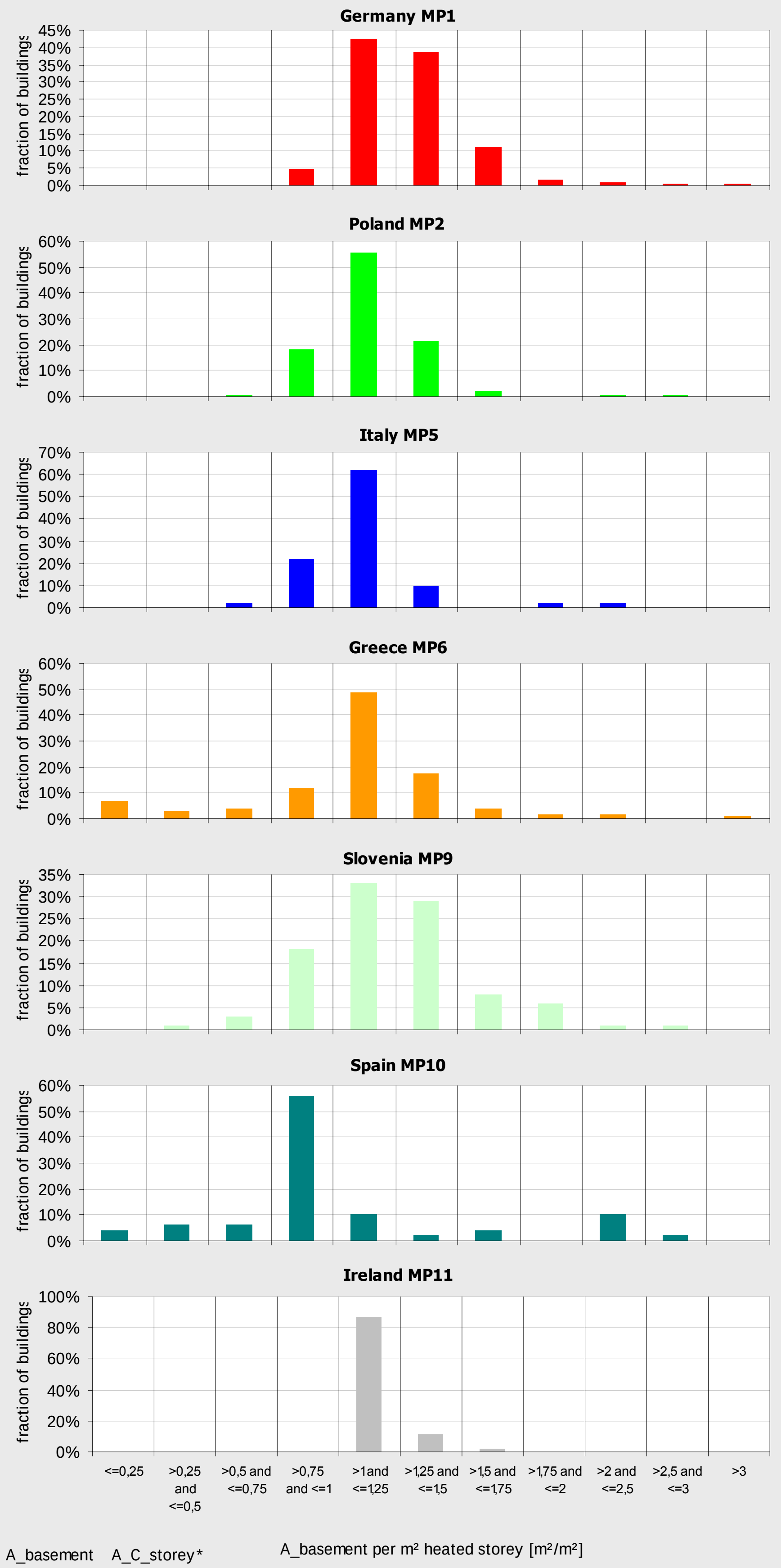


Fig. 128: Frequency of specific floor area basement (basement area related to reference floor area per conditioned storey)



Calculated heat demand

The heat demand for space heating calculated according to the national asset rating methods was analysed (without system losses). Fig. 129 shows the average values per m² reference area for the different construction periods. Comparably very high values of more than 300 kWh/(m²a) are found for the databases of the Netherlands and of Belgium. This can be explained by the higher U-values (see chapter 0). For the other countries a band of 100 to 200 kWh/(m²a) for older buildings is typical (with the exception of Spain, due to different climate conditions). In the case of new buildings the heat demand amounts typically only half of the value of older buildings.

The dependency of the climate is shown in Fig. 130 and Fig. 131 where the annual heat demand is plotted versus the heat transfer coefficient by transmission. Very high correlations can be found for the German, the Slovenian, the Irish and the Dutch database. The correlation is an indicator of the influence of the difference between the average internal and external temperature on the heat demand. In southern countries it is expected to be lower which can also be seen in the charts.

The slope of the trends is an indicator of the degree days which were used in the calculation of the heat demand.[7] This dependence can therefore been used for a plausibility check. The values for the degree days are listed in Fig. 132.

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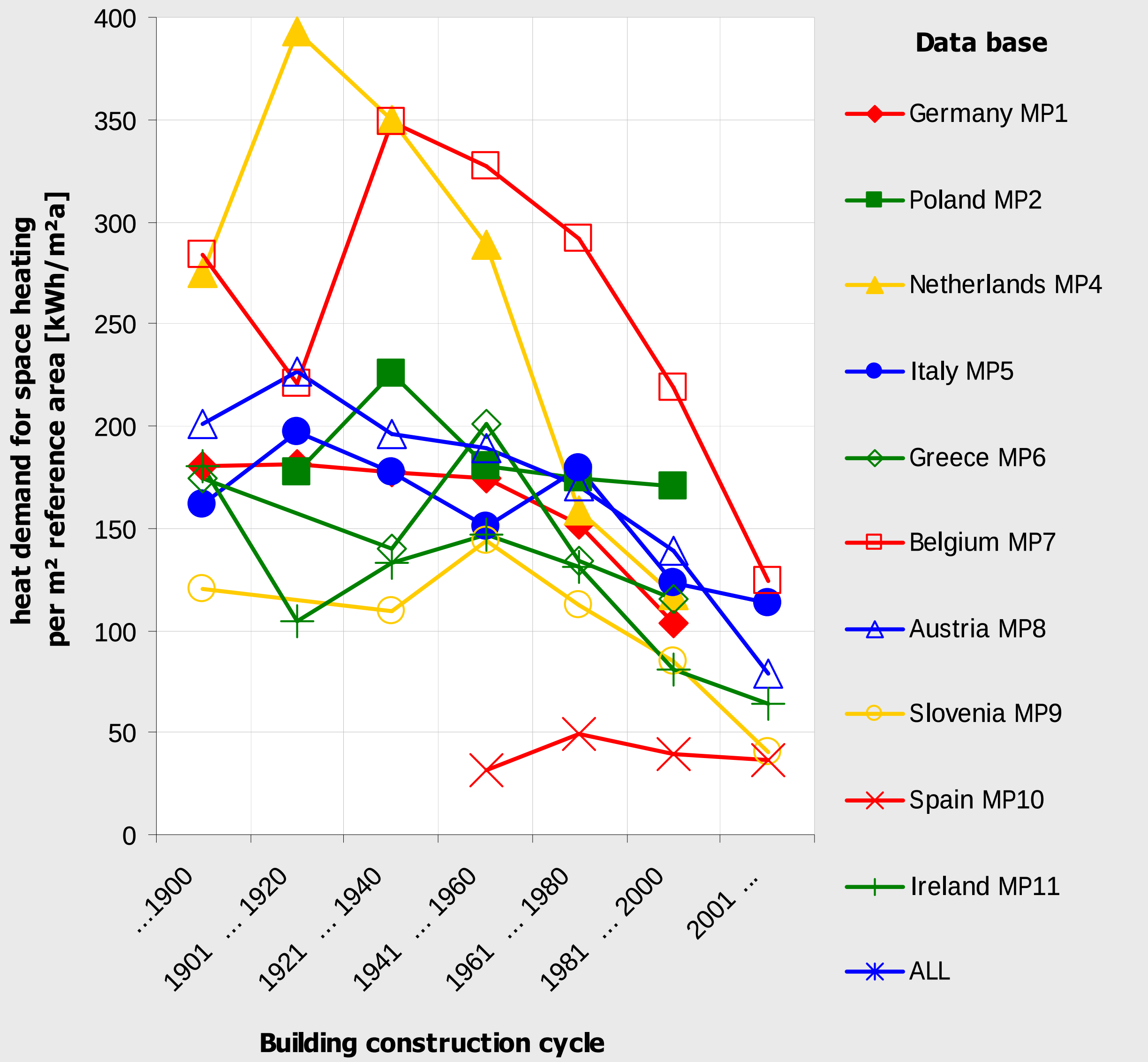
[7] Facing the statistical spread the trends were forced to pass the Zero point in order to get proper values for the slope. Theoretically the curve gets shifted upwards by the ventilation losses and downwards by the utilisable internal and solar gains. This effect was neglected here.

Fig. 129: Calculated heat demand for space heating per m² reference area



year_building* Q_h_per_sqm*

Fig. 130: Calculated heat demand for space heating – dependence on the heat transfer coefficient by transmission – both quantities related to the reference area **(part 1)**
Q_H_per_sqm in kWh/(m²a)
H_T_per_sqm in W/(m²K)

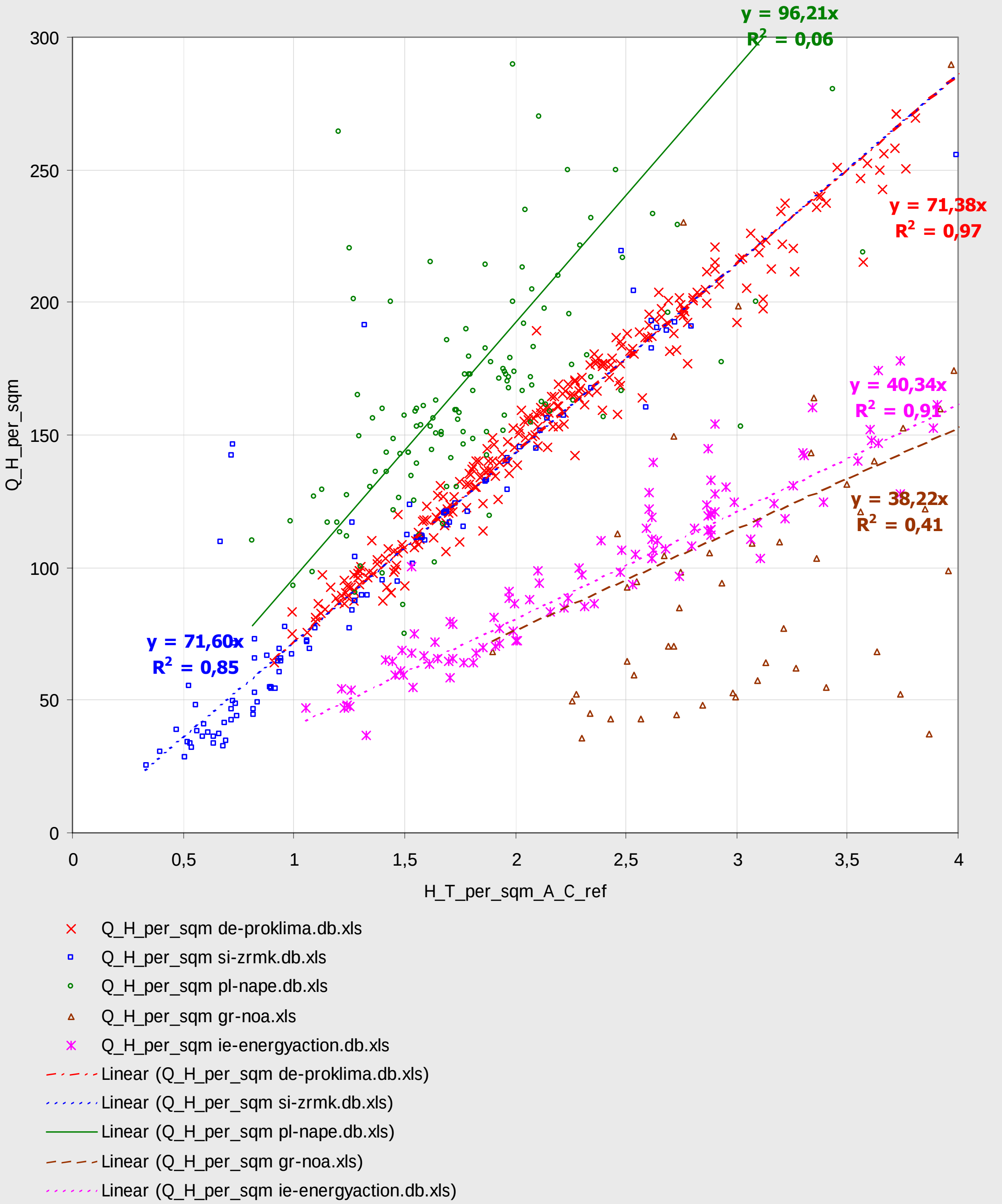


Fig. 131: Calculated heat demand for space heating – dependence on the heat transfer coefficient by transmission – both quantities related to the reference area **(part 2)**
Q_H_per_sqm in kWh/(m²a)
H_T_per_sqm in W/(m²K)

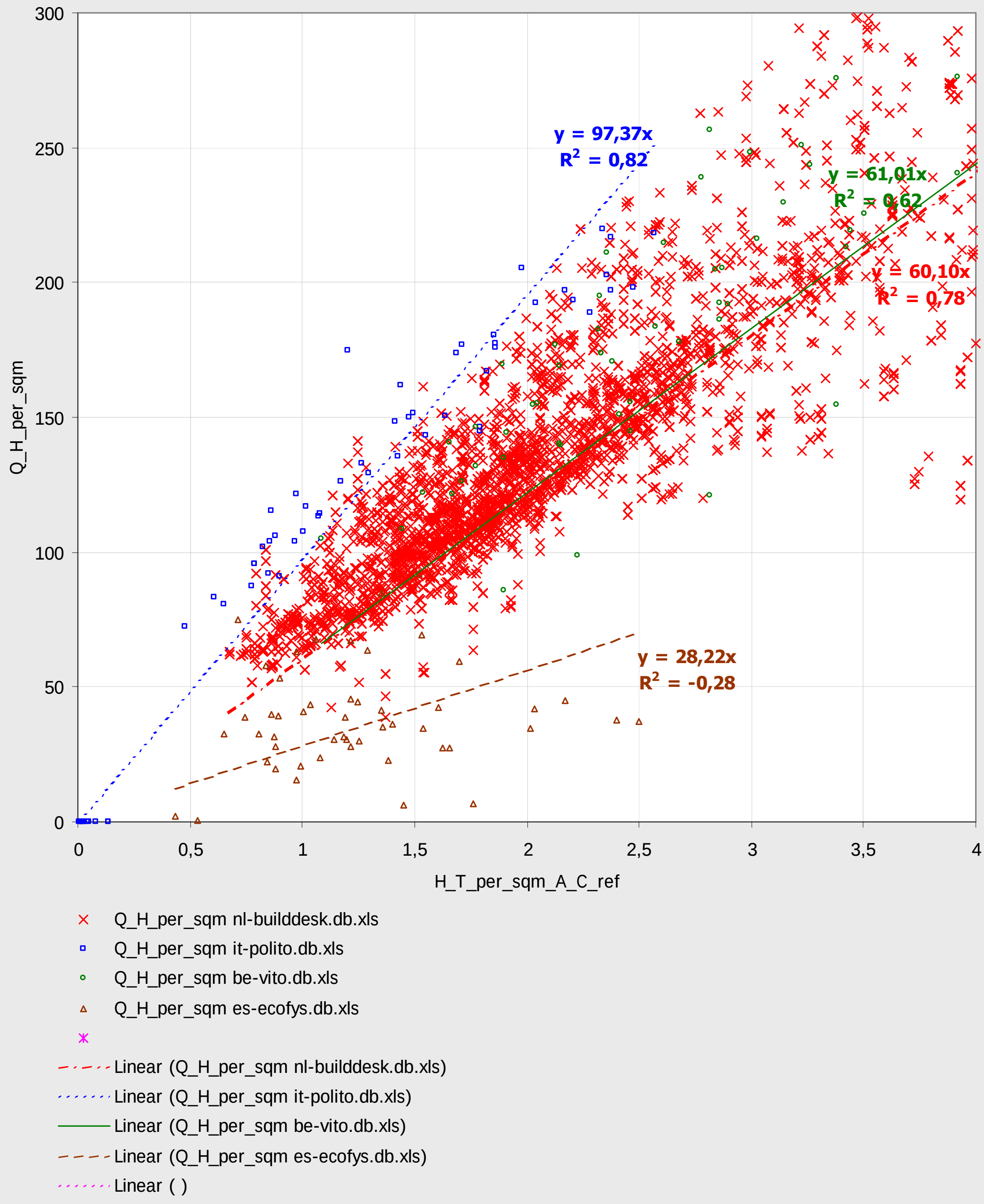


Fig. 132: Overview of the trend slopes

Database	derived degree days in kilo Kelvin hours per year	derived degree days in Kelvin days per year
MP1 / Germany	71 kKh/a	2958 Kd/a
MP2 / Poland	96 kKh/a	4000 Kd/a
MP4 / Netherlands	60 kKh/a	2500 Kd/a
MP5 / Italy	97 kKh/a	4042 Kd/a
MP6 / Greece	38 kKh/a	1583 Kd/a
MP7 / Belgium	61 kKh/a	2542 Kd/a
MP9 / Slovenia	72 kKh/a	3000 Kd/a
MP10 / Spain	28 kKh/a	1167 Kd/a
MP11 / Ireland	40 kKh/a	1667 Kd/a

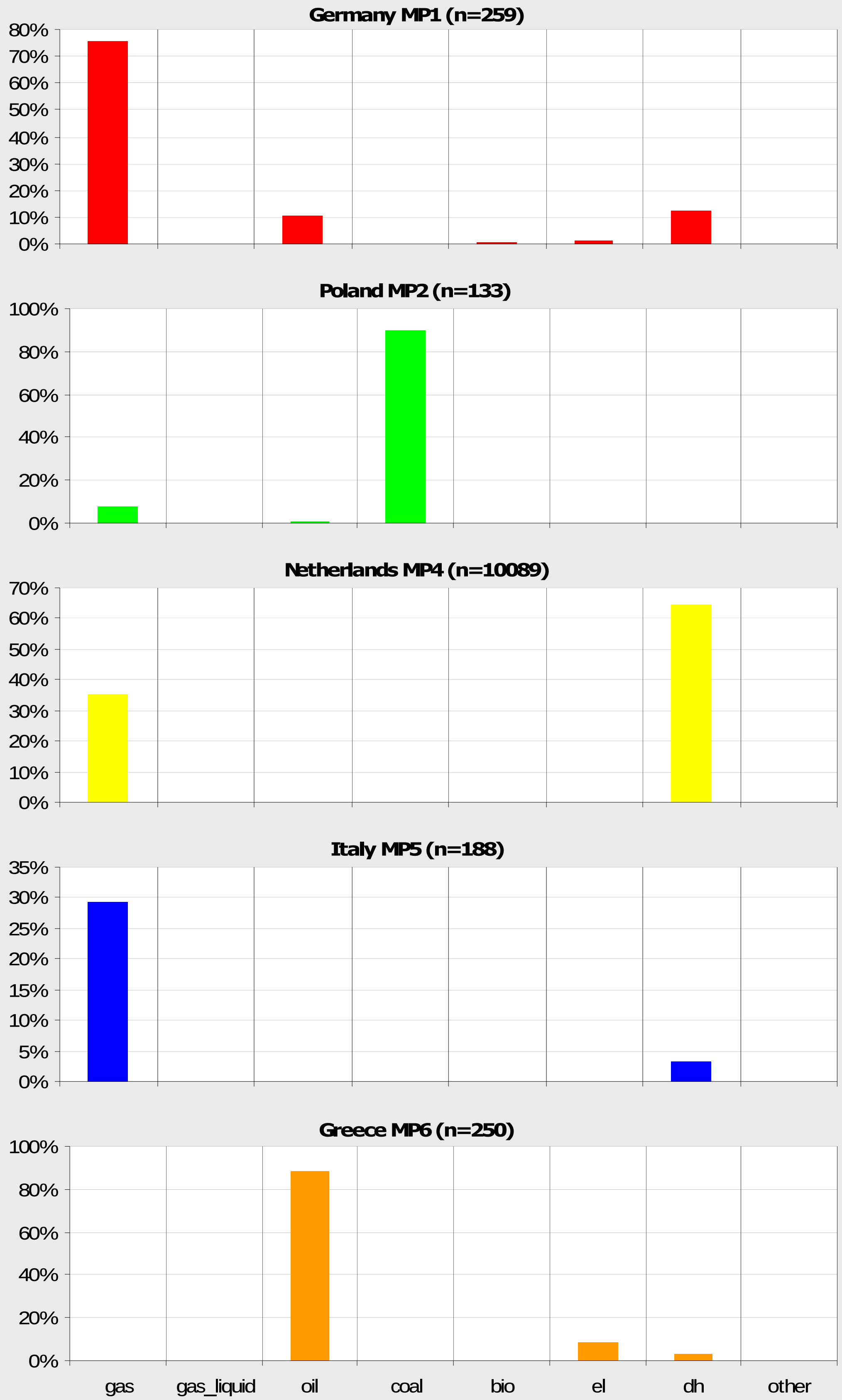
3.5 Supply System

Supply system types

The types of energy carriers and heat generators in the following charts are labelled according to the predefinitions of the DATAMINE data structure. For an explanation of the abbreviations please consider the appendix.

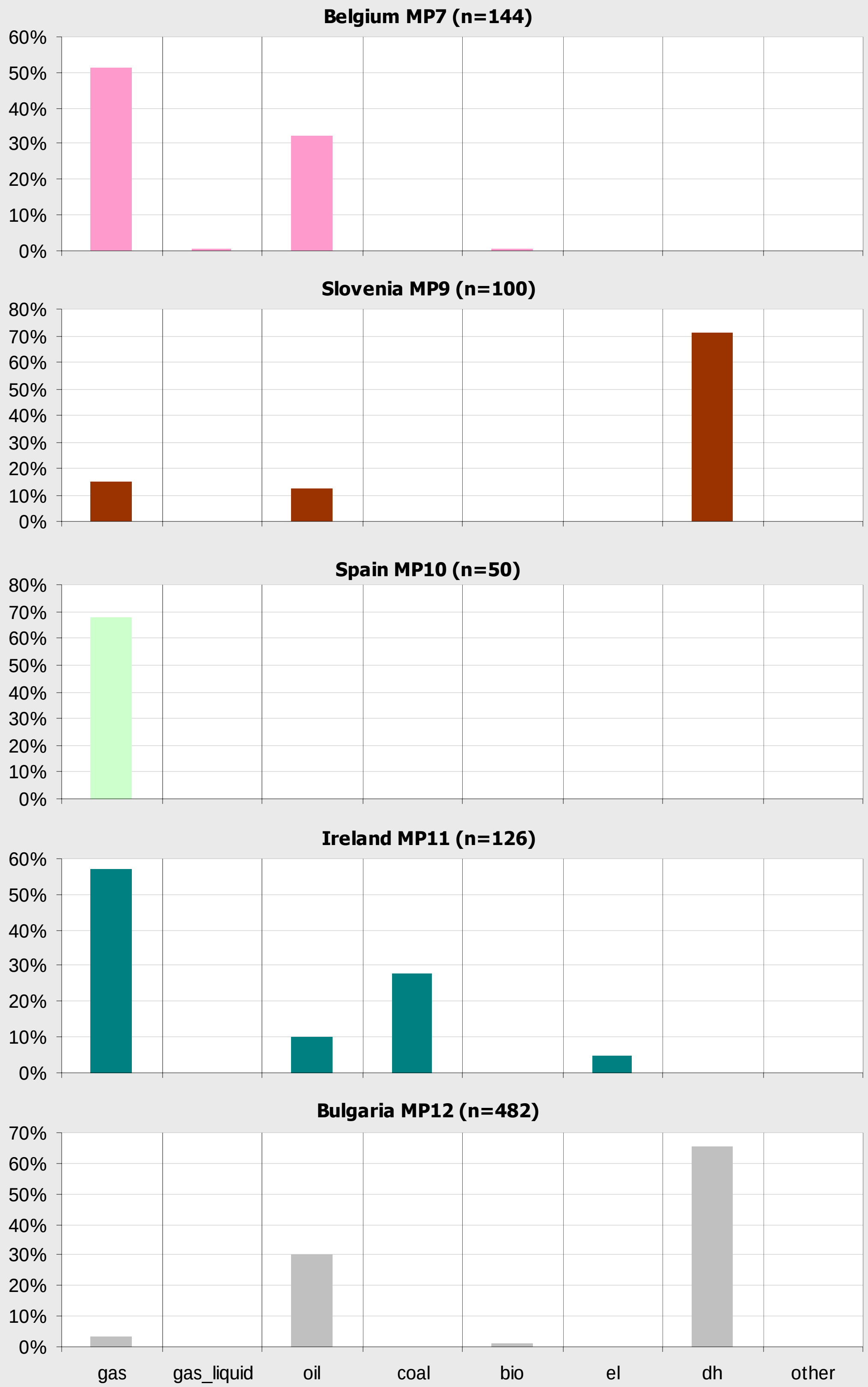
The different energy carriers used for heating are shown in Fig. 133 and Fig. 134. It is very interesting to see that in most of the databases there is one dominant energy carrier. Dependent of the country this would be natural gas, oil, district heating and coal (which also are a kind of district heating systems). The frequency distributions reflect national tendencies as well as specific features of the building samples. Mostly all buildings of the databases are central heating systems, supplied by boilers or by district heating (Fig. 135 / Fig. 136). The other heat generator types such as direct electric heating (“el_d”), heat pumps (“hp”) and stoves are not very common. Only in the German database there is a significant fraction of condensing boilers (type “b_c” in Fig. 137/Fig. 138). For some databases the type of boiler is not known (predefined value “b”).

Fig. 133: Frequency of energy carriers used for heating (part 1)



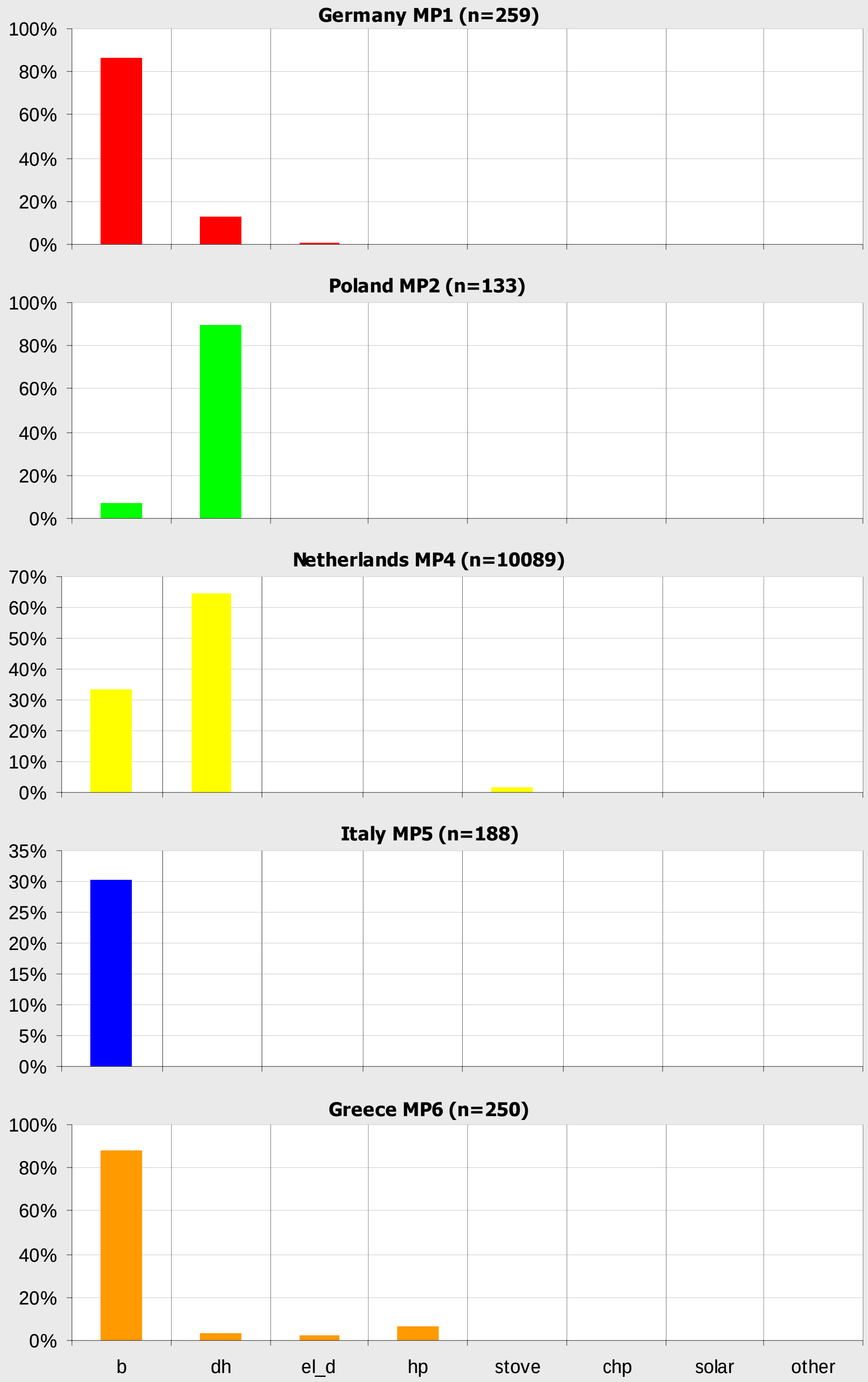
class_ecarrier_1*

Fig. 134: Frequency of energy carriers used for heating (part 2)



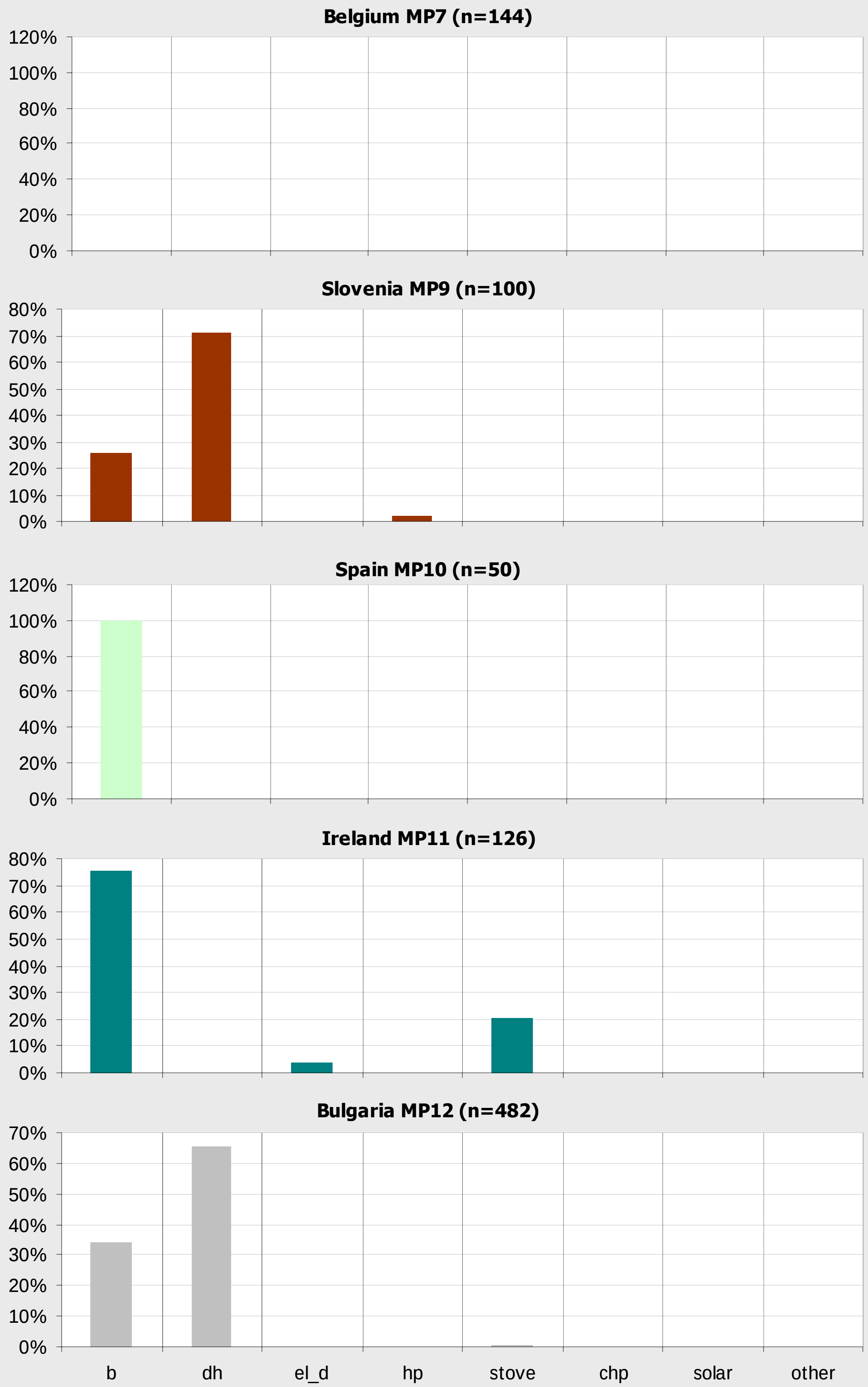
class_ecarrier_1*

Fig. 135: Frequency of heat generators used for heating (part 1)



class_heatgen_1*

Fig. 136: Frequency of heat generators used for heating (part 2)



class_heatgen_1*

Fig. 137: Frequency of heat generators of central heating systems (part 1)

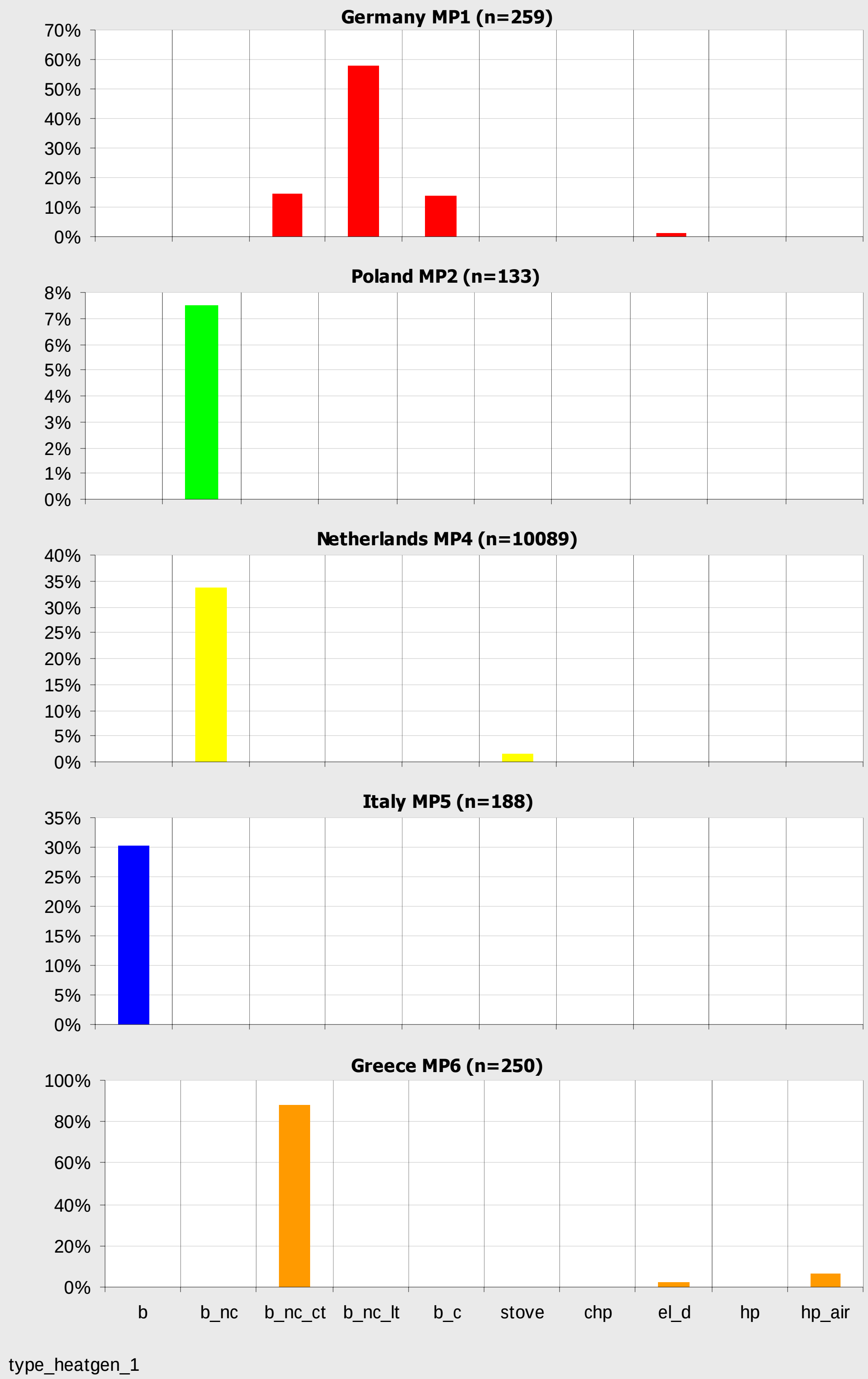


Fig. 138: Frequency of heat generators of central heating systems (part 2)

3.6 Measured consumption

Five databases contained values for the measured consumption of the buildings. The average values by different utilisation types are displayed in the next charts.

Regarding the interpretation of these values the same is valid as in the previous chapters: Since the building samples were taken in a specific way dependent on the data collection scheme and evaluation purposes of each Model Project the values are not representative for the national building stocks.

Nevertheless the following points can be observed:

- The available values of the energy consumption of residential buildings, offices and educational buildings are roughly in a range between 100 and 200 kWh/(m²a),
- The residential buildings of the Italian database are an exception to this. The average consumption for heating amounts to 264 kWh/(m²a). However, this high value is influenced by 6 of 35 buildings which have consumptions of 500 to 1000 kWh/(m²a). In the framework of the analysis it cannot be determined if these significantly high values are correct (according to experiences there are many possible errors for the measured consumption). If the 6 very high values are omitted the average value drops from 264 to 152 kWh/(m²a). A good image of such very asymmetric distributions is given by use of the median and the 25% / 75% quantiles (see Fig. 144 in comparison to Fig. 143). The median amounts to 115, the 25% quantile to 79 and the 75% quantile to 369 kWh/(m²a).
- Measured consumptions for a large variety of utilisation types can be found in the Greek database. The consumptions of the utilisation classes "hospital" amount to 326 kWh/(m²a) (average of 9 hospital buildings).
- Electric consumptions are mainly included in the Bulgarian and Greek database. The consumption of the buildings with no air conditioning lie within a range of 20 to 50 kWh/(m²a) (Fig. 141). Air conditioning is available only in the Greek database (Fig. 142). In this case the consumption amounts to 150 to 200 kWh/(m²a) in case of the categories "office", "hospital", "hotel_restaurant" and "others" (here: airport buildings).

For four databases the dependence of the measured and the calculated consumption could be analysed (Fig. 145). The correlation is rather poor. However, there is a tendency that the measured values are 20 to 50% lower than the calculated ones. Similar results can be found in other statistical analyses (e.g. in the German analysis [IWU 2006]). If the building samples including both the measured and the calculated values were larger, the correlation could be analysed in more detail (e.g. for different utilisation types, building sizes etc.).

Fig. 139: Average values of the measured consumption for different utilisation types / sum of all energy carriers except electricity / only heating (n=426)

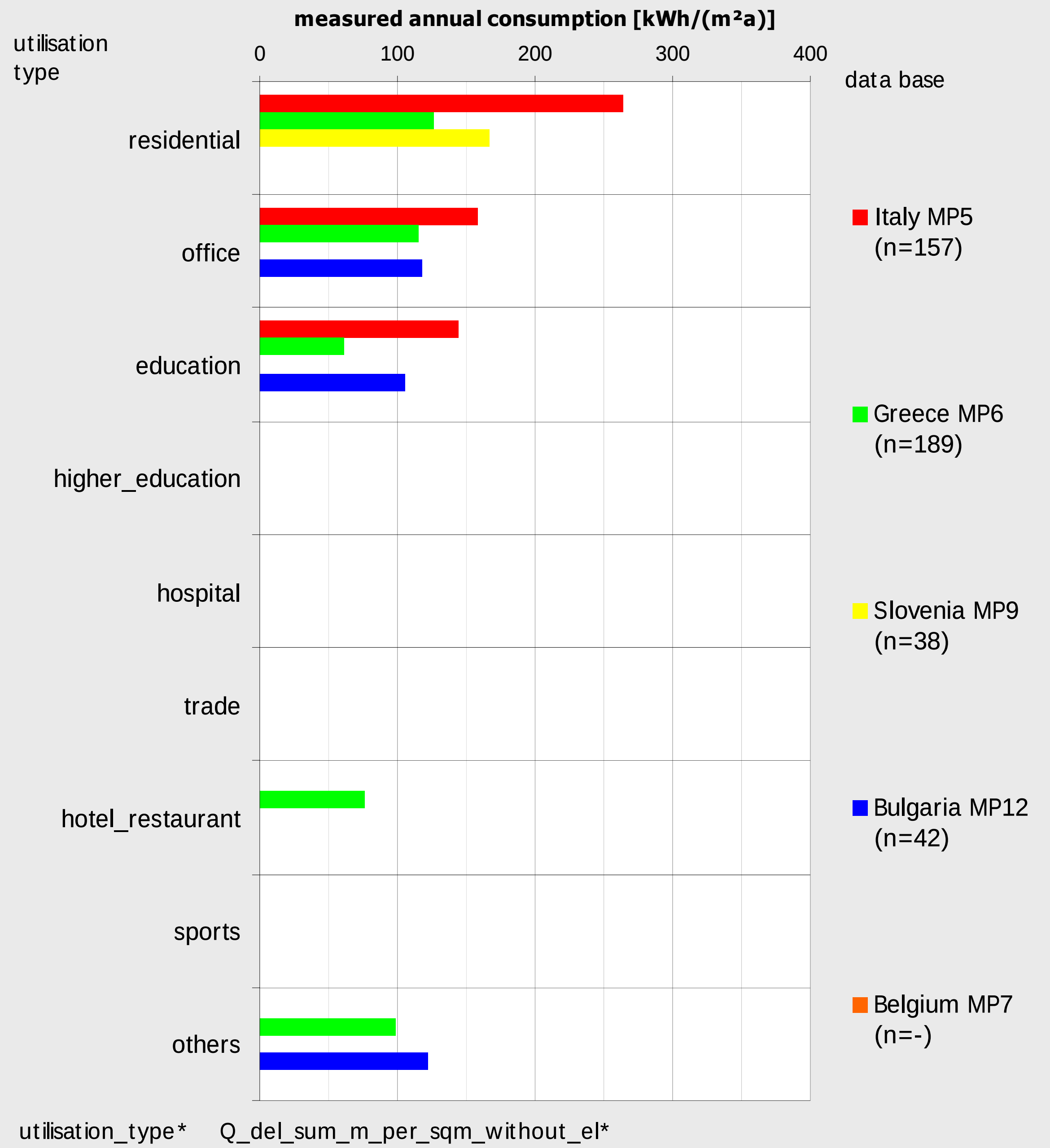


Fig. 140: Average values of the measured consumption for different utilisation types / sum of all energy carriers except electricity / heating and hot water (n=582)

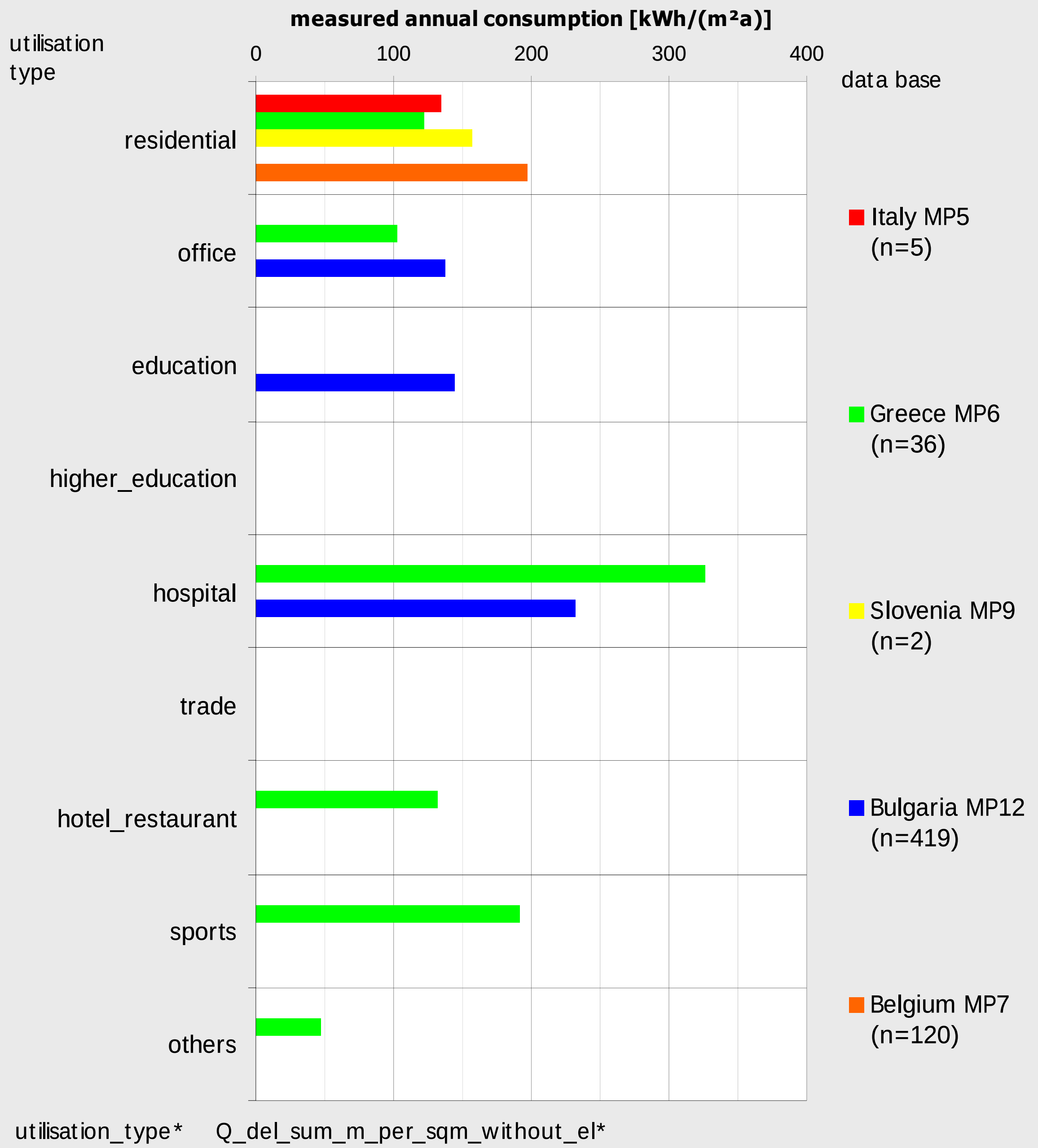


Fig. 141: Average values of the measured consumption for different utilisation types / only electricity, if measured consumption available / consumption for all uses except air conditioning (n=126)

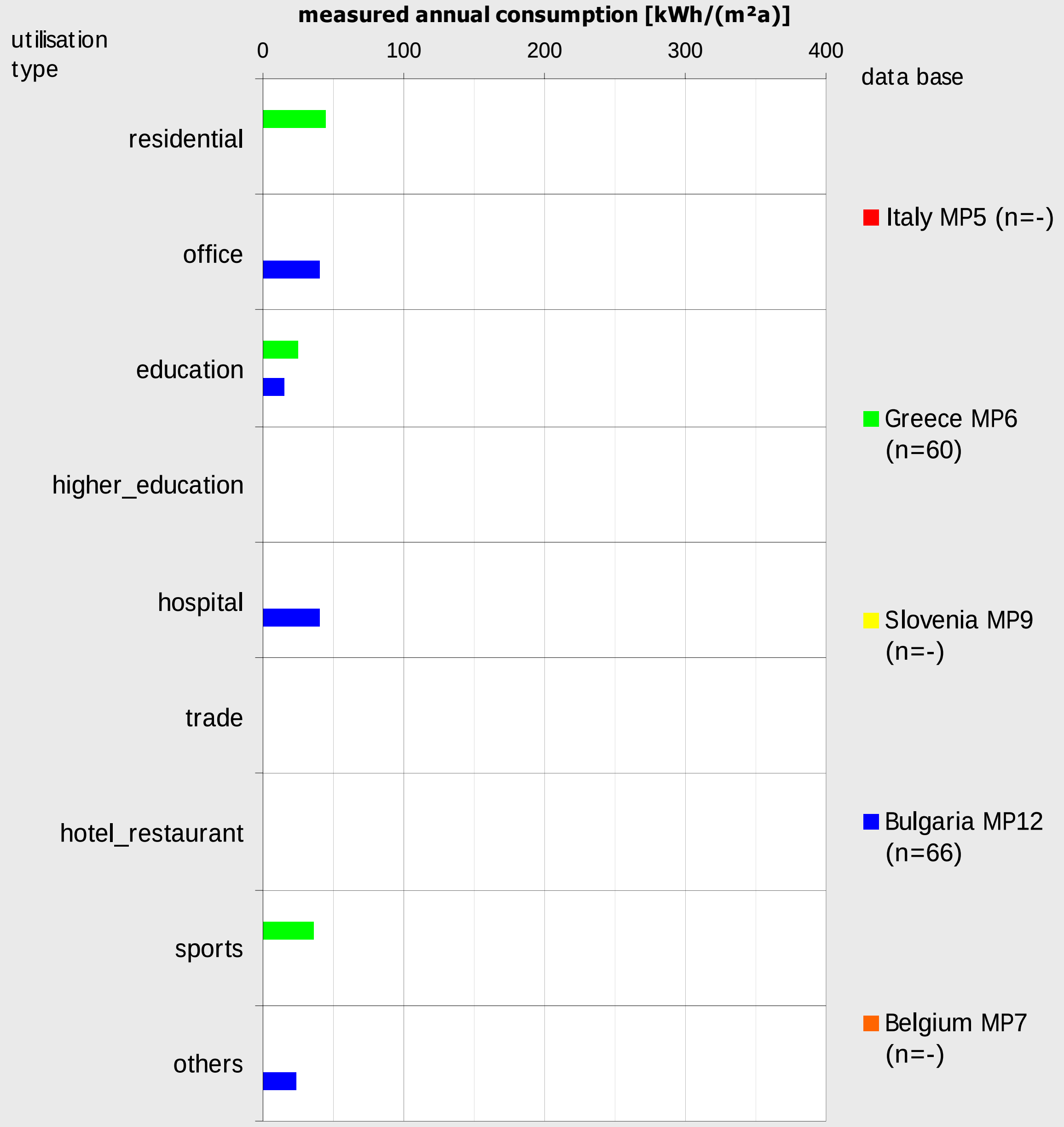


Fig. 142: Average values of the measured consumption for different utilisation types / only electricity, if measured consumption available / consumption for all uses, if air conditioning is included (n=167)

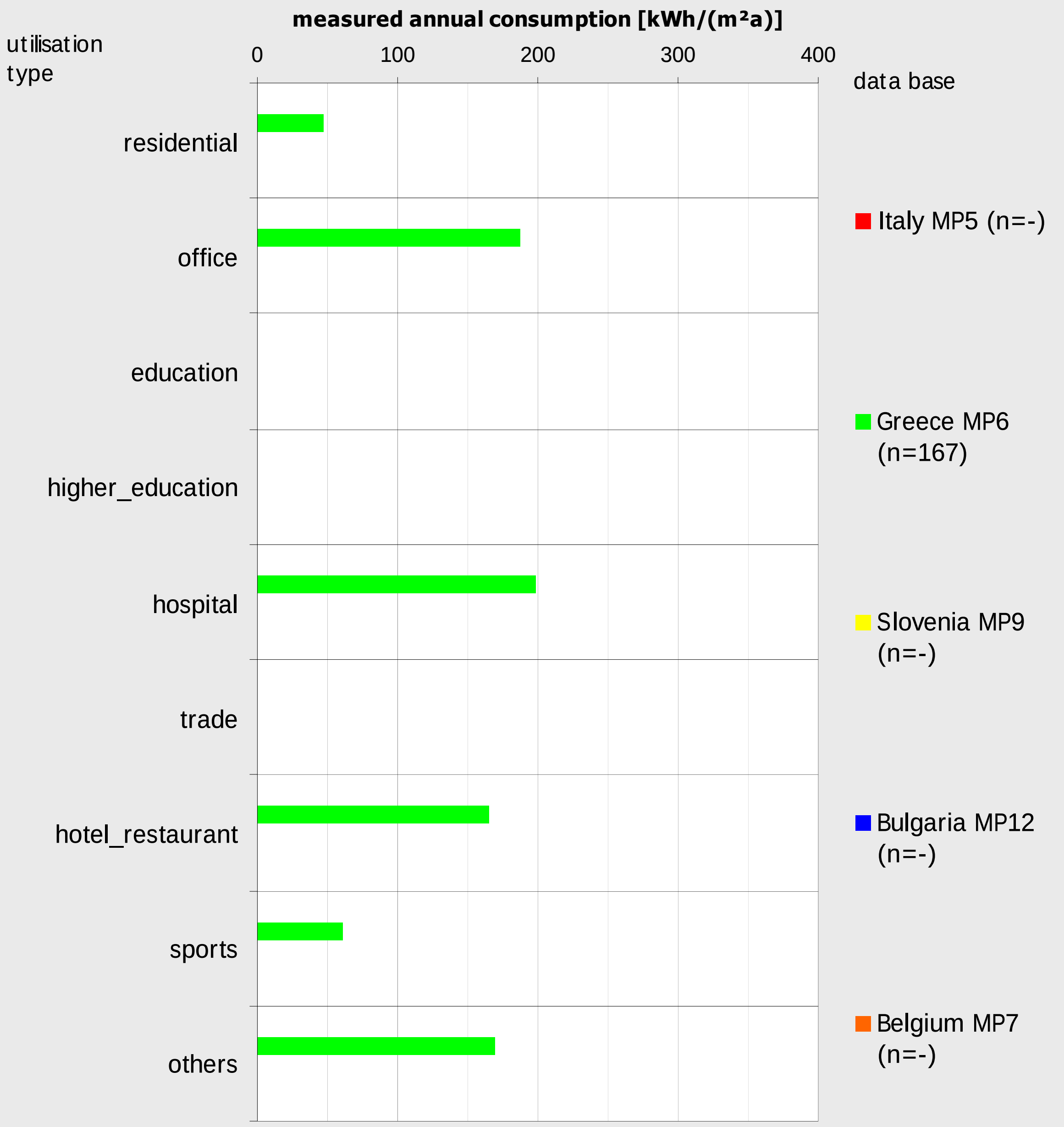


Fig. 143: Result for the analysis displayed in Fig. 139 with functions <u>min / average / max</u> (output of the DATAMINE Analysis Tool)

Predefined evaluation ranges

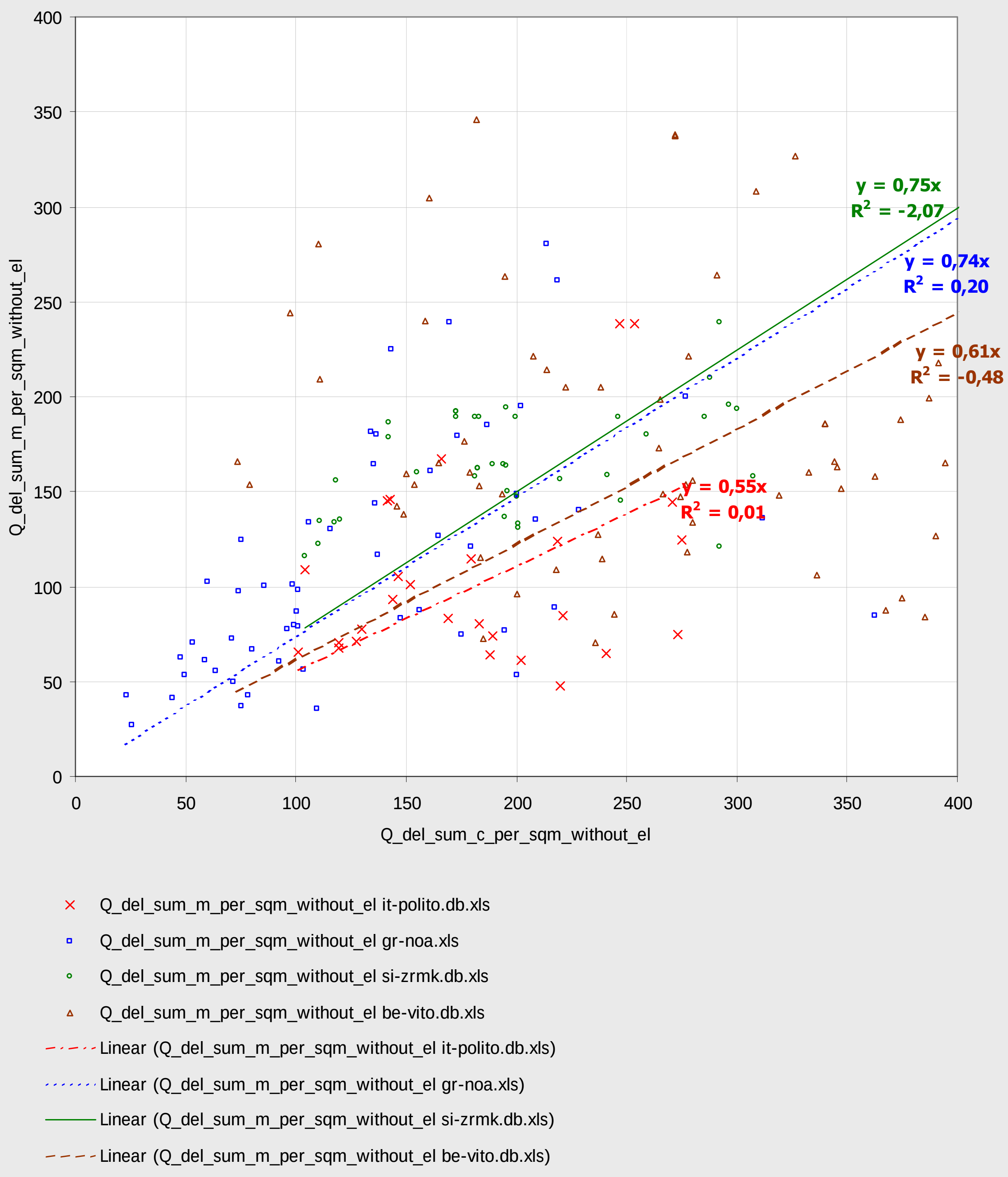
	Statistics	utilisation_type \ database	it-polito.db.xls	gr-noa.xls	si-zrmk.db.xls	bg-sofena.db.xls	be-vito.db.xls	ALL
1	min	residential	47,98	35,30	116,35	-	-	35,30
	average		**263,69**	**126,68**	**166,52**	**-**	**-**	**153,64**
	max		966,51	328,55	238,88	-	-	966,51
	count		n=35	n=161	n=38	-	-	n=234
2	min	office	44,49	86,79	-	61,88	-	44,49
	average		**157,81**	**115,84**	**-**	**118,69**	**-**	**137,71**
	max		627,46	136,19	-	227,02	-	627,46
	count		n=8	n=3	-	n=5	-	n=16
3	min	education	6,03	27,19	-	31,39	-	6,03
	average		**145,12**	**61,70**	**-**	**105,24**	**-**	**134,20**
	max		893,76	98,53	-	274,09	-	893,76
	count		n=114	n=4	-	n=33	-	n=151
4	min	higher_education	-	-	-	-	-	-
	average		**-**	**-**	**-**	**-**	**-**	**-**
	max		-	-	-	-	-	-
	count		-	-	-	-	-	-
5	min	hospital	-	-	-	-	-	-
	average		**-**	**-**	**-**	**-**	**-**	**-**
	max		-	-	-	-	-	-
	count		-	-	-	-	-	-
6	min	trade	-	-	-	-	-	-
	average		**-**	**-**	**-**	**-**	**-**	**-**
	max		-	-	-	-	-	-
	count		-	-	-	-	-	-
7	min	hotel_restaurant	-	75,76	-	-	-	75,76
	average		**-**	**75,76**	**-**	**-**	**-**	**75,76**
	max		-	75,76	-	-	-	75,76
	count		-	n=1	-	-	-	n=1
8	min	sports	-	-	-	-	-	-
	average		**-**	**-**	**-**	**-**	**-**	**-**
	max		-	-	-	-	-	-
	count		-	-	-	-	-	-
9	min	others	-	8,67	-	66,70	-	8,67
	average		**-**	**99,02**	**-**	**122,61**	**-**	**102,96**
	max		-	409,41	-	180,78	-	409,41
	count		-	n=20	-	n=4	-	n=24
10	min	ALL	6,03	8,67	116,35	31,39	-	6,03
	average		**172,20**	**121,94**	**166,52**	**108,50**	**-**	**143,11**
	max		966,51	409,41	238,88	274,09	-	966,51
	count		n=157	n=189	n=38	n=42	-	n=426

Fig. 144: Result for the analysis displayed in Fig. 139 with functions <u>min / average / max</u> (output of the DATAMINE Analysis Tool)

Predefined evaluation ranges

	Statistics	database / utilisation_type	it-polito.db.xls	gr-noa.xls	si-zrmk.db.xls	bg-sofena.db.xls	be-vito.db.xls	ALL
1	25% quantile	residential	79,22	72,80	148,19	-	-	77,74
	median		**114,61**	**106,19**	**162,85**	**-**	**-**	**123,68**
	75% quantile		368,57	158,00	189,62	-	-	177,29
	count		n=35	n=161	n=38	-	-	n=234
2	25% quantile	office	71,93	105,67	-	72,86	-	74,75
	median		**89,37**	**124,54**	**-**	**107,91**	**-**	**100,37**
	75% quantile		130,58	130,36	-	123,77	-	127,45
	count		n=8	n=3	-	n=5	-	n=16
3	25% quantile	education	103,57	37,62	-	48,72	-	87,96
	median		**131,89**	**60,53**	**-**	**92,98**	**-**	**122,35**
	75% quantile		160,52	84,61	-	147,04	-	157,85
	count		n=114	n=4	-	n=33	-	n=151
4	25% quantile	higher_education	-	-	-	-	-	-
	median		**-**	**-**	**-**	**-**	**-**	**-**
	75% quantile		-	-	-	-	-	-
	count		-	-	-	-	-	-
5	25% quantile	hospital	-	-	-	-	-	-
	median		**-**	**-**	**-**	**-**	**-**	**-**
	75% quantile		-	-	-	-	-	-
	count		-	-	-	-	-	-
6	25% quantile	trade	-	-	-	-	-	-
	median		**-**	**-**	**-**	**-**	**-**	**-**
	75% quantile		-	-	-	-	-	-
	count		-	-	-	-	-	-
7	25% quantile	hotel_restaurant	-	75,76	-	-	-	75,76
	median		**-**	**75,76**	**-**	**-**	**-**	**75,76**
	75% quantile		-	75,76	-	-	-	75,76
	count		-	n=1	-	-	-	n=1
8	25% quantile	sports	-	-	-	-	-	-
	median		**-**	**-**	**-**	**-**	**-**	**-**
	75% quantile		-	-	-	-	-	-
	count		-	-	-	-	-	-
9	25% quantile	others	-	22,53	-	88,57	-	23,93
	median		**-**	**40,02**	**-**	**121,48**	**-**	**56,31**
	75% quantile		-	170,48	-	155,52	-	167,97
	count		-	n=20	-	n=4	-	n=24
10	25% quantile	ALL	90,99	66,94	148,19	58,62	-	77,74
	median		**124,48**	**101,84**	**162,85**	**94,11**	**-**	**121,74**
	75% quantile		167,13	155,86	189,62	147,09	-	164,52
	count		n=157	n=189	n=38	n=42	-	n=426

Fig. 145: Correlation of measured and calculated consumption / all energy carriers without electricity, no restrictions for energy uses



3.7 Typology of the analysed residential building samples

For an easy comparison of the energy quality of a large number of buildings it is convenient to derive “average buildings” which represent a specific building type of the respective building stock. The creation of such a typology has been performed for the samples of this analysis – focussing on residential buildings which were available in most of the databases. For this purpose 4 classes of buildings were defined:

Fig. 146: Definition of the residential building types

Type	Label	Number of dwellings	Construction year
old single-familiy houses	SFH_OLD	≤ 2	until 1980
new single-familiy houses	SFH_NEW	≤ 2	after 1980
old multi-family houses	MFH_OLD	≥ 3	until 1980
new multi-family houses	MFH_NEW	≥ 3	after 1980

For these types it was checked how many datasets were available in each database which contained data necessary to derive representatives. The conditions were that the datasets should:

- represent whole buildings (not only apartments)
- contain the areas and U-values for the whole envelope
- contain the number of full storeys and the classification of attic and cellar storey (not/partly/fully conditioned) for the determination of the specific areas (see chapter 0 and 0)

The result is shown in Fig. 147 / Fig. 148. It was not possible to create residential building representatives for the following three databases

– MP 4 / The Netherlands: The number of storeys and the information about the classification of attic and cellar storey (not/partly/fully conditioned) was not available.
– MP 8 / Austria: The envelope areas and the U-values were not available.
– MP 12 / Bulgaria: Datasets of residential buildings were not included.

A criterion was set for the numbers of datasets which should at least be available for the derivation of representatives. The minimum number was fixed to 5 for this exemplary analysis.

For all the building types in each database which fulfilled the mentioned conditions the representatives were determined by calculating the average values for the specific envelope areas, the U-values and the energy need for heating per m² reference area (Fig. 149).

Fig. 147: Frequency of datasets for derivation of residential building types (part 1)

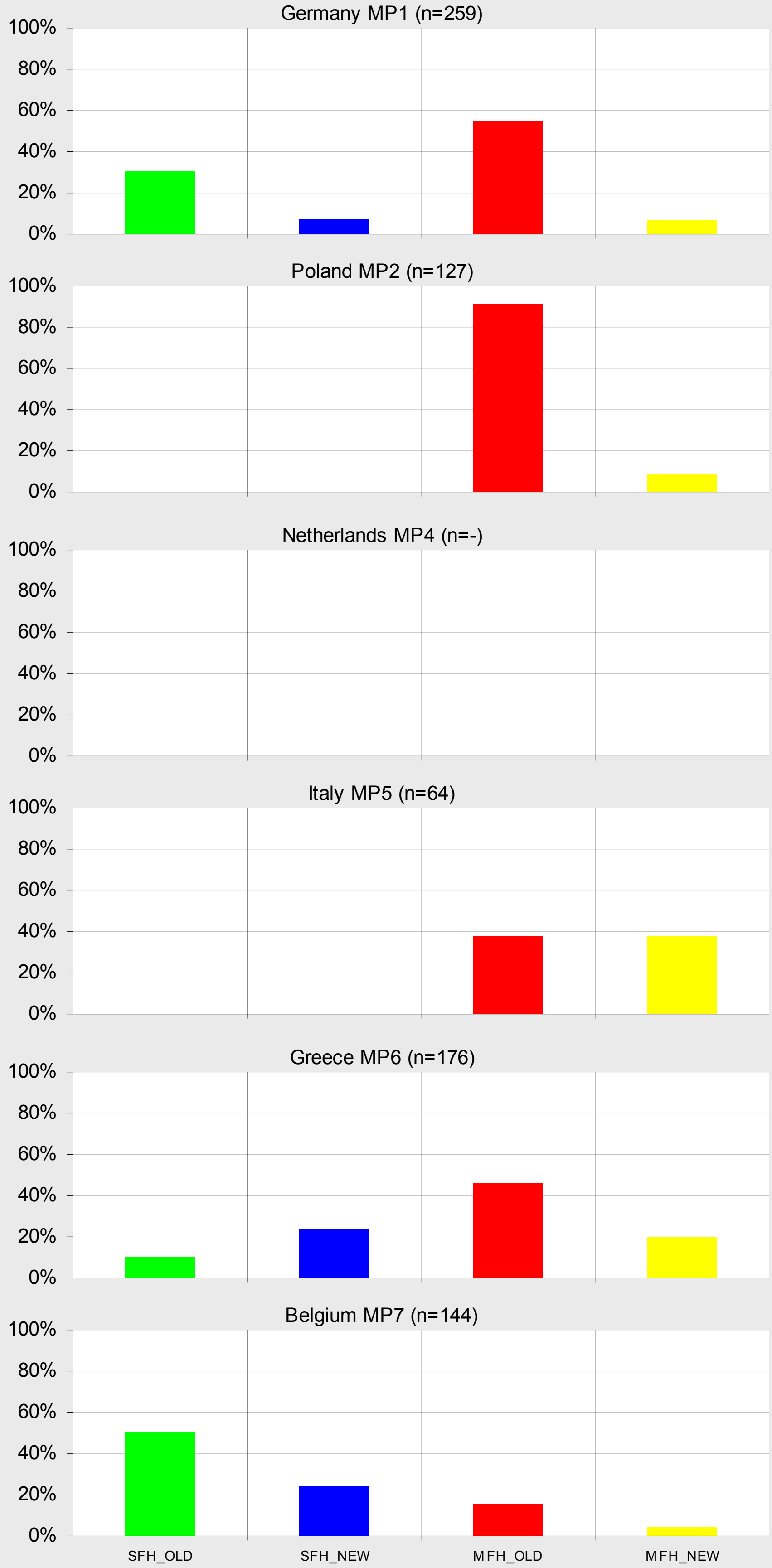


Fig. 148: Frequency of datasets for derivation of residential building types part 2)

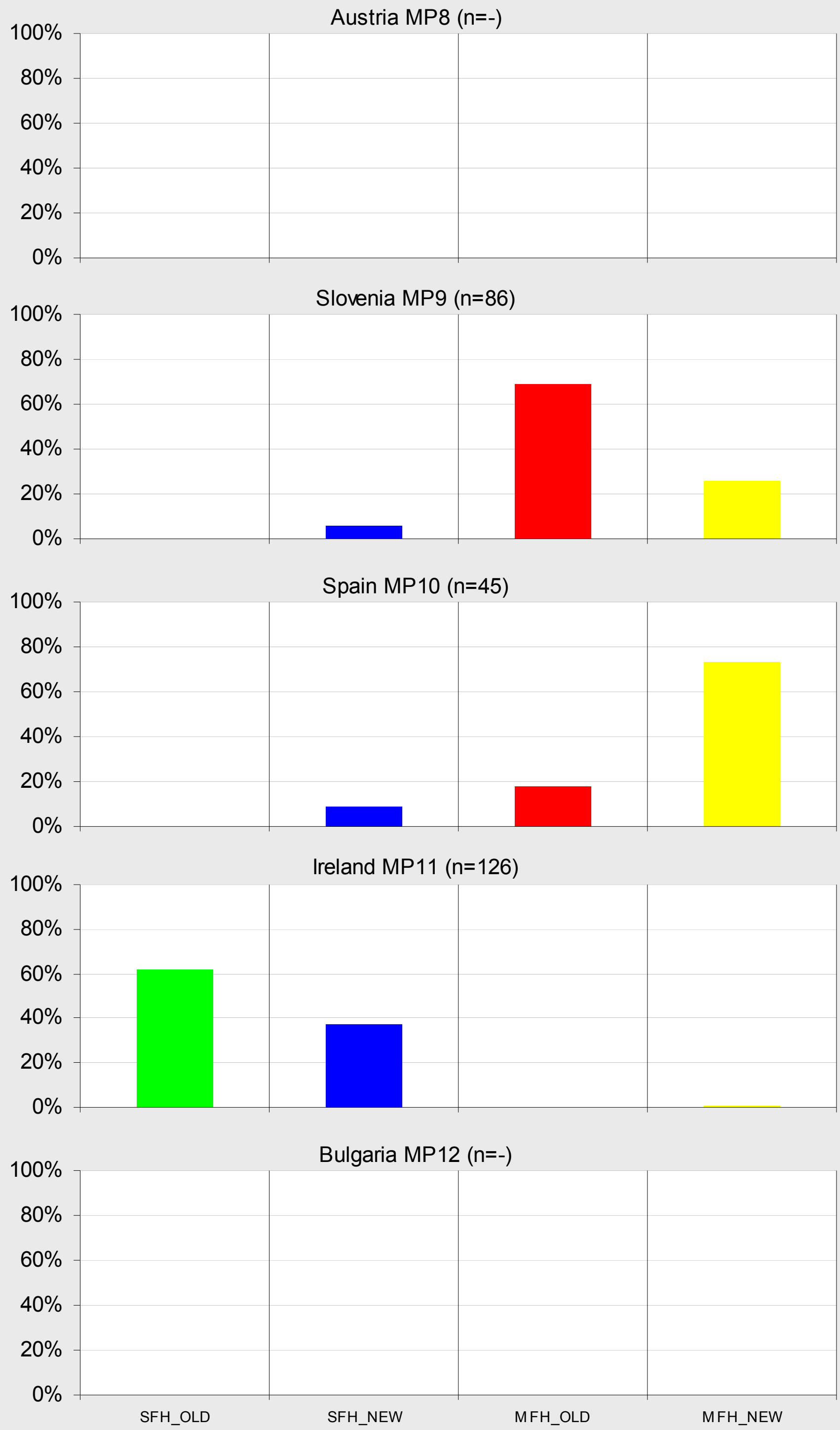


Fig. 149: Representatives of the analysed residential building samples

Building type		**Single Family Houses**				**Apartment Blocks**			
Construction year		**until 1980**		**after 1980**		**until 1980**		**after 1980**	
MP1	number of buildings in the sample	79		20		142		18	
Germany	average conditioned reference area	185 m^2		174 m^2		974 m^2		1497 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	1,66	0,75	1,55	0,37	1,44	1,02	1,65	0,39
	wall	0,90	1,10	0,87	0,46	0,60	1,43	0,43	0,55
	window	0,22	2,72	0,20	2,58	0,21	2,90	0,26	2,71
	basement	1,37	1,00	1,29	0,64	1,28	1,15	1,25	0,65
	energy need for heating	225 kWh/(m^2a)		138 kWh/(m^2a)		184 kWh/(m^2a)		121 kWh/(m^2a)	
MP2	number of buildings in the sample	-		-		116		11	
Poland	average conditioned reference area	-		-		2651 m^2		2400 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	-	-	-	-	1,22	1,10	1,09	0,76
	wall	-	-	-	-	0,67	1,23	0,66	0,83
	window	-	-	-	-	0,18	3,20	0,15	2,50
	basement	-	-	-	-	1,21	1,06	1,09	0,72
	energy need for heating	-		-		195 kWh/(m^2a)		137 kWh/(m^2a)	
MP5	number of buildings in the sample	-		-		24		24	
Italy	average conditioned reference area	-		-		2590 m^2		4358 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	-	-	-	-	0,99	1,35	1,13	0,84
	wall	-	-	-	-	0,72	1,02	0,56	0,79
	window	-	-	-	-	0,13	4,02	0,14	3,03
	basement	-	-	-	-	1,05	1,25	1,19	0,99
	energy need for heating	-		-		122 kWh/(m^2a)		93 kWh/(m^2a)	
MP6	number of buildings in the sample	18		42		81		35	
Greece	average conditioned reference area	120 m^2		151 m^2		1136 m^2		1059 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	1,25	2,28	1,27	1,26	1,26	1,82	1,20	1,31
	wall	1,19	1,59	1,35	1,01	0,81	1,53	0,90	1,09
	window	0,17	4,46	0,17	3,99	0,22	4,43	0,15	4,68
	basement	1,18	1,09	1,18	0,86	1,16	2,01	0,86	1,09
	energy need for heating	143 kWh/(m^2a)		99 kWh/(m^2a)		99 kWh/(m^2a)		106 kWh/(m^2a)	
MP7	number of buildings in the sample	73		35		22		6	
Belgium	average conditioned reference area	132 m^2		147 m^2		305 m^2		266 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	-	1,52	-	0,62	-	1,56	-	1,34
	wall	1,27	1,56	1,23	0,87	1,00	1,53	0,98	1,02
	window	0,24	3,27	0,31	2,63	0,22	3,05	0,26	2,76
	basement	-	0,97	-	0,78	-	1,04	-	0,91
	energy need for heating	344 kWh/(m^2a)		213 kWh/(m^2a)		311 kWh/(m^2a)		243 kWh/(m^2a)	
MP9	number of buildings in the sample	-		5		59		22	
Slovenia	average conditioned reference area	-		293 m^2		1768 m^2		1988 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	-	-	1,84	0,21	3,16	1,03	1,49	0,32
	wall	-	-	0,75	0,31	0,58	1,43	0,55	0,51
	window	-	-	0,18	1,24	0,20	2,26	0,22	1,43
	basement	-	-	1,53	0,33	1,21	0,89	1,35	0,43
	energy need for heating	-		83 kWh/(m^2a)		168 kWh/(m^2a)		90 kWh/(m^2a)	
MP10	number of buildings in the sample	-		-		8		33	
Spain	average conditioned reference area	-		-		1161 m^2		1853 m^2	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	-	-	-	-	0,97	0,67	1,24	0,49
	wall	-	-	-	-	0,66	0,90	0,53	0,72
	window	-	-	-	-	0,13	3,65	0,15	3,62
	basement	-	-	-	-	0,82	0,96	1,20	0,80
	energy need for heating	-		-		43 kWh/(m^2a)		37 kWh/(m^2a)	
MP11	number of buildings in the sample	78		47		-		-	
Ireland	average conditioned reference area	83 m^2		83 m^2		-		-	
	thermal envelope	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]	specific area [m^2/m^2]	U-value [W/(m^2K)]
	roof	1,17	1,11	1,17	0,43	-	-	-	-
	wall	1,08	1,67	1,17	0,50	-	-	-	-
	window	0,22	4,20	0,25	3,51	-	-	-	-
	basement	1,20	0,61	1,09	0,44	-	-	-	-
	energy need for heating	107 kWh/(m^2a)		53 kWh/(m^2a)		-		-	

Explanations

"Single Family Houses": buildings with up to 2 dwellings / **"Apartment Blocks":** buildings with more than 2 dwellings

"energy need for heating": net energy demand for space heating per m^2 reference area, calculated according to national asset rating method

"specific areas":

specific roof area: area of roofs / top floor ceilings per m^2 reference area per conditioned storey

specific wall area: wall area per m^2 reference area

specific window area: window area per m^2 reference area

specific floor area: area of floor above cellar or soil per m^2 reference area per conditioned storey

in case of MP7 (Belgium): specific roof and basement areas could not be calculated since the number of storeys was not available

3.8 Résumé of the Cross-Country Comparison

In general the cross-country comparison was performed in a straight forward way. The harmonised definition of the data fields proved to be an immense advantage. Already during the runtime of the Model Projects each partner had processed a transformation from the systematic used in his country or provided by his software to the DATAMINE structure. Therefore the databases delivered from the different countries were transparent for the evaluator.

A manual pre-check was performed to find inconsistencies or deviations from the DATAMINE standard. Most of the data were of good quality. Only a small number of corrections had to be made. The pre-check turned out to be very useful since the problem points could be found in due time before the performance of the actual cross-country comparison. The concerned partners then had enough time for revision.

For future activities it is recommended to create a tool for the automatic pre-check of data bases directly after collection / transformation. This tool should be checking the following features:

- spelling of the datafield names and predefined values: proof of exact compliance
- plausible ranges of values: minima and maxima
- consistency / plausibility of data: dependence of geometrical data (reference areas and volume, specific envelope areas), calculated energy balance (energy need, system losses and delivered energy).

The DATAMINE Analysis Tool was particularly well suited for the cross-country comparison. Good experiences were made with the simultaneous handling of many data bases of different origin. Also updating the databases (after revision by partners) and repeating certain analyses was no problem. Since the analysis tool is an Excel workbook the export of data and creation of charts was easy to handle. For large databases however the tool tended to be slow. The tool should be improved (express import without single value check) if files with more than 10.000 buildings are going to be analysed in future.

Given the fact that the types and ages of the buildings are inhomogeneous and that the building samples are not representative for building stocks of the concerned countries it is evident that the conclusions regarding national energy efficiency indicators are limited. For the DATAMINE project it was clear from the beginning that the actual energy performance of the national building stocks can not be determined during the project. Rather it was intended to demonstrate which kind of comparisons might be possible if harmonised data collection schemes were installed in different countries. Therefore the comparison of U-values, envelope areas, supply system types, calculated and measured consumption which can be found in this report are to be seen as showcases which illustrate the value of the DATAMINE approach.

Finally a method was presented for the aggregation of information in order to avoid the handling and exchange of complete databases. A simplified typology of residential buildings was derived by classifying the Model Project databases. Each building type is represented by an “average building”, a dataset determined by averaging the specific envelope areas, the U-values and the energy need for heating. Such national building typologies can in principle be used for national building stock assessment and for the calculation of energy saving potentials by refurbishment measures. Of course a more detailed approach than in this example should be used, e.g. distinguishing between the U-values of refurbished building elements (e. g. walls, roofs) and those in their original state and providing more categories of building size and age. In future such typologies may also play an important role for the cross-country comparison of the energy performance – subject to the condition that the national typologies are based on a harmonised data definition like DATAMINE.

Appendix I: References

[BEG2006] Decision on Energy Performance of Buildings. Published in ‘Staatsblad van het Koninkrijk der Nederlanden’, The Hague, December 5 2006.

[DATAMINE SR1] Loga, Tobias; Diefenbach, Nikolaus (ed.): Concepts for Data Collection and Analysis. First Synthesis Report of the EIE project DATAMINE; IWU – Institut Wohnen und Umwelt (Insitute for Housing and Environment) Darmstadt/Germany, Juli 2006

[DATAMINE SR2] Loga, Tobias; Diefenbach, Nikolaus (ed.): Data Collection from Energy Certificates - experiences and analyses. Second Synthesis Report of the EIE project DATAMINE; IWU – Institut Wohnen und Umwelt (Insitute for Housing and Environment) Darmstadt/Germany, March 2008

[ISSO82-1] ISSO-publication 82 part 1 – Guideline EPA-W “Energieprestatiecertificaat” + Algemeen Deel, Stichting ISSO – Rotterdam, January 2007.

[ISSO82-2] ISSO-publication 82 part 2 – Guideline EPA-W “Maatwerkadvies”, Stichting ISSO – Rotterdam, January 2007.

[IWU 2005] Loga, Tobias; Diefenbach, Nikolaus; Knissel, Jens; Born, Rolf: Entwicklung eines vereinfachten, statistisch abgesicherten Verfahrens zur Erhebung von Gebäudedaten für die Erstellung des Energieprofils von Gebäuden („Kurzverfahren Energieprofil“); Untersuchung gefördert durch das Bundesamt für Bauwesen und Raumordnung; IWU, Darmstadt 2005

[IWU 2006] Knissel, Jens; Roland Alles; Rolf Born; Tobias Loga; Kornelia Müller; Verena Stercz: Vereinfachte Ermittlung von Primärenergiekennwerten – zur Bewertung der wärmetechnischen Beschaffenheit in ökologischen Mietspiegeln; Institut Wohnen und Umwelt; Darmstadt 2006

[REG2006] Regulation on Energy Performance of Buildings. Ministry of Housing, Spatial Planning and the Environment, December 26 2006.

Appendix II: Composed Variables used for the Cross-Country Comparison

At the bottom of each chart shown in the previous chapters the used variables are explicitly displayed. Some of these variables are the original DATAMINE datafields, which are defined in the DATAMINE data structure [DATAMINE SR1]. Others are composed of DATAMINE datafields and marked with a * in the charts. In the table below you find the corresponding definitions of theses quantities (the formulas are copied from the DATAMINE Analysis Tool). Not all quantities were used during the cross-country comparison, some were created for use of the national analyses (see country reports on the DATAMINE website www.env.meteo.noa.gr/datamine).

A_thermal_envelope	=A_wall+A_window+A_roof+A_basement
year_building	=if(isnumber(year2_building),if(year1_building>500,if(year2_building>500,(year1_building+year2_building)/2,year1_building),year2_building),if(year1_building>500,year1_building,"-"))
utilisation_type	=vlookup(main_utilisation,tab1,2,false)
A_C_ref	=if(isnumber(A_C_intdim),A_C_intdim,if(isnumber(A_C_extdim),A_C_extdim*0.85,if(isnumber(A_C_living),A_C_living*1.1,if(isnumber(A_C_use),A_C_use*1.4,if(isnumber(V_C),V_C/3.0*0.85,"")))))
H_T_per_sqm_envelope	=H_transmission/A_thermal_envelope
H_T_per_sqm_envelope_calc	=(A_wall*U_wall+A_window*U_window+A_roof*U_roof+0.6*A_basement*U_basement+if(isnumber(H_bridges),H_bridges,0))/A_thermal_envelope
Q_H_per_sqm	=if(isnumber(Q_H_gross),Q_H_gross/A_C_ref,Q_H_net/A_C_ref)
H_T	=if(isnumber(H_transmission),H_transmission,H_T_per_sqm_envelope_calc*A_thermal_envelope)
g_win	=if(isnumber(g_window),g_window,0.6)
Q_H_calc_EnEV_de	=(H_T+0.19*V_C)*66-0.95*(0.567*g_window*(A_window_south*270+A_window_west*155+A_window_east*155+A_window_north*100)+22*0.32*V_C)
Q_H_calc_hlt12	=(H_T+0.19*V_C)*75-0.9*(0.567*g_window*(A_window_south*410+A_window_west*300+A_window_east*300+A_window_north*185)+22*0.32*V_C)
Q_H_calc_LEG	=(H_T+0.6*0.34*2.5*A_C_living)*vlookup(code_climate,tab5,3,false)-0.9*(0.36*g_window*(A_window_south*410+A_window_west*300+A_window_east*300+A_window_north*185)+17*A_C_living)
Q_H_calc_HP_simplified	=(H_T+0.6*0.34*2.5*A_C_ref)*vlookup(code_climate,tab5,3,false)-0.9*(0.36*g_win*A_window*vlookup(code_climate,tab5,4,false)+15*A_C_ref)
Q_H_calc_per_sqm	=Q_H_calc_HP_simplified/A_C_ref
relation_H_T_calc_to_value	=H_T_per_sqm_envelope_calc/H_T_per_sqm_envelope
relation_Q_H_calc_to_value	=Q_H_calc_per_sqm/Q_H_per_sqm
A_wall_U_class1	=if(and(U_wall_1>0,U_wall_1<=0.25),A_wall_1,0)+if(and(U_wall_2>0,U_wall_2<=0.25),A_wall_2,0)+if(and(U_wall_3>0,U_wall_3<=0.25),A_wall_3,0)
A_wall_U_class2	=if(and(U_wall_1>0.25,U_wall_1<=0.5),A_wall_1,0)+if(and(U_wall_2>0.25,U_wall_2<=0.5),A_wall_2,0)+if(and(U_wall_3>0.25,U_wall_3<=0.5),A_wall_3,0)
A_wall_U_class3	=if(and(U_wall_1>0.5,U_wall_1<=1.0),A_wall_1,0)+if(and(U_wall_2>0.5,U_wall_2<=1.0),A_wall_2,0)+if(and(U_wall_3>0.5,U_wall_3<=1.0),A_wall_3,0)
A_wall_U_class4	=if(and(U_wall_1>1.0,U_wall_1<=1.5),A_wall_1,0)+if(and(U_wall_2>1.0,U_wall_2<=1.5),A_wall_2,0)+if(and(U_wall_3>1.0,U_wall_3<=1.5),A_wall_3,0)
A_wall_U_class5	=if(and(U_wall_1>1.5,U_wall_1<=2.0),A_wall_1,0)+if(and(U_wall_2>1.5,U_wall_2<=2.0),A_wall_2,0)+if(and(U_wall_3>1.5,U_wall_3<=2.0),A_wall_3,0)
A_wall_U_class6	=if(and(U_wall_1>2.0,U_wall_1<=10.0),A_wall_1,0)+if(and(U_wall_2>2.0,U_wall_2<=10.0),A_wall_2,0)+if(and(U_wall_3>2.0,U_wall_3<=10.0),A_wall_3,0)
A_window_U_class1	=if(and(U_window_1>0,U_window_1<=1.00),A_window_1,0)+if(and(U_window_2>0,U_window_2<=1.00),A_window_2,0)
A_window_U_class2	=if(and(U_window_1>1.0,U_window_1<=1.5),A_window_1,0)+if(and(U_window_2>1.0,U_window_2<=1.5),A_window_2,0)

A_window_U_class3	=if(and(U_window_1>1.5,U_window_1<=2.0),A_window_1,0)+if(and(U_window_2>1.5,U_window_2<=2.0),A_window_2,0)
A_window_U_class4	=if(and(U_window_1>2.0,U_window_1<=3.0),A_window_1,0)+if(and(U_window_2>2.0,U_window_2<=3.0),A_window_2,0)
A_window_U_class5	=if(and(U_window_1>3.0,U_window_1<=4.0),A_window_1,0)+if(and(U_window_2>3.0,U_window_2<=4.0),A_window_2,0)
A_window_U_class6	=if(and(U_window_1>4.0,U_window_1<=10.0),A_window_1,0)+if(and(U_window_2>4.0,U_window_2<=10.0),A_window_2,0)
A_roof_U_class1	=if(and(U_roof_1>0,U_roof_1<=0.25),A_roof_1,0)+if(and(U_roof_2>0,U_roof_2<=0.25),A_roof_2,0)
A_roof_U_class2	=if(and(U_roof_1>0.25,U_roof_1<=0.5),A_roof_1,0)+if(and(U_roof_2>0.25,U_roof_2<=0.5),A_roof_2,0)
A_roof_U_class3	=if(and(U_roof_1>0.5,U_roof_1<=1.0),A_roof_1,0)+if(and(U_roof_2>0.5,U_roof_2<=1.0),A_roof_2,0)
A_roof_U_class4	=if(and(U_roof_1>1.0,U_roof_1<=1.5),A_roof_1,0)+if(and(U_roof_2>1.0,U_roof_2<=1.5),A_roof_2,0)
A_roof_U_class5	=if(and(U_roof_1>1.5,U_roof_1<=2.0),A_roof_1,0)+if(and(U_roof_2>1.5,U_roof_2<=2.0),A_roof_2,0)
A_roof_U_class6	=if(and(U_roof_1>2.0,U_roof_1<=10.0),A_roof_1,0)+if(and(U_roof_2>2.0,U_roof_2<=10.0),A_roof_2,0)
A_basement_U_class1	=if(and(U_basement_1>0,U_basement_1<=0.25),A_basement_1,0)+if(and(U_basement_2>0,U_basement_2<=0.25),A_basement_2,0)
A_basement_U_class2	=if(and(U_basement_1>0.25,U_basement_1<=0.5),A_basement_1,0)+if(and(U_basement_2>0.25,U_basement_2<=0.5),A_basement_2,0)
A_basement_U_class3	=if(and(U_basement_1>0.5,U_basement_1<=1.0),A_basement_1,0)+if(and(U_basement_2>0.5,U_basement_2<=1.0),A_basement_2,0)
A_basement_U_class4	=if(and(U_basement_1>1.0,U_basement_1<=1.5),A_basement_1,0)+if(and(U_basement_2>1.0,U_basement_2<=1.5),A_basement_2,0)
A_basement_U_class5	=if(and(U_basement_1>1.5,U_basement_1<=2.0),A_basement_1,0)+if(and(U_basement_2>1.5,U_basement_2<=2.0),A_basement_2,0)
A_basement_U_class6	=if(and(U_basement_1>2.0,U_basement_1<=10.0),A_basement_1,0)+if(and(U_basement_2>2.0,U_basement_2<=10.0),A_basement_2,0)
class_ecarrier_1	=vlookup(ecarrier_heatgen_1,tab2,2,false)
class_heatgen_1	=vlookup(type_heatgen_1,tab3,2,false)
class_heating_system_1	=vlookup(centralisation_heatgen_1,tab4,2,false)
class_2nd_ecarrrier_heating	=if(mid(use_heatgen_2,1,1)="1",vlookup(ecarrier_heatgen_2,tab2,2,false),if(mid(use_heatgen_3,1,1)="1",vlookup(ecarrier_heatgen_3,tab2,2,false),""))
class_hotwater_system	=if(or(use_heatgen_1=11,use_heatgen_2=11,use_heatgen_3=11,use_heatgen_4=11),"combined","separate")
class_ecarrier_1_w	=if(mid(text(use_heatgen_1,"00"),2,1)="1",vlookup(ecarrier_heatgen_1,tab2,2,false),"")
class_ecarrier_2_w	=if(mid(text(use_heatgen_2,"00"),2,1)="1",vlookup(ecarrier_heatgen_2,tab2,2,false),"")
class_ecarrier_3_w	=if(mid(text(use_heatgen_3,"00"),2,1)="1",vlookup(ecarrier_heatgen_3,tab2,2,false),"")
class_ecarrier_4_w	=if(mid(text(use_heatgen_4,"00"),2,1)="1",vlookup(ecarrier_heatgen_4,tab2,2,false),"")
class_1st_ecarrier_w	=if(class_ecarrier_1_w<>"",class_ecarrier_1_w,if(class_ecarrier_2_w<>"",class_ecarrier_2_w,if(class_ecarrier_3_w<>"",class_ecarrier_3_w,if(class_ecarrier_4_w<>"",class_ecarrier_4_w,""))))
year_heatgen	=if(year_1_heatgen_1>500,if(year_2_heatgen_1>500,(year_1_heatgen_1+year_2_heatgen_1)/2,year_1_heatgen_1),year_2_heatgen_1)
Q_H_d_per_sqm	=Q_H_d/A_C_ref
Q_W_d_per_sqm	=Q_W_d/A_C_ref
Q_W_s_per_sqm	=Q_W_s/A_C_ref
e_heatgen_1_h	=Q_in_heatgen_1_h/Q_out_heatgen_1_h
e_heatgen_1_hw	=if(use_heatgen_1="11",Q_in_heatgen_1/Q_out_heatgen_1,"-")
e_sys_ecarrier_1_h	=if(and(Q_in_heatgen_2=0,Q_in_heatgen_3=0,Q_in_heatgen_4=0),Q_in_heatgen_1_h/Q_H_gross,"-")
e_sys_ecarrier_1	=if(and(ecarrier_2_c=0,ecarrier_3_c=0),if(ecarrier_1_c=0,electric_1_c/(Q_H_gross+Q_W),ecarrier_1_c/(Q_H_gross+Q_W)),"-")
Q_H_aux_per_sqm	=Q_H_aux/A_C_ref

Q_V_aux_per_sqm	=Q_W_aux/A_C_ref
Q_in_sum_per_sqm	=(Q_in_heatgen_1+Q_in_heatgen_2+Q_in_heatgen_3+Q_in_heatgen_4+Q_H_aux+Q_W_aux)/A_C_ref
Q_del_sum_c_per_sqm	=(electric_1_c+electric_2_c+ecarrier_1_c+ecarrier_2_c+ecarrier_3_c)/A_C_ref
Q_th_building_total_per_sqm	=(Q_H_gross+Q_H_ce+Q_H_d+Q_H_s+Q_W+Q_W_d+Q_W_s)/A_C_ref
Q_out_heatgen_sum_per_sqm	=(Q_out_heatgen_1+Q_out_heatgen_2+Q_out_heatgen_3+Q_out_heatgen_4)/A_C_ref
Q_in_sum_related_to_Q_del_sum_c	=Q_in_sum_per_sqm/Q_del_sum_c_per_sqm
Q_P_per_sqm	=primary_energy/A_C_ref
e_P	=primary_energy/(Q_H_gross+Q_W)
comply_nat_reg_new	=value_indicator1*A_C_national/ben_1
Q_del_sum_m_per_sqm	=(electric_1_m+electric_2_m+ecarrier_1_m+ecarrier_2_m+ecarrier_3_m)/A_C_ref
Q_del_sum_c_per_sqm_without_aux	=(electric_1_c+electric_2_c+ecarrier_1_c+ecarrier_2_c+ecarrier_3_c-Q_H_aux-Q_V_aux-Q_W_aux)/A_C_ref
relation_Q_del_m_to_c	=Q_del_sum_m_per_sqm/Q_del_sum_c_per_sqm_without_aux
relation_Q_del_c_to_m	=Q_del_sum_c_per_sqm_without_aux/Q_del_sum_m_per_sqm
code_country	=lower(left(ID_dataset,2))
code_climate	=code_country&if(or(bu_climate="U",bu_climate="-"),"","-"&bu_climate)
A_facade	=A_wall+A_window
A_facade_per_sqm_A_C_ref	=A_facade/A_C_ref
A_roof_per_sqm_A_C_ref	=A_roof/A_C_ref
A_window_per_sqm_A_C_ref	=A_window/A_C_ref
A_basement_per_sqm_A_C_ref	=A_basement/A_C_ref
n_storey_eff	=n_storey+if(attic_cond="c",0.75,0)+if(attic_cond="p",0.75*0.5,0)+if(cellar_cond="c",1,0)+if(cellar_cond="p",0.5,0)
A_C_storey	=A_C_ref/n_storey_eff
A_roof_per_sqm_A_C_storey	=A_roof/A_C_storey
A_basement_per_sqm_A_C_storey	=A_basement/A_C_storey
H_T_per_sqm_A_C_ref	=H_T/A_C_ref
class_size_residential	=if(utilisation_type="residential",if(isnumber(n_apartments),if(n_apartments<=2,"SFH","MFH"),if(A_C_ref<=200,"SFH","MFH")),"")
type_res_building_simple	=if(utilisation_type="residential",if(isnumber(year_building),if(class_size_residential="SFH",if(year_building<=1980,"SFH_OLD","SFH_NEW"),if(year_building<=1980,"MFH_OLD","MFH_NEW")),""),"")

Appendix III: DATAMINE Data Structure

The following pages present the Excel worksheet with all quantities of the DATAMINE data structure. The definition of the 255 data fields is given first, followed at the end by classification lists, which provide predefined values for some of the data fields.

The tables are also available in form of an MS Excel file which can be downloaded from the DATAMINE website: www.meteo.noa.gr/datamine.

DATAMINE DATA STRUCTURE

Version 1.0 from 30th October 2006

No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
				Predefined Values applicable for all data fields		
				initialisation, there has been no input		***<empty>** : no input (data field is empty)*
				this information is not available for the certifier		***U:** unknown*
				the component for which this information is required is not existent		***-:** not existent (minus symbol)*
A	**Energy Certificate Data**					
1	data set identity code	ID_dataset		primary key for the unambiguous identification of the data set during data processing	p	**two letter ISO country code** **+ "-"** **+ ID_building (building identity code, see below)** **+ "-"** **+ "0" in case of a whole building. In case of an apartment the index number "1", "2", "3" ... of the apartment in the building** **+"-"** **+ dataset index number "1", "2", "3", ... if there are several data sets for the same building or apartment (indicate always "1" if only one dataset exists for a building).** *examples:* *"de-..(building identity code)...-0-2", indicates that it is a German building, that the data set is about the whole building (and not a single apartment) and that it is the second data set for this building in the data base* *"nl-..(building identity code)...-2-1" indicates that it is a Dutch building, the data set corresponds to apartment no. 2 of the building and it is the first data set for this apartment in the data base.* *Building identity code: Code system to be defined for each application or country. It is used for the data set identity code (see above). Please don't use names and addresses for reasons of data privacy protection. A very simple solution would be just to* ***special remarks to the apartment index number in the buildin***
2	indicator for building or apartment	indicator_ap		indicates, if the data set (that means the energy certificate) reflects a whole building or an apartment, see predefined values	p	 **b**: the data set is for a building p: the data set is for a part of a building (more than one apartement or a part of a non-residential building) a: the data set is for an apartement
3	status of the dataset	status_dataset		serves as an indicator for evaluation	p	**test:** dataset for test purposes only **real:** dataset for a building in the actual state **design:** dataset for a building in a future state (no information available, if it is a new building or retrofitted building) **design_new**: design data set for a new building to be erected **design_existing**: design data set for an existing building to be renovated
4	date of certification	ce_date			f	value free but format predefined: **"yyyy-mm-dd"** *for example "2006-01-24"*

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
5	status of the certificate	status_ce		see predefined values, depending on national specification		**offical:** it is an official certificate according to national regulations **nonofficial:** it is not an offical certifcate Remark: If this quantity is used, provide a definition of "official" and "nonofficial"
6	certification software	software		if applicable: software used for energy certification (according to predefined values)	p	Provide a national list of sotware tools (if the applied software is not included in the list: indicate "other")
7	qualification of energy consultant	consultant		qualification of the energy consultant who issues the energy certificate	p	**This data field is free for national definition, if necessary. Otherwise use the following code:** **a**: architect **e:** engineer (university, technical college) **c**: craftsman **s**: building owner (self-cerification) **other**: other remark: if a different definition is provided, the above given letters a,e,c,s may not be used.
8	reason of the making of the energy certificate	reason		There may be different reasons for the building owner to order an energy certificate	p	**law:** energy certificate was made because it was demanded by law or other (national) regulation (no further information available) **law_new:** energy certificate was demanded because it is a new building **law_owner:** energy certificate was demanded because the owner changed **law_tenant:** energy certificate was demanded because tenants changed **law_display:** display in public buildings **law_other:** other occasion demanded by law **incentive:** energy certificate was made because it was a prerequisite for the financial support by an energy saving incentive programme **voluntary:** energy certificate was voluntarily ordered by the building owner (= was not demanded by law or by an incentive programme)
9	data quality indicator	data_quality		If there is information available on data quality, it can be given here according to a list of predefined values. Details have to be defined on national level, if applicable.	p	to be defined for each country, if applicable

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
10	code for proposed measures	measures		in case that the energy certificate includes proposals for energy saving measures they can be indicated by a 8 digit binary code There are two possible cases to be considered in the binary code (see predefined values): 1. The data set describes a building in the actual state (status_dataset: "real"), so the proposed measures are not considered in the respective dataset (especially in the energy balance). In this case all proposed measures (also if they belong to different "packages" of proposed measures) should be indicated in the digits 1-7 and digit 8 should be set "0". 2. The data set describes a certain "package" of proposed measures (which are considered in this dataset). In this case status_dataset is "design_..", the proposed measures of this certain package should be indicated in the digits 1-7 and digit 8 should be set "1".	p	8 digit binary code: **1. digit:** thermal insulation of wall ("1" if proposed, "0" if not proposed) **2. digit**: new windows or glazing ("1" or "0", see above) **3. digit**: insulation of roof or upper floor ceiling **4. digit**: insulation of ground floor or cellar ceiling **5. digit**: modernisation of the heat supply system **6. digit**: modernisation of the cooling / air conditioning system **7. digit**: modernisiation of the lighting system **8. digit**: "1" if all proposed measures are already considered in this dataset, "0" if not e.g. "00001000" indicates, that the modernisation of the heat supply system is the only proposed measure and that this modernisation measure is not considered in this dataset
11	type of 1. national indicator	type_indicator1		In the different countries, also depending on the type of building and certificate, there are different indicators which characterise the energy performance of the building. For example the energy performance may be indicated by the total primary energy demand in kWh/m²a or just by a letter between A (very good) and J (very bad). Usually there will be more than one indicator (e.g. separate indicators for the whole building, the building envelope and the heating system). For every country a list of the most important indicators used in the energy certificates (according to EPBD implementation) has to be provided. Even if the quantity is labeled "national indicator" also other suitable kinds of indicators may be considered, e.g. internationally harmonised indicators	p	to be defined for each country (provide a list according to the scheme of predefined values)
12	value of 1. national indicator	value_indicator1		value of the above defined indicator given in the energy certificate	f	
13	type of 2. national indicator	type_indicator2		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)
14	value of 2. national indicator	value_indicator2			f	
15	type of 3. national indicator	type_indicator3		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)
16	value of 3. national indicator	value_indicator3			f	
17	type of 4. national indicator	type_indicator4		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)
18	value of 4. national indicator	value_indicator4			f	
19	type of 5. national indicator	type_indicator5		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)
20	value of 5. national indicator	value_indicator5			f	
21	type of 6. national indicator	type_indicator6		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
22	value of 6. national indicator	value_indicator6			f	
23	type of 7. national indicator	type_indicator7		similar to 1. Indicator	p	to be defined for each country (provide a list according to the scheme of predefined values)
24	value of 7. national indicator	value_indicator7			f	
B	**General Building Data**					
25	building location: city	bu_city			f	
26	building location: post code	bu_post_code			f	
27	building location: region	bu_region		if applicable, for each country a list of regions (respectively provinces, departments, Bundesländer ...) should be provided	p	according to national list of regions
28	building location: climate zone	bu_climate		if national climate zones are defined a list should be provided	p	according to national list of climate zones
29	building erection year/period: first year	year1_building	a (year)	year of erection (finishing) of the building. If not the concrete year but the approximate time period is known (e.g. building was erected some time between 1900 and 1920) insert here the first year of this time intervall (in the example: 1900)	f	For example the year 2000 is indicated "2000" (and not: "00") In case of planned buildings: indicate planned erection year or period (Than in any case also indicate status_dataset: "design")
30	erection year/period : last year	year2_building	a (year)	If the year of erection is exactly known insert it here a second time. If it is not exactly known insert the last year of erection period (in the example: 1920)	f	
31	main building utilisation	main_utilisation		main utilisation of the building.	p	see classifiation list for "Utilisation Types" A more detailed national definition of utilisation types is possible. If so, provide a definition list. This new definition must build upon the old one according to the following scheme: Add a line to the old definition and then add the detailed specification. Always keep the old definition as an option. Example: old: school new: school: school (no further information available) school_primary: primary school school_secondary: secondary school school_vocational: vocational school school_other: other school (neither primary nor secondary)
32	fraction of main building utilisation	f_main		fraction of the building which is assigned to the main building utilisation (value between 0 and 1). The fraction may be defined according to a suitable quantity of building size, if possible according to a suitable definition of conditioned floor area (see below) or building volume.	f	
33	second building utilisation	second_utilisation		second utilisation of the building	p	see classifiation list for "Utilisation Types"
34	fraction of second building utilisation	f_second		fraction of the building which is assigned to the second building utilisation.	f	
35	third building utilisation	third_utilisation		third utilisation of the building	p	see classifiation list for "Utilisation Types"
36	fraction of third building utilisation	f_third		fraction of the building which is assigned to the third building utilisation. Remark: If there are up to 3 building utilisations: f_main + f_second + f_third = 1, if there are more than 3: f_main + f_second + f_third < 1	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
37	conditioned reference floor area	A_C_national	m²	reference area determined according to national EPBD regulations Since different definitions exist in the different countries this area is used only for national evaluation. Please give input for the following areas in addition. Only if some area type is not available it may rest empty. Of course the national reference area may be identical with one of the following areas. general remark: "conditioned" building area (or building volume) refers here and in the following to that part of a building which is supplied by a heating system and/or an air-conditioning system. (air-conditioning means here at least cooling, not only ventilation)	f	
38	conditioned gross floor area	A_C_extdim	m²	conditioned floor area calculated on the basis of external dimensions (measured to the outside surface of external walls)	f	
39	conditioned floor area	A_C_intdim	m²	conditioned floor area calculated on the basis of internal dimensions (measured to the inside surface of external walls) The floor area may be the gross internal area (= total building area measured inside external walls) or the net internal area (= total building area measured inside external and internal walls) - since the difference is small we don't distinguish between both. The conditioned area is generally equal with the heated area or with the air-conditioned area, dependend of which is the bigger one.	f	
40	conditioned useful floor area	A_C_use	m²	section of the conditioned net floor area primarily dedicated to the utilisation of the building, excluding functional and circulation areas (excluding e.g. stair cases in all buildings, corridors in non-residential buildings). In office buildings the conditioned useful floor area is equivalent to the net lettable area.	f	
41	conditioned living area	A_C_living	m²	section of the conditioned net floor area inside of the appartments of the building (only to be filled in for buildings which are completely or at least partly used as residential buildings)	f	
42	conditioned building volume	V_C	m³	conditioned volume of the building (external dimensions)	f	
43	value of further indicator of building size	building_size		value of the further indicator of building size defined in the classification list (to be related to the main building utilisation)	f	
44	fraction of the conditioned floor area supplied with a heating system	f_heating		fraction of the conditioned floor area that is supplied by a heating system (normally f_heating = 1, unless the air-contitioned area is bigger than the heated area). If none of the above mentioned floor areas is available, the fraction may also be related to the conditioned building volume	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
45	fraction of the conditioned floor area supplied with a mechanical ventilation system	f_mecvent		fraction of the conditioned floor area that is supplied by a mechanical ventilation system (may be > 1 if e.g. an underground parking is included in the building). If none of the above mentioned floor areas is available, the fraction may also be related to the conditioned building volume	f	
46	fraction of the conditioned floor area supplied by a cooling / air-conditioning system	f_ac		fraction of the conditioned floor area that is supplied by a cooling or air-conditioning system If none of the above mentioned floor areas is available, the fraction may also be related to the conditioned building volume	f	
47	number of storeys	n_storey		number of conditioned floors/storeys of the building (without attic storey, without cellar) (see below) If there is a completely conditioned underground storey it is not considered here (In this case there is a completely conditioned cellar, so cellar_cond=c, see below). If there are more than one conditioned underground storeys the number exceeding 1 has to be considered here (add them to the number of storeys above ground).	f	
48	conditioned part of the attic storey	attic_cond		see predefined values	p	**c**: completely conditioned **p**: partly conditioned **n**: not conditioned
49	conditioned part of the cellar or underground floor	cellar_cond		see predefined values only areas which are heated and/or air-conditioned (supplied with at least a cooling system), e.g. no underground parking	p	**c**: completely conditioned **p**: partly conditioned **n**: not conditioned
50	number of apartments in the building	n_apartments		number of apartments in residential or mixed buildings	f	
51	situation of attached neighbour buildings (or apartments)	attached_neighbours		see "predefined values".	p	if the dataset is for a building indicate: b**_alone**: stand-alone building / no neighbour b**_n1**: part of a set of connected buildings, with one neighbour (e.g. building at the end of a row) b**_n2**: part of a set of connected buildings, with two or more neighbours (e.g. building inside a row or a block, or building as part of a complicated complex) If the dataset is for an apartment or another part of the building, indicate: **a_top:** apartment on top of the building (beneath the roof or a non-heated attic) **a_bottom**: apartment at the bottom of the building (above soil or a non-heated cellar) **a_top_bottom:** apartment beneath roof/attic and above soil/cellar **a_inner**: an "inner" apartment, that means neither on top nor at the bottom of the building (= apartment is adjacent to conditioned rooms above and below)

No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
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52	further building type indicator	building_indicator		according to national conditions further information on the buildings may be given (e.g. brick wall building, wood building, panel building) if applicable. If the indicator is used, this should be carried out according to the scheme of "predefined values". That means a list of predefined values should be defined on national level.	p	to be defined for each country, if applicable
53	Indicator for indoor environmental quality	ieq		to be defined on national level, if applicable	p	to be defined, if applicable
C	**Building Envelope Data**			general remark: building envelope means all building elements/surfaces which seperate the heated/conditioned building interior from the building exterior. So all those elements must be assigned to either "walls", "roofs and upper floor ceilings", "basement areas" or "windows". In case of existing buildings often there are no exact but only estimated values available (e.g. element areas or U-values). Nevertheless they should be inserted here. Heat transfer coefficients (U-values) do not include the effects of thermal bridges at the edge of the elements (that means where they are adjacent to other elements: For example thermal bridges where walls are connected to the roof or to a balcony). Those thermal bridges are only considered in H_bridges. On the other hand thermal bridges inside the elements are usually included. For example in case of windows the U-value is a mean value considering the glasing, the frame and the thermal bridges at the connection of glasing and frame (but the thermal bridges of the connection of window and wall are not considered in the U-value).		
	complete building envelope:					
54	total transmission heat transfer coefficient of the building	H_transmission	W/K	Total heat transfer coefficient of the building envelope according to transmission losses = Transmission losses of the building in Watt per Kelvin temperature difference between inside and outside air = Sum of the product U-value x area x correction factors for all surfaces of the building envelope + Heat transfer coefficient of thermal bridges. The correction factors take into account that temperature differences are lower if the elements of the building envelope are not against outside air but against ground or a cold room, for example. The value relates to the existing situation of the building (not a possible prescribed value according to national regulation)	f	
55	transmission heat transfer according to thermal bridges	H_bridges	W/K	Heat transfer coefficient of the building's heat bridges (should also be included in the total transmission heat transfer coefficient of the building H_transmission)		
	walls:					

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
56	Total wall area	A_wall	m²	area of opaque vertical elements ("walls") of the building envelope (not windows), exterior surface excluding the surface of windows in the wall. the orientation of the walls (e.g. north/south) does not play a role here: add all surfaces and give only one value. Include doors if they are not transparent. According to the above "general remark" only walls with heat losses are to be considered (e.g. no walls adjacent to heated neighbouring buildings)	f	
57	Average U-value of wall	U_wall	W/(m²K)	weighted U-value of all walls, U_wall = (U_wall_1 x A_wall_1 + U_wall_2 x A_wall_2 + ... + U_wall_n x A_wall_n x f_wall_n) / (A_wall_1 + A_wall_2 + ... + A_wall_n) Here are : U_wall_i = Uvalue of wall type i ; A_wall_i = total surface of wall type i	f	
58	fraction of total wall area against outside air	f_wall_air		walls may be against outside air, other non-heated rooms (e.g. cellar) or solid. Here the fraction of the total wall area adjacent to outside air is to be indicated between 0 and 1. If, for example, 80 % of the total wall area is against outside air and 20 % against solid, indicate here: 0,8.		
59	area of representative wall 1	A_wall_1	m²	area of the largest wall type. Walls with the same or similar U-values should be seen as one wall, independent of their orientation. "Largest wall type" means wall type with the biggest surface area.	f	
60	U-value of representative wall 1	U_wall_1	W/(m²K)	U-value (thermal transmittance) of walls 1	f	
61	area of representative wall 2	A_wall_2	m²	area of the second largest wall type.	f	
62	U-value of representative wall 2	U_wall_2	W/(m²K)	U-value (thermal transmittance) of walls 2	f	
63	area of representative wall 3	A_wall_3	m²	area of the third largest wall type	f	
64	U-value of representative wall 3	U_wall_3	W/(m²K)	U-value (thermal transmittance) of walls 3	f	
	windows:					
65	Total window area	A_window	m²	similar as for walls, now for windows please note: window area = glasing + frame !! Do not deal with frames separately (e.g. by defining them as walls). Doors may be treated as windows or as walls.	f	
66	average U-value of windows	U_window	W/(m²K)	similar as for walls	f	
67	average g-value of windows	g_window		g-value = total solar energy transmittance of glazing (for radiation perpendicular to the glazing), here: weighted value according to the area of different windows	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
68	type of shading systems	type_shading		Indicate shading systems which are applied to avoid overheating in summer. See predefined values (binary code)	p	6 digit binary code: **1.digit:** "1" if the building is completely equipped with active or passive shading systems, "0" if not ("completely" means: indicate "1" only if a shading of all or almost all of the relevant windows can be attained. Relevant windows are those which might cause overheating in summer (depending on building type and climate, may for example be without northern windows). **2. digit**: application of shutters/roller blinds outside the windows or between the window panes **3. digit:** application of other movable outside shading systems **4. digit:** application of passive (non movable) outside shading systems (may be non movable shading fins or balconies, for example) **5. digit:** application of window roller blinds inside the rooms **6. digit:** considerable shading is provided by the building's surrounding (e.g. by trees or neighbouring buildings)
69	window area oriented south	A_window_south	m²	if there are windows with exact south-west or south-east orientation, assign 1/2 of their area to "south" and 1/2 to "west" or "east", respectively. Orientations north-west and north-east are treated in the same way.	f	
70	window area oriented west	A_window_west	m²		f	
71	window area oriented north	A_window_north	m²		f	
72	window area oriented east	A_window_east	m²		f	
73	area of representative window 1	A_window_1	m²	area of the largest window type, similar as for walls, again combine windows with similar U-values, independent of their orientation.	f	
74	U-value of representative window 1	U_window_1	W/(m²K)		f	
75	area of representative window 2	A_window_2	m²		f	
76	U-value of representative window 2	U_window_2	W/(m²K)		f	
					f	
	roofs and upper floor ceilings			roof means all elements of the building envelope at the top of the building, roofs and upper floor ceilings both have to be considered here (but only if they are part of the "heat exchanging" building envelope)		
77	total roof area	A_roof	m²	total area of roofs and upper floor ceilings (in case of tilted roofs: actual area - not the footprint)		
78	average U-value of roof elements	U_roof	W/(m²K)	similar to walls		
79	type of representative roof element 1	type_roof_1		type of the larges roof type, again combine elements with the similar U-values	p	**tr**: tilted roof element **fr**: flat roof element **uc**: upper floor ceiling **r**: roof element (unknown if tilted or flat)
80	area of representative roof element 1	A_roof_1	m²	similar to walls	f	
81	U-value of roof element 1	U_roof_1	W/(m²K)	similar to walls	f	
82	type of representative roof element 2	type_roof_2			p	see roof 1
83	area of roof element 2	A_roof_2	m²		f	
84	U-value of roof element 2	U_roof_2	W/(m²K)		f	

No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
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	basement areas:			basement means here all horizontal elements of the thermal building envelope with a floor (that means: where people walk upon). e.g. cellar ceilings are to be considered as well as the basement floor against ground (as far as they are part of the "heat exchanging" building envelope). Floors which are adjacent to outdoor air ("pilotis") are here also to be considered (although actually they are of course in an upper storey)		
85	total basement area	A_basement	m²	similar to walls		
86	average U-value of basement	U_basement	W/(m²K)	similar to walls		
87	area of representative basement element 1	A_basement_1	m²	similar to walls, largest basement type	f	
88	U-value of basement element 1	U_basement_1	W/(m²K)		f	
89	area of representative basement element 2	A_basement_2	m²	second largest basement type	f	
90	U-value of basement element 2	U_basement_2	W/(m²K)		f	
D	**System Data**					
	heat generation for space heating and hot water supply					
91	degree of centralisation of 1. heat generator	centralisation_heatgen_1		see predefined values. If possible the main system of heat generation in the building (that one which produces the largest amount of heat) should be chosen as first heat generator	p	**dh**: district heating **cb**: central system for the building **ap**: system for each apartment (or for a group of rooms e.g. in office buildings) (in case of one-appartment buildings use cb) **rm**: heat generators in the rooms (e.g. stoves, small electric hot water devices) **other**: other
92	type of 1. heat generator	type_heatgen_1		type of main heating system, see "predefined values". Heat generators of the same type are combined, e.g. if a building is heated by 6 stoves in different rooms they are all united in type_heatgen_1: st (stoves)	p	see "classification lists": heat generator types
93	energy carrier of 1. heat generator	ecarrier_heatgen_1		energy carrier see "predefined values"	p	see sheet "classification lists": energy carrier type
94	use of 1. heat generator	use_heatgen_1		A code indicating the use of the heat generation system (Is the system supplying heat for heating or hot water?). See predefined values. If the heat generator also produces heat (or in case of a "reversible" system even cold) for the air conditioning/cooling system this will be considered below (see quantities assigned to air conditioning)	p	binary code **1. digit**: heating **2. digit**: hot water => 10: only heating, no hot water 11: heating and hot water 01: hot water, not heating
95	erection year/period of 1. heat generator: first year	year_1_heatgen_1	a (year)	Erection year of the heat generator. If it is not exactly known, but the approximate time period is know, insert here the first year of this time intervall (e.g. 1970 if the heat generator was installed some time between 1970 and 1980). If a part of the heat generator was modernised (e.g. boiler installed 1980, new burner installed 1995) insert here the installation year of the main part of the heat generator (in this case: 1980).	f	For example the year 2000 is indicated "2000" (and not: "00")

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
96	erection year/period of 1. heat generator : last year	year_2_heatgen_1	a (year)	If the installation year is exactly known, insert it here a second time. If only the approximate period is known, insert here the last year of that period (e.g. 1980 for a heat generator that was installed between 1970 and 1980).	f	
97	degree of centralisation of 2. heat generator	centralisation_heatgen_2		similar to 1. heat generator. As far as possible the second largest heat generator (that one which produces the second largest amount of heat) should be considered here.	p	
98	type of 2. heat generator	type_heatgen_2			p	
99	energy carrier of 2. heat generator	ecarrier_heatgen_2			p	
100	use of 2. heat generator	use_heatgen_2			p	
101	degree of centralisation of 3. heat generator	centralisation_heatgen_3		similar to 1. heat generator here: third largest generator (and so on)	p	
102	type of 3. heat generator	type_heatgen_3			p	
103	energy carrier of 3. heat generator	ecarrier_heatgen_3			p	
104	use of 3. heat generator	use_heatgen_3			p	
105	degree of centralisation of 4. heat generator	centralisation_heatgen_4		similar to 1. heat generator	p	
106	type of 4. heat generator	type_heatgen_4			p	
107	energy carrier of 4. heat generator	ecarrier_heatgen_4			p	
108	use of 4. heat generator	use_heatgen_4			p	
109	district heating generation types	types_dh		In case there is district heating, specifiy the type of heat generation if information is available (see predefined code system)	p	5 digit code. Insert "0" if the type of heat generation is not used, "1" if it is used (contribution to heat generation unknown or up to 50 %) and "2" if it is the dominant heat generator (> 50 % of heat production) **1. digit**: boilers **2. digit**: cogeneration systems **3. digit**: solar thermal systems **4. digit**: fuel driven heat pumps (e.g. gas motor heat pump) 5**. digit**: others e.g. code 12000 means that more than 50 % of district heat is produced in CHP engines and the rest is produced in boilers
110	district heating fuels	fuels_dh		fuels used for heat generation in the district heating system (if applicable)	p	5 digit code. Insert "0" if the fuel is not used, "1" if it is used (share of fuel demand unknown or up to 50 %) and "2" if the share of this fuel (measured by the upper calorific value) is above 50 %. **1. digit**: gas **2. digit**: oil **3. digit**: coal **4. digit**: biomass **5. digit**: others e.g. 100100 means that the heat generators of the district heating network are using gas and biomass and that it is not known which of these two fuels dominates
	heating system: control and heat distribution					

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
111	type of heat distribution for space heating	type_distribution_heating		heat distribution means the heat transport from a central heat generator (which supplies more than one room) to the rooms, see predefined values	p	**water**: hot water serves as the heat carrier of the heating system (e.g. supplying radiators or a floor heating system) **air**: air as heat carrier **ref**: refrigerant as heat carrier **no**: no heat carrier (e.g. stoves) **mixed**: mixed system (e.g. combination of hot water and air heating system)
112	insulation grade of distribution pipes of the space heating system outside the heated part of the building	insulation_distribution_heating		The insulation grade may be "low", "medium" or "good". Because the available data may be very different there are two possible ways to describe the insulation grade: a) by the thermal transmittance U_L b) by the insulation layer thickness d If national regulations use fixed categories for the classification of pipe insulation instead of U-values or insulation thickness, please dedicate each of these categories to one of the predefined values "low", "medium" and "high".	p	a) If the linear thermal transmittance U_L [W/(m·K)] is known: **high:** $U_L \leq$ 0,25 W/(m·K) **medium:** $U_L \leq$ 0,5 W/(m·K) **low:** else b) If the insulation layer thickness d [mm] is known: **high:** $d \geq 0{,}75 \cdot d_{Pipe}$ **medium:** $d \geq 0{,}25 \cdot d_{Pipe}$ **low:** else If a relevant fraction of the distribution system is not insulated indicate "low".
113	alignment of main supply pipes for heating distribution	align_distribution_heating		alignment of horizontal main supply pipes zone "V" (distribution to the shafts)of and of vertical main supply pipes zone "S" (vertical shafts) according to prEN 15316-2-3. (This specification is an indicator for the not recoverable heat losses.) see predefined values		**outside_central**: horizontal mainly outside of the thermal envelope (e.g. under the cellar ceiling), vertical central strings inside the building **outside_walls:** horizontal mainly outside of the thermal envelope (e.g. under the cellar ceiling), vertical alignment near the outer walls of the building. **inside_central**: horizontal mainly inside of the thermal envelope, vertical central strings inside the building **inside_walls**: horizontal mainly inside of the thermal envelope, vertical alignment near the outer walls of the building
114	control of the heat emission	control_heat_emission		see predefined values	p	**c**: control of the heat emission by the building users is possible (e.g. by valves at the radiators), no further infomation available **c_simple**: simple system: heat emission is directly adjusted by the users (e.g. by simple non-thermostatic valves) **c_th**: user control by thermostatic valves or other thermostatic control equipment **c_complex**: user control by a complex system (more complex than just thermostatic control, e.g. including timers) or by a building management system **nc**: there is no heat emission control (e.g. no valves at the radiators)
115	heat distribution set temperature	heat_set_temperature	degrees Celsius	maximum supply temperature of the heat distribution (at the coldest day of the year)	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
116	control of heat distribution temperature	heat_temperature_control		see predefined values	p	**constant:** constant heat distribution temperature (no control) **control:** controlled heat distribution temperature (no further information) **control_out:** control of heat distribution temperature only according to outdoor air temperature **control_other_simple**: other simple control of the heat distribution temperature (by only one set value, e.g. control of distribution temperature according to indoor air temperature) **control_comp:** more complex control system for the heat distribution temperatur (more than one set value, e.g. indoor as well as outdoor air temperature or control by a building management system)
	hot water: heat distribution					
117	type of heat distribution for hot water supply	type_distribution_hotwater		see predefined values	p	**circ**: circulation system: hot water is pumped through a loop (leading from the heat generator or storage tank through the building and back) to supply the water taps quickly with hot water when they are opened. **no_circ**: no circulation system: the water taps are supplied by the heat generator or storage tank with a one-way pipe system (not by a loop).
118	insulation grade of distribution pipes of the hot water system	insulation_distribution_hotwater		equal to space heating pipes, see above	p	equal to space heating pipes, see above
119	alignment of horizontal main supply pipes for hot water distribution	align_h_distribution_hotwater		alignment of horizontal main supply pipes for hot water distribution zone "V" (distribution to the shafts) according to prEN 15316-3-2. (This specification is an indicator for the not recoverable heat losses.) see predefined values		**outside**: mainly outside of the thermal envelope (e.g. under the cellar ceiling) **inside**: mainly inside of the thermal envelope
	ventilation					
120	type of mechanical ventilation system	type_mecvent		This quantity refers to the operation of mechanical ventilation systems. If the ventilation system also serves as the heating system (using air as the heat carrier) this must be indicated above in type_distribution_heating. See predefined values	p	**-**: no mechanical ventilation system (also exhaust air systems only for short time use in bath and/or kitchen are to be indicated as "no mechanical ventilation system") **mv**: mechanical ventilation system, no further information available **mv_ex**: exhaust air ventilation system **mv_supex**: supply/exhaust air ventilation system, no further information available **mv_supex_he**: supply/exhaust air ventilation system with heat exchanger(s) for heat recovery and/or cold recovery **mv_supex_nhe**: supply/exhaust air ventilation system without heat exchangers remark: if heat recovery is carried out by a heat pump, this is not a "heat exchanger". The heat pump has to be indicated as a heat generator separately (see above)

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
121	air change of the mechanical ventilation system	airchange	1/h	design value of the air change rate of the building's mechanical ventilation system in m³ per hour.	f	
122	control of air change	control_air		see predefined values	p	**constant:** air change rate is constant during operation **control:** controlled air change rate (control during operation of the system by the users and/or an automatic control system)
	Air Conditioning/Cooling (AC)					
123	use of air conditioning / cooling system	use_ac		see predefined values.	p	binary code **1. digit**: cooling **2. digit**: dehumidification **3. digit**: humidification e.g. "110" means cooling with dehumidification, but without humidification
124	cold transport to the rooms	type_distribution_ac		see predefined values	p	**no**: no cold distribution (because cold is produced in the rooms) **air:** cold air is transferred to the rooms **water**: cold water is transferred to the rooms **ref**: cold transfer by a refrigerant **mixed**: mixed system
125	cold emission into the rooms	emission_ac		see predefined values	p	**air:** cold air is directly injected into the room **he**: a heat exchanger is applied to transfer cold to the room (no further information available) **he_fan**: the room air is transferred to the heat exchanger with the help of a fan (e.g. fan-coil unit) **he_area**: a large area heat exchanger without a fan is applied (the heat exchanger is usually placed at the surface or inside of a wall or ceiling) **he_other:** other system with a heat exchanger **mixed:** mix of cold air injection and heat exchangers **other:** other system
126	degree of centralisation of the 1. cold generation system	centralisation_cold_1		see predefined values	p	**dc**: district cooling **cb**: central cooling for the building (e.g. cold generation in a central chiller) **ap**: system for an apartment or for a group of rooms (e.g. in an office building) **rm**: cooling/air conditioners for single rooms (e.g. wall units, split unit heat pumps) **mixed**: mixed **other**: other

	DATAMINE DATA STRUCTURE					
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No.	**data field name**	**data field label**	**unit**	**definition**	**input type** f: free p: predefined	**predefined values**
127	type of 1. cold generation system	type_cold_1		type of the 1. cold generation engine (If there is more than one cold generator that one which produces the largest amount of cold should be indicated here). If a "reversible" process driven by a compression engine is applied (that means that the system is also operated as a heat pump for production of heat for space heating and/or hot water supply) the system must also be considered in the list of heat generators for space heating and hot water supply (and maybe also in the below list of heat generators for the air conditioning/cooling system) separately. This is also the case if the motor which drives the compression engine is a cogeneration system (exhaust heat is used for space heating, hot water or air conditioning/cooling).	p	**comp:** compression engine, type unknown **comp_ncog_nrev:** compression engine, driven by a non-cogeneration motor (without exhaust heat use), non-reversible cold generation cycle process (= only operated for air conditioning and cooling in summer, not producing heat for space heating or hot water supply) **comp_cog_rev:** compression engine, driven by a cogeneration motor (with exhaust heat use), reversible process (=also producing heat for space heating and hot water supply) **comp_ncog_rev:** compression engine, driven by a non-cogeneration motor, reversible process **comp_cog_nrev:** compression engine, driven by a cogeneration motor, non-reversible process **heat**: heat driven cold production (eg. absorption process, adsorption process) **dc**: district cold **passive**: cold production without using a cold generation engine (use of natural cold sources, "passive cooling", e.g. natural ventilation, evaporative cooling, ground cooling) **other**: other
128	cold source of the 1. cold generation system	source_cold_1		cold source = heat sink of the ac system	p	**air**: outdoor-ambient air (all other than via a cooling tower) **ct**: outdoor-ambient air via a cooling tower **water**: ground water, water from a lake or river **soil**: soil **dc**: district cold **other**: other
129	energy carrier of the 1. cold generation system	ecarrier_cold_1		If the cold generation process is driven by a compression engine, insert the energy carrier used by the motor. If the process is driven by heat, specify the information according to the predefined values. If there is passive cooling no more specific information is necessary	p	If the cold generation process is driven by a compression engine insert the energy carrier used by the motor according to the classification list **"energy carrier types**". If the cold generation process is driven by heat or in case of district cold or "passive" cooling insert again: **heat**, **dc** or **passive**
130	erection year/period of 1. cold generation system: first year	year_1_cold_1	a (year)	similar to erection year/period of 1. heat generator	f	
131	erection year/period of 1. heat generator : last year	year_2_cold_1	a (year)	similar to erection year/period of 1. heat generator	f	
132	degree of centralisation of the 2. cold generation system	centralisation_cold_2		similar to 1. cold generation system	p	
133	type of 2. cold generation system	type_cold_2		similar to 1. cold generation system	p	
134	cold source of the 2. cold generation system	source_cold_2		similar to 1. cold generation system	p	
135	energy carrier of the 2. cold generation system	ecarrier_cold_2		similar to 1. cold generation system	p	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
136	type of 1. heat generator used by the air conditioning/cooling system	type_heatgen_ac_1		Heat generators may be used by the ac system for the driving of the cold generation cycle (e.g. in an absorption process) or for the energy input to the humidification and dehumidification process. Also steam generators should be indicated here.	p	insert the type of heat generator from the classification list "heat generator types". If it is a steam generator insert: "steam generator"
137	use of 1. heat generator used by the air conditioning/cooling system	use_heatgen_ac_1		see predefined values (binary code). If the heat generator is also used for space heating and/or hot water supply this has to be indicated in the digits 4 and 5. The heat generator must than be included in the above list of heat generators for space heating and hot water supply separately.	p	binary code **1. digit**: cold generation **2. digit**: dehumidification **3. digit**: humidification **4. digit**: space heating **5. digit**: hot water supply
138	energy carrier of the 1. heat generator used by the air conditioning/cooling system	ecarrier_heatgen_ac_1		energy carrier of heatgen_ac_1	p	according to classification list "energy carrier types"
139	type of 2. heat generator used by the air conditioning/cooling system	type_heatgen_ac_2		similar to heatgen_ac_1	p	
140	use of 2. heat generator used by the air conditioning/cooling system	use_heatgen_ac_2		similar to heatgen_ac_1	p	
141	energy carrier of the 2. heat generator used by the air conditioning/cooling system	ecarrier_heatgen_ac_2		similar to heatgen_ac_1	p	
142	insulation grade of distribution pipes and/or ducts of the cooling/air conditioning system	insulation_distribution_ac		quality of insulation of the pipes and/or ducts which distribute cold water or cold air. See predefined values	p	the insulation grade may be one of the three levels **low**, **medium or high** (general criteria for the three levels are not yet defined: So if used, documentate your definition)
143	set temperature of the cold distribution system	cold_set_temperature	degrees Celsius	design value (lowest temperature) of the cold distribution network	f	
	Pump efficiency					
144	information on pump efficiency	eff_pump		information on the energy efficiency of water pumps used by the systems for heating, hot water supply and/or cooling/air-conditioning	p	**c:** automatic control of all pumps (or most of the pumps, more than 75 %). E.g. power control dependent of pressure difference. **nc:** no automotic control of pumps (or only less than 25 % are provided with a control system) **mixed:** 25 % - 75 % of the pumps are automatically controlled (also indicate "mixed" if you know that it is mixed but do not know the exact percentage)
	Lighting					
145	fraction of high efficiency lighting	f_higheff_lighting		fraction of the conditioned part of the building that is supplied by high efficiency lighting systems. The fraction should be related to the floor area, if this is not possible another suitable and comparable quantity (e.g. number of rooms) may be applied. High efficiency lighting systems are here defined by a luminous efficiency (=luminous flux in lumen per installed electric power in W) of more than 50 lm/Watt. The luminous efficiency of ordinary electric light bulbs is about 12 lm/W, of halogene lights about 12 lm/W and of energy saving compact fluorescent lights about 77 lm/W)	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
146	electric power of the lighting system	P_lighting	W	total electric power of the complete lighting system of the conditioned rooms (all lamps + control equipment of the lighting system) in Watt (W)	f	
147	average illuminance of the building	illuminance	lx	average illuminance in lux (lx), 1 lux = 1 lumen/m²: weighted average of the design value for all rooms according to their conditioned area	f	
148	control of the lighting system	control_lighting		see predefined values	p	**standard**: standard control (by manually operated switches) **auto_small**: automatic control (by motion detectors and/or automatic brightness control or even more elaborated systems up to complex building management systems) in a smaller part of the building (up to 50 % of the building) **auto_large**: automatic control in the largest part (more than 50 %) of the building
	Completeness of information					
149	completeness indicator of the heat/cold supply system	completeness_sys		binary code showing if some important information is complete or not. For example if there are 5 types of heat generators for heating and hot water supply they can not all be considered in the above quantities because there are only 4 types foreseen. So in that case the first digit of the binary code must be set "0"	p	"1" for complete, "0" for not complete **1. digit**: "1" if all relevant heat generation systems for space heating and hot water supply were considered, "0" if not **2. digit**: "1" if all relevant cold generation systems were considered, "0" if not **3. digit**: "1" if all relevant heat generation systems for air conditioning/cooling were considered, "0" if not
E	**Calculated Energy Demand (Asset Rating)**					
	Methods and boundary conditions					
150	calculation method of energy demand for heating and hot water	method_heat_hw		For each country a list and a short description of national calculation methods for the making of energy certificates by asset rating has to be provided. The applied method has to be indicated here by a string or symbol defined in the respective national list.	p	to be defined for each country
151	method of energy demand calculation for air conditioning / cooling	method_ac		see above	p	to be defined for each country
152	calculation method for electric energy demand of lighting and (if applicable) other electric energy demand	method_light		see above	p	to be defined for each country
153	heating climate index of the calculated energy demand	type_climate_h_c		Heating climate index describing the climate date which are applied during asset rating. Usually heating degree days. If possible the same type of index should be used as for operationa rating, if both is carried out (see type_climate_h_m in section F).	p	to be defined on national level according to the applied method of asset rating. Indicate detailed information on the type of climate indicator.
154	value of the heating climate index (calculated energy demand)	climate_h_c		Indicate the climate index value on which the asset rating (that means also the below given numbers of the energy balance calulation) are based.	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
155	other climate index of the calculated energy consumption	type_climate_ot_c		If there is a cooling/air conditioning system this index should describe the respective climate conditions. If not, a second type of heating climate index (e.g. heating days) may be shown here. If possible the same type of index should be used as for operational rating, if both is carried out (see type_climate_ot_m in section F).	p	to be defined on national level according to the applied method of asset rating. Indicate detailed information on the type of climate indicator.
156	value of the other climate index (calculated energy demand)	climate_ot_c		Indicate the climate index value on which the asset rating (that means also the below given numbers of the energy balance calulation) are based.	f	
	Energy demand for heating and hot water supply					
157	gross heating energy demand of the building	Q_H_gross	kWh/a	heat energy demand of the building = heat energy to be supplied to the building to cover transmission and ventilation losses minus solar and other internal heat gains. Q_H does not include losses of the heating system. "Gross" means that the energy input by ventilation heat recovery is also not considered.	f	
158	net heating energy demand of the building	Q_H_net	kWh/a	net heat energy demand (considering the contribution of a ventilation heat recovery system): Q_H_net = Q_H_gross - Q_V_recovery where Q_V_recovery is the heat recovery by the ventilation system during the heating period (only heat recovery by an air-to-air heat exchanger (heat pumps and other air heating devices are indicated as heat generators and not considered here). If there is no heat recovery by heat exchangers: Q_H_net = Q_H_gross	f	
159	heat losses of the space heating caused by non-ideal heat emission control	Q_H_ce	kWh/a	heat emission losses of the space heating: losses according to the way of heat emission in the rooms; in the respective standards (e.g. prEN 15316-2-1) one assumes that radiators with low-standard valves result in higher room temperatures than those with high-standards thermostatic valves. Those higher temperatures can be expressed in terms of energy losses.)	f	
160	distribution losses of the heating system	Q_H_d	kWh/a	Heat distribution losses of the heating system	f	
161	storage losses of the heating system	Q_H_s	kWh/a	Storage heat losses of the heating system If there is combined storage for heating and hot water consider all losses in the hot water system (and not here). If storage is closely related to one of the spaceheaters the losses may be considered as a reduction in Q_out of the spaceheater (and then not be indicated in Q_H_S). In this case Q_out of the spaceheater is the output of the storage tank which is supplied by the spaceheater. At any rate a double counting of energy storage losses is to be avoided		
162	hot water energy demand of the building	Q_W	kWh/a	hot water energy demand (without distribution losses)	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
163	hot water distribution losses	Q_W_d	kWh/a	heat distribution losses of the hot water system	f	
164	hot water storage losses	Q_W_s	kWh/a	heat losses of hot water storage If storage is closely related to one of the waterheaters the storage losses may be considered in Q_out of the waterheater (and then not be indicated in Q_W_s). In this case Q_out of the spaceheater is the output of the storage tank which is supplied by the waterheater	f	
165	net heat output of heatgen 1 (heat generation system 1) for space heating and hot water supply	Q_out_heatgen_1	kWh/a	net heat output of heatgen 1 (= heat generation system 1, see above) net heat generation: not including generation losses Only the heat output for space heating and/or hot water supply is to be considered here. If the heater is also used for the air conditioning/cooling system the assigned energy output is not considered here.	f	
166	net heat output of heatgen 1 for space heating	Q_out_heatgen_1_h	kWh/a	heat produced by heatgen 1 which is used for space space heating If heat is only produced for the heating system the value will be identical to Q_out_heatgen_1	f	
167	energy input to heatgen 1 (for space heating and hot water supply)	Q_in_heatgen_1	kWh/a	energy input to heatgen 1 for space heating and hot water supply. Energy input is quantified according to energy carrier used for heat generation: ecarrier_heatgen_1 (amount of electric energy if the energy carrier is electricity, upper calorific value if the energy carrier is a fuel, energy content of the heat if it is district heating). Attention: Only the energy input for heat generation should be indicated here (not the auxiliary energy e.g. for control equipment, pumps and fans). Only the energy input used for space heating and hot water supply is to be considered. If the heater is also producing heat for the air conditioning / cooling system the assigned energy input is not to be considered here. If heatgen 1 is a cogeneration engine consider here only that part of the energy input that is assigned to space heating and hot water supply according to the applied calculation method (that means: do not consider that part of the energy input that is assigned to the production of electric or mechanic energy)	f	
168	energy input to heatgen 1 for space heating	Q_in_heatgen_1_h	kWh/a	similar to Q_in_heatgen_1, but here only the amount of energy input assigned to space heating is to be considered	f	
169	net heat output of heatgen 2 (heat generation system 2) for space heating and hot water supply	Q_out_heatgen_2	kWh/a	similar to heatgen 1	f	
170	net heat output of heatgen 2 for space heating	Q_out_heatgen_2_h	kWh/a		f	
171	energy input to heatgen 2 (for space heating and hot water supply)	Q_in_heatgen_2	kWh/a		f	
172	energy input to heatgen 2 for space heating	Q_in_heatgen_2_h	kWh/a		f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
173	net heat output of heatgen 3 (heat generation system 3) for space heating and hot water supply	Q_out_heatgen_3	kWh/a	similar to heatgen 1	f	
174	net heat output of heatgen 3 for space heating	Q_out_heatgen_3_h	kWh/a		f	
175	energy input to heatgen 3 (for space heating and hot water supply)	Q_in_heatgen_3	kWh/a		f	
176	energy input to heatgen 3 for space heating	Q_in_heatgen_3_h	kWh/a		f	
177	net heat output of heatgen 4 (heat generation system 4) for space heating and hot water supply	Q_out_heatgen_4	kWh/a	similar to heatgen 1	f	
178	net heat output of heatgen 4 for space heating	Q_out_heatgen_4_h	kWh/a		f	
179	energy input to heatgen 4 (for space heating and hot water supply)	Q_in_heatgen_4	kWh/a		f	
180	energy input to heatgen 4 for space heating	Q_in_heatgen_4_h	kWh/a		f	
181	auxiliary electric energy of the heating system	Q_H_aux	kWh/a	electric auxiliary energy related to heating, e.g. for pumps, control equipment, ...	f	
182	auxiliary electric energy of the ventilation system	Q_V_aux	kWh/a	electric auxiliary energy related to the ventilation system, e.g. for fans, control equipment, ... If the ventilation system is closely connected to an air conditioning system and the auxiliary energy demand of ventilation can not be quantified separately: Set Q_V_aux=0 and count the auxiliary energy in the air conditioning system below.	f	
183	auxiliary electric energy of the hot water system	Q_W_aux	kWh/a	electric auxiliary energy related to hot water suply, e.g. for control equipment and pumps	f	
	Cooling /AirConditioning					
184	cold energy demand of the building	Q_C	kWh/a	annual cold energy demand according to the applied calculation method	f	
185	cold energy distribution losses	Q_C_d	kWh/a	cold losses according to the distribution of cold to the rooms	f	
186	cold storage losses	Q_C_s	kWh/a	If there is cold storage the cold losses may be considered here. Alternatively, they may be considered as a reduced cold output of the cold generator which feeds the storage system (In this case Q_out_cold_1(or2) of the cold generator has to consider the output of the storage system and not the input to the storage system which is caused by this cold generator). At any rate a double counting of the losses must be avoided.	f	
187	cold output of cold generation system 1	Q_out_cold_1	kWh/a	annual cold production of cold generation system 1	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
188	energy input to cold generation system 1	Q_in_cold_1	kWh/a	The energy input to cold generator 1 is quantified according to the energy carrier (ecarrier_cold_1):amount of electric energy if the energy carrier is electricity, upper calorific value if the energy carrier is a fuel, energy content of the heat if the cold generation process is driven by heat. attention: only the energy input for heat generation should be indicated here (not the auxiliary energy e.g. for control equipment, pumps and fans) If cold generation system 1 is a cogeneration engine consider here only that part of the energy input that is assigned to the driveing of the cold generation process (not for heat generation and not for the production of electric or mechanic energy used for other purposes)	f	
189	cold output of cold generation system 2	Q_out_cold_2	kWh/a	similar to system 1	f	
190	energy input to cold generation system 2	Q_in_cold_2	kWh/a	similar to system 1	f	
191	net heat output of 1. heat generator used by the air conditioning / cooling system	Q_out_heatgen_ac_1	kWh/a	Net heat output of heatgen 1 (= heat generation system 1, see above) net heat output: not including generation losses Only the heat output used by the air conditioning/cooling system (for cold generation, humidification and dehumidification) is to be considered here. If the heater is also used for heating/hot water supply the assigned part of the heat output must not be considered here.	f	
192	energy input of 1. heat generator used by the air conditioning / cooling system	Q_in_heatgen_ac_1	kWh/a	energy input to 1. heat generator used by the air conditioning/cooling system.The energy input is quantified according to the energy carrier used for heat generation: ecarrier_heatgen_ac_ 1 (amount of electric energy if the energy carrier is electricity, upper calorific value if the energy carrier is a fuel, energy content of the heat if it is district heating). attention: only the energy input for heat generation should be indicated here (not the auxiliary energy e.g. for control equipment, pumps and fans) only the energy input used for the heat generation assigned to cooling and air conditioning is to be considered. If the heater is also producing heat for space heating/ hot water supply the assigned energy input is not to be considered here. If heatgen 1 is a cogeneration engine consider here only that part of the energy input that is assigned to heat generation for cooling/air conditioning. (that means: do not consider that part of the energy input that is assigned to the production of electric or mechanic energy)	f	
193	net heat output of 2. heat generator used by the air conditioning / cooling system	Q_out_heatgen_ac_2	kWh/a	similar to heatgen_ac_1	f	
194	energy input of 2. heat generator used by the air conditioning / cooling system	Q_in_heatgen_ac_2	kWh/a	similar to heatgen_ac_1	f	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
195	electric auxiliary energy demand of the air conditioning / cooling system	Q_C_aux	kWh/a	electric auxiliary energy demand, e.g. for control equipment, pumps and fans If auxiliary energy demand for ventilation was not considered separately above in Q_V_aux it has to be considered here	f	
	Ligthing and other electric energy demand					
196	total other electric energy demand of the building	Q_E_other	kWh/a	total other electric energy demand of the building (without energy input to heating, hot water and cooling systems, neither for heat, hot water and cold generationg, nor auxiliary energy)	f	
197	information on other demand	info_other_electric	kWha	give information about what is included in the other electric energy demand see predefined values	p	**c**: complete electric energy demand (all appliances in the building) **l**: only lighting **other**: other
198	electric energy demand for lighting	Q_E_lighting	kWh/a	electric energy demand for lighting. If a value for "other electric energy demand" (see above) is given lighting should also be included there.	f	
	Cogeneration					
199	total heat generation by CHP	Q_H_CHP	kWh/a	total heat production of cogeneration (CHP) engines in the building		
200	total electric and mechanic energy generation by CHP	Q_E_M_CHP	kWh/a	total net electric and/or mechanic energy production of cogeneration (CHP) engines	f	
201	type of energy carrier used by cogeneration engines	ecarrier_CHP		type of fuel which is used by the cogeneration engines, see predefined values	p	according to classification list "energy carrier types" or "mixed" if it is a mix of fuels
202	energy input to cogeneration engines	Q_in_CHP	kWh/a	Energy input (upper calorific value) of the energy carrier which is used by the cogeneration engines in the building. CHP engines have also to be considered above (e.g. as heat generators). The difference is, that here the total energy input of the energy carrier to the CHP engine has to be considered whereas above only that amount of energy input is to be considered that is assigned to space heating, hot water supply or cooling/air conditioning, respectively.	f	
F	**Basic Parameters of Operational Rating**					

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
203	method of operational rating	method_op		If there is more than one national method: provide a list and a short description of national calculation methods for the making of energy certificates by operational rating. The applied method has to be indicated here by a string defined in the list (in the same way as in the other lists of "predefined values" in this data structure).	p	to be defined for each country
204	first month and year of measurement period	date_1_op		first year of the time period that was considered for the operational rating	f	use the following format: mm-yyyy, for example: 06-2005 for June 2005 if the month is unknown just indicate the year, e.g. 2004 for 2004
205	last month and year of measurement period	date_2_op		last year of the time period that was considered for the operational rating	f	use the following format: mm-yyyy, for example: 06-2005 for June 2005 if the month is unknown just indicate the year, e.g. 2004 for 2004
206	information on climate or weather correction	climate		Indicate here if the measured energy data in section G (summary of energy consumption) are based on the actual consumption or if a climate or weather adaptation was carried out (see predefined values); Please, consider the following principles: If possible, the **actually metered data** (not corrected according to weather or climate) should be indicated. Because all values of section G are related to a one-year period, a time correction may be necessary, e.g. by calculating the annual mean value of the period of operational rating. But this is not the same as a weather or climate correction because there is no adaptation to mean climate data. Sometimes also a correction according to **building use** is carried out (adaptation to a reference building utilisation). Data which is corrected in that way should not be inserted in section G.	p	**nwc:** no weather/climate correction **weather:** weather correction. Adaptation according to time: Correction to the climate data of an average year at the building location **climate:** climate correction (no further information available). Adaptation according to time and space: Correction to a regional or national mean value of climate data of an average year. **climate_national:** climate correction to a mean national climate **climate_zone:** climate correction to the officially defined climate zone where the building is located (if there is an official national system of climate zones) **climate_regional:** climate correction to a mean regional climate (only if it is not an official climate zone)
207	heating climate index of the measured energy consumption	type_climate_h_m		Climate index of the heating season. The index must describe the climate conditions of the measured energy data given in Section G. Usually heating degree days are used.	p	national definition to be provided.
208	value of the heating climate index (measured energy consumption)	climate_h_m		The indicated value must fit with the values of measured energy consumption which are indicated in section G . If for example these values are corrected according to national climate, the national climate index of that climate zone has to be given here. If (what should usually be the case) no climate adaption was carried out the climate index value should then be given according to the average weather data of the location of the building during the period of operational rating.	f	
209	other climate index of the measured energy consumption	type_climate_other_m		If there is a cooling/air conditioning system this index should describe the respective climate conditions. If not, a second type of heating climate index (e.g. duration of the heating season: heating days) may be shown here.	p	national definition to be provided.
210	value of the other climate index (measured energy consumption)	climate_other_m		similar to climate_h_m	f	

No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
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211	indicator of energy types considered in the operational rating	op_consider		This indicator shows, which of the 7 types of energy consumption and energy generation (being documented in the following chapter G) are considered for the building classification by operational rating (see chapter H), see predefined values	p	8 digit binary code "1" indicates that the value of energy consumption or energy generation is considered for building classification by operational rating "0": indicates that the value is not considered (e.g. because it is a special energy use) digit 1: consideration of electric_1 digit 2: consideration of electric_2 digit 3: consideration of ecarrier_1 digit 4: consideration of ecarrier_2 digit 5: consideration of ecarrier_3 digit 6: consideration of gen_1 digit 7: consideration of gen_2
G	**Summary of Energy Consumption and Energy Generation (for both Operational and/or Asset Rating)**					
	Remark No.1: This chapter is in the first place for operational rating. In this case asset rating results are included in the same scheme as far as					
	available to better allow a comparison of measured and calculated values. If only asset rating was carried out this section allows to give					
	a summary of the results from the point of view of energy carriers					
	Remark No.2: The values of measured or calculated energy consumption (or generation, respectively) must be filled in according to the following principles:					
	- if possible, the complete building's energy consumption of every energy carrier should be considered					
	- if the energy consumption of a certain energy carrier is split to different values, they may not "overlap".					
	For example: if the total electric energy consumption and the electric energy consumption for heating are known:					
	insert for electric_1 the value of the electric energy consumption for heating and for electric_2 the total electric energy					
	consumption minus the value of electric_1					
	in this case do not indicate electric_2 as the total electric energy consumption (because it is "overlapping" with electric_1)					
	Energy Consumption (measured and/or calculated values)					
	Electric Energy consumption					
212	use of electric energy 1	electric_1_use		here it has to be indicated to which uses the measured and/or calculated electric energy consumption is related	p	binary code with 9 digits for: **1.digit**: space heating **2.digit**: hot water 3**.digit**: air conditioning / cooling **4.digit:** auxiliary electric energy for space heating, hot water, ventilation and/or air conditioning / cooling 5**.digit**: lighting 6**.digit:** cooking 7**.digit**: other processes 8**.digit**: swimming pool 9**.digit**: others e.g. if electricity consumption for heating and hot water generation (including auxiliary) is given, indicate: 11010000

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
213	measured electricity consumption according to electricity use 1	electric_1_m	kWh/a	measured electric energy consumption in kWh/a (operational rating) Remark: energy consumption must always be related to a one-year period.	f	
214	calculated electric energy consumption according to electricity use 1	electric_1_c	kWh/a	calculated electric energy consumption (electric energy demand according to asset rating) in kWh/a Remark: energy consumption must always be related to a one-year period.	f	
215	use of electric energy 2	electric_2_use		similar to electric energy 1	p	
216	measured electricity consumption according to electricity use 2	electric_2_m	kWh/a		f	
217	calculated electric energy consumption according to electricity use 2	electric_2_c	kWh/a		f	
	Consumption of other energy carriers					
218	type of energy carrier 1	ecarrier_1_type		Usually other types than electricity are considered here. But if necessary, electricity may also to be considered once more.	p	see classification list "Energy Carrier Types". If the values are related to heat consumption (other than only district heat), indicate: "heat".
219	use of energy carrier 1	ecarrier_1_use		here it has to be indicated to which uses the measured and/or calculated energy consumption is related	p	binary code with 9 digits for: **1.digit**: space heating **2.digit**: hot water 3**.digit**: air conditioning/cooling **4.digit:** auxiliary electric energy for space heating, hot water, ventilation and/or air conditioning/cooling 5**.digit**: lighting 6**.digit:** cooking 7**.digit**: other processes 8**.digit**: swimming pool 9**.digit**: others e.g. if gas is used for heating, hot water and cooking: 110001000
220	measured consumption of energy carrier 1	ecarrier_1_m	kWh/a	measured consumption of energy carrier 1 in kWh/a (operational rating) Consider always the upper calorific value in case of fuels. In case of electricity and heat it is the electric or heat energy, respectively. Remark: energy consumption must always be related to a one-year period.	f	
221	calculated consumption of energy carrier 1	ecarrier_1_c	kWh/a	calculated consumption of energy carrier 1 in kWh/a (asset rating) Consider always the upper calorific value in case of fuels. In case of electricity and heat it is the electric or heat energy, respectively. Remark: energy consumption must always be related to a one-year period.	f	
222	type of energy carrier 2	ecarrier_2_type		similar to ecarrier_1	p	

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
223	use of energy carrier 2	ecarrier_2_use			p	
224	measured consumption of energy carrier 2	ecarrier_2_m	kWh/a		f	
225	calculated consumption of energy carrier 2	ecarrier_2_c	kWh/a		f	
226	type of energy carrier 3	ecarrier_3_type		similar to ecarrier_1	p	
227	use of energy carrier 3	ecarrier_3_use			p	
228	measured consumption of energy carrier 3	ecarrier_3_m	kWh/a		f	
229	calculated consumption of energy carrier 3	ecarrier_3_c	kWh/a		f	
	Energy generation in the Building					
230	1. type of energy generation in the building	gen1_type		see predefined values. Only on-site energy production may be considered	p	**el**: electricty (no further information available or contribution from different types of systems) **el_cog**: electricity produced by cogeneration systems **el_pv**: electricity produced by photovoltaics **el_wind**: electricity produced by wind **el_other**: electricity produced by other systems **h**: heat **c**: cold
231	use of produced energy of type 1	gen_1_use		see predefined values	p	**total:** the indicated amount is the total production of that energy carrier in the building (production means that the demand of the energy generation system itself is not included). No further information on the use is available. **total_int:** the indicated amount is the total production, the amount is completely consumed inside the building (e.g. heat supply of the building) **total_ext:** the indicated amount is the total production, the amount is completely delivered to consumers outside of the building **total_int_ext:** the indicated amount ist the total production, the amount is partly used inside and outside of the building **part:** the indicated amount is only a part of the production of that energy carrier in the building, no further information available **part_int:** the indicated amount is only a part of the production, the amount is completely used inside the building **part_ext:** the indicated amount is only a part of the production, the amount is completely delivered to users outside the building **part_int_ext:** the indicated amount is only a part of the production, it is partly used inside and outside the building
232	measured amount of produced energy of type 1	gen_1_m	kWh/a	measured amount according to operational rating	f	
233	calculated amount of produced energy of type 1	gen_1_c	kWh/a	calculated amount according to asset rating	f	
234	2. type of energy generation in the building	gen_2_type			p	
235	use of produced energy of type 2	gen_2_use			p	

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No.	**data field name**	**data field label**	**unit**	**definition**	**input type** f: free p: predefined	**predefined values**
236	measured amount of produced energy of type 2	gen_2_m	kWh/a		f	
237	calculated amount of produced energy of type 2	gen_2_c	kWh/a		f	
	Special Sources of electric energy					
238	type of special electric energy sources	type_electric_sp		Special sources means "not from the public grid" (e.g. local sources of electric energy) Remark: The meaning of "special" is here different from the meaning in "special energy use" in op_consider (see above)	p	national list of definitions to be delivered (if used)
239	amount of electric energy which is supplied to the building by special sources (measured value)	electric_sp_m	kwh/a		f	
240	amount of electric energy which is supplied to the building by special sources (calculated value)	electric_sp_c	kwh/a		f	
241	completeness indicator of energy balance (operational rating)	completeness_energy		This indicator indicates, if the complete amount of energy consumption and the complete amount of electric energy generation are considered in the values (operational rating) of chapter G (electric_1 and 2, ecarrier_1,2,3 and gen_1,2)	p	5 digit binary code "1": complete; "0": not complete **digt 1:** electric energy consumption **digt 2:** consumption of other fossile fuels **digit 3:** consumption of other energy carriers **digit 4:** electric energy generation remark: also indicate "1" if the respective amount is zero because there is no such type of energy consumption or no electric energy generation in the building
H	**Primary Energy, CO2 Emissions and benchmarks (for both operational or asset rating, respectively)**					
242	definition of primary energy	method_primary_energy		There might be countries which use several different methods to define primary energy. For example the treatment of some renewables might be different (e.g. the biomass might be counted or not counted as primary energy) Provide a list of applied methods (according to the usual scheme of predefined values). For each method provide a list of "primary energy factors" of the energy carriers (Not for beeing indicated in the data fields but for a separate documentation of national implementation of Datamine). The primary energy factor (in kWh/kWh) is a weighting factor defined as overall energy consumption (in kWh) per 1 kWh energy content of the energy carrier . Energy content in kWh of the energy carrier always means the upper calorific value in case of fuels. In case of electricity and heat it is the electric or heat energy, respectively (see classification list "energy carrier")	p	to be defined in a list

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
243	definition of CO2	method_CO2		similar to primary energy (it has to be indicated by which method the CO2 emissions are defined. For example it should be made clear if only on-site emissions or also the emissions of production and transport of the energy carriers are considered). Provide a list of methods and - for general documentation - a list of CO2 emission factors for each method. CO2 emission factors (in kgCO2/kWh) are defined as the CO2 emissions in kg divdided by the energy content of the energy carrier in kWh (upper calorific value).	p	to be defined in a list
244	definition of other weighted energy type	method_weighted		There might be types of weighted energy other than primary energy. In this case provide a definition of the weighted quantity and again provide a list of methods and weighting factors.	p	to be defined in a list
245	applied type of energy rating	rating_type		Type of rating (asset rating or operational rating) on which the following information on primary energy, CO2 emissions and weighted energy are based	p	**as:** asset rating (information is based on calculated energy demand) **op:** operational rating (information is based on measured energy consumption), no further information available **op_corr**: operational rating, a climate correction, weather correction or user correction was carried out before calculating primary/weighted energy demand and/or CO2 emissions **op_ncorr**: operational rating, no climate, weather or user correction was carried out. **as_op:** rating is based on both operational and asset rating
246	primary energy demand of the building	primary_energy	kWh		f	
247	uses to which the primary energy demand is related	primary_energy_uses		binary code, see predefined values	p	6 digit binary code **digit 1:** space heating: "1" if heating is considered in the primary energy demand, "0" if not **digit 2:** hot water supply: "1" if considered, "0" if not (and so on) **digit 3**: cooling/air conditioning **digit 4**: ligthing **digit 5**: other energy uses **digit 6:** auxiliary energy (additional information for heating/hot water/cooling/airconditioning): "1" if auxiliary energy e.g. for pumps, fans is considered, "0" if not e.g. 110001 means that primary energy is related to heating and hot water supply (including auxiliary energy)
248	CO2 emissions of the building	co2	kg		f	
249	uses to which CO2 emissions are related	co2_uses		binary code, see predefined values	p	similar to primary energy, see above
250	weighted energy demand of the building	weighted	kWh		f	
251	uses to which the weighted energy demand is related	weighted_uses		binary code, see predefined values	p	similar to primary energy, see above

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No.	data field name	data field label	unit	definition	input type f: free p: predefined	predefined values
252	1. type of benchmark	type_ben_1		type of 1. benchmark or reference quantity according to predefined list	p	provide a national list of benchmarking and/or reference value types, if applicable. A type of benchmark or reference value might be the national stock average or building regulation level of primary energy consumption for heating and hot water, for example.
253	value of 1. benchmark	ben_1		value of the 1. renchmark or 1. reference quantity according to the above type	f	
254	2. type of benchmark	type_ben_2		see above	p	see above
255	value of 2. benchmark	ben_2			f	

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Classification Lists

Code	Definition
Energy Carrier Types	
gas	natural gas, type unknown
gas_E	natural gas E
gas_LL	natural gas LL
liquid_gas	liquid gas
oil	heating oil
coal	coal, type unknown
coal_hard	hard coal
coal_lignite	lignite coal
bio	biomass, type unknown
bio_fw	firewood
bio_wp	wood pellets
bio_wc	wood chips
bio_other	biomass, if different from firewood or wood pellets
el	electricity
dh	district heating
other	other energy carriers
-	not existent or no energyware (e.g. solar heat produced in the building)

Remarks

Only tradable energy carriers (= energyware: fuels, electricity and district heating) are considered in this table.

For solar heat produced in the building "-" has to be indicated as energyware.

Energy carrier consumption/demand in kWh always means the upper calorific value in case of fuels. In case of electricity and heat it is the electric or heat energy, respectively

Code	Definition
Heat Generator Types	
b	boiler (type unknown)
b_nc	non-condensing boiler (further details unknown)
b_nc_ct	constant temperature non-condensing boiler
b_nc_lt	low temperature non-condensing boiler
b_c	condensing boiler
dh	district heating
el_d	direct electric: any device which uses electricity for direct heat generation, e.g. electric stoves (no heat pumps which use also heat from the environment)
hp	heat pump (type unknown), remark: also reversible engines that work as a cold generator in summer are to be considered here or (if heat source is known)
hp_air	heat pump, using the outside air as the heat source
hp_soil	heat pump, using the soil (the ground) as the heat source
hp_exair	heat pump, using exhaust air of a ventilation system as the heat source
hp_water	heat pump, using ground water or a water stream as the heat source
hp_other	heat pump, using more than one or other heat sources (e.g. industrial exhaust heat, low-temperature district heat)
stove	stove (fuel fired, in case of electric stoves use el_d)
chp	cogeneration system: combined heat and (electric) power generation
solar	solar thermal system
steam	steam generator (any type)
other	other

Remark:

An air/air heat exchanger for heat recovery in a ventilation system is not defined as a heat generator (also not: "ot") but indicated in the ventilation system.

Utilisation Types		assigned further indicator of building size
residential	residential: not specified or mixed residential utilisation	**persons**
single_family	single-family house, terraced house	persons
apartment	apartment house, residential accomodation	persons
home	collective accomodation, children's home, retirement home	persons
office	office (general)	persons
computer_centre	computer centre	
stand_by_duty	on-call service, stand-by duty (police, fire brigade, technical services, call centres ...)	persons
education	education / school: not specified or mixed	**pupils**
school	ordinary school, special school	pupils
school_vocational	vocational school	pupils
kindergarten	kindergarten, nursery school	pupils
higher_education	higher education: not specified or mixed	
lecture	lecture hall	persons
laboratory	laboratory	
library	library	
hospital	hospital / health care: not specified or standard hospital utilisation	**beds**
surgery	operating room, emergency surgery etc.	
nursing	sick-nursing, long-term care	beds
trade	trade: not specified or mixed	
shop	retail trade, shop	
storage	storage depot, wholesale	
production	production, workshop, maintenance	
agriculture	agriculture, animal husbandry, plant breeding	
hotel_restaurant	hotel and restaurant: not specified mixed utilisation	**beds**
hotel	hotel, hostel	beds
restaurant	restaurant	
sports	sports: not specified or mixed sports utilisation	
sports_hall	sports hall, fitness centre etc.	
swimming_pool	indoor swimming pool	pool_surface_area
others	other utilisations: not specified or mixed	
assembly	assembly hall, arrival hall, church, concert hall, museums	persons
day_care	day care (youth centres, senior centres, ...)	persons
garage	garage, underground car park	cars