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

Model Project 7 / Belgium

A first quality control and analysis of official EAP-auditing data for existing single-family dwellings

– Summary Report –

VITO

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1 Summary

Objectives of the DATAMINE Project

The starting point of DATAMINE is the fact that the actual state of the European building stock and the on-going retrofit processes are not very well known until now. 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. Given the great variety of buildings as well as certificate types in Europe and the very different status of national EPBD implementation 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.

For this purpose Model Projects are carried out in 12 EU member states. In each Model Project data collection and monitoring by use of EP Certificates is 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.

The experiences and evaluations which were made in the German Model Project are described in this report (which is also available in an extended version in German language). Similar reports exist for the other DATAMINE Model Projects showing the individual concepts and results. A survey of the most relevant results from all Model Projects is given in the DATAMINE Synthesis Report SR2 "Data Collection from Energy Certificates – Experiences and Analysis".

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.

Collaboration 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:

Figure 1: 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 voluntary 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:

Figure 2: 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:

Figure 3: 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

The objectives of the Belgian DATAMINE Model Project

The model project carried several smaller objectives and tasks. Principally, three smaller subprojects are distinguished:

1. VITO performed quality-control of 10 audits in the database and gave feedback to the authorities and auditors via a report and workshop.
2. A comparison was drawn with existing statistical data of the residential sector in Flanders. The scheme was to check to what extent the EAP-data are representative.

3. The main target was gathering experience in the making of a “typology” of building elements. The use of this typology is to simplify energy auditing that means to save time and costs.

The key actors

- VITO who coordinated and carried out the model project
- Flemish Energy Agency who gave their support and the EAP-data
- EAP-auditors

Data source

Since October 2005 energy performance data are collected in the Flemish Region by ‘certified’ energy experts using an auditing procedure for existing single family dwellings (the Energy Advice Procedure, briefly EAP). This auditing procedure was commissioned by the three Belgian regions. Research on the procedure started in 1996 and ran 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. In Belgium EAP will only be applied as a voluntary procedure, delivering tailored energy advice (down) to size for occupants of existing dwellings. At the moment, the Walloon Region is working on the extension of the existing EAP-procedure for existing single family dwellings towards a procedure applicable for apartments.

Data collection method

Official audits are uploaded to the central server of each region. The data collection was thus carried out beyond the DATAMINE project. The EAP-database on the central server of the Flemish Region was the starting point for the Belgian Model Project. Because data gathering for the region of Brussels and Wallonia started later (2008 and respectively 2006).

Analyzed dwelling stock

Figure 4: 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

Results

The 10 quality controls (manually performed) of some arbitrary EAP-audits were serving as input for the workshop. The outcome/results of this quality control showed that some (extra) efforts were necessarily for the follow up of EAP in order to increase the quality of the audits. For this reason, a workshop was organised by VITO and VEA towards the EAP-auditors. The workshop is regarded as a success since there were 155 attendees while there were 130 registrations. The main issues were:

- Results and reflection of the quality control;
- How to reduce the cost of an audit while keeping the quality standard acceptable;
- Technical discussion about the software and building technologies.

To draw a comparison with existing statistical data, the database is compared with statistics based on polls of 2003 and 2005. These comparisons show that the methodology, developed in specific for the official audit procedure, gives good results despite the limited size of the database. However, the database cannot be called completely ‘relevant’ for the Flemish housing stock. The reasons therefore are the fact that some categories of building ages are strongly over represented while others are under represented. The difference in representation is expectable since some categories are more/less appropriate to have a refurbishment and so this is reflected on the EAP-database.

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.

Conclusions and recommendations

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 web places 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 support 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 online 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 → 8 from chimney-sweepers (new regulation 2006) – more detailed information available about boiler type (power, type, annual charge, measurement of combustion efficiency) → Belgium : typical problem is oversized boilers in domestic region (surveys : average charge = 10 to 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,….; modeling-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 Sustainable, Financial and Quality evaluation of Dwellings) 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

2 Description of the Belgian Model Project

Objectives and key actors

Background

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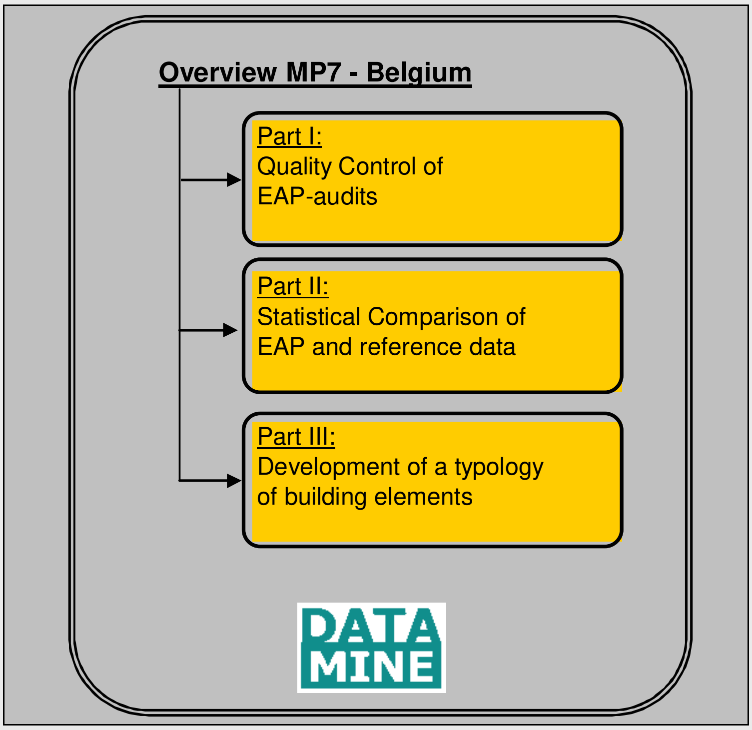
Figure 5: Model project overview



As the Flemish authorities were involved as source of data, they are first beneficiary of the results of the project. Because this auditing procedure only started on October 2005 in Flanders and therefore was still in its introductory phase, follow-up and quality-control were essential. VITO performed quality-control of 10 audits in the database and gave feedback to the authorities and auditors via a report and workshop.

Secondly, a comparison was drawn with existing statistical data of the residential sector in Flanders. The scheme was to check to what extent the EAP-data are representative and where the differences are located in this comparison.

Finally, the main target was gathering experience in the making of a "typology" of building elements. The use of this typology is to simplify energy auditing that means to save time and costs. During the Model Project, most of the attention is paid to the typology because for this, there had to be worked very intensively with the database.

Key actors

- VITO who coordinated and carried out the model project.
- Flemish Energy Agency who gave their support and the EAP-data.
- EAP-auditors who gave their support on the first part of the model project.

EAP- software

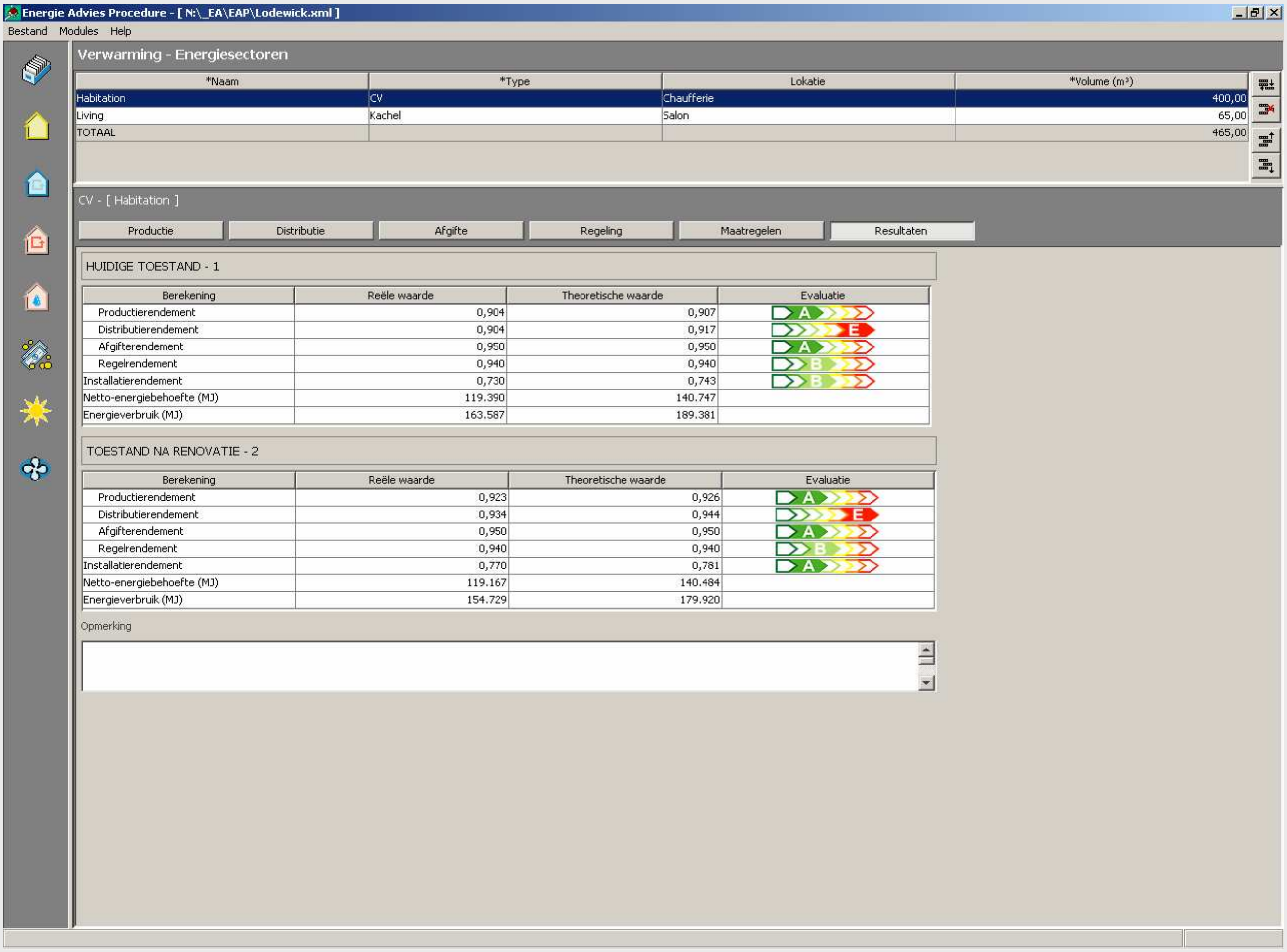
The software is an offline version which must be installed on the hard disk, this is different then the EPC-software in Flanders which works via an online server. EAP-software is public available and can be downloaded for free but only registered auditors may use it to carry out official EAP-audits! It is subdivided in six main parts:

- General part;
- Envelope;
- Heating;
- Domestic Hot Water;
- Ventilation;
- Summer comfort.

Several automatically proposed measures can be selected for the different parts. The advantage is that so a comparison is made between the current building state and a fictitious state after renovation.

Note: The modules “ventilation” and “summer comfort” are two optional modules that are currently seldom used.

Figure 6: Print screen of the EAP-software



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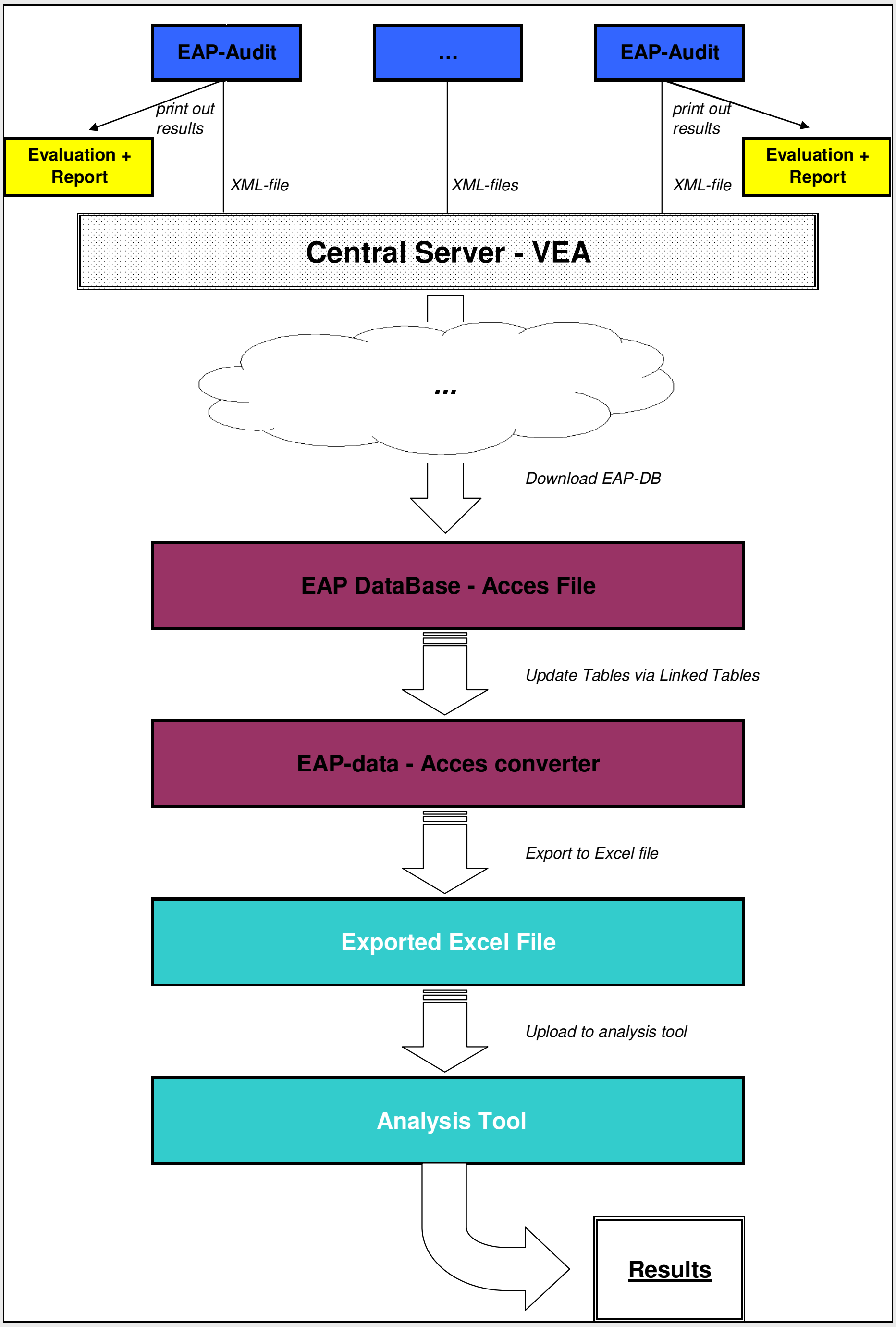
The EAP-software produces an XML-file. These files have to be uploaded to the central server of the Flemish Energy Agency. Data collection in Flanders is thus a centralized matter. The database is initially composed out of XML-files which are transformed to an access database. This database consists out of 72 tables (queries not included) of which 12 tables contain specific audit input/output data. This results in more then 400 data fields. Thus for some future applications it is possible to retrieve very detailed information. Without going too much in detail, the data processing can be envisioned as follows.

Figure 7:EAP-data processing flow chart



Part I: Quality control of EAP-audits

In this part, supporting the Flemish approach regarding energy audits in existing single-family dwellings is achieved by:

- A quality control of 10 audits from the EAP-database;
- Organizing a workshop for recognized energy experts which will try to list all important points of interest necessary for improving the quality of the executed energy audits.

By performing this study, VEA tries to contribute to implementing the European directive regarding building energy performance and to an improved energy audit quality.

VITO performed a total number of 10 control-audits. After the first part of control-audits, a provisional state of affairs was made up. The results were used as input for the workshop with official energy experts. The second part of control-audits paid more attention to the points of attention that were identified during the workshop.

Quality control was done by visiting the site and required punctually checking the following:

- The precision of building envelope measurement;
- The inputted building envelope structures ;
- The inputted data for the heating installation;
- The final report and the information given to the owners.

Per controlled audit, a concise control report was drawn up.

The workshop tackled the following subjects:

- Results of the onsite control-audits;
- Managing audit costs. Tips to limit audit working time, balancing cost/quality;
- Discussing technical details concerning software and construction techniques.

The workshop's peripheral activities included:

- Formulating the content;
- A syllabus for the participants;
- Drawing up the invitations and following up on the enrolment;
- The study day's contextual layout;
- Study day evaluation

Part II: Comparison of EAP and reference data

By comparing the analysis to surveys and data from the land register it is possible to assess the representativeness of buildings that have already been audited in respect to the Flemish building stock. Three different sources are consulted:

- EAP data: these come from audit data that have been requested by VEA

- Surveys: these data come from surveys conducted between 2003 and 2005. These data are random and aim to reflect the average Flemish building stock.
- Land register: these data come from compulsory reporting of building owners in Flanders. These data cover the complete Flemish building stock.

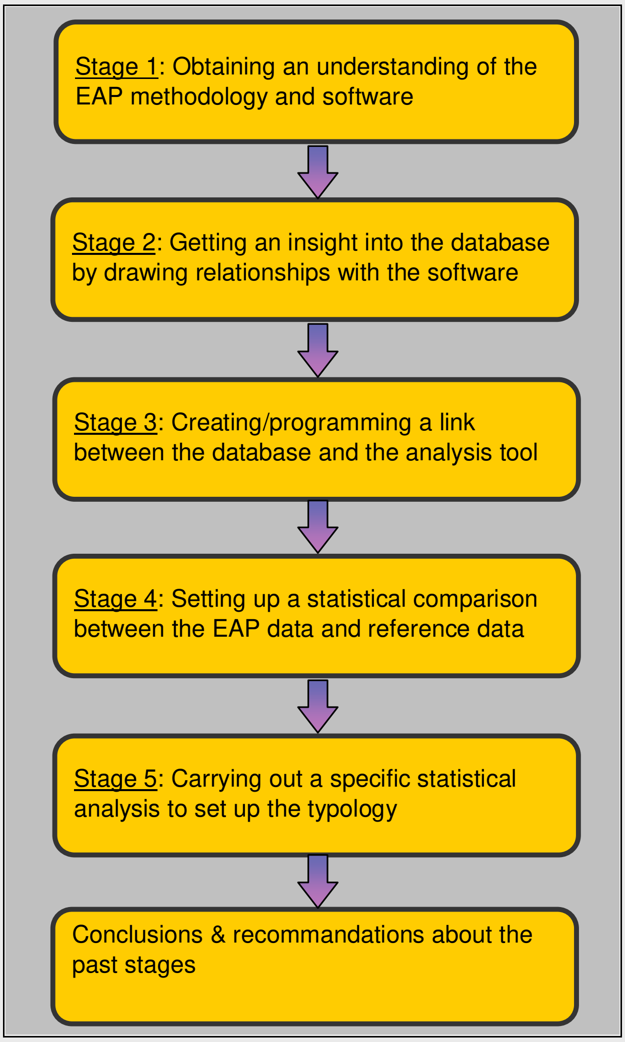
Part III: Typology of building elements

The figure below shows roughly the different steps which are taken in order to develop the typology. Stage 1 & 2, both closely related to each other, were preconditions in order to continue with the rest. After all, It was impossible to write queries on a database of which the background was not controlled.

Since the database contains much more data then requested, it was necessary to write queries to make a selection. Some demanded parameters were also not directly exploitable from the database so other queries were written to compose the variables.

In Stage 4, a comparison between the EAP data and reference data is made. The analysis of general data allows an insight into the audited building stock. By drawing conclusions from the graphs, the trust-worthiness of the EAP data was checked.

Fig. 8: Different stages of the evolution to a typology of building elements



Setting up a typology

Calculating U-values of walls is very time consuming in EAP, because the different layers of each wall have to be measured, defined an inputted into the software. That's why the search started to develop a new method that quickly calculates the necessary U-value. The analyses would benefit from a method that draws up formulas for calculating the U-value for different types of wall. The formula contains two parameters so to use is simple yet offering enough accuracy. The constant C1 and C2 that are present in the formula were calculated in Excel. The wall parameters that could be used in the formula are: building age, cavity thickness, insulation or brick. Which parameters are used depends on the type of wall.

First, the external walls are subdivided into four different groups via the Flemish EAP-data.

- External walls with cavity and insulation
- External walls with cavity, without insulation
- External walls where the cavity is fully filled with insulation
- External walls without insulation or cavity

Subsequently, the EAP data is organized according to those four categories. EAP has a library with some hundred standard walls and their matching U-values. Walls of the same type from a different type of material are put together. Every audit file refers to this library so there can be made a summary of the introduced parameters (building age, cavity thickness,…) and the U-values from the library.

Next, two random values C1 and C2 are chosen to calculate the formula. Using this random value, the approximate value of the U-value can be calculated. When this approximate value has been calculated, the difference between the real and the calculated U-value can be determined. The sum of all differences, between the real and the calculated U-value, has to be as small as possible in order to approach the actual U-value as closely as possible.

If the calculated U-value is larger than the real value, there is a positive difference; if the calculated U-value is smaller than the real value, there is a negative difference. The negative results will counter the positive ones when calculating the sum of the difference. The sum of the difference will therefore not be representative for the actual difference between the calculated and the real U-value. The sign of the difference will be removed by raising the difference to the square. The function is calculated for C_1 and C_2 with the smallest possible squared difference.

Finally, in those cases where possible, a better formula is derived, depending on different parameters. This can be achieved e.g. by looking at the mutual relationship between the U-value and the date of construction on the one hand, and between the U-value and the insulation thickness on the other hand.

Existing U-value from EAP

EAP has a library with some hundred standard walls and their matching U-values. Walls of the same type from a different type of material are put together. If these walls are sorted according to the typology classification, U-values intervals are produced.

For masonry-only walls:

- of 29cm: [0.90-1.38]
- of 28cm: [0.93-2.08]
- of 19cm: [1.25-2.62]
- of 14cm: [1.55-2.33]
- of 9cm: [2.04-3.07]

for walls with cavity and insulation:

- Cavity and insulation of 6cm: [0.40-0.55]
- Cavity of 4cm and insulation of 6cm: [0.37-0.55]

for walls with cavity, but without insulation:

- Cavity of 4cm: [1.69-0.63]

for insulated walls without cavity:

- Insulation of 6cm: [0.41-0.63]

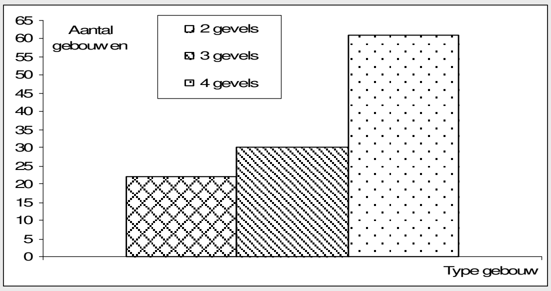
3 Data evaluation

General statistics

The analysis covers 113 audits; the first audits are dated the first of March 2004.

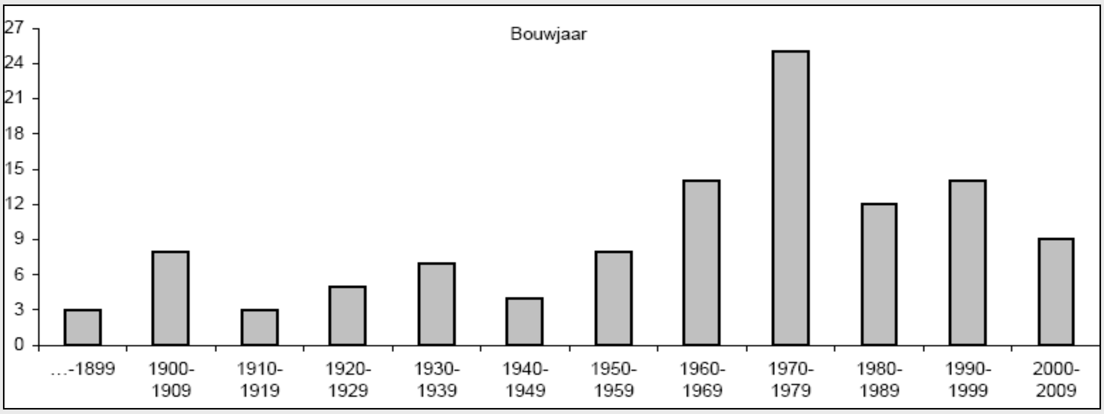
Building type

Fig. 9: Number of buildings per building type



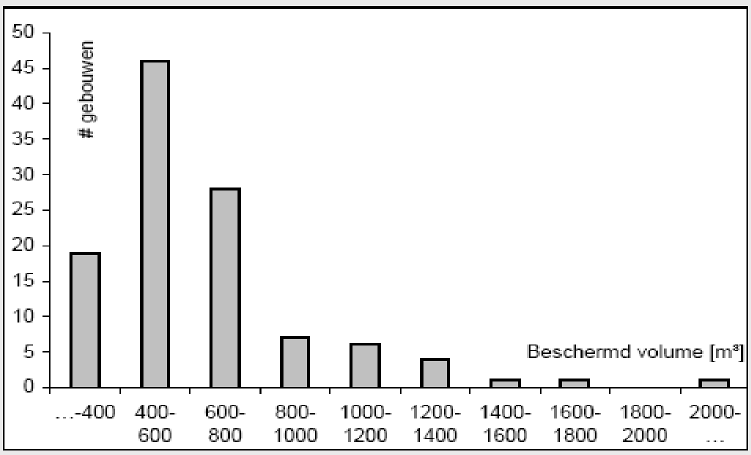
Building age

Figure 10: Number of buildings per building age category



Building size

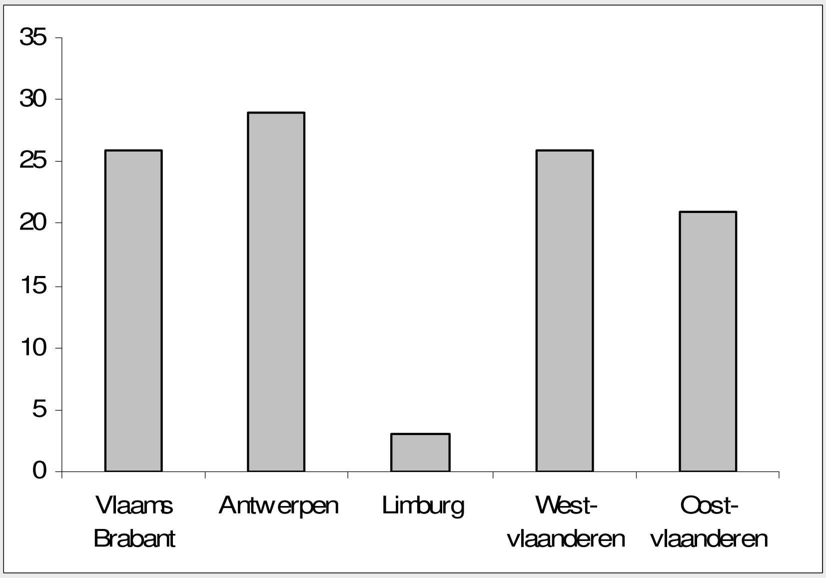
Figure 11: Number of buildings per building size



Location

The audits mention the city's postal code. Using the postal codes, subdivisions per province can be made. This analysis then shows which provinces are ahead, or lag behind compared to the rest of Flanders. The analysis shows that the province of Limburg was just starting with the EAP-programme.

Fig. 12: location of the audited buildings



Specific audit data

Energy demand

Figure 13: Building size versus net energy demand

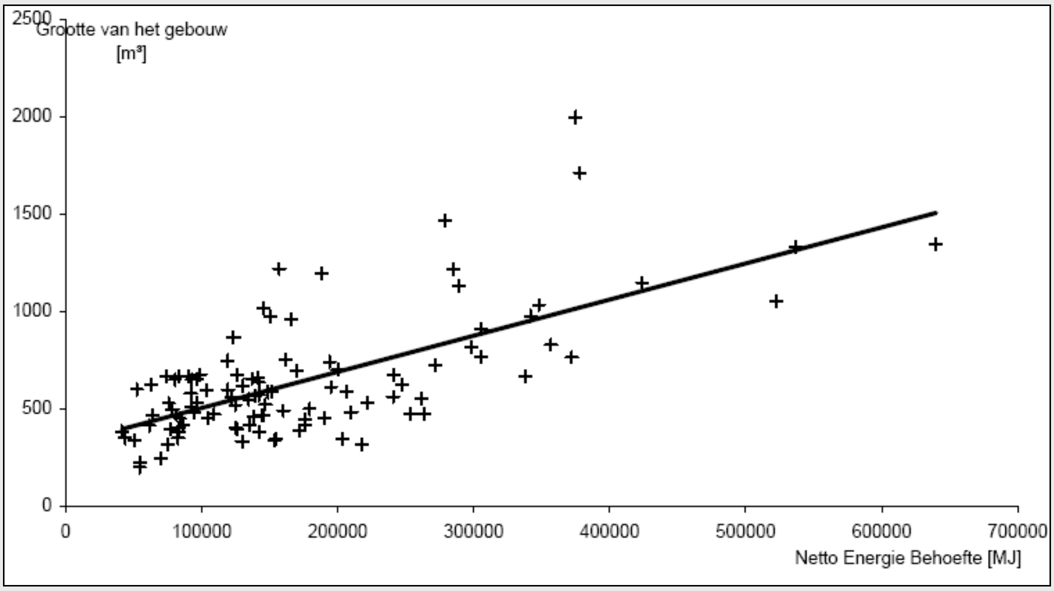
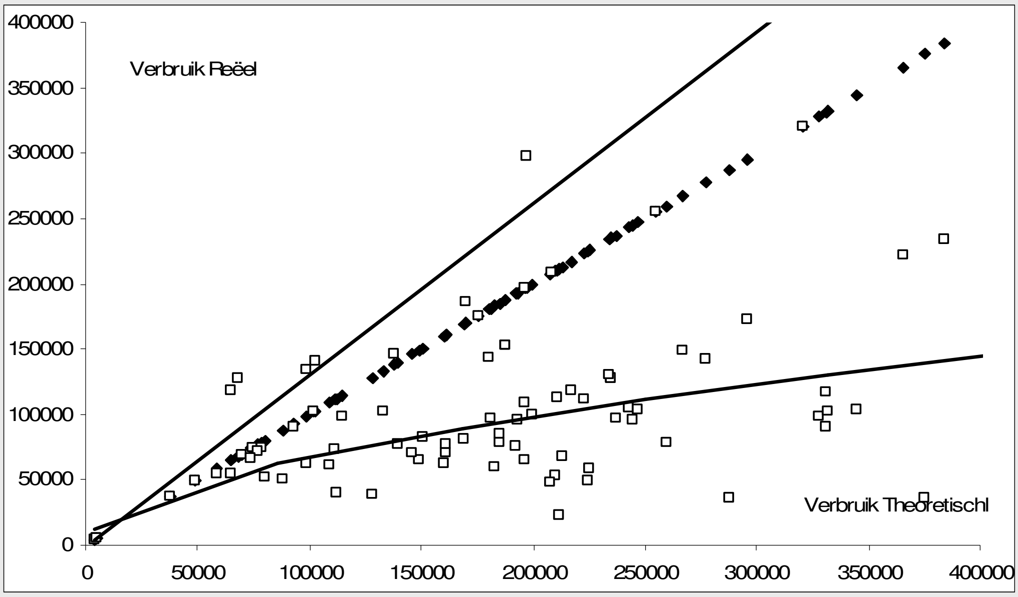
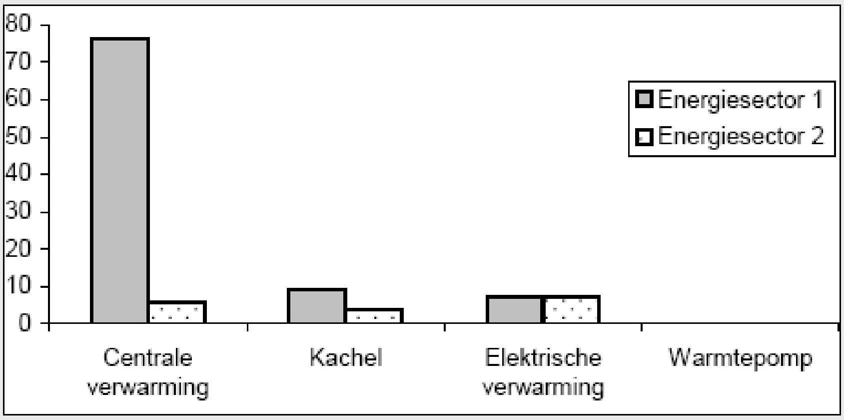


Figure 14: Real versus theoretic energy consummation



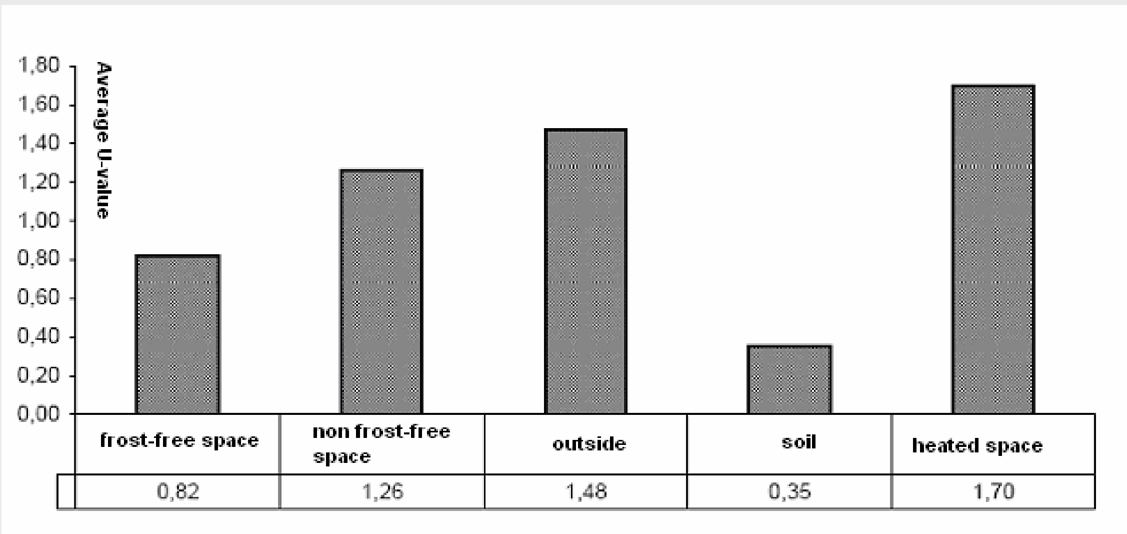
Heating installation

Figure 15: Number of heating installation per type



Building envelop

Figure 16: Average U-value per type of surrounding

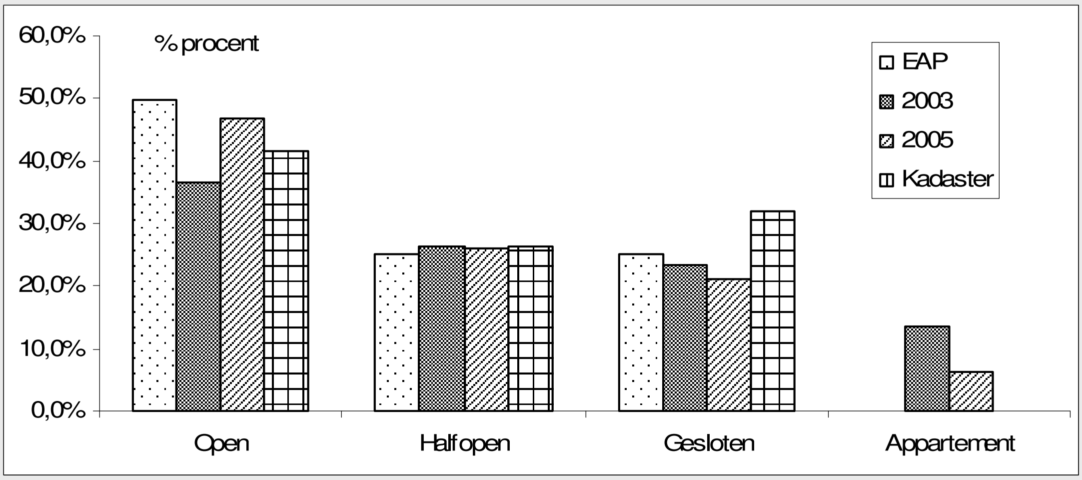


Comparison with reference data

Building type

The values run parallel in all three cases. Low density development is still the most used building type in Flanders, followed by semidetached and high density development. Data concerning apartments are not included in EAP, because this type of dwelling is not audited. This fact is reflected to the percentages in the graph.

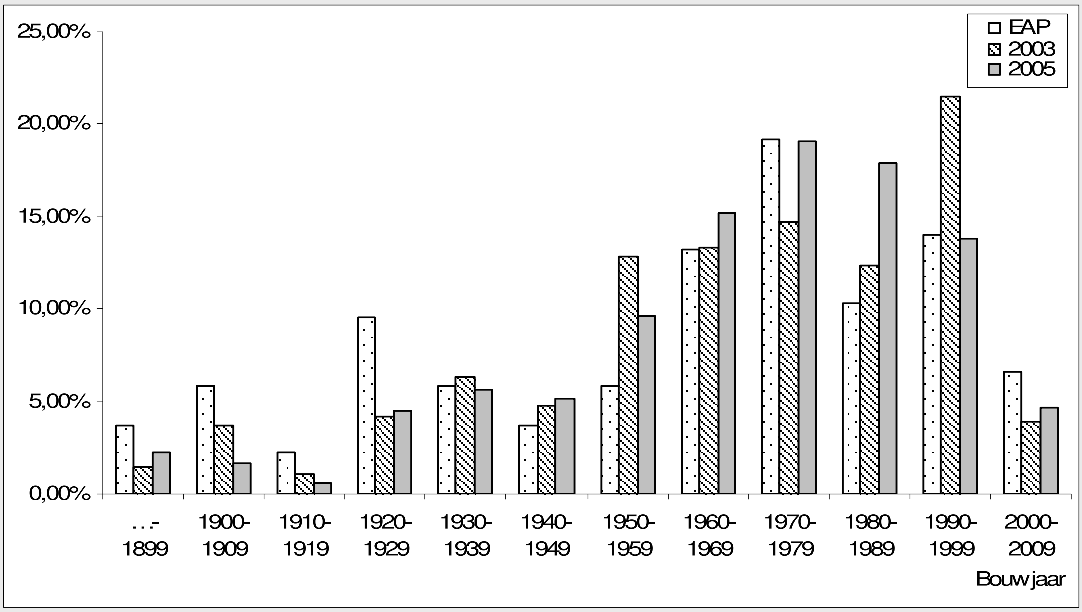
Figure 17: Building type per database in percentages



Date of construction

The following figure shows the houses in relation to the date of construction. Each bar above a year indicates the number of houses built in that year in terms of percentage. The 2005 survey covered about 2000 houses, while EAP deals with 136 instead of 113 houses.

Figure 18: Building date of construction



The graph shows two EAP peaks in periods 1920-1929 and in 1970-1979. The EAP value does not correspond to the values from the survey, but greatly exceeds them. This might possibly be explained by the target group that wishes to perform an audit. People that want to have an audit performed have just bought a house, or want to renovate one. Buying/renovating a house happens at specific moments in life, namely at an alteration of generations.

Typology of building elements

External wall with cavity and insulation

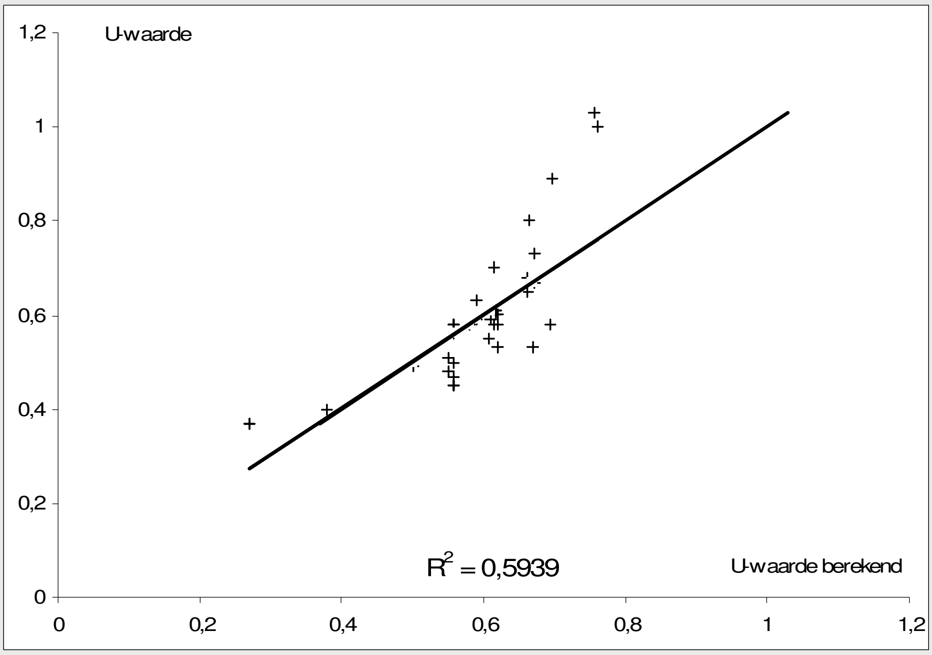
Assuming the date of construction and the insulation thickness are decisive parameters, the formula is as follows:

$$U=C_1.\text{date of construction} + C_2.\text{insulation thickness}$$

The difference between the calculated and the real U-value is calculated to verify if this formula sufficiently approaches the real U-value. The difference should be as small as possible; another formula to verify the formula's validity would be the R^2-value.

The average difference between the calculated and measured U-value is 0.062725. The average real U-value is 0.57215, which means that the difference is one tenth of the result.

Figure 19: Calculated U-value in relation to the real value



Because the bigger U-values in figure 20 lie farther from the straight line, a better formula is in order. This can be achieved by looking at the mutual relationship between the U-value and the date of construction on the one hand, and between the U-value and the insulation thickness on the other hand. This is shown in Figure 21.

Figure 20: Relationship between real U-value and date of construction

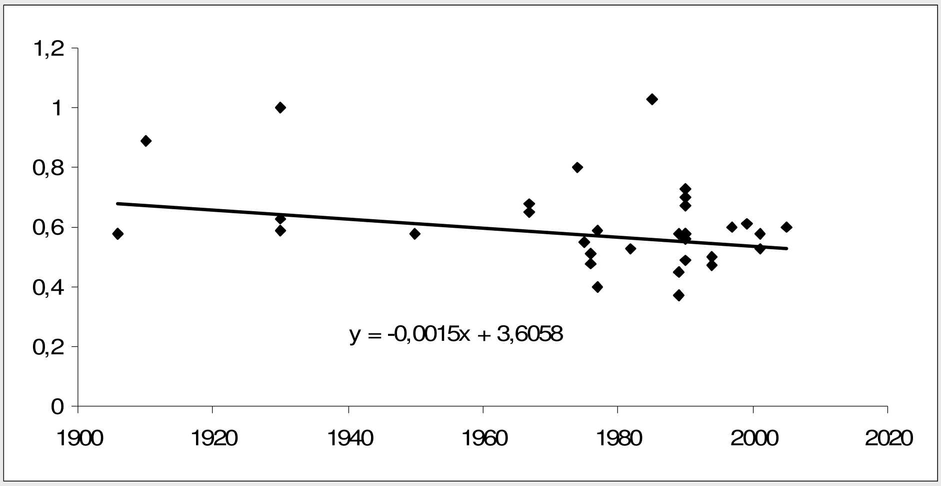


Figure 21: Relationship between the real U-value and the insulation thickness

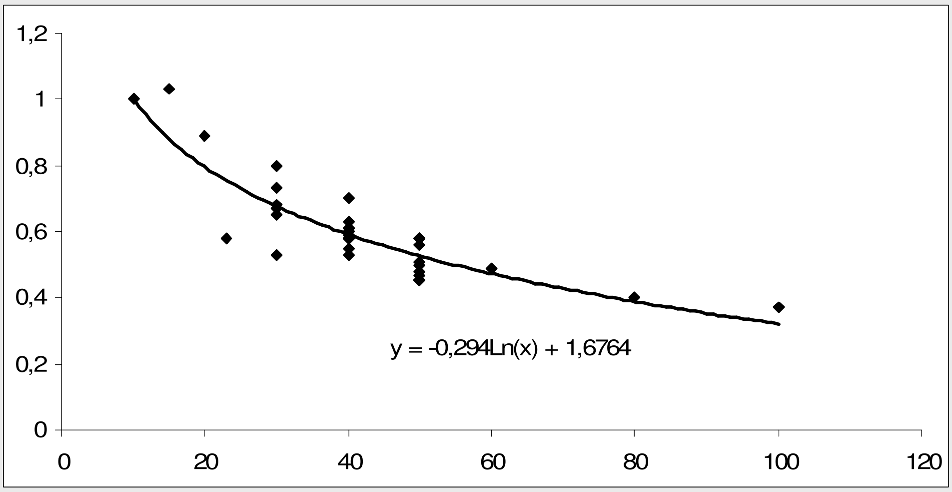


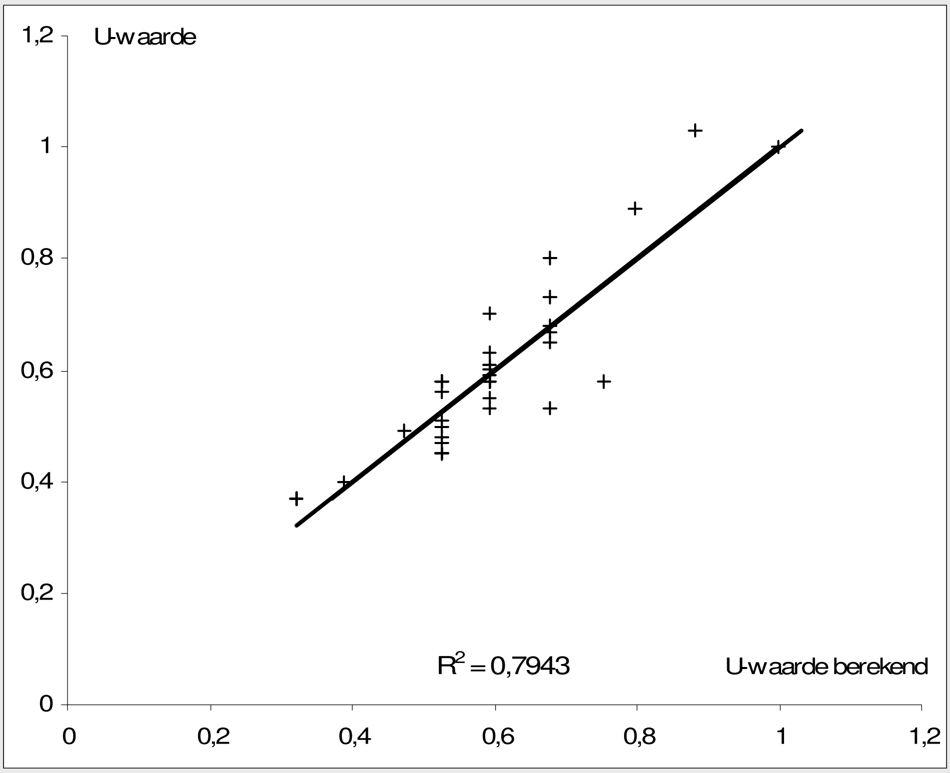
Figure 20 shows that there is no relationship between the date of construction and the U-value, while there is indeed a logarithmic relation between the U-value and the insulation thickness in figure 20.

The following formula can be derived from this:

U=1.6764 – 0.29398.*Ln*(*insulation thickness*)

The average difference is now 0.047629; this number is smaller than the average difference from the previous formula, which indicates a better result. Figure 22 also shows that the large calculated U-value is closer to the actual U-value. The correlation coefficient, or R^2-value, of the second approach is closer to 1 than the first approach, namely 0.7943 compared to 0.5939.

Figure 22: Calculated U-value in relation to real U-value



The formula 'U = 1.6764 – 0.29398.*Ln*(*insulation thickness*)' can be tested by comparing it to the appropriate EAP interval. The insulation thickness of walls with cavity and insulation in EAP are calculated with a thickness of 60mm. When 60mm is filled in the formula above, this will result in a U-value of 0.47 W/m^{2}K. This is in between the [0.40-0.55] interval, which is good.

Wall with cavity, but without insulation

This type of external wall has a cavity, but it isn't insulated. The formula can therefore only consider cavity thickness and date of construction.

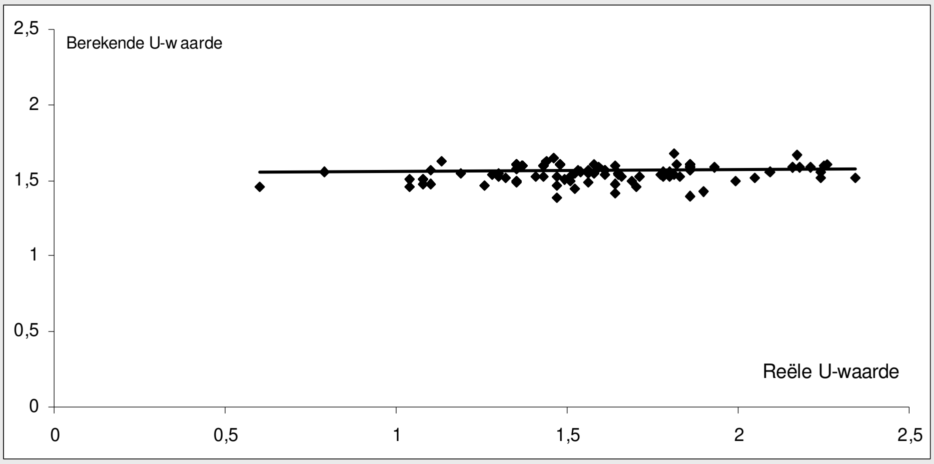
$$U = 0.00072289.\textit{date of construction} + 0.0023591.\textit{cavity thickness}$$

This formula results in an average difference of 0.24538 and an average U-value of 1.5583; the difference is one third of the U-value. It is quite normal that this type of wall produces a greater difference; in 6.5.2 it had already been indicated that the U-values for this type of wall are further apart than those of other types.

C_2 is about ten times greater than C_1, and that's why the effect of the date of construction parameter seems to be negligible; this is however not the case. The difference will be even greater, namely 0.39647, when the date of construction parameter is left out.

Figure 23 shows the course of the actual and theoretical U-value. The graph shows a steeper actual course, compared to the theoretical course. In the end however, the result is reliable enough.

Figure 23: The real U-values compared to actual U-value



Comparing the formula '*U* = 0.00072289.*date of construction* + 0.0023591.*cavity thickness*' to the EAP intervals offers the next solution. 1967 is taken as average date of construction and 40mm is entered as cavity thickness. This results in a U-value of 1.51, which does not lie in between the [1.69-2.06] interval. A possible explanation might be that the calculated values come from an EAP library and cover a much larger and higher interval. By manually entering the structure of the wall into EAP, much lower U-values can be obtained than in this library. Figure 23 shows many U-values below 1.6W/m^{2}K, so that the values often lie outside the [1.69-2.06] interval.

External wall where the cavity is fully filled with insulation

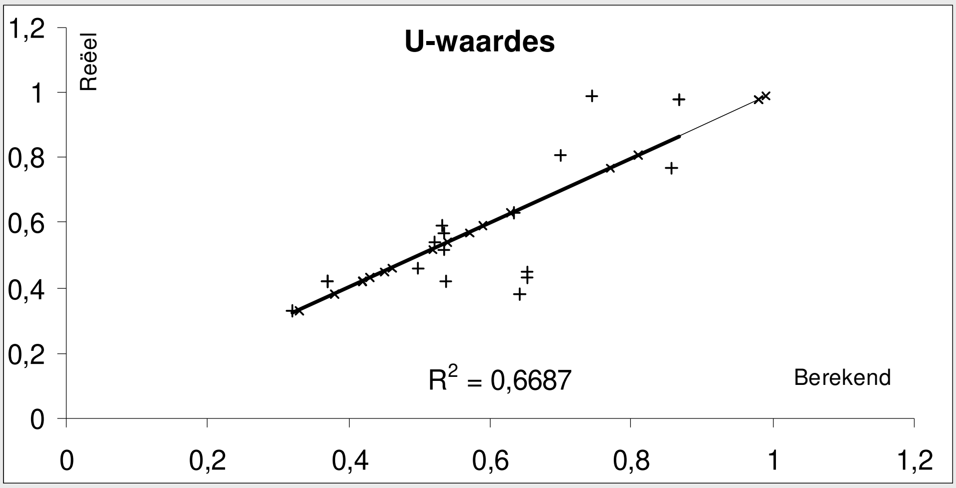
Once again, a formula is drawn up with the following parameters: date of construction and insulation thickness.

U = 0.00060120.*date of construction* – 0.011050.*insulation thickness*

This formula results in an average difference of 0.030596 and an average U-value of 0.56905. This low difference indicates a good result.

Figure 24 shows that there is no notable difference between the differences in high and low values in relation to the straight line. Together with an R^2-value of 0.6687, this indicates a moderate spreading, because the R^2-value should be as close to 1 as possible.

Figure 24: Calculated U-value compared to real U-value



The formula '*U* = 0.00060120.*date of construction* – 0.011050.*insulation thickness*' can be tested by comparing it to the appropriate EAP interval. In EAP, the insulation thickness for cavity walls with insulation is 60mm and the average date of construction is 1983. When these values are filled in the formula above, this will result in a U-value of 0.53 W/m^{2}K. This lies within the [0.41-0.63] interval, which is good.

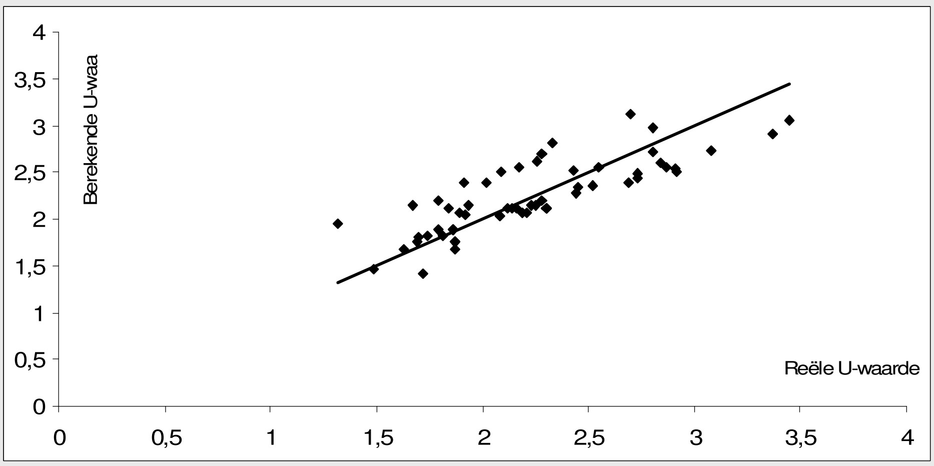
External wall without cavity or insulation

Calculating the U-value of a wall without cavity or insulation can only be done with brick thickness and date of construction as possible variables. This results in the following formula:

U = 0.0017415.*date of construction* – 0.0043104.*wall thickness*

This formula results in an average difference of 0.10660 at an average U-value of 2.24085. A difference of one twenty-fourth of the average U-value is therefore an extremely good result for this type of wall. The interval obtained with this formula is smaller than the EAP-data interval.

Figure 25: Calculated U-value compared to real U-value



When the '*U* = 0.0017415.*date of construction* – 0.0043104.*wall thickness*' formula is compared to the EAP library, the result is not as good. Suppose the thicknesses of 29cm, 28cm, 19cm and 14cm are entered into the formula, this will result each time in U-values greater than 3.2 W/m^2K. A value of 3.2 W/m^2K lies outside the EAP intervals. In EAP, the lower values are obtained in minor masonry walls, which are seldom used in practice. U-values of 2.0 W/m^2K are awarded an E-label, which means that the values from the formula as well as EAP are awarded an E-label. This means that the formula is precise enough for the procedure.

4 Conclusions & Recommendations

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 web places 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 support 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,….; modeling-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 Sustainable, Financial and Quality evaluation of Dwellings) 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.

Future opportunities

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

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