Summarizing an abundance of factors into one: Practical implementation of energy labelling for existing buildings in Belgium

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Abstract
In the light of the European Directive on Energy Performance of Building, Vito participated in the conception of the official method for the evaluation of energy performance of existing buildings by order of the Belgian authorities.

The present residential sector in Belgium has some very specific difficulties. Because of the high average age of the buildings and the typical personal construction culture, there is an enormous diversity of the existing houses. A labelling procedure should therefore take into account all possible aspects and construction data in order to allow a useful comparison.

41 existing houses have been evaluated with this new procedure. To ensure a thorough test, the diversity of the participating houses and installations has been chosen as large as possible. As a surplus value for the occupants of the house, the evaluation resulted in energy-saving recommendations for the building envelope, the heating installation and preparation of domestic hot water.

The results are first of all a view on the applicability of this new procedure. Despite of the difficulties of comparison at first sight, the actual results give clear indications about the performance of the house in terms of energy consumption and energy savings potential.

In order to further evaluate the procedure, the actual implementation of the recommendations has been followed up. The procedure has been evaluated by means of questionnaires and qualitative sociological interviews. The results show important advantages and problems for future public acceptance of energy savings, once the European directives will be fully implemented.

Introduction: European Directives and the Belgian situation

The residential sector in Belgium is particular in comparison to the situation in neighbouring countries. On characteristic is the elevated average energetic performance of dwellings. This shows in the average energy consumption for space heating of a Belgian house, as can been seen in comparison to other European countries in Figure 1.

It shows that the average Belgian consumption lies significantly higher, even when corrections for climate conditions have been taken into account. There are several reasons needed to explain this extreme result. It is a fact that the average Belgian building stock is on average very old, as can be seen in Figure 2. At the same time the average surface is one of the higher in the European Union. Still, this does not suffice to explain the difference completely.

Additional reasons can be found in the local building culture and the corresponding legislation. There is a strong habit, which is maintained through the years, for a Belgian to build his own house. This does result in a very diverse spectrum of constructions and techniques. Not only is the future owner of the house strongly involved from the design stage up to the final delivery, but most owners add gradually over the years extensions to the original construction. The final average house is therefore a very complex entity, completely designed according to the tastes of the owner, and with different parts constructed in different periods. Because of this singular mentality, there is no certainty at all that the technically most appropriate solutions have been applied for every component. Generally, residential construction does rarely happen in a consorted way. This shows for instance in the quasi-complete absence of a rather effective and energetically advantageous technique as district heating in Belgium. The total result is a building stock with a huge variety, but with poor energetic properties.

In order to deal with the problem of this poor average performance, the energy authorities enabled the conception of a Energy Advice Procedure (EAP), designed to evaluate the performance of existing buildings, to label this performance and to propose effective interventions for improvements. This conception started with the set-up of the procedure around 1998. Both the complete procedure and software have been completed by now and the first practical tests have started.

It has to be stated that this procedure was not a direct answer to the Energetic Performance of Buildings Directive 2002/91/EC, issued in January 2003. Energy labelling for the residential sector has been proposed by European instruments as early as 1993. The most recent and most direct stimulus for a labelling system specifically targeted at the residential sector, is directive 2002/91/EG. This directive requires a setup for:

- the general framework for a methodology of calculation of the integrated energy performance of buildings;
- the application of minimum requirements on the energy performance of new buildings;
- the application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation;
- energy certification of buildings; and
- regular inspection of boilers and of air-conditioning systems in buildings and in addition an assessment of the heating installation in which the boilers are more than 15 years old.

The Belgian Authorities gave effect to the directive by starting the implementation of a building labelling procedure for new constructions. The theoretical and practical knowledge gained through the EAP-process will serve for this new instrument as well, and it is expected that the two instruments will converge in the future.

The EAP-procedure is a procedure, being developed for two specific situations:

- The first situation is a change of ownership of existing buildings. The seller of the building will have to present a certificate with the corresponding labels of the energetic performances. This information can give the buyer more insight in the value of the building. The labels should therefore in a similar way as the labels for the for new constructions influence the price of the existing building.
- The second situation is where an owner wants to invest in a renovation of the building. The performance of an audit according to the EAP-procedure can give precise and detailed information about the most effective ways to increase the energetic performance.

These are not necessarily two distinct situations. Renovation is often performed after the purchase of an older building, and studies show that renovation is a strongly growing trend in the Belgian construction market. (Dhondt, 2004).

If the impact of the EAP-procedure has to be tested, the effect in these two situations should be regarded. The first question should be: In case of a renovation: what information results from the procedure, and how does it affect the future renovations executed by the owners? And in case of the sale of a building: what is the appreciation of the resulting information and how does it affect the view of the owners and potential buyers on the building?

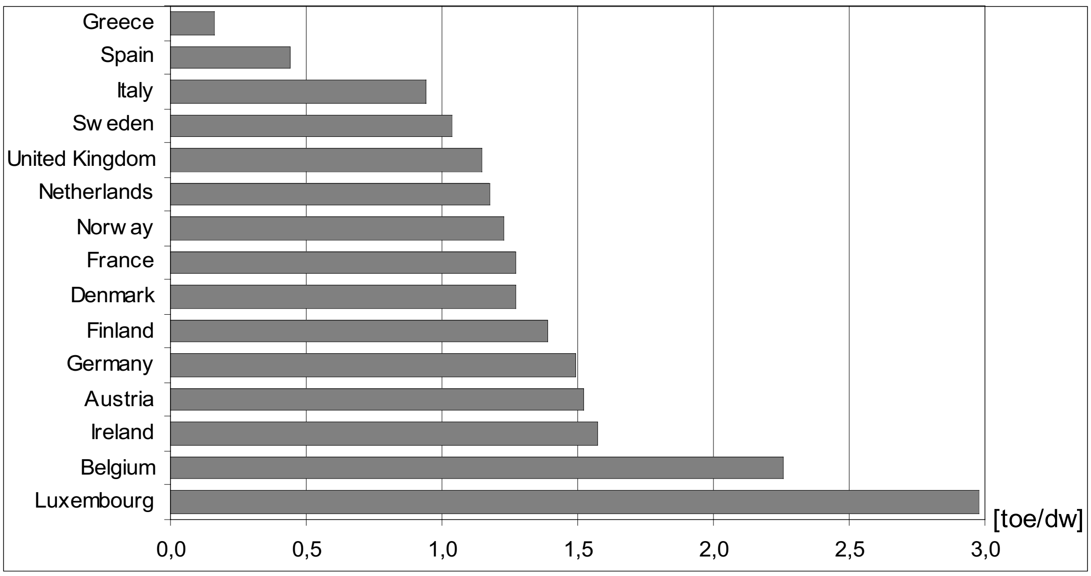

Figure 1. *Average energy consumption for space heating of European Dwellings, with climate corrections (in tons of oil equivalent per dwelling) (Odyssee Data Base, 2000).*

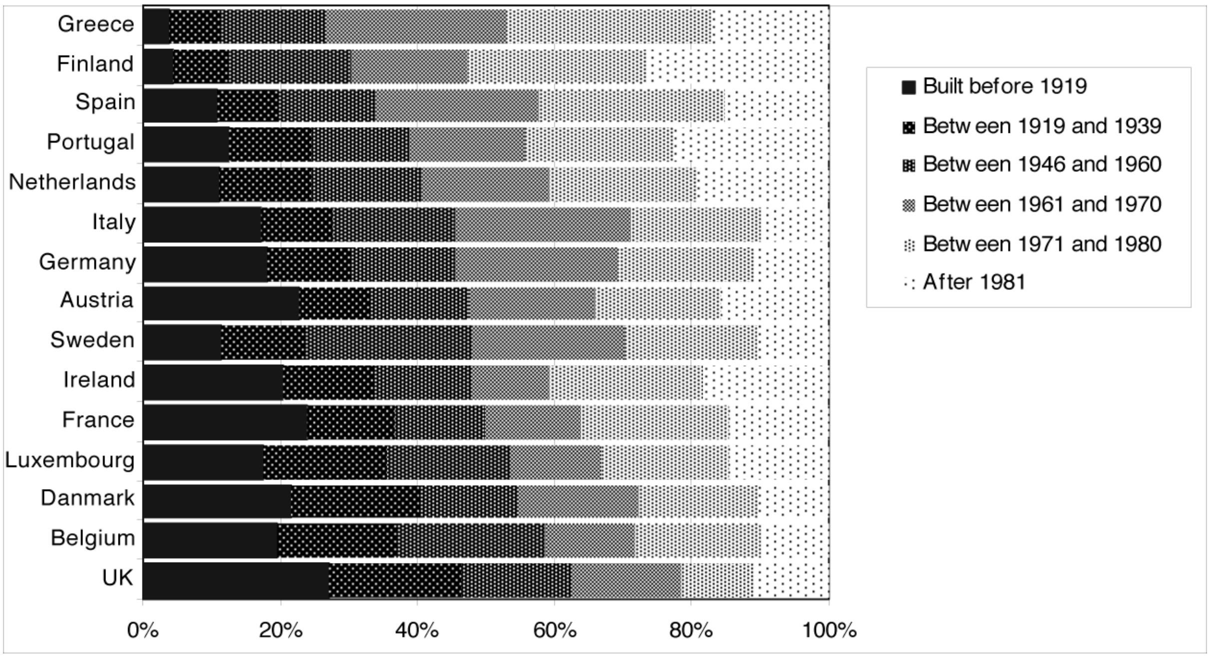

Figure 2: *Division of the housing stock according to the year of construction for European Countries (Eurostat,1991) .*

Framework of the study

Results in this publication are based on the technical results of a large study on Socio-technical factors influencing Residential Energy consumption of the Flemish Institute for Technological Research (Vito), and the Catholic University of Louvain-la-Neuve (UCL). The study combines two teams with different backgrounds. The sociological team of the UCL performs a large-scale analysis of the energy-consumption of Belgian households and qualitative interviews. In order to add precise technical data of residential consumption to the sociological research, Vito performed the full energetic analysis of 41 different houses through Belgium. These audits covered two parts. Firstly the EAP-procedure has been applied to the building. Secondly an audit of the electrical appliances present in the house was performed. All electrical appliances were connected to electrical meters and their electrical consumption will be followed during one year.

The application of the EAP-procedure during the audits should constitute a complete overall test of the procedure. First of all, the energetic analysis of the building was performed trough the EAP-procedure with the final software. This already gives an indication of the practical applicability of the theoretical procedure. Secondly, energy saving recommendations were presented to the owners. And finally the procedure led to a detailed report for the owners, presenting all results and labels together with additional information. The owners were requested one month afterwards to answer a questionnaire about their perceptions of the procedure, their impression of the results and their ideas about the effects.

To decide exactly which 41 houses to analyse, several actions were undertaken to gather volunteers for this research from all over Belgium. Finally some 250 families from all over Belgium responded. Out of this group, Vito selected the participants according to several criteria. Given the number of houses to be audited, it was not possible to compose a sample which would be representative for the entire Belgian housing stock. The large variety in energetic performances of the Belgian houses, made this even more difficult. The sample had to be composed to provide a thorough test of the EAP-procedure. So the aim was to achieve a selected sample with the largest possible diversity. This diversity was reached not only on technical criteria such as energy source, heating installation , house dimensions, type of house, and building age , but also on sociological criteria, like net monthly family income, family composition and age of the family members. The selection according sociological criteria showed to be equally important. The EAP-procedure not only takes technical data into account, but also the actual heating energy consumption of the inhabitants are of importance. Moreover a variation in education level of the volunteers had to be maintained to test of comprehensibility of the EAP-procedure and the final report.

The energetic analysis of the houses consisted of the full EAP-procedure. During this project, the different procedures have been executed by experts from Vito, which also contributed to the development of the EAP-procedure and software. As explained above, the EAP-procedure was not set up as a direct answer to the European Building Performance Directive. The procedure is based on the normalised European heating calculation methods being developed, but does not take lighting or air conditioning into account. The procedure covers however the three large parts:

- The building envelope: The entire envelope of the heated volume is described. This description take into account all different parts with their compositions, sizes, orientations and configurations. The description of the envelope is undoubtedly the most complex and labour-intensive part of the evaluation.

- The heating installation: the main heating installation is described. The energetic performance of the installation is split up in separate performances for production, distribution, control system and heat emission. The procedure determines a theoretical calculation of the energy consumption, based on all technical data. But the procedure equally gives results calculated from the actual yearly consumption of the family, thereby taking the actual consumption of the family into account.
- The hot tap water: the installation for heating domestic water is described. The energetic performance distinguishes the production performance, distribution losses and storage losses.

The EAP-procedure equally foresees the control of the thermal comfort during the summer and the ventilation (Vekemans, 2003). But these aspects have not been applied in the framework of this study.

For every separate part, for combinations, and until the composite entity, every time a label is attributed, energetic losses and gains are shown, as well as energetic and economic effects in case of renovation.

Labels are attributed from A+ to E, where A+ indicates excellent performance and E insufficient performance. The criteria for labelling do depend on the part being judged. For instance, the criteria for windows are much wider then those for walls or roof parts. The criteria were chosen in correspondence with the actual building practises in Belgium, so A+ corresponds with the best technically possible practise, and E with the worst. Given the fact that the procedure has been set up for existing residential buildings, the criteria to define the different classes have been chosen wide enough. Not every older building should fall immediately under label E. The final result shows a label for the three main parts: one for the building envelope, one for the heating installation and one for the hot tap water.

Together with the judgement on the classification of a specific part, a recommendation for an improvement is produced and the results of this potential future intervention is calculated. This is visible in Figure 3, where a screen of the EAP-software is displayed. The evaluation of the building envelope shows the envelope line per line by its different components, each with a label. Some of the weaker parts are proposed to be replaced by A or A+ components.

The procedure produces its results therefore not only as a certification and a label for the existing situation, but at the same time by presenting a possible future situation where the weakest parts have been renovated. For every analysed house, a report was composed, including all technical details, practical explanations of the procedure and technical sheets for every proposed intervention. This report was discussed with the owners of the house in order to ensure that all the results where clear. All renovations in the houses executed after the EAP-analysis have been followed up.

Results of the EAP-procedure and saving potential for renovations

The actual results of the EAP-procedure offer good insight in the actual state of the investigated houses and the related saving potentials. The analysis of the building envelope yields a yearly energy need. This is connected to the analysis of the heating installation in order to give the yearly primary energy consumption. To complete the total

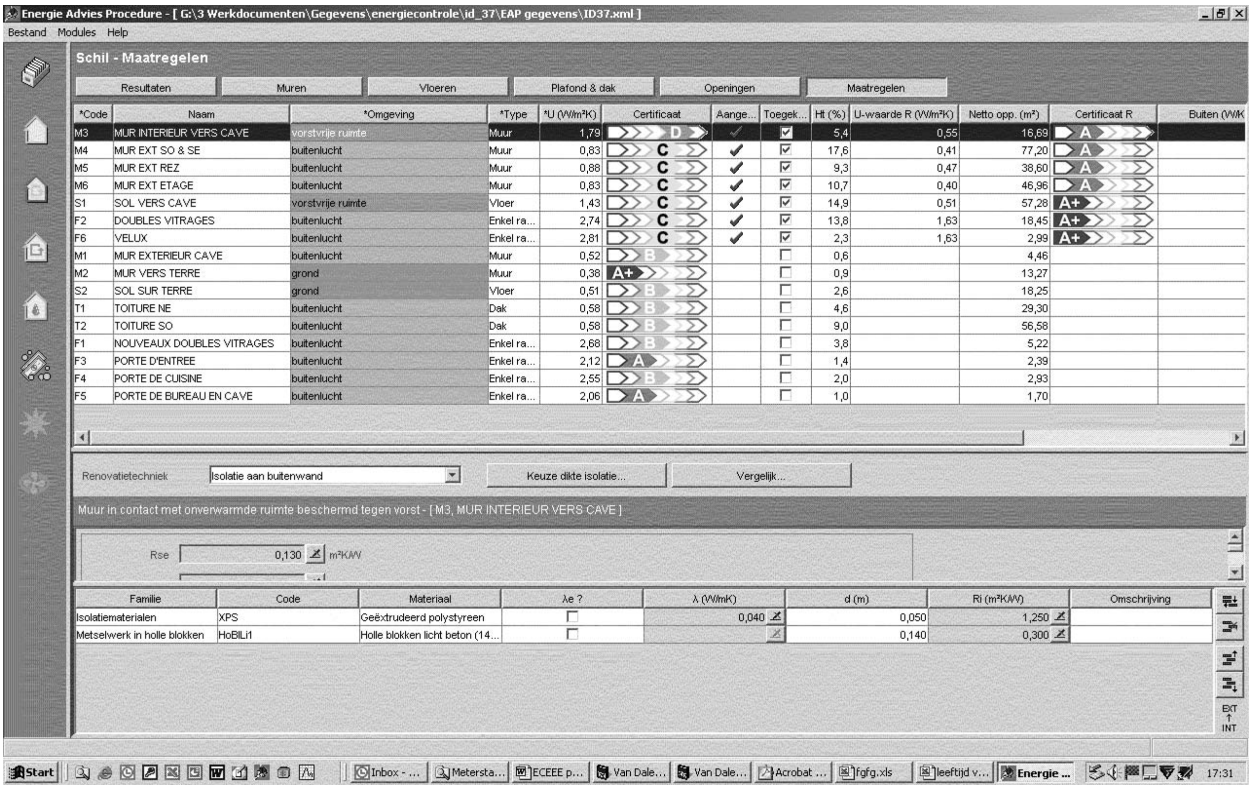

Figure 3: *Screen view of the evaluation of the building envelope in the EAP-software.*

consumption, the yearly primary energy consumption for the heating of domestic hot water is added.

This result shows the yearly energy consumption, totally independent of the inhabitants' behaviour. The calculation defines an envelope in the building containing all rooms and spaces which can possibly be heated by the main heating installations. In reality several rooms are often kept colder. But the procedure takes a 100% occupation into account. This is not only occupation in space, but also in time. Reductions in practical consumption because the heating is turned off during the day are not taken into account. This is needed to keep standardisation and comparison between different buildings possible. However, it stays very clear that this consumption is a purely theoretical consumption. This theoretical consumption stays useful in case the building is sold. But for actual renovations, it is useful to readapt all results in function of the actual energy consumption of the family.

The actual energy consumption can be given by a member of the household, and this information is taken into account. The entire calculation is repeated in reverse. The load curve of the heating installation is adapted and this leads to altered heat losses in envelope, installation and domestic hot water. Energy saving potentials are deducted from each of the three parts. The results for all audited houses are shown in Figure 4.

It is no surprise that the reduction potential of most of the houses is very large. These potentials are determined according to the actual situation, taking technical as well as practical restrictions in to account. In former studies, similar exercises showed an average reduction potential of 37% (Vekemans, 2001). The average saving potential in this case was 32%, so this result confirms former investigations in this field.

The saving potential was determined on the basis of 260 practical energy saving recommendations. These recommendations cover all possible interventions to reduce the heating charges of the audited houses. It is hardly possible to distinguish one certain type of intervention as the most effective. This depends too much on the actual situation in the house. The recommendations and their results are gathered for every broad category in Table 1.

The presentation of energy saving recommendations like in Table 1 gives some indications. The variation in each category is very large. It will now depend largely on the priorities put by the owner to decide which intervention will be executed. Based on the information which follows from the EAP-procedure, the decision criteria can roughly be put in two distinct categories: environmental or economical. The environmental criteria are mostly related to actual energy consumption and reductions. The economical criteria indicate effects on the energy bill.

Table 1 already shows one indication very clearly. Showerheads are apparently moderate in energy savings compared to larger interventions, but their economical yield is huge. But this is the only acceptable general conclusion which can directly be drawn from these data. Other remarks are possible, but assumption of their general validity is too big a step.

INTERVENTION AT THE BUILDING ENVELOPE

Several recommendations propose additional insulation for the building envelope. These recommendations are split

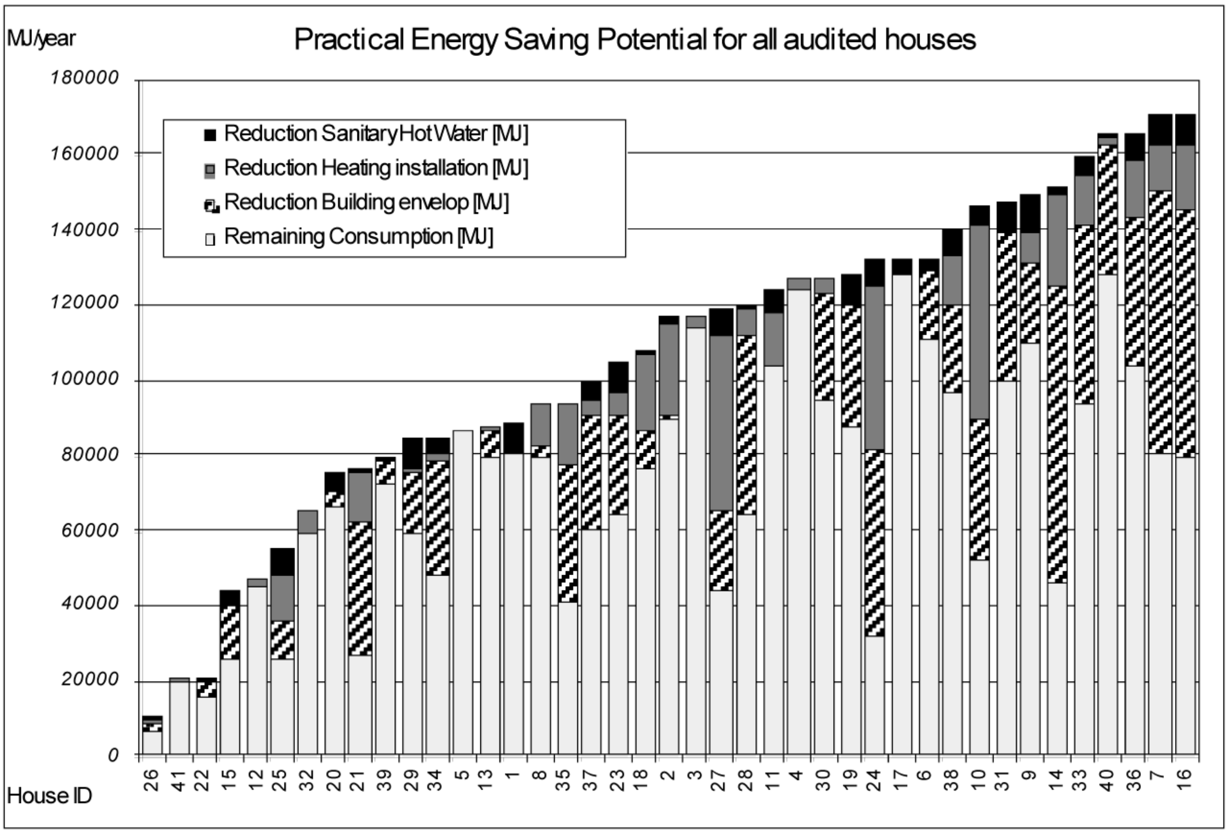

Figure 4: *Practical energy consumption of the audited houses and reduction potentials*

Table 1. Proposed Energy saving recommendations and their respective energetic and economical effect.

Advice	Yearly Primary Energy saving [kWh]			Time to breakeven [years]	
	Average	Minimum	Maximum	Minimum	Maximum
Reflection foil behind radiators	70	0	141	4,4	
Maintenance boiler	467	0	1 513	1,6	
Windows and doors	950	0	8 448	9,0	
Inner wall insulation	1 001	111	3 992	1,7	11,3
Distribution pipes insulation	1 136	101	4 923	0,6	67,5
Floor insulation	1 239	245	2 201	5,1	51,3
Showerhead	1 421	439	2 744	0,3	4,2
Control system	1 990	108	6 504	1,5	180,0
Storage tank insulation	2 156	2 156	2 156	5,0	5,0
Outer wall insulation	2 283	100	5 872	13,0	
Roof insulation	4 995	85	31 113	0,8	133,6
Solar boiler	5 735	3 049	9 425	5,2	61,0
Boiler replacement	6 519	1 189	17 765	4,3	58,1

between insulation of the walls, the roof, doors and windows and floors. For the insulation of the walls, the theoretical building physics show that additional exterior insulation of walls is the better option in many cases. This solution gives easier remedies for cold bridges and thus gives better prevention of condensation. Interior insulation gives risks for condensation in the wall and a reduction of available room space. For every case where insulation is recommended for a wall separating the heated space and the exterior, the insulation is proposed for the outside of the wall. The presented recommendations for inner wall insulation only recommends the insulation at the cold side of an inner wall separating the heated space with unheated rooms, such as the garage, caves or attics.

A very important effect for the economic viability of additional insulation is the possibility for the owner to carry out the interventions themselves, without the help of a contractor. This is the supposed situation for floor insulation, roof insulation and insulation of inner walls. Insulation at the exterior of walls and replacement of windows and doors by more performing alternatives have to be executed by professionals. These interventions are therefore much more expensive and less profitable. The only exception constitutes the replacement of single glaze windows by high performance double glaze windows. This replacement recovers the costs mostly on ten years and very commonly on five years. Other contracting work is less interesting from an economic point of view.

However, when the work can be carried out by the owner, the reduced price of the interventions enables substantial savings both of energy and money. Especially the insulation of roofs is often very cost-effective. If feasible, these interventions often give a reduction potential of 30% of the actual energy consumption.

Table 2. Average reduction of primary energy consumption when all interventions are gathered per house according to their payback period.

T < 5 years	8,9%
5 < T < 10 years	9,1%
10 < T < 15 years	5,3%
20 years < T	13,4%

INTERVENTIONS AT THE HEATING INSTALLATION

Recommendations concerning the heating installations also show some patterns. Proper insulation of distribution tubes is quite often neglected. However, this is also a rather easy intervention which can be done by the owner. The cost-effectiveness is therefore rather high. However, other common recommendations, like installation of reflection foil behind radiators, turn out to be almost without energetic effect.

The largest saving potential can be achieved economically by boiler replacement. This is often cost-effective on the longer term and has more energy saving potential then installation of solar boilers.

At the side of preparation of domestic hot water, the insulation of distribution tubes returns. Owners often request a detailed evaluation of the effects of a solar boiler. This intervention however recovers only rarely on less then 20 years. This result is quite deceiving. Information about the installation of solar boilers was largely distributed and official policies aimed to encourage the installation of solar boilers. However, the economic results take the effects of subsidies, fiscal advantages and other premiums into account. And even in this case the economical viability of these installations is pretty low.

SAVING POTENTIALS AND PAYBACK PERIODS

The initial results pointed out an average energy saving potential out of 32%. When regarding the economic reality of these recommendations, one can add up all the interventions for each house which are cost-effective in less then 5 years. Then the same exercise can be done for all the interventions which achieve break-even between 5 and 10, between 10 and 20 years, and finally longer then 20 years. For every range, this sum can be regarded as a package of interventions. The effect on the energy consumption of these packages is known. Averages are shown in Table 2.

This means that on average for the audited buildings, the consumption of primary energy can be reduced with 8,9% with interventions that recover the costs on less then five years. If the payback period is extended to ten years, this can give way to an additional 9,1% reduction, or 18% in total.

These figures do somehow show the large potential for energy reductions in the residential sector. It has of course to be kept in mind that these figures stem from a varied and selected sample of 41 buildings, which can hardly be representative for the entire of Belgium. Moreover, the figures in Table 2 overestimate slightly the actual potential. This straightforward representation does not regard interactions between different interventions. One common interaction is between insulation and the heating installation. Insulation has an effect on the net energy need of the house. Consequently the load of the heating installation will decrease and so the annual total efficiency of the installation will decease too. This explains that when the reduction of Table 2 are added, the total cumulative reduction seems to be 36,7%, and not 32% as stated above.

Still these are valuable indications. Usually, energy reduction is seen to be a rather long-term undertaking. It is hopeful at first sight to see that a substantial part of the reductions can be executed in a cost-effective way.

One should however not be completely pinned down to the interpretation of payback periods when considering the results of an audit. This approach has some serious inconveniences and leads easily to misinterpretation. One of the first reasons is the fact that all reductions are calculated as a share of the actual present yearly consumption of the family. This means that when a family has an energy-saving behaviour, their consumption is significantly reduced. At the same time, the resulting energetic and financial benefits for any proposed intervention are reduced in the same way. So this approach leads to the paradox that the more one's behaviour is energy saving, the less cost-effective the proposed interventions will be. Apparently less energy conscious consumers will find interventions at their building much more cost-effective. This is an important aspect of this standardised procedure, because this procedure has not been designed to influence behaviour, or to give advice on this level. However, if the major reduction potential lies on the behavioural side, it should be noticed by the auditor.

A second effect is quite similar. The procedure starts from the present situation of the building. When the present heating installation produces the heat in a very expensive way, the annual energy bill will increase seriously. This is often the case with electric space heating systems. The effect on the results of the procedure will be analogous. Because the heating energy is very expensive, the potential economic benefits suddenly increase. Often in dwellings with electrical space heating, almost every possible intervention turns out to be cost-effective. The few situations when the installation of a solar boiler turned out to recover the costs in less then 15 years, were in this case. It is therefore not directly the best idea simply to follow the interventions with the lowest payback period. Energetically it is a strange decision to connect a solar boiler to an electric heating for domestic hot water. It would be much more effective to tackle the principal energy source instead, and to propose the replacement of the main heating installation. These are only two of the cases, which show that even with the most detailed software, the auditor still has to be able to judge situations in an objective and technical way.

Practical consumption versus theoretical consumption

As explained above, both the theoretical as the practical or real consumption of the households are considered. Comparing these two data shows remarkable results. The comparison between the real and the theoretical energy consumption for the audited houses is shown in Figure 5. Both for theoretical and practical energy consumption, the trend line is added to show a more general behaviour.

The dotted trend line follows the theoretical energy consumptions. This is a straight line and shows the large variation of the audited houses considered in this project. The smallest consumption corresponds to a small apartment, whereas the largest consumption – equivalent to 75 670 kWh per year – corresponds with a large poorly isolated house from the start of the last century. Every possible energetic performance in between was represented in the selected sample.

The real consumption however, does not follow the same line. This real behaviour is curved and attains a maximum level around 41 000 kWh per year. The variation around this trend remains large and has a amplitude of about 9 500 kWh. Still, if this general trend is realistic, it may imply that the reduction potentials discussed above will not be attained in practise.

The reason for the flattened curve for large energy consumptions is clear. The considered houses are usually or larger or poorly insulated or both. The inhabitants limit their energy consumption for economic reasons. They limit their consumption by reducing the heated volume of their house. Some rooms, usually sleeping rooms or hobby rooms, are kept unheated. The inhabitants use their building eventually to less then the full 100%. If these inhabitants decide to implement one of the propositions, they reduce the theoretical energy consumption of their house, and as can be seen in the former paragraph, this reduction can be considerable. This is reflected in the position of the house in Figure 5, which moves towards the left side. However, for the houses with larger theoretical energy consumption, a considerable move towards the left does not translate itself in a serious reduction of the practical energy consumption. The final end of the practical curve is flat, so the reduction of the practical consumption is only a fraction of the theoretical reduction.

This difference between a reduction in theory and almost no reduction in practice can be explained by looking at the actual situation. When a partial renovation of the house is carried out, the owners often increase their use of the building afterwards. So an intervention for a better insulated construction or a more efficient heating installation, does not yield a smaller consumption but a higher level of thermal comfort. This effect is known both by economists and environmentalists as the Rebound-effect.

Figure 5 illustrates clearly that increasing the energetic performance of buildings does not automatically induce large reductions of energy consumption. The Rebound effect is known, but it can hardly be quantified. Studies for Flemish houses suggest the same effect, but practical data is lacking to take this effect into account in calculations (Hens et al., 2001). Other studies for Austria suggest a general average Rebound-effect of 20 to 30% (Haas et al., 2000). A re-

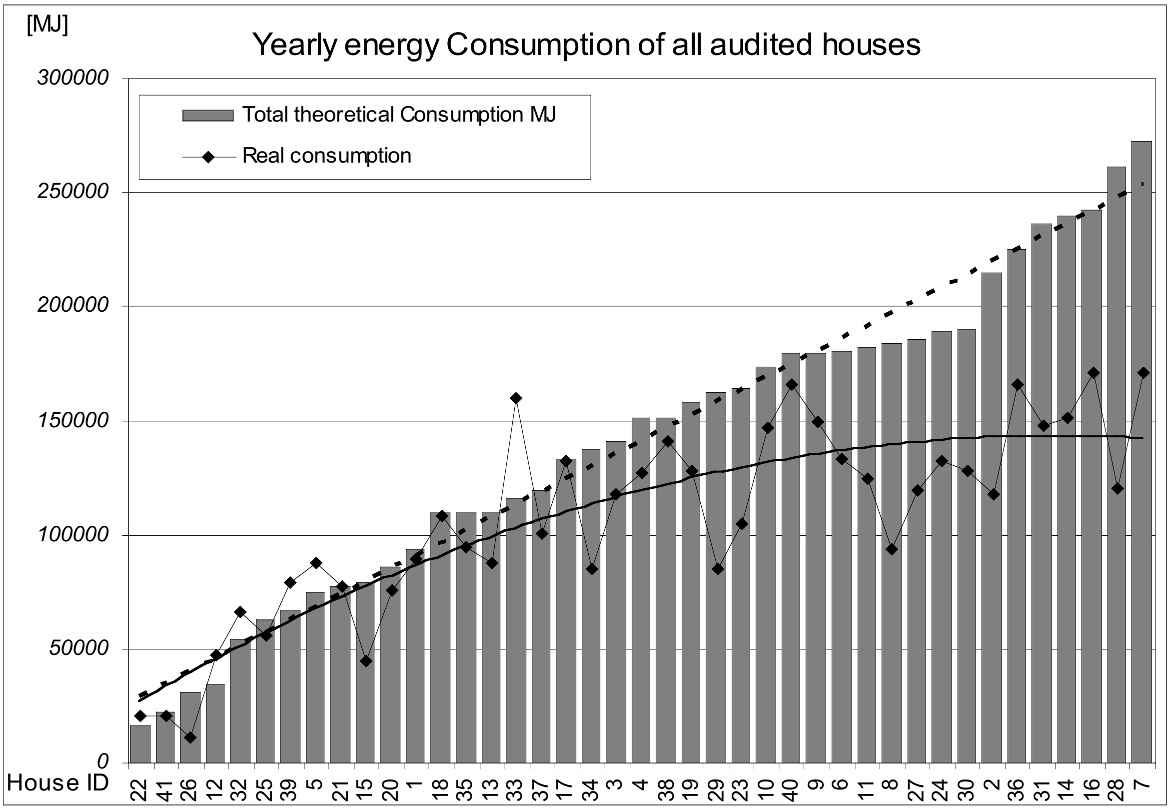

Figure 5. *Comparison between the yearly theoretical and practical energy consumption.*

view of studies in America suggests a rebound effect between 10 and 30% for space heating (Greening et al., 2000).

It is clear that this effect, imprecisely defined as it may be, has a large impact on the calculations presented above, and even more on the suggested practical energy saving potentials of the residential sector in Belgium. When Figure 4 is compared with Figure 5, it shows that exactly the larger consumers have the largest reduction potential in absolute terms. At the same time, any intervention at the houses of the larger consumers will result in the biggest rebound effect. Rebound effects should not be expected in houses with better energetic performances. Figure 4 shows that large reductions remain possible in houses with smaller consumptions. But unfortunately, these reductions do not represent the bigger part of the total reduction potential.

Acceptance and effects of the EAP-procedure

The first effects of the audit can be seen from the interventions which the owners eventually are willing to carry out. After the audits, the team of sociologists from the UCL did qualitative interviews of some participants of the audits (n=4). These interviews have been carried out approximately three months after the visit of Vito. One part of the interviews concerned the modifications carried out in the house as a result of the audit. It has to be noted that these audits have been realised within the framework of the aforementioned study. The audits were absolutely free of charge and on a voluntary basis. This might have an influence on the answers given.

REASONS TO CARRY OUT INTERVENTIONS OR NOT

The audit can act as a trigger for modifications or renovations. As a matter of fact, the information was independent of any commercial aim and was more complete than the information that the owners could have gathered on their own. The judgement of the qualified persons having a more global view, allowed the owners to increase their awareness and to take decisions accordingly.

It is necessary to distinguish two types of modifications:

- The superficial modifications which do not generate large savings neither budgetary nor energetically. These do not turn the household upside down and they can be performed without large investments.
- The more demanding modifications which require the decision to mature as a result of their larger extent.

Superficial modifications are commonly executed by owners which received an audit, such as insulation of the piping of heating installations, installations of economic showerheads, or even energy-saving bulbs. The more demanding transformations can remain latent and less concretized as a result of certain barriers, some of which may be:

- The financial barrier is very important whenever a financial investment is large and the yield requires a longer term.
- The lack of immediate effects : the households then give priority to other tasks.
- The scope of the works. Several households were actually carrying out renovations or had just finished them.

They do not want immediately to start new renovations again.

- Some households prefer to wait for a more advantageous moment (e.g. a building fair).
- The difficulty to practically execute the proposed interventions. Not all owners felt comfortable by carrying out the interventions themselves, even having received technical explanations at the time of the audit.

Often for these larger or more demanding interventions, the resulting information from the audit helped the household to create a better understanding. The recommendations however are not always directly executed, despite the pertinence which is accepted. After all the owners are the only persons able to consider the pros and cons and to decide in the end to apply the measures or not.

GUARANTEES FOR A VALUABLE RESULT

The EAP-procedure gives clear indications for the owners in case of a renovation. This is not the only aim of the procedure. The results should also show the energetic performance of the building without interference of the inhabitants' behaviour.

In order to establish an idea how this procedure is perceived by the owners of the house, Vito sent a questionnaire to all house owners one month after the audit. The results of the questionnaire give some indication about the value of the audit.

Figure 6 presents the distribution of opinions amongst the owners when asked for the most interesting or valuable information resulting from the audit. The owners often cite the labels as most interesting. Because of their visual strength, labels are very effective tools to present the actual energy efficiency of devices, components or other parts. This is also reflected here. More than 90% of the respondents found the labels to be "valuable" to "very valuable".

Figure 6 shows that next to the labels, most of the report was equally received with interest. The respondents were also asked for the attention they would pay to the report if they were to buy a new house. This question had been asked before within the framework of other surveys and preliminary investigations, but these results are rarely to the point. The experiences during this study showed that most owners do not have a correct idea what an audit actually is about. In this case, this question was possible, because the owners now had received an audit and were aware of the information the report could provide. None of the owners indicated that the report would not interest them in case of a transaction. The most attention would be paid to the appreciation of the building envelope (73%), followed by the general appreciation (64%) and the heating installation (59%). Some owners specifically indicate that this report would influence their appreciation of the price for a new building. However, the report will not provide the final arguments for the decisions. The qualitative interviews show a variety of motivations that have been considered to buy the house, like space, luminosity, location. Among these motivations, the energetic characteristics of the dwelling are not necessary the principal criteria.

Recommendations for future implementations

Having established a complete EAP-procedure does not suffice for the implementation of a labelling system. The procedure on itself can create a value for the owners of the building. But certain conditions should be fulfilled before these results are regarded as valuable. When asked about their assessment of important characteristics for an auditor, two characteristics turn out to be very important: technical knowledge and the capacity to explain the results clearly (as can be seen in Figure 7). So the auditor should not only be technically skilled, he should equally have the necessary social capacities. This is also reflected in the answers of the qualitative interviews.

These two characteristics are visibly the most important, if the audit needs to create value for the owners. On a second level, two other characteristic turned up. Apparently the neutrality and the availability of the auditor are requested. Neutrality equally returned in the interviews concerning the objectivity of the auditors. The information resulting from the EAP-procedure can only be valuable if this is not biased by the auditor. Most other information available is

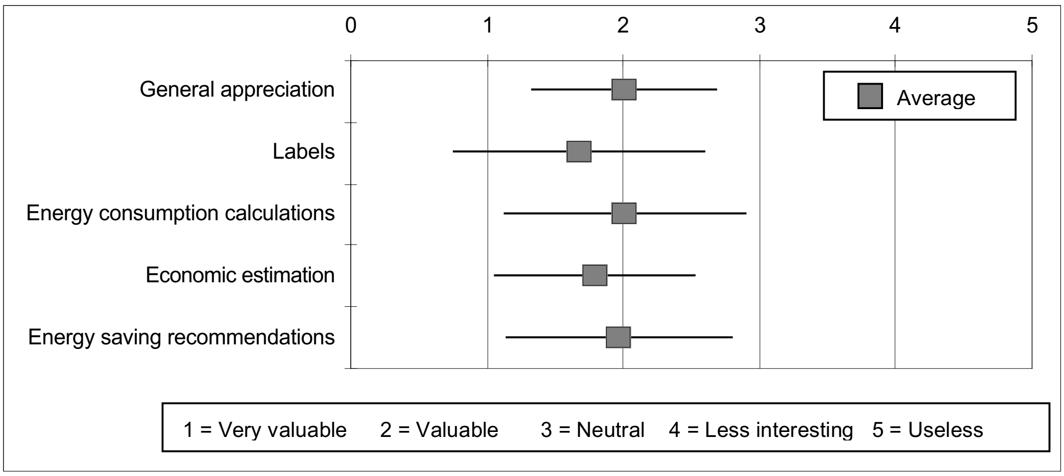

Figure 6. *Distribution of opinions concerning different parts of the report.*

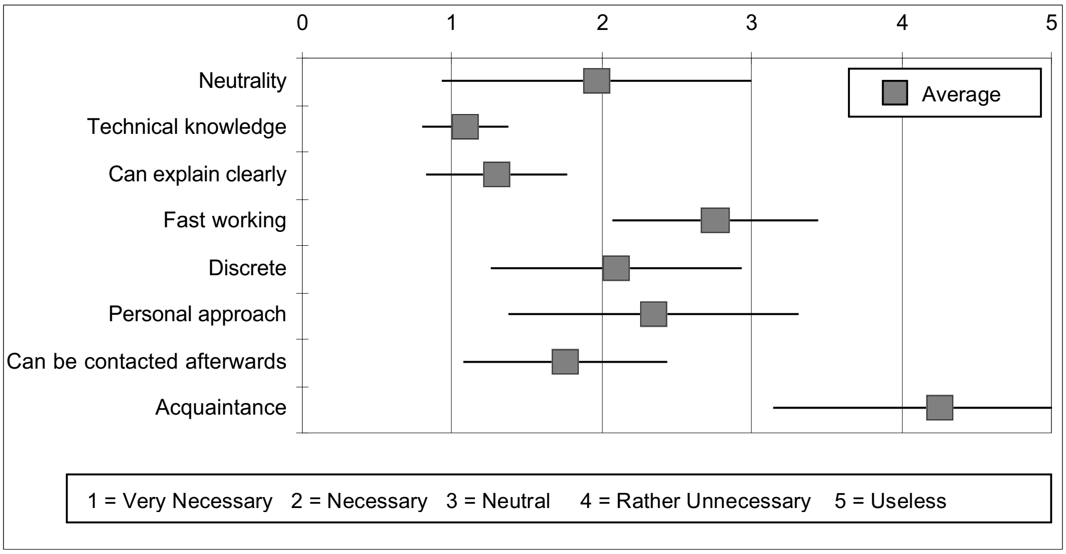

Figure 7. *Important characteristics for an auditor.*

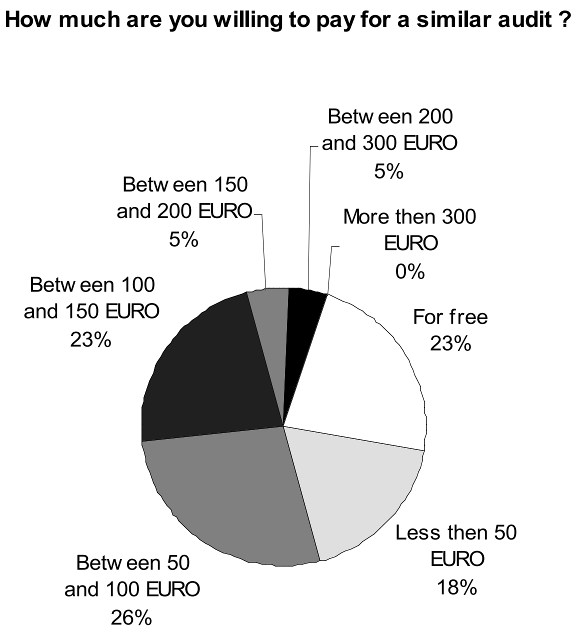

Figure 8. *Willingness to pay for the audit.*

given by contractors or manufacturers, and this information is often regarded as less objective.

The availability was needed, as the entire matter of heating and building composition stays a technical matter. Several owners prefer to read the report thoroughly and to contact the auditor afterwards for additional questions.

Finally, even while the owners recognize the specific value of the results for them, they do not seem willing to pay a large sum for the performed audit. The EAP-procedure and the software has been developed having in mind a limit for an audit of 4 hours and thus a limit of the actual cost of an audit of less then 250 Euro. However, 95% of the owners are not willing to pay more then 200 Euro for a similar audit. 67% of the owners is not even willing to pay more then 100 Euro. In order to implement the complete procedure in Belgium, the discussion on the final price to be paid by the owners will clearly be of importance.

Conclusions

This paper gathers results from the first practical test of the EAP labelling procedure in Belgium. The EAP-procedure is rather complex and several results can be drawn from these experiences:

- From a technical point of view, the procedure offers the possibility to define the energetic performance of an existing building and all of its components in a standardised and detailed manner. The large variety of buildings upon which the procedure now has been tested did not pose technical problems.
- The definition of possible energy saving recommendations creates important additional information. The applicability of these recommendations has been regarded and the overall results show differences between the actual energy saving potentials and the economic viability of several interventions. Unlike common perception, several 'passive' interventions e.g. boiler replacement of roof insulation often have a better economic viability and larger potential for consumption reduction.
- Comparison between theoretical and real energy consumptions already give indications on limitations for energy savings, this in combination with Rebound-effects. This effect has not been taken into account up to now, and there is no clear quantification available. Studies in other countries however suggest this effect to have considerable implications. More research on this subject will certainly be needed.
- The procedure and the results seem to be easily accepted by the owners of the audited houses. Their remarks indicate that the acceptance of the procedure depends on the technical knowledge of the auditors, their social capacities and their objectivity. A successful implementation of

the procedure in Belgium will have to guarantee these characteristics.

- The information and pieces of advice given by the experts of the audit are largely appreciated and can encourage modifications or renovations. Still, various and complex barriers can discourage or postpone changes. A complete policy to encourage renovation can make use of a correctly implemented labelling system, but should also provide other actions.

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