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Lessons Learned from the Analysis of the Database of Energy Performance Certificates

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Abstract

As a consequence of the Energy Performance of Buildings Directive, Flanders has set up an energy performance certification (EPC) system for existing buildings, being mandatory when selling or letting a house. This EPC gives the energy rating of a house in kWh/m² floor area, calculated based on detailed housing characteristics. Between 2008 and 2013, 617.489 EPCs have been registered, representing 22% of the current dwelling stock. At the same time, in order to meet the EU2020 objectives, the Flemish government has set up different policy programs to stimulate deep energy renovation. Despite the magnitude of detailed data on Flemish dwellings in the EPC database, comparison with the Flemish land register and two large scale housing surveys showed that the EPC database cannot be considered as fully representative for the Flemish dwelling stock. The distribution between apartments and single family houses is different and the EPC database underestimates the presence of insulation due to the frequent use of default values in case of missing evidence to prove presence of insulation. However, the EPC database as well as the surveys show that up to now too few houses meet the requirements of the renovation programs. Yet, with the database containing detailed data of every house and being already connected to an energy calculation software program, by extending it with a cost-benefit calculation tool, a renovation advisory tool could be created with which house owners or architects could investigate different renovation scenarios by means of comparative energy and cost calculations.

Keywords – renovation; houses; representativeness; policy; advisory tool

1. Introduction

In the fight against global warming, it has become increasingly important to reduce energy consumption particularly in the buildings sector, which alone accounts for 40% of the EU's final demand for energy [1]. Therefore the Energy Performance of Buildings Directive (EPBD), the main legislative instrument at EU level to achieve energy performance, obliged all Member States to apply minimum requirements regarding energy performance of new and existing buildings, at latest by January 2006 [2].

The directive required that an Energy Performance Certificate (EPC) (not more than ten years old) must be available for purchasers or tenants when a new or existing building is sold or let. In addition, the certificate must also include recommendations for cost-effective improvements in energy performance.

In Flanders, the EPC was made available for the sale of residential units on November 1, 2008 and for rental housing units on January 1, 2009. The most important value on the Flemish EPC is the energy score that reflects the calculated energy consumption in kWh per year per m² of usable floor area. The energy score is calculated based on the geometrical data and the available information on wall, roof and floor insulation, windows and doors, the ventilation system and the heating and domestic hot water supply systems. In the calculation of the energy score, user behavior and climatic conditions are standardized and thus the energy score does not represent the actual energy consumption of the last occupants. In Flanders the EPC can only be supplied by an accredited energy expert, who has to make use of an inspection protocol that defines how the presence of insulation, insulation thickness, characteristics of the heating system, etc. can be determined and which documents may be used as valid evidence. If certain aspects of the actual state cannot be proven, the inspection protocol determines the default values to be used, which often depend on the year of construction. The EPC also provides recommendations for improvement of the energy performance, but to minimize the time spent by the expert on the EPC (and thus also to minimize the cost of the EPC), these recommendations are generically generated by the software.

The EPC is calculated by means of an online EPC calculation software tool, which is only accessible for the experts. All input data are collected in a central database which included over 600.000 certificates on January 10, 2013. This represents already 22% of all Flemish housing units (in total 2.836.293 on January 1, 2013). These data might be of significant meaning to researchers, government, builders,… as it contains massive information on general characteristics (year of construction, type of dwelling, type of ownership), detailed geometrical data of building size, walls, windows, roofs, floors,… and energy characteristics (insulation, glazing, heating, renewable energy,…) of the Flemish dwellings.

However, despite the richness of this information, it cannot be considered automatically as representative for the Flemish dwelling stock, since it only concerns housing units that have been sold or let since 2009. Furthermore often after purchasing a house, the new house owner renovates his house and none of the energy saving measures executed during renovation will be incorporated in the EPC, since the new house owner does not have an incentive to request (and pay) for a new EPC as long as he does not sell the house. Even if he sells the house within ten years, he can use the ‘old’ EPC and just inform interested buyers on the renovation measures

taken to avoid the cost of a new EPC (in general between 150 and 300€, often depending of the quality of/time spent by the expert to establish the EPC).

Therefore at first the representativeness of the EPC database for the Flemish dwelling stock has been analyzed by comparing it with data from statistically representative, but much smaller samples. Additionally the current state of the Flemish dwelling stock was determined, specifically the distance to target to the energy performance requirements set by the Flemish government in its Energy Renovation Program for 2020 [3] and in its Renovation Pact for 2050 [4]. These requirements are that all dwellings should have by 2020 at least roof insulation, double glazing and a well performing heating system. By 2050 all dwellings should have a maximum energy score of 100 kWh/m².

This paper first presents the methodology used for the analysis and describes the databases that have been used for the determination of the representativeness. Then the results on representativeness are presented and discussed, followed by the distance to target to the requirements of the Energy Renovation Program 2020 and the Renovation Pact 2050. Finally, policy recommendations are given on how the available data can be used to support the renovation programs of the Flemish government.

2. Methodology

For the analysis of the EPC database statistical frequency analyses and multi-variate analyses were conducted with SAS Enterprise Guide 9.3 on all data that were included in the database on January 10, 2013. All results of this analysis can be found in [5, only in Dutch]. In this paper, only the results relevant for the representativeness and the distant to target analysis are presented.

To assess the representativeness of the data in the EPC database, the data were compared to data from other databases such as the Flemish land register, the Eurostat housing survey 2011 and the Large Housing Survey 2013.

The land register is an official federal database that gives an overview of the Belgian dwellings and buildings on January 1 of the year. It contains information on period of construction, building type (single-family house or apartment), and dwelling type (detached, semi-detached or attached). Also the geographical distribution per region, province and city is available [6]. For this research, only the data for the Flemish region have been used.

The Eurostat housing survey 2011: in July 2010 Belgium took the opportunity to conduct Computer Assisted Personal Interviews (CAPI) on energy related parameters in households with financial support of Eurostat. This ECS-survey (Energy Consumption Survey) among 3.396 Belgian families (of which 1.774 Flemish families) gave a better insight in the household energy consumption and dwelling characteristics (especially

equipment level and insulation characteristics) at Belgian and regional level [7]. Only the data for the Flemish Region have been used here.

The Large Housing Survey 2013 was a large scale study, financed by the Flemish government to assess the affordability and quality of Flemish dwellings. In addition to a survey of 10.000 households, an internal technical inspection of 5.000 dwellings (selected from the 10.000 households) was made resulting in more detailed information, specifically on the presence of insulation, glazing type, heating type, energy carrier for heating and presence of renewable energy systems [8].

To determine the current state of the dwellings in relation to the distant to target of the energy performance requirements of the Energy Renovation Program 2020 and the Renovation Pact 2050, the percentage of dwellings that fulfilled the objectives of these renovation programs was calculated.

3. Results and discussion on the representativeness

To determine the representativeness of the EPC database for building and dwelling type and for construction year, a comparison was made with the Flemish land register, since this register contains information on all housing units in Flanders.

To analyze the representativeness of the EPC database for presence of insulation and insulating glazing, a comparison was made with the Eurostat survey and the Large Housing survey. For the heating system, the form of the data in the different data sources did not allow a proper comparison between data sources.

3.1 Comparison by type of building and type of dwelling

There is a large difference in distribution between apartments and single-family houses between the EPC database and the Flemish land register (Fig.1). The EPC database contains much more apartments (54%) than the land register. This can be explained by the fact that in Flanders apartments are more often rented for a shorter period (as a transitional dwelling) and therefore much more landlords of apartments had to fulfill the requirements of providing an EPC in comparison to owners of single-family houses. Within the single-family houses, the EPC database contains slightly more attached and semi-detached houses than is found in the land register (Fig.1).

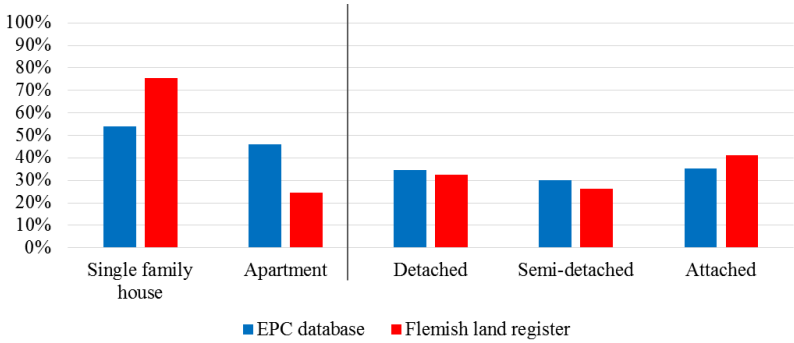

Fig. 1 Percentage of Flemish dwellings in EPC database and land register for type of building (single family vs apartment) and type of dwelling (detached, semi-detached or attached)

3.2 Comparison by construction year

Next to a difference in building type, also a difference between construction periods can be noticed (Fig.2). For the construction periods 1962-1970 and 1971-1981 the EPC database contains more or less the same percentage of dwellings as the Flemish land register, but for the construction period 1919-1961, there is an overrepresentation in the EPC database and for the period before 1900 and after 1981, there is an underrepresentation.

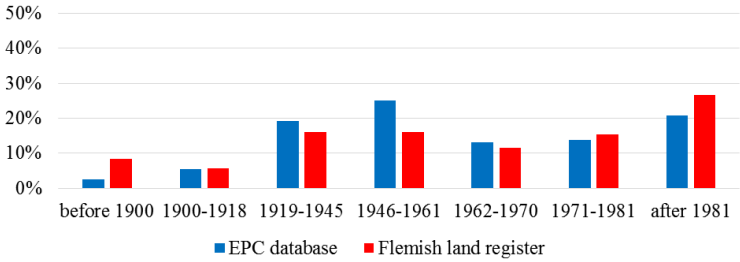

Fig. 2 Percentage of Flemish dwellings in EPC database and land register for construction period

3.3 Comparison by presence of insulation

For the presence of floor, wall and roof/attic insulation, only percentages are given for single family houses, because for the apartments the percentages diverged between the three databases. This might be due to the fact that a question on roof and floor insulation in apartments can be confusing or irrelevant for apartments that are not at the top or the ground floor. Since the location of a flat in the apartment building was not surveyed, it was often not clear if the answer on insulation was related to the flat or to

the apartment building. Therefore, Figure 3 gives the presence of insulation in single family houses according to the EPC database, the Eurostat survey and the Large Housing Survey.

As Figure 3 shows, the EPC database contains more single-family houses with no roof/attic insulation compared to the Large Housing Survey 2013 and the Eurostat survey 2011. In case of wall insulation and floor insulation, a high convergence was noted between the EPC database and the Eurostat survey. In contrast, the Large Housing Survey showed a larger proportion of single-family houses with wall insulation and floor insulation and a smaller proportion of single-family houses without wall insulation or floor insulation compared to the EPC database.

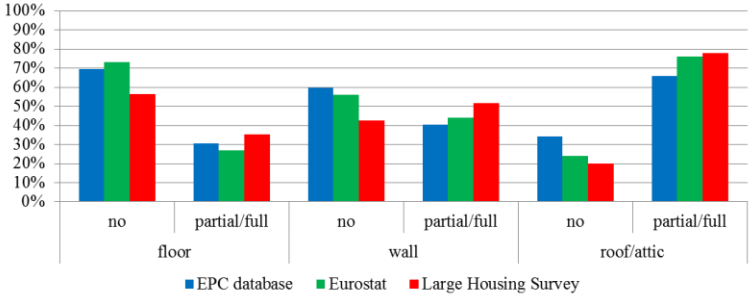

Fig. 3 Percentage of Flemish single family houses in EPC database, Eurostat Survey and Housing Survey for the presence of insulation

For the presence of single glazing, it was not possible for all three databases to distinguish between single family houses and apartments. Therefore, Figure 4 gives the data for single glazing for all housing units, but subdivided for houses having only single glazing, partial single glazing and no single glazing.

Fig. 4 shows that there is a high convergence between the three databases for the percentage of housing units with only single glazing, but for housing units with no single glazing (so having some kind of double or triple glazing), the EPC database seems to underestimate the actual percentage.

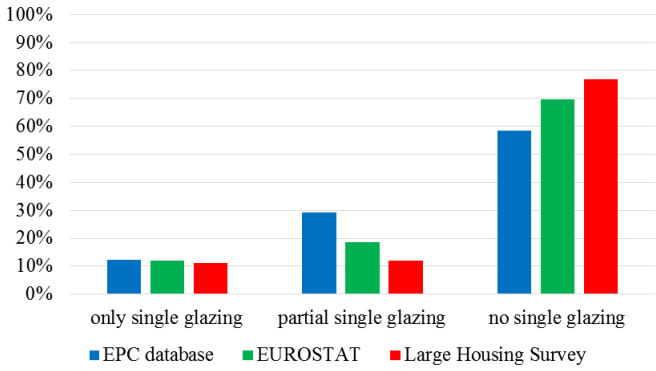

Fig. 4 Percentage of Flemish dwellings in EPC database, Eurostat Survey and Housing Survey for the presence of non-single glazing

3.4 Discussion

As Figure 3 and 4 show, the estimation of the presence of insulation/insulating glazing in the EPC database is in general lower than in the Eurostat Survey and the Large Housing Survey. For floor, wall and roof/attic insulation, this is probably due to the rules for proving evidence in the inspection protocol. In case the presence of insulation cannot be proven visually or with technical drawings, technical documents or invoices of contractors, the energy expert has to adopt the default value provided in the software. The default values depend on the construction year and are in general rather negative, meaning that they are more often an underestimation than an overestimation of the insulation quality. This is a policy choice to avoid that energy experts would only rely on default values and therefore would (un)intentionally overestimate the energy performance of the house. As the analysis of the use of documents to prove evidence showed [5], for 13% of the houses with EPC the expert relied on technical drawings for the establishment of the EPC, 7% relied on technical documents on the heating systems and 6% on invoices of the contractors. Since more than one type of evidence can be used for the establishment of the EPC, this means that the majority of EPCs is established without any proof of evidence and only relying on the default values. This is partly due to the fact that for older houses very few documents are still available, but also partly because EPC experts want to reduce the time spent to an EPC as much as possible to reduce the cost, since most house owners only want an EPC because it is mandatory and are not so much concerned about the quality of it. The Large Housing Survey also surveyed among landlords what their knowledge of the existence of the EPC is and to which extent they have an EPC for the houses

they rent out [8]. It appeared that 40% has no EPC for any of their rental houses and of these landlords, 38% knew they should have one, whereas 62% declared not to know they should have one. So it can be concluded that still much effort as well as important changes are needed to develop the EPC into a better communication instrument to properly inform house renters on the energy performance of the house they rent and to support new house owners in their decision making on renovating their house.

4. Results and discussion on meeting the energy renovation program requirements

4.1 Meeting the requirements of the Energy Renovation Program 2020

In Flanders, the Energy Renovation Program of the Flemish Government stipulated in 2009 that at latest on January 1, 2021 all existing houses should have roof insulation and an efficient heating system and none of the houses should have single glazing. Table 1 gives the percentage of Flemish dwellings in the EPC database and in the Eurostat Survey that meet no requirement, only one requirement, only two requirements or all three requirements of the Energy Renovation Program 2020.

Table 1. Percentage of Flemish dwellings in the EPC database and Eurostat Survey that meet none, only one, only two or all three requirements of the Energy Renovation Program 2020

Measures of Energy Renovation Program 2020	EPC database	Eurostat survey
	%	%
No roof insulation, insulated glazing or efficient heating	29	4
Only roof insulation	8	4
Only insulated glazing	24	11
Only efficient heating	3	4
Roof insulation and insulated glazing	21	21
Insulated glazing and efficient heating	5	11
Roof insulation and efficient heating	2	4
Roof insulation, insulated glazing and efficient heating	9	41

This shows that there is a large difference between the performance of the dwellings in the EPC database and what is the actual state of the existing dwelling stock according to the Eurostat Survey. Where from the dwellings in the EPC database still 29% does not meet any of the requirements from the Energy Renovation Program 2020 (according to the data in the database) and only 9% meets all requirements, according to the Eurostat survey only 4% does not meet any requirement and 41% meets all requirements.

4.2 Meeting the requirements of the Renovation Pact 2050

The Energy Renovation Program 2020 was established by the previous Flemish government in 2007. With the start of a new government in 2014, a new renovation program, called the Renovation Pact, was set up with a time frame up to 2050. Many details of the Renovation Pact (what are the different requirements, what is the roadmap to follow towards 2050, how can the EPC be improved, etc.) are still under development, but at this moment in the official governmental documents, an overall energy performance requirement can be found, being that all existing houses in 2050 should have an energy score no larger than 100 kWh/m². Since the achieved energy score will have to be justified by means of a kind of EPC, it is interesting to see how many houses in the EPC database meet this requirement at this moment. As mentioned above, on the Energy Performance Certificate, the energy score is given in kWh/m² floor area. It is visualized on a red to green bar and an energy score of 180 kWh/m² or lower is presented on this bar as equivalent to a new building. The maximum value on the bar is 700 kWh/m², although in the database there are houses with a score higher than 700 kWh/m². As Figure 5 shows, from the housing units in the EPC database, 20,2% has an energy score below 200 kWh/m² (more or less equivalent to a new building) and only 1,3% a score below 100 kWh/m²! Furthermore 50,5% has a score between 200 and 500 kWh/m² and 18,3% between 500 and 700 kWh/m²; 11% has an energy score above 700 kWh/m².

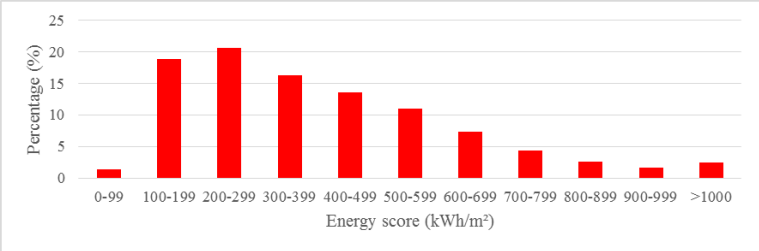

Fig. 5 Percentage of Flemish dwellings in the EPC database according to the energy score

5. Conclusions and policy recommendations

The analysis of the EPC database and the comparison with other more statistically representative samples clearly showed that the EPC database is not (yet) the most appropriate data source for policy makers for information on the actual distant to target for the Energy Renovation Program 2020. Also the very low percentage of houses in the EPC database that meets the requirement of 100 kWh/m² is probably an underestimation of the reality. However, it might be clear from all results that both for 2020 and 2050 a huge effort still has to be made to achieve an energy efficient building stock by then.

Nevertheless, two policy recommendations can be made. First, there is a clear need for a scientifically well founded indicator to follow up the evolution of the overall energy performance of the existing building stock as well as of the presence of energy efficient measures such as roof insulation, wall insulation, floor insulation and insulated glazing. Up to now no good data source with this information is available that is updated on a regular, yearly basis. The Eurostat survey and the Large Housing Survey are valuable sources, but they both represent expensive and very time-consuming research. Also in international scientific literature, no example of such an indicator has been mentioned yet (to my knowledge). Secondly, despite the fact that the EPC database did not prove to be representative for the Flemish dwelling stock, it contains very useful and detailed data on each of the houses with EPC, such as geometrical data. The database is now linked to a steady state online energy calculation software for the calculation of the energy score. Extending this software with an online module for cost calculations would create the opportunity for a (new) house owner or his architect or energy expert to investigate rather easily different energy renovation scenarios, including the costs and benefits. This way, the EPC could serve much more as a renovation advisory tool, something that is now missing.

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