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Capturing the multifaceted nature of energy poverty: lessons from Belgium

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1. Introduction

Having (secure) access to a sufficient amount of energy services is key to experiencing a decent quality of life (Walker et al., 2014). However, in recent years, there has been a growing concern in many EU countries about the inability of some households to afford a sufficient amount of energy, and to satisfy basic energy needs (Dubois and Meier, 2016). The phenomenon of energy poverty raises some critical challenges for policy-makers as it has both economic and social justice implications (Walker and Day, 2012 ; Gillard et al., 2017). It is also a critical issue in ensuring an inclusive energy transition (Carnegie LaBelle, 2017; Powers, 2017) that does not leave the most vulnerable people behind.

Energy poverty is widely discussed by governmental and non-governmental bodies across Europe, but less frequently addressed by specific policy measures (Thomson and Snell, 2013). This is probably due, at least partly, to energy poverty being a multifaceted notion (Moore, 2012; Bouzarovski and Petrova, 2015; Middlemiss and Gillard, 2015). Definitions vary widely, and can take in a range of impacts on households: including *affordable warmth* (Boardman, 1991), and non-heat impacts (Simcock et al., 2016), as well as looking at the problem as more or less dynamic (changing over time): witness the concept of energy vulnerability (Bouzarovski and Petrova, 2015), or multifaceted (affecting different people in different ways): witness the concept of *précarité énergétique* in the French political discourse (ONPE, 2014). This diversity also results in different emphases on the various facets of energy poverty, with weight placed on specific drivers, impacts and dynamics according to national priorities (see for e.g. Middlemiss, 2017).

In this paper, we attempt to translate our analytical starting point (i.e. understanding energy poverty as a multifaceted phenomenon) into a set of quantitative measures (we call this a 'barometer'). In doing so we draw on insights about how energy is experienced in real life, both in fuel poor households (Middlemiss and Gillard, 2015) and more generally (Maréchal and Holzemer, 2015).

Accordingly, in this paper, we outline a new way of measuring energy poverty developed in the Belgian national context. The energy poverty barometer represents a deliberately broad use of data from the EU SILC survey, already mentioned by the European Commission in its Third Energy Package for monitoring energy poverty (European Commission, 2010). We do this by drawing on a combination of objective and subjective measures, as well as by using both extent and depth measurements, to give a nuanced picture of the complex state of energy poverty in Belgium. The design of this new set of measurements is intended to capture the multifaceted nature of the problem, and to explore the idea that different people are affected by different kinds of energy poverty (e.g. feeling the cold, paying too much for energy, under consumption of energy) building on insights in the literature on the lived experience of fuel poverty. Note that such a starting point mirrors similar efforts in French energy poverty policy (Devalière et al., 2012 ; ONPE, 2014).

The paper is structured as follows. Part 2 consists of a review of existing energy poverty indicators , as well as an introduction to the Belgian context. In part 3, we describe both approach and methodology we followed to set up a Belgian energy poverty barometer and present its first results. To reflect our understanding of energy poverty, this barometer is made of three different types of indicators: one set of indicators (extent and depth) capturing households facing disproportionately high energy expenditures compared to their disposable income after housing costs, one set of indicators (extent and depth) capturing households that restrain their energy expenditures below their expected basic energy needs, and finally one indicator (extent) capturing households' perceptions of energy poverty in the home. Part 4 will discuss different points regarding both the barometer methodology and its main results, as well as the overlaps between the different forms of energy poverty, while part 5 will synthesize main conclusions.

2. Background

2.1. What is energy poverty?

Energy poverty has no common definition within the EU but benefits from a consensus recognising it as a major and increasing societal challenge that goes beyond an economic imbalance in the household's budget (Healy and Clinch, 2004; Thomson and Snell, 2013). Energy poverty is in fact linked to several exclusion and/or impoverishment issues and is part of a wider bundle of shortages which spreads across the individual and collective life of the persons suffering from it (Huybrechs et al., 2011). This can have far-reaching consequences among which the occurrence of severe health issues (Healy, and Clinch, 2004; Boardman, 2010; Liddell and Morris, 2010; Howden-Chapman et al., 2012; Ormandy et al., 2012; Teller-Elsberg, 2016). As recently summarised in Sovacool (2015: 362), energy poverty 'extends well beyond defaulting on energy bills, and can threaten personal wellbeing and modern notions of equity, justice, and fairness'.

Energy poverty is a dynamic and complex process. The socioeconomic situation of the household, the energy performance of the dwelling and energy prices are important drivers of energy poverty. These are widely viewed as the classical determinants of energy poverty (Boardman, 2010), to which the recent Commission proposal to define energy poverty refers explicitly and exclusively[1]. However, there are other factors that increase households' vulnerability to energy poverty. For instance, the composition of the household (e.g. presence of an older person or young children), the professional status of its members (e.g. unemployed, working part-time, self-employed working at home, etc.), and their health conditions, directly impact the need for heating and lighting. Being a tenant increases households' vulnerability as rented dwellings are, on average, less energy-efficient (Gillingham et al., 2012), but also because tenants have less opportunities to adapt their infrastructure to better suit their requirements (Ambrose, 2015). The term energy vulnerability aims to emphasise those factors that increases 'the precariousness of particular spaces and groups of people' (Bouzarovski and Petrova, 2015:37; see also Middlemiss and Gillard 2015).

Energy poverty is thus an urgent issue. Tackling it adequately requires better understanding, defining and measuring of this cross-cutting and multifaceted phenomenon. The analysis performed in Holzemer et al. (2014) shows that this definition should ideally be based on a deep analysis of the different realities at play. This is necessary to meet social objectives and allow more enlightened political choices as regards their impacts on energy poverty. It highlights also that data availability for

[1] Households in energy poverty have an "*Inability to afford basic energy services, such as adequate warmth, cooling, lighting and the energy to power appliances, due to a combination of low income, high energy expenditure and poor energy efficiency of their homes*" (Dunin-Majewska, 2017:8).

measurement has to be taken into consideration (see also Pachauri and Spreng, 2011; Moore, 2012; Nussbaumer et al., 2012; Thomson and Snell, 2013).

Bearing these considerations in mind, the research presented in this paper started with a rather large definition to include as many existing situations as possible: "Energy poverty refers to a situation where a person or a household faces particular difficulties to satisfy his/her basic energy needs in his/her dwelling" (Huybrechs et al., 2011). The term includes all in-house uses of energy[2] and do not explicitly refer to any kind of causal determinants.

2.2. How can we measure energy poverty?

For the purpose of policy making, the most important challenge is to find a good balance between the choice of a conceptual definition that appropriately accounts for the multiple and interrelated causalities at play, and the feasibility of translating the chosen definition into operational terms.

As regards the measurement of energy poverty, the work of Brenda Boardman (1991, 2012) has had a major impact. She elaborated the *Fuel Poverty Ratio* (FPR) which is still widely used today[3] due to its apparent simplicity and ease of interpretation. The FPR calculates that a household is fuel poor when the required expenditure on energy services within the home is at least 10% of household income. It is likely that many have lost sight of the fact that the 10% ratio was derived from UK statistics in the early 90's to approximate a twice-median required energy expenditure.

Whereas the idea of a 10% threshold is simple to grasp, the FPR is a lot more difficult to compute as it builds on complex modelling of what a given household should spend on energy services to reach a minimum level of comfort (e.g. 21°C in living rooms and 18°C in the rest of the house). This modelling exercise is highly contestable as it rests on many assumptions which, by definition, could be contested (e.g. setting the comfortable temperature 1°C lower would exclude some individuals from the statistics of energy poverty).

However, starting from objective needs rather than from actual expenditures allows us to include those individuals who self-restrain their consumption below basic needs. Several studies have shown that households confronted with financial difficulties restrict their energy consumption below a certain level of comfort (Huybrechs et al., 2011; Anderson et al., 2012; Dubois, 2012; Waddams Price et al., 2012 ; May, 2013). The idea of using 'modelled' levels of consumption has been preserved in later measures including those put forward by authors criticising the approach derived from Boardman (such as Hills, 2012). Although we agree with the importance of accounting for *hidden* energy poverty, modelling, as in the FPR, does not allow us to distinguish between two types of energy poor (those who self-restrain and those who spend too much). This constitutes a strong shortcoming in terms of policy guidance.

The FRP has been widely criticised (see Hills, 2012 and associated references). The arguments often raised are the outdated and highly specific nature of the UK statistics and data used to determine the

[2] Note that this definition thus purposely excludes the energy costs related to transportation. This decision was taken in order to avoid adding even more complexity to this multifaceted and cross-cutting understanding of energy poverty. The researchers recognise that mobility, the location of the dwelling and their related costs are intrinsically related. Moreover, if electric vehicles are widely adopted in the domestic sector in the future, it will become more difficult to distinguish household energy consumption dedicated to the dwelling or to transportation.

[3] See for example: ONPE, 2014.

ratio, as well as the fact that the ratio is fixed and very sensitive to energy prices. Based on those elements, several alternative indicators have been put forward (see figure 3 in Pachauri et al., 2011 for a list of some of those indicators with respect to the dimension through which energy poverty is apprehended). Among those, there are the "Energy Affordability Gap" (Fisher et al., 2005), the "précariTER" tool (Devalière et al., 2011) and "Low Income High Costs" (Hills, 2011), the latter having replaced the FPR in England (see for example DECC, 2015). Subjective measures of energy poverty, based on whether someone feels they are able to service their energy needs, are also widespread (see for example ONPE, 2014; Devalière et al., 2011; Waddams Price et al., 2012; Bouzarovski, S., 2013). These allow for easy comparison across geographical scales (Thomson and Snell, 2013), but risk hiding differences in expectation and cultural norms of comfort, both within and between nations (Petrova et al., 2013).

In their recent review of the many indicators of energy poverty, Thomson et al. point out that all of these alternatives also have their limits, especially when seen through a broader lens of energy vulnerability (2017). Critiques of LIHC in the UK, for instance, find that certain households are excluded from the definition (Moore, 2012: smaller homes), that energy prices no longer have an impact on the indicator despite recent increases (Moore, 2012; Middlemiss, 2017) and that LIHC plays a convenient political role in separating out austerity and energy policy (Middlemiss, 2017). We could take the same critical lens to each of the indicator-types (Thomson et al. 2017).

Rather than throwing the baby out with the bathwater, our approach here is to explore the potential for using indicators in an additive way: to understand how these indicators might complement each other to give a fuller picture of the state of affairs in (Belgian) energy poverty. Such a multifaceted approach is both recommended by Thomson et al. in their extensive review (2017), and espoused in the French national context, where the 'basket of measures' approach includes French adaptations of LIHC, 10% and subjective measures (ONPE, 2014, Devalière et al., 2011). We see this as an ontological shift, informed by work on the lived experience of energy poverty which paints a more complex picture of household's experiences of these issues (Middlemiss and Gillard, 2015). The shift here is from attempts to find 'the' indicator of energy poverty, suggesting a positivist vision of a world waiting to be counted, to an admission that there is no perfect measure, because the world is complex, and we can only capture an imperfect image of it using such quantitative top-down indicators.

2.3 The Belgian context

Belgium is a federal state with three regions (the Flemish region, the city-region of Brussels-Capital and the Walloon region), each having specific competencies regarding gas and electricity markets (including consumer protection), as well as regarding measures to improve the energy efficiency of the dwellings.

For many years, and especially since the liberalisation of the energy markets in 2007, Belgium has adopted several social measures as regards energy. This includes federal and regional social tariffs for electricity and/or gas, the Energy Fund and the Social Heating Fund aimed at helping households facing difficulties with their energy bills. In addition, power limiters and prepayment meters can be placed to avoid energy disconnections in case of energy debts.

Each of the three regions has adopted its own combination of measures and implementation pathways around the federal common base (e.g. Brussels-Capital and Wallonia have extended the social tariffs to other categories of beneficiaries such as households with debts or very low income, while Flanders did not), which means that Belgian households have different assistance and proceedings as regards access to energy or energy affordability according to their place of residence.

As regards the characteristics of the dwelling stock (Census, 2011), Belgium is a densely populated country (360 inhabitants per km²) with, on average, a low proportion of apartments (71% of the occupied dwellings are situated in residential buildings with one dwelling) and a high percentage of homeowners (66% of the occupied dwellings). In contrast, medium and large city centres have a higher proportion of rented dwellings (e.g. up to more than 60% in Brussels) as well as a higher share of apartments. On average, less than a quarter of the rented dwellings are owned by a social housing company in Belgium (this proportion is even lower in the Brussels-Capital Region). In addition, it must also be stressed that the Belgian residential stock is relatively old (23% of occupied dwellings were built before 1919, in Brussels and Wallonia this proportion rises to 30% and 39% respectively) and energy inefficient.

In 2011, a team composed of researchers from the Université Libre de Bruxelles and the Universiteit Antwerpen carried out a general study (Huybrechs et al., 2011) aiming at answering outstanding questions on energy poverty, including: what is energy poverty, and what does it mean specifically in Belgium?; what are its causes and consequences?; who suffers from it?

The study revealed that, in Belgium, energy poverty is a multifaceted and extensive problem, and that households facing difficulties to satisfy their basic energy needs in their home could experience a variety of situations:

- they could have an energy bill that was too high in relation to their disposable income (after deduction of housing costs),
- they could reduce their energy consumption below their basic needs to avoid financial difficulties,
- or they could be scared of not being able to afford their energy bill due to their circumstances.

Statistics publicly available at that time to analyse energy poverty were mostly proxies derived from administrative data (e.g. number and average amount of energy debts, number of power limiters on electricity or prepayment meters, number of payment plans, etc.). It was clear that none of these were adequate to measure the breadth of this issue and take the range of energy poverty situations satisfactorily into consideration, even with a combination of different data. This was due to the low coherence between these data (e.g. methodologies and available indicators vary between regions) on the one hand, but also to their inability to explain why these energy poverty symptoms were sharply increasing in Belgium (Huybrechs et al., 2011). The incomplete characterisation of energy poverty was also a barrier to the design of effective policies and measures to tackle energy poverty.

In addition, alongside the continued increase in energy prices 2000-2010, the complexity of the institutional context as a result of the liberalisation of the energy market has negatively impacted the accessibility to (affordable) energy for people already facing socioeconomic or cultural difficulties (Huybrechs et al., 2011).

Accounting for these interrelations - which cannot be easily grasped using a single metric - we aimed to build an ‘energy poverty barometer’ by developing and gathering a set of complementary indicators.

The aim of this barometer was to assess energy poverty at the macro level (national and regional), illustrate its different aspects, understand its causes and monitor its evolution.

3. Constructing the Energy Poverty Barometer for Belgium

3.1. Determining the barometer indicators

Based on field observations from previous research (Huybrechs et al., 2011)[4] and our reading of the literature on measuring energy poverty (Boardman 1991, 2010; Moore, 2011, 2012; Pachauri et al., 2011; Devalière et al., 2011 ; Hills, 2012; Liddell et al., 2012 ; Nussbaumer et al., 2012 ; Waddams Price et al., 2012), we opted for a three-dimensional barometer in order to provide a broad understanding of energy poverty (see also the discussion in O'Sullivan et al., 2015 on a *composite measure* of energy poverty, or Dubois and Meier, 2016). This is summarised in Table 1.

[4] Focus groups were organised with people experiencing energy poverty situations and with practitioners. A detailed qualitative survey was also carried out in 2012 by Synovate with 15 people experiencing energy poverty in the city of Antwerp.

Table 1: Energy poverty situations and the five related indicators developed in the barometer

Dimensions	Nature of the indicator	Issue	EP situations to highlight	Developed indicators
Affordability of energy needs	'objective'	Too high energy expenditures compared to disposable income	Energy expenditures represent such an important share of the household budget that the household has to reduce expenditures for other basic needs, or to incur energy debt.	Measured energy poverty indicators (mEP): • extent: number of households affected, • depth: gravity of their situation compared to the threshold
Self-restriction below basic energy needs	'objective'	Too low energy expenditures	The household has energy expenditures that are assessed to be too low compared to a decent standard of living (energy consumption of similar households: same composition, same dwelling size). This excludes explained low energy expenditures in case of very well insulated dwellings.	Hidden energy poverty indicators (hEP): • extent: number of households affected • depth: gravity of their situation compared to the threshold
Feeling the cold	subjective	Living experiences and ability to reach a desired comfort level	The household does not feel comfortable with their energy bill and their able to heat their dwelling according to their own needs (not according to 'standard needs' as in the two first dimensions).	Perceived energy poverty (pEP): • extent: number of households concerned.

The first dimension refers to the way energy poverty is classically *measured*. It seeks to identify households which dedicate too high a share of their income to energy expenditures. The second dimension highlights the possibility for energy poverty to be *hidden* when households restrain their energy consumption (voluntarily or forced) below a certain level of comfort[5]. These two forms of 'objective' energy poverty are complemented by a subjective measure which reflects the experiences of households.

Adequately monitoring energy poverty requires measuring both the extent of the issue (i.e. how many households are affected) and its depth (i.e. how seriously are people affected) as argued in Hills (2012). The barometer is therefore composed of both 'extent' and 'depth' indicators for *measured* and *hidden* energy poverty. These are two important parameters for policy makers and field actors to potentially adapt their actions towards households in energy poverty. Note that indicators included in the barometer are calculated on a household basis and as such they cannot be used to highlight personal difficulties of one household member.

The two 'objective' types of indicators, mEP and hEP, are relative because the thresholds used are determined taking into account the whole population. Thresholds are recalculated each year, unlike the previous application of the Fuel Poverty Ratio in Belgium. This dynamic monitoring allows us to take into consideration societal and economic changes, as argued in Hills (2011). It also means that,

[5] The term 'hidden' refers to the fact that these situations of (self-)imposed restrictions are by far the most difficult to identify through existing support mechanisms. Nor can they be easily assessed with common administrative data (e.g. number of repayment plans with an energy provider, number of disconnection from the gas or electricity network, etc.). Furthermore, indicators building on the modelling of energy expenses (such as the Fuel Poverty Ratio or the Low Income High Cost ratio) cannot be used to identify this segment of the population.

these 'objective' indicators essentially assess *inequalities* within the global Belgian population and in different segments, rather than defining an absolute minimum that is required to fulfil household's energy needs.

mEP and hEP indicators combine different elementary values (e.g. level of available income, housing cost, energy bills, etc.). Their variations have to be interpreted through the variations of their components as well as through their mutual influences. The energy barometer is therefore a good way to create a global picture of the context in which energy poverty takes place and to better understand the complex links between energy poverty and related policies (e.g. energy markets, consumer protection, housing, energy efficiency, etc.).

The third indicator (pEP) focusing on the subjective part of the issue takes into consideration energy poverty situations that are not always identified through more objective indicators. It is a 'self-declarative' indictor measuring the proportion of households having answered not being able to afford their future energy bills. We recognise the limits of this kind of indicator (see above), but in the spirit of our recognition of this problem being multifaceted, it is important to remain open to the possibility that the other indicators do not capture all forms of energy poverty.

Finally, as is the case for any type of indicator, results are highly dependent on the assumptions made to define and calculate them. The main assumptions are discussed in the following paragraphs for each type of indicator, and potential variant(s) in the calculation method are presented as appropriate. Holzemer et al. (2014) provide a more detailed description of the methodological approach and a sensitivity analysis regarding the impacts of the different assumptions made for the construction of the barometer.

3.2 Methodology and initial results

Selection of the database

There is no accurate database in Belgium to correctly model households' energy needs according to standard living conditions, therefore the two first sets of indicators (measured and hidden energy poverty) have been calculated on the basis of real energy expenditures. We draw on the European "Statistics on Income and Living Conditions" (SILC) survey for this data. This survey gives us a substantial resource of household data related to socio-economic conditions, energy consumption and housing characteristics to feed into the barometer. The use of this database is also relevant in that it allows both for cross-country comparison within the EU and for annual updates to monitor change (see also Thomson and Snell, 2013).

The SILC survey is undertaken annually in Belgium since 2003, by means of computer-assisted face-to-face interviews with a sample of 6,000 private households (i.e. more or less 14,500 individuals). It is notable that the sampling of the survey potentially registers a slight bias seeing that some households highly likely to suffer from energy poverty (for instance homeless people, illegal tenants, households in deep poverty) are not (frequently) in the sample (Nicaise and Schockaert, 2014). The results presented below come from the Belgian EU-SILC survey databases for years 2009, 2011 and 2013.

Measured Energy Poverty (mEP) indicators

mEP - extent

Measured energy poverty (mEP) is based on the "Low Income High Costs" (LIHC) indicator developed by Hills (2012). It works by determining a threshold beyond which energy services are considered as unaffordable. We take guidance from Hills (2011) here in our use of equivalised disposable income[6] to exclude higher income households, the integration of housing costs[7] into the calculation, and the dynamic (changing yearly) and relative nature of our threshold. However, given the statistics available in Belgium, we were not able to work with modelled energy expenditures as in Hills (2011). As we also wanted to identify specific households that restrain their energy consumption below their basic needs (i.e. for the hEP indicator, see below), we used data on real energy expenditures. Furthermore, we computed our thresholds in a similar way to Brenda Boardman's Fuel Poverty Ratio (1991).

In concrete terms, the threshold used for the mEP indicator is equal to twice the median ratio obtained by dividing energy expenditures related to the dwelling[8] by the household's disposable income[9] excluding housing costs (e.g. rent or monthly mortgage repayment[10]). Accounting for the notion of 'low income' (Hills, 2011; Anderson et al., 2012), the indicator only considers households belonging to the first five deciles of equivalised disposable income[11].

In order to isolate the issue related to excessively high housing costs, the housing cost was capped at a maximum of twice the median of housing costs[12]. As shown in Table 2, using the 2013 SILC data, the mEP threshold is established at 14.04% since the median ratio between energy expenditures and disposable income excluding housing cost was 7.02% that year. To illustrate this with a concrete example, a household with a monthly disposable income of 1,500€, a monthly energy bill of 250€ and a monthly housing cost of 500€ is considered to be in *measured* energy poverty, as the ratio between its energy expenses and its disposable income excluding the housing cost is 25%.

Table 2: mEP thresholds for 2009, 2011 and 2013

	2009	2011	2013
mEP affordability threshold	**14.20%**	**14.70%**	**14.04%**

Source: Delbeke and Meyer, 2015

Table 3 displays the extent of *measured* energy poverty in 2009, 2011 and 2013, showing a very slight decrease in the number of households concerned, at national level as for each of the three regions[13]. However, results show a substantial differentiation at the regional level. Wallonia seems indeed to

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[6] An equivalised income (http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary) corresponds to an adjusted income that accounts for household's composition (each adult of the household represents one unit, a child older than 14 years half a unit and a child younger than 14 years 0.3 unit). The use of this equivalised income avoids systematically classifying large families or families with several family nuclea as 'richer family' (or belonging to the five highest income deciles).

[6] A variant of the mEP indicator could be obtained by ignoring this maximum value for housing costs. This variant would then serve to highlight both type of difficulties.

[7] In contrast to Hills, 2011, we take mortgage repayments into consideration in our housing cost.

[8] Energy expenditures are calculated by adding different BE-SILC variables (H 28b bis, H 28c, H 28d, H 28e, H 28f) and assessing energy expenditures for households having them combined with other housing occupation charges (H 28i, H 28g, H 28h, H 28k).

[9] Variable BE-SILC HY020.

[10] Our variable 'housing cost' is obtained by summing up BE-SILC variables (H 41 + H $22_{1\text{-}10}$ + H 30e + H 28g + H 46g + H 28n). Some complementary adjustments have been made. For more details, please refer to Holzemer et al., 2014. Variables H 26 and H 43 have not been integrated because they are already included in the disposal income variable.

[11] The median housing cost is expressed as a percentage of income. The disposable income used for the calculations refers to variable EQ-INC20 of the SILC survey.

[12] A variant of the mEP indicator could be obtained by ignoring this maximum value for housing costs. This variant would then serve to highlight both type of difficulties.

[13] Belgium is a federal state made of three regions: Flanders, Wallonia and the Brussels-Capital region. The latter is quite distinctive because it is a very dense urban area, while the two others combine urban and rural areas.

experienced more *measured* energy poverty than Flanders, Brussels being in between. Further analyses of indicator determinants could highlight part of the explanation: in Wallonia, dwellings are relatively big and dispersed (53.4% of the Walloon dwellings are detached or semi-detached houses compared to 13.2% apartment buildings[14]), households have a lower average income than in Flanders, the climate is slightly colder, etc. For Brussels, the very low average income level (the lowest of the three regions) of the inhabitants is probably compensated by the characteristics of the dwellings (smaller size and mostly in terraced houses or apartments[15]). Moreover, Brussels being a densely urban area, inhabitants mostly use natural gas and electricity as energy sources (see also Dubois, 2015 for a more detailed analysis of urban and rural specificities with respect to energy poverty, including the access to differentiated vectors). These energy sources benefit from numerous social measures in Belgium compared to heating oil or solid fuels (e.g. coal or wood) that are more used in Wallonia (Huybrechs et al., 2011).

Table 3: Extent of mEP in Belgium and its three regions for 2009, 2011 and 2013

% households affected by mEP	2009	2011	2013
Belgium	**14.6%**	**14.2%**	**14.0%**
Flanders	**10.7%**	**10.5%**	**10.5%**
(Brussels-Capital)*	**(13.9%)**	**(17.6%)**	**(15.5%)**
Wallonia	**20.0%**	**19.5%**	**19.1%**

* Figures for the Brussels-Capital Region are put into brackets because the sample size of households in mEP is too small to be statistically representative

Source: Delbeke and Meyer, 2015

This first mEP indicator gives us an indication regarding the proportion of households concerned (the *extent* of the issue) but provides no information on the gravity of the situation experienced by these households. It is therefore necessary to develop another metric, the depth of *measured* energy poverty.

mEP - depth

The 'depth' notion draws on Hills's notion of the fuel poverty gap (2011) and seeks to answer to the following questions: "How far are households in mEP from the affordability threshold? How much would these households need to save on their energy expenditures to allow them to benefit from affordable energy services?".

The *depth* indicator assesses the gap between the actual energy expenditures of households identified in *measured* energy poverty, and the maximum energy expenditures that are considered affordable for that household (i.e. the mEP threshold multiplied by the household's equivalised disposable income after housing cost). This gap amounts to the amount of money (in €) that the household in *measured* energy poverty spends in excess of what is considered as its maximum affordable energy bill.

Coming back to our former example, the household in *measured* energy poverty should have a monthly energy bill of maximum €140.4 in 2013 for it to be considered affordable (i.e. 0.1404 * [€1,500 - €500]). In reality, this household spends €250, so that the depth of its *measured* energy poverty in 2011 is €109.6.

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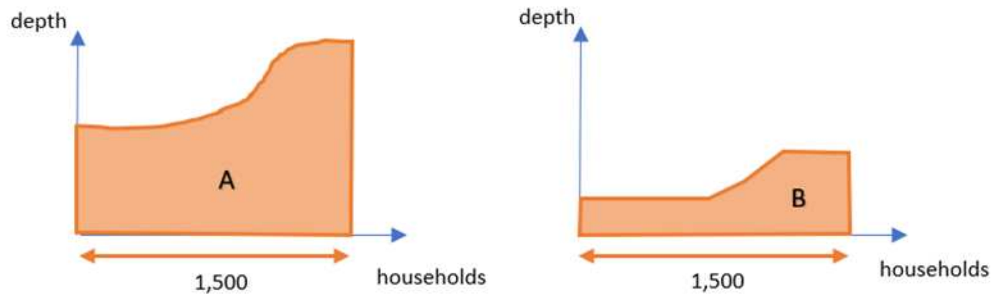
[14] Federal Public Service of Economy, Cadastral statistics 2013.

[15] 53% of Brussels dwellings are apartments (idem).

Figure 1: Illustration of the depth concept (based on Holzemer et al., 2014)



Consider two different populations A (left graph) and B (right). The x-axis measures the number of households in population, while the y-axis measures the gravity of the energy poverty situation analysed (the depth) on both graphs. Populations A and B have the same number of households (1,500)
but different depths (y-axis per household, and yellow surface area for the whole population): population B is by far in a better situation than population A because depths measured at the household level (value of the y-axis) as well as at the population level (yellow surface area) are lower.

Globally, within the whole Belgian SILC sample for 2013, the median depth of households in *measured* energy poverty was €60.6 per month. Table4 shows both a slight increase since 2009 and how the Brussels-Capital Region is rather different to the rest of the country. The mEP-indicator for this region is indeed much lower than for the other two regions of Flanders and Wallonia. This is probably due to its urban nature (e.g. smaller households, better access to energy sources which attract support, smaller dwellings, etc.).

Table 4: Depth of mEP in Belgium and its three regions, for 2009, 2011 and 2013

Depth assessment for households in mEP (€/month)	2009	2011	2013
Belgium	**59.7**	**60.2**	**60.6**
Flanders			*62.5*
Brussels-Capital			*48.2*
Wallonia			*63.8*

Sources: Holzemer et al., 2014b ; Delbeke and Meyer, 2015

Hidden energy poverty (hEP) indicators

The second set of indicators highlights the energy poverty situations where households restrict their energy expenditures below their basic needs (e.g. due to prepayment meters, self-disconnection or network disconnection, etc.), either voluntarily or not.

Hidden energy poverty (hEP) is a reality that is generally not reflected in administrative and traditional energy poverty statistics[16]. For instance, households facing difficulties in paying their energy bills can have prepayment meters installed. For these households, statistics would typically display the numbers of meters installed but would not provide any useful information as to whether these households suffer from self-rationing and consumption below basic energy needs due to their incapacity to find funds.

As a complement to mEP, the hEP indicators were designed to assess the number of households affected (extent) and to estimate the potential gravity (depth) of the issue of *hidden* energy poverty.

[16] For example, the LIHC indicator (Hills, 2011) includes the hidden energy poverty issue through the modelling of households' energy needs. It is however not able to specifically identify concerned households. The Boardman's FPR identifies only households with excessive energy expenses and not those who have to limit their energy expenses below their needs.

In these indicators too, the reasoning was to exclude the five higher deciles of equivalised disposable income.

The underlying idea is to determine a threshold below which real energy expenditures are potentially too low to be able to satisfy household's basic needs. If real energy expenditures are lower than the threshold, then the household is 'suspected' of suffering from *hidden* energy poverty. In this case, the threshold was calculated using clusters of 'equivalent households' as regards household's composition and household's dwelling size (number of rooms). Starting from the median energy expenditures of households with a similar composition on the one hand, and the median energy expenditures of households with similar size of dwelling on the other hand, the threshold is calculated through averaging both values, and dividing the result by two.

Equation 1: Calculation of the hEP threshold

$$hEP\ threshold\ for\ households\ with\ 3\ members\ (H3) living\ in\ a\ 4\ room\ dwelling\ (D4) = \frac{[(median\ of\ EE\ of\ all\ H3) + (median\ of\ EE\ of\ all\ households\ living\ in\ a\ D4)]}{2}$$

EE being the energy expenditures

To illustrate how the hEP indicator is designed, the energy consumption of a couple living in a 6-room dwelling, for example, will be compared to the average between both the median energy expenditures of all households made of two adults and of all households living in 6-room housing[17].

The threshold therefore amounts to half the 'average' energy bill of 'similar' households (including those living in a well-insulated dwelling). This threshold is used as a proxy to determine the basic energy needs of this specific household.

The hEP indicator does not allow us to identify all households that restrict their energy consumption below their specific needs. It does account for the composition of the household but not for specificities such as the presence of a baby, an older or a disabled person with higher energy needs for physiological reasons. Moreover, households with both the same composition and the same dwelling size could have very different energy expenditures according to the energy performance of their dwelling and equipment. Obviously, there are some instances too for which a low level of consumption can be explained. Households living in well-insulated dwellings[18] have been excluded from the calculation.

For the whole Belgian sample of the EU-SILC survey in 2013, around 4.6% of the households are identified as suffering from *hidden* energy poverty (Table 5).

Table 5: Extent of hEP in Belgium and its three regions for 2009, 2011 and 2013

% households suspected to be in hEP	2009	2011	2013

[17] To avoid working with too little samples, we prefer working with the average of two different energy consumption medians (one for the households with the same composition and one for the households living in a housing similar in size) than the median of one single sample (same household composition and same housing size.

[18] Well-insulated dwelling means: at least some double glazing and some roof insulation and some wall insulation and some floor insulation (questions H 8d A, B, C and E of the BE-SILC survey questionnaire). Seeing that these questions were not present in the SILC survey until 2013, it was not possible to withdraw this category of households from the former hEP indicators. Results for the hEP extent indicator are therefore less accurate for 2009 and 2011. This is why these are in brackets in Table 5.

Belgium	**(4.7%)***	**3.4%**	**4.6%**
Flanders		*3.4%*	*3.6%*
Brussels-Capital		*7.3%*	*11.1%*
Wallonia		*2.9%*	*3.1%*

*** Data to exclude well-insulated dwellings were not available in 2009, so that the percentage is overestimated and not directly comparable to the following years**

Sources: Holzemer et al., 2014b; Delbeke and Meyer, 2015

The depth of hidden energy poverty was calculated in Table 6. The logic of calculation slightly differs from the one for *measured* energy poverty in order to adapt it to the issue of under consumption. Here we chose to compare the actual consumption of the household suspected of suffering from *hidden* energy poverty to the standard bill of equivalent households (i.e. the average of the 'similar composition' and 'similar dwelling size' medians of energy expenditures). This value can be interpreted as providing a measure of the monetary gap to reach a standard level of comfort.

Table 6: Depth of hEP in Belgium and its three regions in 2011 and 2013

Depth assessment for households in hEP (€/month)	2011	2013
Belgium	**95**	**93.6**
Flanders		*95.8*
Brussels-Capital		*90.3*
Wallonia		*95.1*

Sources: Holzemer et al., 2014b; Delbeke and Meyer, 2015

The median depth for the 4.6% households identified as being in *hidden* energy poverty in 2013 was €93.6 per month.

Perceived energy poverty (pEP) indicators

The third measure in our energy poverty barometer concerns the perception of households as regards their ability to pay their energy bill(s). In contrast with the former two types, this indicator of *perceived* energy poverty (pEP), is subjective and is entirely based on the household's experience, and its perception of its financial (in)capacity to heat its housing properly. This indicator thus reflects subjective elements such as the sensitivity towards the issue of energy and their personal preferences as regards temperature and internal comfort.

To ensure consistency over the three dimensions of the barometer, the subjective measure also builds on the EU-SILC survey which asks about the affordability of heating the home according to one's wants[19]. This is a very similar approach to that adopted in Waddams Price et al. (2012). However, it must be stressed that such an approach is limited in scope in that it only focusses on heating and does not include affordable access to other energy services.

[19] For interested readers, the precise question in the BE-SILC survey (household questionnaire) is question H 54d which is formulated as follows: "*Many people cannot afford certain things. Assuming that you wanted to, can your household afford the following:?*
d. heating your home sufficiently. YES / NO ".[20] According to our analysis, 15.7% of all Belgian households were 'at risk of poverty' in 2015. On average 70% of these suffered from EP too, while globally more than 40% of the households in EP (at least one of the three forms) were not 'at risk of poverty' (Delbeke and Meyer, 2015:14).

The subjective measure does not aim to compute a threshold against which to assess a potential situation of energy poverty. Therefore, this third measure differs from the former two sets of indicators both because it is subjective and because it is not relative.

To be consistent with the other two indicators, the pEP indicator takes only into account answers of the households belonging to the first five deciles of equivalised disposable income.

In 2013, around 5.7% of households have been identified as being in perceived energy poverty (table 7). Here too, regional scores are quite different, with Flanders displaying the lowest percentage (but continuously rising between 2009 and 2013) and Brussels the highest.

Table 7: Extent of pEP in Belgium and its three regions for 2009, 2011 and 2013

% households suspected to be in pEP	2009	2011	2013
Belgium	**4.7%**	**6.0%**	**5.7%**
Flanders	*1.7%*	*2.8%*	*3.3%*
Brussels-Capital	*11.1%*	*13.2%*	*10.2%*
Wallonia	*6.9%*	*8.3%*	*7.4%*

Sources: Holzemer et al., 2014b; Delbeke and Meyer, 2015

4. Discussion

In this section, five specific points are discussed in more details. The first one focusses on the design of the barometer and the related 'low-income' assumption. This is followed by a discussion on the extent to which the different indicators overlap. The third point discussed is the link with policy measures. In the fourth and fifth ones, we recognise that our macro-scale barometer is not an appropriate tool for targeting households in energy poverty at the micro scale nor for capturing the whole issue of energy poverty. Our barometer is one efficient tool that has to be complemented with field surveys.

4.1 Impact of the 'low-income' assumption

Results obtained for the five indicators that make up the barometer (see figure 3) are strongly dependant on the chosen methodology and design (see, for instance, Thomson and Snell, 2013 regarding the definition of 'disposable income' or Moore, 2012 concerning 'housing costs'). Several variants could have been developed such as, for instance, indicators that include wealthier households or an mEP indicator without a maximum cost for housing. Here, specific attention is paid to the 'low-income' assumption and its influence on the barometer.

In the way we designed our indicators, we systematically decided to exclude households belonging to the five highest deciles of equivalised income (Holzemer et al., 2014b:15). This decision assumes that energy poverty is driven notably by lower income as in Hills (2011). Households with lower income have indeed less abilities to act on their energy consumption (Huybrechs et al., 2011): they often use less efficient appliances (that cost less on the primary market or are available on the secondary market at lower cost), are more likely to be tenants and/or to restrain their energy consumption (cf. prepayment meters and power limiters in case of energy debt).

However, by equivalising income and including the fifth decile, we do not associate energy poverty to monetary poverty only: there is an evident link between both issues but energy poverty also concerns households not 'at risk of poverty'.[20]

In order to assess how our assumption influences the results, we also performed the calculations for the three extent indicators on all households, whatever their income category. When we do this, all percentages increase only moderately (14.7% instead of 14.0% as regards mEP, 7.0% instead of 4.6% for hEP and 6.8% instead of 4.7% for pEP; see Table 8). This is especially the case for mEP, which suggests that this form of energy poverty is more sensitive to the low income driver. Extent indicators for hEP and pEP increase slightly more when all income groups are included. The higher percentage of households in pEP could reflect that even households with higher incomes do not feel comfortable with their energy bills (due to uncertainties about future energy prices or on future climate conditions, the relatively high cost of energy, temporary budget imbalances, changes in the composition of the household, etc.), while the higher percentage in hEP is more complicated to interpret: it could be explained by the higher proportion of low energy consuming equipment in well-off households but also by a long-term absence (e.g. a stay abroad, a hospitalization, etc.) or other physiological habits (e.g. older people could become less sensitive to cold and not realise that they need to warm their dwelling a little bit more to avoid health problems).

Table 8: Comparison of the extent indicators (2013) with and without the low income assumption

% households suspected to be in EP	Only households belonging to the first five deciles of equivalised income	All households										
		Total	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
mEP	14.0%	14.7%	56.6%	34.3%	24.8%	19.8%	9.2%	4.8%	3.5%	1.2%	0.3%	0.0%
hEP	4.6%	7.0%	12.2%	7.3%	7.0%	7.3%	5.0%	6.8%	4.0%	4.7%	5.3%	4.5%
pEP	4.7%	6.8%	16.8%	13.5%	10.2%	5.2%	5.0%	3.0%	1.2%	1.2%	1.7%	0.2%

Source: figures are extracted from Delbeke and Meyer, 2015

4.2 *Different indicators for different forms of EP*

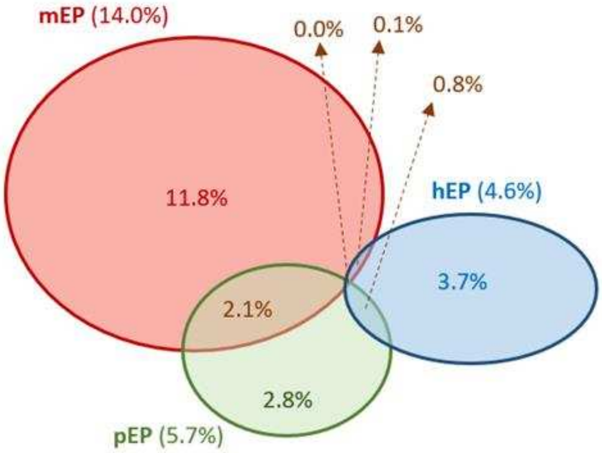
It is interesting to proceed to an indicative comparison of what these different indicators seem to highlight. It is important to recall that both *measured* and *hidden* energy poverty indicators are based on relative thresholds (i.e. varying each year according to the changing circumstances) and are therefore dynamic. The mEP threshold, for example, reached 13.7% in 2010 and 14.7% in 2011 meaning that energy expenses had to represent a higher share of the household disposable income without housing cost for a household to be considered in mEP. This was mainly due to favourable climatic conditions, 2011 being a warmer year than 2010.

Globally 21.5% of the Belgian households suffer at least from one form of energy poverty (Figure 3). Some of them combine two forms and only one household on 6,006 in the sample of the Belgian SILC-survey (0.0%) is identified as energy poor according to all three indicators.

[20] According to our analysis, 15.7% of all Belgian households were 'at risk of poverty' in 2015. On average 70% of these suffered from EP too, while globally more than 40% of the households in EP (at least one of the three forms) were not 'at risk of poverty' (Delbeke and Meyer, 2015:14).

We would expect very little overlap between measured (mEP) and hidden (hEP) energy poverty indicators, given their respective construction, but it is interesting to see that the third subjective indicator (pEP) covers only some of the households in mEP or hEP (Figure 3). The mEP indicator only overlaps with the pEP indicator for 15 % of the households being in mEP whereas this value rises to 17 % of households when hEP and pEP are compared in the same way.

Figure 3: Overlaps between the three types of energy poverty indicators in Belgium (extent, 2013)



Source: based on Delbeke and Meyer (2015)

Although they build their measures on different assumptions, studies such as Waddams Price et al. (2007) or Devalière et al. (2011) have also commented on the partial overlap between the 'expenditures fuel poor' and the 'feel fuel poor' emphasizing the importance of subjective measures. However, and in contrast to the explanation raised in Dubois (2012: 109), our results show that the limited overlap between *measured* and *perceived* energy poverty can only be partly explained by *hidden* energy poverty.

What Figure 3 shows is that only about 51 % of households which perceive themselves to be energy poor can be detected with objective indicators, be they *measured* or *hidden*. This result tends to suggest that a subjective approach is complementary and that it reveals another form of fuel poverty than the two objective measures. It may also be that some of the households perceiving difficulties are either situated outside but close to the vulnerability zones defined by the thresholds, or are moving towards inclusion in the two objective measures (i.e. which they perceive but which cannot yet be detected).

What is intuitively less logical though is not the fact that a great number of households perceiving themselves to be energy poor are not detected through objective measures, but rather that a great number of households being detected through objective measures (i.e. 85 % of those in mEP and 83 % of those in hEP) do not report to be energy poor when approached through the subjective measure (see also Waddams Price et al., 2012 ; Thomson, 2013 ; Hards, 2013 ; Day and Hitchings, 2011 ; Dubois, 2012).

From the exploratory roundtables undertaken while designing the barometer (Huybrechs et al., 2011), it may be the case that households in mEP tend to somehow realign their norms with their financial resources and/or do not it consider appropriate to report experiencing financial difficulties (due to feelings of shame or a conformity bias). Hills highlights, for example, that older people are particularly reluctant to talk about their difficulties, and that they often do not realise the potential negative impacts on health of living in a cold home (Hills, 2011:17 and 67). As far as households in hEP are concerned, the low overlap with the subjective measure could be partly explained by a behavioural change in energy consumption patterns. Once these households have (sometimes drastically) reduced their consumption, they are able to limit their financial difficulties with respect to energy bills. Here also, there likely is a process of habituation and norm alignment (Maréchal and Holzemer, 2015) that operates for these households not reporting any difficulty in heating their home sufficiently (Hills, 2011).

4.3 Usefulness of the barometer for policy measures

So what is the value of our new aggregated and multifaceted means of measuring and monitoring energy poverty in Belgium? We argue that the aggregation of three types of indicators in the barometer is particularly useful for monitoring the complex phenomenon of energy poverty. Each of the three indicators highlights a different type of problem to policy-makers, and allows for its measurement and monitoring. Given that there is very limited overlap between the households identified by the indicators, our results also suggest that the various problems measured here are symptomatic of different forms of energy poverty. Our starting point, of understanding energy poverty as a heterogeneous problem is borne out in the data.

So which problems do the different indicator types bring to the fore? The mEP indicators highlight the concept of affordable energy. They identify households for which necessary energy expenditure is too high, and for which it is difficult to achieve decent living standards. Further analysis is needed however to assess if the situation is due to a lack of revenue (e.g. too low disposable income, too high housing costs) or to excessively high energy bills (e.g. energy tariffs applied are too expensive according to their profile of consumption and/or their energy consumption is too high due to households' higher energy needs or due to poor energy efficiency of the dwelling). Given our understanding of energy poverty as a multifaceted problem, we expect to find that for some households income is more of a concern, and for others excessively high energy bills. Policy measures aimed at improving the economic situation for lower income households (e.g. financial support, more energy efficient dwellings, access to lower cost energy vectors or to energy contracts adapted to consumption needs, etc.), or at regulating housing cost have the potential to influence mEP indicators. It is therefore particularly useful to analyse the evolution of the different indicators' components over time in order to understand the role played by the main energy poverty drivers and by government policy. In Belgium for example, the positive influence of low energy prices since 2013 has been counteracted by both stagnation of income (cf. governmental decision to freeze loans and allowances) and higher housing costs. As a result, the number of households in mEP remains relatively stable between 2013 and 2015, while the depth indicator clearly shows a decrease (Delbeke et al., 2017:8-10).

The hEP indicators, on the other hand, testify that some households are restricting their energy consumption below their needs, and thus experiencing energy deprivation. Policy measures which restrict energy consumption, such as electricity limiters, prepayment meters or disconnection procedures could influence these results. These indicators are useful to assess the achievement of the goal of a decent quality of life for all citizens in the Belgian Constitution (art 23). Even if energy *per se* is not recognised as a citizens' right in the Belgian constitution, art. 23 refers to the right of having a decent home. For Belgian associations, this right includes an access to energy, which is sometimes recognised by case laws. Here too, an evolutionary analysis of the different indicators' components is essential to understand how drivers such as low income, high energy prices and bills, housing cost, size and quality of the dwelling, etc. influence results over time.

Finally, the subjective indicator gives a general overview of how citizens experience energy access and affordability. It suggests that the problem is more widespread than we currently understand. Further, the lack of overlap between this and the objective indicators suggests the needs for communication about the health risks of under heating for those in objective energy poverty, who do not recognise themselves as energy poor.

4.4 A tool for targeting energy poor households ?

As regards the design of policies and measures aimed at addressing energy poverty, or the specific targeting of households in energy poverty, the barometer is not sufficient in itself. This would require, indeed, a specific and thorough analysis of the mechanisms at play as well as of the underpinnings of the multifaceted, dynamic and complex issue that is energy poverty. Given the disparities between the different Belgian regions highlighted above, it is also likely to require a localised analysis, unpacking some of the specific challenges associated with the geography, market and social structures concerned. As already highlighted in Huybrechs et al. (2011), any household may, at some point, experience difficulties related to energy poverty (an energy-inefficient dwelling, a lower income, late payment of energy bills, etc.). However, it is the accumulation of these difficulties and their mutual reinforcement in a dynamic process that is likely to anchor the household in ongoing energy poverty. This renders the identification of households at risk of falling into energy poverty all the more difficult. More specifically, as mentioned above, the barometer cannot identify those households that are in a transitory phase or situated at the limit of the thresholds used in the calculation, even if the third indicator of the barometer, based on self-declaration, could include some of these cases.

It is also important to note that macro surveys at national level generally register biases. Thomson and Snell (2013) raise some of the weaknesses of the EU-SILC survey as regards energy poverty as do Nicaise and Schockaert (2014) (specifically for Belgium) such as the underrepresentation of some population segments (e.g. refugees, people living collective housing establishments like prisons or homes, etc.) and the failure to highlight local specificities (e.g. the influence of local measures like regional social energy tariff, Huybrechs et al., 2011).

At the macro scale, the *measured* and *hidden* energy poverty indicators are calculated each year and therefore use evolving thresholds. This is an intentional characteristic of the barometer which allows us to identify trends in a whole population but cannot be used to decide whether a given household is energy poor or not. The choice of a relative (and evolving) threshold should thus make us cautious when comparing different years since energy prices, wages, habits and housing cost can dramatically change in the meantime. The integration of these trends in the analysis is beyond the scope of this paper. However, it is worth mentioning that we chose to work with evolving thresholds in the barometer as they make it feasible to detect the potential unequal and inequitable repercussions that one or several structural change(s) (for example a global increase in energy tariffs, a general freeze on loans and social benefits, etc.) could have on some segments of the population.

4.5 A tool to be used for itself ?

While we have attempted to construct a heterogeneous measurement of energy poverty through this barometer, it is likely that the barometer does not capture all forms of energy poverty. It is surely necessary to complement analyses carried out at the macro level with more localised data, to paint an even fuller picture of this phenomenon. Local, more qualitative approaches have the potential to touch on the lived experience of the energy poor (Anderson et al., 2012; Brunner et al., 2012; Middlemiss and Gillard, 2015) which cannot be readily inferred from statistics at the macro scale (setting aside the challenges of collecting together quantitative data sets). They can also take into account temporal issues affecting households, including, for instance, circumstances that could temporarily imbalance the household budget (e.g. divorce, death, unemployment, etc.). Further, they are likely to be able to capture local phenomena, associated with the specific living conditions and requirements of geographical, social and cultural spaces. When we use macro-level data, we focus on inequalities between households in the longer term and therefore on more structural causes of energy poverty (i.e. the combination of different factors that limits the adaptation capabilities (Dubois, 2012; Day et al., 2016) of the concerned households). The usefulness of a mixed-methods approach was highlighted by Dubois and Meier (2016) notably because this allows for a still more detailed understanding of this heterogeneous issue.

5. Conclusions

Trying to measure or, at least, assess the magnitude and gravity of a cross-cutting and multi-dimensional issue is not an easy task. Energy poverty falls into this category. The policy objective of tackling this major issue of economic and social justice thus requires dedicating sufficient resources to the design of tools that can provide an adequate understanding of its precise scope and nature as well as of the mechanisms at play.

In line with insights from the literature, we opted for the design of an energy poverty barometer, or an aggregation of indicators, in order to account for the various forms of energy poverty which cannot be properly grasped with the use of a single indicator. This barometer, developed for the Belgian context, is based on the establishment of three types of indicators. *Measured* energy poverty sets out to highlight excessive energy expenditures with respect to income and housing cost; *hidden* energy poverty underlines the existence of self-rationing practices; *perceived* energy poverty seeks to capture the lived experience of being in a situation of energy poverty.

Results from the barometer illustrate that energy poverty is multifaceted and encompasses different realities. Altogether, they suggest that about 21.5% of the Belgian population experience energy poverty in at least one of its forms. What may be somewhat less expected is the very low overlap between the 3 different forms of energy poverty. We suggest that these measures account for rather different forms of energy poverty.

Households identified through the barometer are expected to represent the most *structural* segment of households suffering from energy poverty. They are similar households to those 'vulnerable' consumers in the EU terminology. However, the barometer is designed to provide a broad picture regarding the trend of energy poverty. It could thus well be that some energy poor households would not be detected by the barometer. It is expected that these households would represent a more *cyclical* segment of the energy poor. Policy measures should ideally account for these different types of situations.

Being a macro-level construct (and thus with its set of inherent limitations), the barometer alone is insufficient to grasp this problem. It needs to be complemented with field observations undertaken at a more local scale. Combining such a broad range of top-down indicators with further investigations into local circumstances is likely to be productive, given the multifaceted picture painted by the quantitative data here. A resulting broader and more systemic understanding of energy poverty would help to move beyond stereotypes and the 'one size fits all' approach to intervention which could be detrimental for some affected households (Snell et al., 2015).

Addressing complex and cross-cutting societal issues such as energy poverty requires new organisational approaches and, probably, the co-construction of new tools in order to put our societies on an inclusive energy transition pathway. The Belgian energy barometer is a first tangible step in this direction.

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References

Ambrose, A., 2015. Improving energy efficiency in private rented housing: what makes landlords act? Indoor and Built Environment, 24 (7): 913-924.

Anderson, W., White, V., Finney, A., 2012. Coping with low incomes and cold homes. Energy Policy, 49: 40–52.

Boardman, B., 1991. Fuel poverty: from cold homes to affordable warmth.

Boardman, B., 2010. Fixing fuel poverty – Challenges and solutions. London/Earthscan.

Bouzarovski, S., 2013. Energy poverty in the European Union: landscapes of vulnerability, energy and Environment, 3 (3): 276-289.

Bouzarovski, S. & Petrova, S., 2015., A global perspective on domestic energy deprivation: overcoming the energy poverty-fuel poverty binary, Energy Research and Social Science, 10: 31-40.

Brunner, K.M., Spitzer, M., Christanell, A., 2012. Experiencing fuel poverty. Coping strategies of low-income households in Vienna/Austria. Energy Policy, 49: 53–59.

Carnegie LaBelle, M., 2017. In pursuit of energy justice. Energy Policy, 107: 615-620.

Census, 2011. Statistics from the Belgian FPS Economy SMEs, Self-Employed and Energy – DG Statistics. http://census2011.fgov.be/index_fr.html, accessed on October 2017.

Day, R. & Hitchings, R., 2011. 'Only old ladies would do that': Age stigma and older people's strategies for dealing with winter cold. Health & Place, 17: 885-894.

Day, R., Walker, G., Simcock, N., 2016. Conceptualising energy use and energy poverty using a capabilities framework. Energy Policy, 93: 255–264.

DECC, 2015. Annual Fuel Poverty Statistics - Report, 2015. London, UK.

Delbeke, B. & Meyer, S., 2015. The energy poverty barometer (2009-2013), King Baudouin Foundation, Platform Against Energy Poverty, Brussels, 18 p. (available at www.kbsfrb.be).

Delbeke, B., Meyer, S., Coene, J., 2017. The energy poverty barometer (2009-2015), King Baudouin Foundation, Platform Against Energy Poverty, Brussels, 27 p. (available at www.kbs¬frb.be).

Devalière, I., Briant, P., Arnault, S., 2011. La précarité énergétique: avoir froid ou dépenser trop pour se chauffer, INSEE Première, n 1351, mai 2011.

Devalière, I. & Teissier, O., 2014. Les indicateurs de la précarité énergétique et l'impact de deux dispositifs nationaux sur le phénomène. *Informations sociales*, 115-124.

Dubois, U., 2012. From targeting to implementation: The role of identification of fuel poor households. Energy Policy, 49: 107-115.

Dubois, U., 2015. La précarité énergétique en milieu urbain - Vers une analyse en termes de vulnérabilité. Les Annales de la recherche urbaine, 110: 186-195

Dubois, U. & Meier, H., 2016. Energy affordability and energy inequality in Europe: Implications for policymaking. Energy Research & Social Science, 18:21–35.

Dunin-Majewska, W., 2017. Energy Poverty in Clean Energy Package. EUSEW17. 12p.

European Commission, 2010. Commission staff working paper: an energy policy for consumers, Brussels: European Commission.

Fisher, P., Sheehan, M., Colton, R., 2005. On the brink: 2005—The home energy affordability gap—Virginia. Belmont MA Fish. Sheehan Colton.

Gillard, R., Snell, C., Bevan, M., 2017. Advancing an energy justice perspective of fuel poverty: Household vulnerability and domestic retrofit policy in the United Kingdom. Energy Research & Social Science, 29: 53-61.

Gillingham K., Harding M., Rapson D., 2012. Split Incentives in Residential Energy Consumption. The Energy Journal, 33 (2).

Hards, S. K., 2013. Status, stigma and energy practices in the home. Local Environment, 18: 438-454.

Healy, J.D. & Clinch, J. P., 2004. Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland, Energy Policy, 32 (2): 207-220.

Hills, J., 2011. Fuel poverty: the problem and its measurement; CASE report, 69; Department for Energy and Climate Change, London, UK.

Hills J., 2012. Getting the measure of fuel poverty, final report on the fuel poverty review.

Holzemer, L., Delbeke, B., Meyer, S., Oosterlynk, S., 2014. Baromètre de la Précarité énergétique 1/ Méthodologie et détails techniques. ULB-CEESE et UA-OASeS. Anvers-Bruxelles.

Holzemer, L., Delbeke, B., Meyer, S., Oosterlynk, S., 2014b. Baromètre de la Précarité énergétique 2/ Premiers résultats 2009-2011. ULB-CEESE et UA-OASeS. Anvers-Bruxelles.

Howden-Chapman, P., Viggers, H., Chapman R., O'Sullivan K., Barnard, L., Lloyd, B., 2012. Tackling cold housing and fuel poverty in New Zealand: a review of policies, research, and health impacts. Energy Policy, 49: 134-142

Huybrechs, F., Meyer, S., Vranken, J., 2011. La précarité énergétique en Belgique. Final Report. UA-OASeS et ULB-CEESE, Anvers-Bruxelles.

Liddell, C., Morris, C., 2010. Fuel poverty and human health: a review of recent evidence. Energy Policy, 38: 2987-2997.

Liddell, C., Morris, C., McKenzie, S. J. P., & Rae, G., 2012. Measuring and monitoring fuel poverty in the UK: National and regional perspectives. Energy Policy, 49: 27-32

Maréchal, K. & Holzemer, L., 2015. Getting a (sustainable) grip on energy consumption: the importance of household dynamics and 'habitual practices', Energy Research and Social Science, 10: 228-239.

May, X., 2013. Analyse de la facture énergétique des ménages et mesure des difficultés rencontrées par les personnes âgées, Université Libre de Bruxelles Institut de Gestion de l'Environnement et d'Aménagement du Territoire (ULB- IGEAT), Final Report to the Federal Public Service 'Economy, SMEs, Self-employed and Energy', October 2013, http://economie.fgov.be/fr/binaries/Analyse_facture_energetique_difficultes_personnes_agees_tcm326-252357.pdf

Middlemiss, L. & Gillard, R., 2015. Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor. Energy Research and the Social Science, 6: 146-154.

Middlemiss, L., 2017. A critical analysis of the new politics of fuel poverty in England. Critical Social Policy, 37 issue(3): 425-443.

Moore, R., 2012. Definitions of fuel poverty: Implications for policy. Energy Policy, 49: 19-26.

Nicaise, I. & Schockaert, I., 2014. The hard to reach among the poor in Europe: Lessons from Eurostat's EU-SILC survey in Belgium. In R. Tourangeau, B. Edwards, T. Johnson, K. Wolter, & N. Bates (Eds.), Hard-to-Survey Populations (pp. 541-554). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139381635.032

Nussbaumer, P., Bazilian, M., Modi, V., 2012. Measuring energy poverty: Focusing on what matters. Renewable and Sustainable Energy Reviews, 16: 231–243.

ONPE, 2014. Premier rapport annuel de l'Observatoire National de la Précarité Energétique.

Ormandy, D. & Ezratty, V., 2012. Health and thermal comfort: from WHO guidance to housing strategies. Energy Policy, 49: 116-121.

O'Sullivan, K.C., Howden-Chapman, P., Fougere, G., 2015. Fuel poverty, policy, and equity in New Zeland: the promise of prepayment metering, Energy Research and the Social Science, 7: 99-107.

Pachauri, S., & Spreng, D., 2011. Measuring and monitoring energy poverty. Energy Policy, Clean Cooking Fuels and Technologies in Developing Economies, 39: 7497–7504.

Petrova, S., Gentile, M., Makinen, I. H. & Bouzarovski, S. 2013. Perceptions of thermal comfort and housing quality: exploring the microgeographies of energy poverty in Stakhanov, Ukraine. Environment and Planning A, 45, 1240-1257.

Powers, M., 2017. An inclusive energy transition: expanding low income access to clean energy programs. North Carolina Journal of Law & Technology, 18;4.

Simcock, N., Walker, G., Day, R., 2016. Fuel poverty in the UK: beyond heating? People, Place and Policy Online, 10**:** 25-41.

Snell, C., Bevan, M., Thomson, H., 2015. Justice, fuel poverty and disabled people in England. Energy Research & Social Science, 10: 123–132.

Sovacool, B.K., 2015. Fuel poverty, affordability, and energy justice in England: policy insights from the warm front program. Energy, 93 (1): 361–371.

Teller-Elsberg, J., Sovacool, B., Smith, T., Laine, E., 2016. Fuel poverty, excess winter deaths, and energy costs in Vermont: Burdensome for whom?, Energy Policy, 90: 81-91.

Thomson, H., 2013. Fuel Poverty Measurement in Europe: A rapid review of existing knowledge and approaches conducted for Eaga Charitable Trust.

Thomson, H. & Snell, C., 2013. Quantifying the prevalence of fuel poverty across the European Union. Energy Policy, 52: 563-572.

Thomson, H., Bouzarovski, S., Snell, C., 2017. Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data, Indoor and Built Environment.

Waddams Price, C., Brazier, K., Pham, K., Mathieu, L., Wang, W., 2007. Identifying fuel poverty using objective and subjective measures, CPP Working Paper 07-11, http://competitionpolicy.ac.uk/documents/107435/107587/ccp07-11.pdf

Waddams Price, C., Brazier, K., Wang, W., 2012. Objective and subjective measures of fuel poverty. Energy Policy, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy, 49: 33–39.

Walker, G. & Day, R., 2012. Fuel poverty as injustice: integrating distribution, recognition and procedure in the struggle for affordable warmth. Energy Policy, 49: 69-75.

Walker, R., Liddell, C., Mc Kenzie, P., Morris, C., Lagdon, S., 2014. Fuel poverty in Norther Ireland: humanizing the plight of vulnerable households, Energy Research and Social Science, 4: 89-99.