Selecting Indicators to Measure Energy Poverty

Under the Pilot Project 'Energy Poverty – Assessment of the Impact of the Crisis and Review of Existing and Possible New Measures in the Member States

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"Selecting Indicators to Measure Energy Poverty"

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"Selecting Indicators to Measure Energy Poverty"

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TABLE OF CONTENT

Executive Summary

Energy poverty is defined in this report as a situation in which households are not able to adequately heat their homes or meet other required household energy services at an affordable cost (Pye et al, 2015). Research suggests that energy poverty has important consequences if not addressed, such as impacting health, further entrenching poverty and making other objectives less attainable, e.g. addressing climate change. Indicators from the EU Statistics on Income and Living Conditions (EU-SILC) suggest that 10.2% of the European population are unable to keep their homes adequately warm. Other evidence points to particularly high levels of energy poverty in specific regions of Europe, including Central Eastern Europe and Southern Europe. However, much of this current understanding is based on proxy indicators, relating to consensual survey-based approaches.

The European Commission (EC) aims to support Member States in their task to protect vulnerable consumers and to address energy poverty by identifying best practices and supporting information exchange. The aim of this study is to support the EC to better understand energy poverty by improving EU wide data collection and monitoring.

This was done in this study in various steps. This report provides a ***conceptual map*** to help explore the causes and effects of energy poverty. The conceptual map is the basis for identification of the necessary indicators that could usefully address understanding, monitoring and modelling the energy poverty problem. Energy poverty is a **complex and multi-dimensional concept.** Because the *idea* of energy poverty is itself multi-faceted, it can only be adequately captured through a set of indicators that capture economic, social and technical aspects of the condition.

The report includes an assessment of 178 indicators used in the literature and in official reports. Based on the definition of energy poverty, the conceptual map and an individual qualitative assessment of these indicators, a shortlist of preferred indicators was selected for further analysis and testing. The selected indicators fall under the following two categories:

- **Expenditure-based**: Metrics that capture affordability of (adequate) energy services ***or*** inadequate consumption by using financial information.
- **Consensual-based**: Self-reported indicators provide an effective way of understanding perceived energy poverty and more explicit insights than quantitative metrics. This family of indicators could be a 'backstop' or complementary to other indicators.

Furthermore, a set of **supporting indicators** was compiled. These indicators capture factors that relate to energy poverty and can help explain and predict the phenomenon. These indicators complement and add value to the general definition of energy poverty used in this report by providing the necessary quantification to measure the number of households in energy poverty. They also bring focus for policy action in MS as they measure factors that contribute to the social experience of energy poverty. The shortlisted energy poverty metrics and supporting indicators were tested using household-level data from Spain, Italy, the Netherlands and Slovak Republic. This testing exercise allowed to confirm, on one hand, that the energy poverty metrics could be applied at MS level and, on the other hand, to compare the appropriateness of the different metrics in specific contexts. Detailed results of the country assessments are presented in Annex 1. Based on the testing, we provide final recommendations regarding the set of key energy poverty metrics and supporting indicators, highlighted in Table 0-1.

Table 0-1: Energy poverty Metric recommendations

Approach	Energy Poverty Metrics	Justification for choice
Expenditure-based	Household is energy poor if its share of income spent on energy services is larger than twice the national median (2M).	Standard and simple metric that reflects households that have an excessively high level of energy costs relative to income.
	Household is energy poor if its income after energy costs falls below poverty line AND the share of its income spent with energy is above the national median (Low Income High Costs – LIHC).	On top of capturing households that have a high share of income dedicated to energy, this indicator imposes the condition of after-energy costs income being too low in absolute terms.
	Household is energy poor if its energy expenditure is lower than half the national median energy spending (Hidden Energy Poverty – HEP).	This reflects if a household has an abnormally low energy consumption.
Consensual-based	Household is energy poor if it declares not to be able to warm the house during cold season (Warmth).	This is the most noticeable effect of a households not being able to provide a decent level of energy consumption.

In its last chapter, the report explores options for the development of a ***tool*** to monitor energy poverty. This tool should be a platform to gather and disseminate information on policy measures developed by Member States, research and initiatives on energy poverty, and advance the understanding of energy poverty. Several relevant initiatives were reviewed in this phase (for instance, the French National Observatory of Energy Poverty, the EU Fuel Poverty Network, the INSIGHT_E Observatory, the Odyssee MURE platform, Belgium's Energy Poverty Barometer and the UK's reporting on Fuel Poverty). The suggested tool has the following main functionalities:

1. Quantitative measurement and monitoring energy poverty;
2. Information dissemination and outreach; and
3. Ad-hoc technical assistance.

With these functionalities in mind, different options were proposed for the design of the tool. The main three options differ principally in the way they handle governance, e.g. how responsibilities for running it are distributed and managed. These options are listed below, from the least involved to the most complex governance approach:

1. Web-app tool integrated into an existing platform;
2. New energy poverty platform; and
3. New energy poverty platform with MS involvement.

In combination with these main governance options, a set of content modules were developed. These modules can be added to each of the different tool options providing more or less functionality. The modules are structured in four main sections:

1. Energy poverty metrics;
2. Energy poverty policy;
3. Dissemination; and
4. Technical assistance.

Finally, the report provides a roadmap for the tool. With energy poverty clearly positioned in the Directorate's broader priorities, the broad aims and specific requirements of the tool will become still clearer.

1 Introduction

1.1 Energy Poverty in the EU

Energy poverty, often defined as the situation in which individuals or households are not able to adequately heat their homes or meet other required energy services at affordable cost, is a problem present in many Member States.[1] Multiple drivers of energy poverty, different households' responses, and policy impact make this a challenging problem to both understand and address. In order to measure the extent and severity of the problem, a variety of energy poverty indicators exist and are applied in several countries. This study aims to review these indicators and suggest those that are most meaningful for policy-makers to support them in getting a high-level understanding of the problem, which can then be used to help develop and target policies and measures.

Research suggests that energy poverty has important consequences if not addressed, such as deteriorating health (Marmot Review, 2011), further entrenching poverty, and even hindering policies directed at fighting climate change (Hills, 2012). Indicators from the EU-SILC survey show that 10.2% of the European population felt unable to keep the homes adequately warm.[2] Other evidence points to particularly high levels of energy poverty in specific regions of Europe, including Central Eastern Europe and Southern Europe (Tirado Herrero and Bouzarovski, 2014). Much of the current understanding, however, is based on proxy indicators, relating to consensual survey-based approaches, i.e. based on the subjective experience and perception of those being interviewed (Thomson and Snell, 2013). While these have provided a useful basis for highlighting the problem, it is evident that further development of indicators is required to inform both the EC and Member States (Member States) of the actions that are needed (Pye et al. 2015).

The deficit in understanding reflects limited recognition of the issue in most Member States, at least by relevant national and regional authorities, and proxy data available at the European level that are insufficient to provide a comprehensive assessment. This study aims to help bridge the gap in understanding, by evaluating how indicators can be developed and operationalised with the purpose of putting actions in place to address energy poverty. Such indicators should possess the following characteristics:

1. Support a definition of energy poverty that is broadly accepted across key stakeholders;
2. The ability to be updated over time without excessive effort or cost;
3. Provide comprehensive spatial coverage, at least at the MS level but potentially with additional spatial granularity; and
4. Allow for comparability of the indicator(s) across Member States, and their effective implementation.

It is critical that the EC develops a strong and comprehensive approach to energy poverty, supporting Member States with their own strategies to tackle the problem. The importance assigned to energy poverty by the EC is reflected in the provisions under the Third Energy Package, in the communication

[1] Different definitions for energy poverty are presented and discussed in chapter 2.1.
[2] Eurostat SILC, EU-28 in 2014 (http://appsso.eurostat.ec.europa.eu/nui/show.do)

'*Delivering a New Deal for Energy Consumers*'[3] and in the recent communication on the Energy Union[4]. As Europe moves towards more integrated energy markets, it should ensure that consumers get a fair deal and protect the economically vulnerable households.

While the European Economic and Social Committee has suggested the need for a common definition for energy poverty (EESC 2013), the EC does not have an official definition. In their document 'An Energy Policy for Consumers', they state, "*There is no consensus on what actually constitutes energy poverty. The lack of a uniform definition should not be a problem per se as it allows for solutions that are adapted to national and local conditions*" (EC, 2010).

Under the Third Energy Package, the EC put obligations on Member States to define vulnerable consumers in the energy markets, and put in place measures to provide for their adequate protection. Specifically, the Directives in question (2009/72/EC & 2009/73/EC) state, "*Member States shall take appropriate measures to protect final customers, and shall, in particular, ensure that there are adequate safeguards to protect vulnerable customers. In this context, each Member State shall define the concept of vulnerable customers which may refer to energy poverty…*" The Directives also state, "*Member States which are affected and which have not yet done so should therefore develop national action plans or other appropriate frameworks to tackle energy poverty, aiming at decreasing the number of people suffering such situation.*"

The 2010 Energy Efficiency of Public Buildings Directive (EPBD)[5] and the 2012 Energy Efficiency Directive (EED)[6] also refer to energy poverty. The EPBD, in Recital 20, states, "*Member States should provide the European Commission with a list of measures to reduce market barriers and encourage investments to increase energy efficiency in buildings contributing to reduce energy poverty*." The EED, in Article 7, states, "*Member States shall set up an energy efficiency obligation scheme. The scheme may include requirements with a social aim in the saving obligations they impose, including by requiring a share of energy efficiency measures to be implemented as a priority in households affected by energy poverty or in social housing.*"

These Directives uphold the subsidiarity principle, i.e. where Member States respond to the provisions according to their national circumstances and priorities. However, the EC has a role in supporting the Member States, and ensuring that sufficient action is in place to protect consumers and reduce the risks and incidence of energy poverty as far as possible. This study aims to provide a set of metrics that can be used to follow energy poverty in Europe as a whole, but which is versatile and flexible enough to be adapted to country-specific circumstances.

Concerning energy poverty, very few Member States, i.e. the UK (as constituent countries), Ireland, Cyprus, France and Slovakia - explicitly recognise the issue in legislation, although others are considering the issue e.g. Austria. Member States which explicitly adopted a concept for energy poverty

3 COM(2015) 339 final, Delivering a New Deal for Energy Consumers. https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v8.pdf

4 COM(2015) 80 final - A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. Brussels, 25.02.2015.

5 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, http://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3TjwtD8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031

6 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012L0027

(and those discussing approaches to it), provide an important experience base, which was largely summarised in the INSIGHT_E study (Pye et al. 2015). This study aims to be the basis for determining how the EC can better understand the issue of energy poverty, and disseminate good practice on measures to combat it. It follows an identification of need in the EC communication on '*Delivering a New Deal for Energy Consumers*', and links well with recent activities by the Vulnerable Consumers Working Groups (VCWG) (under the Citizens' Energy Forum) and INSIGHT_E consortium.

1.2 Objectives

The EC aims to support Member States in their task to protect vulnerable consumers and to address energy poverty by identifying good practices and supporting information exchange. The aim of this study is to support the EC in understanding energy poverty by improving EU wide data collection and monitoring on the topic. The specific objectives of this assignment are:

- To identify indicators suited for regular and systematic assessment of energy poverty and the impact of policies in the EU (at MS level or available from literature);
- To provide recommendations on the most suitable set of indicators, considering the need to improve the comparability and monitoring of energy poverty across Member States; and
- To provide recommendations on options for a tool that could facilitate monitoring and comparing energy poverty, its drivers and outcomes, and at the same time to provide information on measures addressing energy poverty.

1.3 Reading Guide

The report is structure as follows:

- Chapter 2 includes a review of existing definitions of energy poverty and a conceptual map that allows for a full understanding of the causes and effects.
- Chapter 3 focuses on the different approaches for measuring energy poverty, an in-depth review of existing indicators, and the selection of the most relevant energy poverty metrics and supporting indicators.
- Chapter 4 aims to give insight on the application of the selected metrics in a set of Member States (including Italy, Spain, the Netherlands and Slovakia).
- Chapter 5 explores options for the development of a tool to monitor and compare energy poverty, gather and disseminate policy information, research and initiatives on energy poverty, and steer and advance the understanding of energy poverty.
- Chapter 6 provides conclusions and recommendations.
- Annex 1 is the Technical and Methodological Report, which provides further detail on the methodology and results.
- Annex 2 is the list of the different indicators assessed at individual level, along with their source and final score.
- Annex 3 provides detailed conceptual maps.
- Annex 4 collects the interview notes, which validate the approach, indicator selection and country results. A Conceptual Map for Energy Poverty

This chapter focuses on a review of existing definitions of energy poverty and a conceptual map that allows for a full understanding of its causes and effects. Following Pye et al (2015), for the purposes of this study, **energy poverty is defined as the situation in which individuals or households,**

particularly those in lower income, are not able to satisfy required household energy services, or cannot do so at an affordable cost.

There are multiple drivers of energy poverty - rising energy prices, recessionary impacts on national and regional economies (impacting ability to address the energy poverty issue), household incomes, energy inefficient homes, limited access to supply options, etc. – which make this a challenging problem. The approach taken in this study regarding energy poverty has the following features:

- It covers household energy services. This means it is broader than heating but does not extend to householders' use of energy for mobility.
- It is agnostic about fuel supply, focusing on all fuel supply types, not just electricity and gas.
- It requires consideration of access to adequate energy service provision at affordable cost.
- Finally, the study puts focus on energy poverty as a phenomenon typical of low income households.

It is worth noting that the aforementioned concept of energy poverty is a *linked yet distinctive issue from vulnerable consumers, and requires different metrics to define it and measures to tackle it* (Pye et al, 2015). In the context of the EU policy discourse, consumer vulnerability relates to a limitation in the ability of consumers to access fully the benefits provided by the internal energy markets (gas and electricity). This may manifest as a risk of disconnection, problems of payment, and inability to access low tariffs due to lack of information or payment method. Vulnerability may be due to a number of reasons (as defined by Member States) but typically includes consumers who are low income, elderly, have a disability or illness, etc. In summary, it is consumer-based, limited to internal energy markets, and focuses on vulnerability as it affects consumers' ability to fully benefit from energy markets.

1.4 Energy Poverty Definitions

The phenomenon of energy poverty is translated into concrete metrics of energy poverty, which is done in various approaches that will be discussed in this study. The various definitions of energy poverty that exist in the literature and across Member States' official definitions portray two kinds of energy poverty situations, i.e. 1) households that spend a high share of income on energy; and 2) households that have insufficient expenditure in energy. We list some of the key definitions of energy poverty being used or under consideration across Member States and by researchers. These definitions and their related metrics (which will be discussed in chapter 3) were reviewed and compared, enabling a choice of simple and meaningful indicators that can be extensively applied in the EU, and which will be presented in the upcoming chapters.

Table 1-1 Energy poverty definitions[7]

Author/ MS	Definition	Supporting metric	Reference
Bouzarovski (2014)	**Energy poverty**: Inability of a household to secure a socially- and materially-necessitated level of energy services in the home	NA	Bouzarovski (2014)
Slovakia [official]	Energy poverty: Energy poverty under the law No. 250/2012 Coll. of Laws is a status when average monthly expenditures of household on consumption of electricity, gas, heating and hot water production represent a substantial share of average monthly income of the household.	NA	Thomson (2016)
France [official]	**Energy Poverty**: A person who encounters in his/her accommodation particular difficulties to have enough energy supply to satisfy his/her elementary needs. This being due to the inadequacy of resources or housing conditions.	Three indicators proposed but not operationalised – i) Energy Effort Rate (EER, or TEE in French) (ratio between energy expenses and income of the household), which should not exceed 10%[1], reduced to the first three income deciles; ii) LIHE (BRDE in French) indicator, which considers that a household is in a situation of energy poverty if the two conditions of low income and high energy expenditures are met; iii) “Cold Indicator” which relies on testimonials regarding the level of thermal comfort or the extent of budget constraint	ONPE (2014)
Ireland [official]	**Energy poverty** is a situation whereby a household is unable to attain an acceptable level of energy services (including heating, lighting, etc.) in the home due to an inability to meet these requirements at an affordable cost.	10% metric – but with higher thresholds to determine severity	DCENR (2014)
Belgium	**Energy poverty**: Households spend too high a proportion of their disposable income on expenditure for energy	Twice median expenditure threshold used (income equivalised). Only the lower five income deciles are included. Complimented by depth / hidden poverty metrics.	KBF (2015)
	Hidden energy poverty: households have an abnormally low level of spending on energy services	Household’s expenditure is below the median expenditure of those households of the same size and type.	
Hills (2012) / England [official]	**Fuel poverty**: A household i) income is below the poverty line (taking into account energy costs); and ii) their energy costs are higher than is typical for their household type.	LIHC + fuel poverty gap. Income is calculated on an ‘after housing costs’ basis (deducting mortgage, payments, rent) and equivalised to account for the household composition. Income threshold is below 60% of net median income.	DECC (2013)

[7] In addition to the above definitions, many research initiatives at the European level have assessed different aspects of energy poverty, and applied different definitions e.g. for example, Bouzarovski (2014) under the EVALUATE project. These are not repeated here but can be found in Pye et al. (2015), Table 2, for the ten initiatives reviewed.
[1] In 2006, this ratio was 4.3% taking into account domestic energy use. In 2012, an average household spent an average 1,702 €/year for domestic energy and 1,502 € for fuel, which accounted together for 8.1% of its total spending (Ministère de l'Ecologie, du Développement Durable et de l'Energie, 2014).

Author/ MS	Definition	Supporting metric	Reference
Austria	**Energy poverty**: A household is considered energy poor if its income is below the at-risk-of poverty threshold and, at the same time, it has to cover above-average energy costs.	LIHC. At-risk-of-poverty threshold is 60% or less of the median income (equivalised). Above-average costs - either 140% of the median expenses could be considered above average, or fixed at 167% of the median costs.	E-Control (2013)
Cyprus [official]	**Energy poverty** may relate to the situation of customers who may be in a difficult position because of their low income as indicated by their tax statements in conjunction with their professional status, marital status and specific health conditions and therefore, are unable to respond to the costs for the reasonable needs of the supply of electricity, as these costs represent a significant proportion of their disposable income.	NA	Pye et al. (2015)
Scotland [official]	**Fuel poverty**: A household, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use.	Satisfactory heating regime - recommended by the World Health Organisation is 23°C in the living room and 18°C in other rooms, to be achieved for 16 hours in every 24 for households with older people or people with disabilities or chronic illness and 21°C in the living room and 18°C in other rooms for a period of nine hours in every 24 (or 16 in 24 over the weekend) for other households.	Scottish Executive (2002)
Wales [official]	**Fuel poverty** is defined as having to spend more than 10% of income (including housing benefit) on all household fuel use to maintain a satisfactory heating regime. Where expenditure on all household fuel exceeds 20% of income, households are defined as being in severe fuel poverty.	10% metric. Satisfactory heating regime – as above	Welsh Assembly Government (2010)
Northern Ireland [official]	A household is in **fuel poverty** if, in order to maintain an acceptable level of temperature throughout the home, the occupants would have to spend more than 10% of their income on all household fuel use.	10% metric. Satisfactory heating regime – as above	DSDNI (2011)

Several definitions include the concept of energy expenditure. However, different definitions use different approaches towards what should be comprised by energy expenditures. Some emphasise that energy expenditure should capture the broader idea of energy 'services' as opposed to 'fuel' or even 'energy', where services capture notions of utility and adequacy rather than energy consumption (Sovacool, 2011). There is definitely a shift in recent research towards the notion of energy services that deliver 'capability' and away from fuel supply / energy consumption that delivers specific energy needs e.g. for heating (as reflected in the fuel poverty definitions for UK constituent countries), and therefore toward metrics based on modelled or required levels of energy expenditure rather than observed levels. For France, the definition emphasises both the supply of energy itself and the satisfaction of basic needs, in the household.

A second important issue with defining energy poverty refers to the population group that can be considered energy poor. Policy-makers appear to prefer viewing energy poverty explicitly as a phenomenon in low income groups (as reflected in the definitions of Belgium, England, Austria and France). This is allegedly important for channelling resources to those most in need, and reflects the fact that some metrics of energy poverty also classify mid-to-high income households as energy poor. This is less apparent in academic research. The approach that considers energy poverty as a phenomenon that is exclusive to households that are already considered as low income, sees energy poverty merely as a symptom of the broader problem of poverty, and not as a parallel definition of poverty. This is a perspective that is reflected in the policy approach of Northern European Member States (Pye et al. 2015). However, a counter argument is that energy poverty is a useful concept for targeting groups that suffer financial pressures due to energy bills, but are not considered poor under the general poverty definitions (Hills 2012).

1.5 A Conceptual Map of Energy Poverty

A conceptual map was developed to help explore the causes and effects of energy poverty, and to provide a basis for identification of the necessary indicators needed to better understand the problem, and to focus policy intervention. Without such a map, it is difficult to understand the linkages between different drivers of energy poverty, different interventions that can affect such drivers, and potential outcomes. This map allowed identification of the types of indicators required, and potential combinations of indicators to measure and monitor energy poverty in Chapter 3. Our justification for including the different factors – and relationships – is provided in the subsequent review of the literature.

The conceptual map, shown in Figure 1-1, is necessarily complex, due to the many different drivers and factors that are relevant to the energy poverty issue. It consists of the following features, which are described in more detail below:

- The **household energy system**: energy service demand, energy use and expenditure;
- **Drivers** that impact the affordability of household energy services and could lead to energy poverty;
- Key **factors** influencing or causing energy poverty, specifically relating to i) physical infrastructure, ii) policies, and iii) socio-economic & demographic factors; and
- **Outcomes**. These are (in part) resulting from households being in a situation of energy poverty.

1.5.1 The household energy system: energy service demand, energy use and expenditure

At the centre of the map is the basic flow of energy service demand, energy use and resulting expenditure – in other words, the household energy system. The levels of household energy service demand, resulting energy use, and the cost of this energy, are a function of the different variables that impact on any one of these. The resulting expenditure levels will reflect affordability, and lead to different levels of energy services. Expenditure (or lack of it due to unaffordability) is also affected by many factors, notably income – but a range of other factors e.g. other expenditure priorities, and policy support measures. Affordability concerns can lead to specific outcomes (indebtedness, disconnection etc.), and lower levels of energy services, again leading to negative outcomes.

1.5.2 Drivers leading to energy poverty

The conceptual map also includes a set of drivers that directly or indirectly impact the affordability of household energy services, and could lead to energy poverty. These are included in Table 1-2 below.

Table 1-2 Drivers for energy poverty

Driver	Description & literature basis
STRUCTURAL: Socio-political systems	This structural driver represents previous and current political and economic systems. It may be important for understanding some of the underlying causes of energy poverty. It is an important influencing factor on energy market development, institutional structures, heating infrastructure, dwelling stock and tenure, and energy supply. Bouzarovski et al. (2012), particularly cites the example of Bulgaria – and legacies of communist-era centrally planned economies. This is a strong determinant of building efficiency, energy systems, policy framework, etc. Bouzarovski et al. (2014) provides insights on the Hungarian situation.
MARKETS: Market system	This driver represents the type of energy market, and extent of liberalisation and level of competition, which can have an important bearing on the choice of energy service tariffs / products, and the type of interventions for assisting with energy affordability. Pye et al. (2015) highlights the difference in types of interventions depending on market system, notably in relation to consumer protection. There is also a clear link between market competitiveness, tariff choice, and type of specific tariffs under different regimes e.g. regulated prices versus social tariffs.
NATURAL SYSTEMS: Climate	This driver determines energy demand, particularly for heating and cooling. It also influences the level of investment in / sufficiency of building fabric efficiency and heating system type. Tirado Herrero and Bouzarovski (2014) highlight the trend for higher levels of self-reported inability to keep the home warm in Southern Europe. This points to inadequate heating systems and inefficient housing for shorter, less severe cold months – but also recent recessionary effects. Conversely, highly efficient housing in colder Scandinavia is observed. Other key references include Healy and Clinch (2002) and Thomson and Snell (2013).
MACRO-ECONOMY: State of the Economy	This driver can influence income (see below). Tirado Herrero and Bouzarovski (2014) highlight the link between increasing rates of energy poverty due to economic downturn, austerity measures and rising energy prices – in different regions of the EU.
ECONOMIC: Income	This driver can influence the level of energy service provision, depending on energy costs as a share of income. It also may determine the tenure of a household, the dwelling size, and any additional support that might be available through policy interventions. It can also have a bearing on fabric quality of a building. Level of income is a key feature of energy poverty, and is incorporated into different metrics e.g. LIHC (Hills 2012), 10% expenditure, etc. This links to many important factors, as per the conceptual map – and therefore is one of the most important drivers.
POLICY: Policy framework	This driver represents the policy framework that is in place, explicitly targeted at supporting vulnerable consumers and / or addressing energy poverty. This strongly determines the type of interventions that are put in place. Recognition of the energy poverty challenge is a key driver of related policies, whether that be how social or energy policy is formulated – and resulting interventions. This in turn is informed by socio-political systems. Pye et al. (2015) made some preliminary efforts to consider types of policy approaches and measures in different countries across the EU.

1.5.3 Factors influencing energy poverty

Linked to the drivers, there are a set of three factors that will influence the situation regarding energy poverty. These include physical infrastructure, policy interventions, and socio-economic and demographic factors.

Physical infrastructure includes the building stock, and the energy infrastructure that supplies the building stock. It affects a range of issues relating to energy consumption levels, access to energy supply, and ability to improve building fabric. Energy consumption levels are impacted by building energy efficiency, size of households and the types and efficiency of heating systems available. The efficiency of buildings (and necessary investment) can be affected by the tenure of those buildings (social housing, private rental or private ownership), and the building type. For example, some building types are more suitable for large-scale retrofit programmes. The type of energy available to households can also be crucial; for example, non-connected rural communities may have limited access to more affordable supplies. Urban communities linked to district heating may also be limited in choice, tied into higher cost, lower efficiency systems. Buzar (2007a) notes how housing tenure and heating systems can limit energy efficiency interventions and fuel switching choices in the Eastern European context. Key drivers of physical infrastructure include socio-political systems and income.

Preston et al. (2014) provide a useful overview of the characteristics of fuel poor households, based on physical property characteristics and socio-demographics, for the UK. It highlights poorer building efficiency, less access to gas, and older properties for example, in relation to physical properties.[8]

Policy interventions are also key. Pye et al. (2015) provides a review of types of measures implemented across Member States to address energy poverty and protect vulnerable consumers. There are many different measures, all designed and implemented according to different country situations. They can be categorised as follows: i) short term financial interventions, to address affordability concerns; ii) additional consumer protections specifically targeted at vulnerable consumers, particularly in the internal energy markets; iii) energy efficiency measures targeting structural energy poverty problems; and iv) improved consumer awareness and information. What measures are formulated and how they are implemented is a key function of the policy framework driver.[9]

Demographics includes characterising groups who may be at risk of energy poverty for reasons not necessarily linked to income (elderly, disabilities, rural communities, single parent households, etc.). This also includes household size, which could be a factor in level of energy service demand. As noted in Preston et al. (2014), households in energy poverty often display specific socio-demographic features. In terms of vulnerable groups, most Member States have gone some way to determining vulnerability by socio-demographic group; for a useful overview, see Table 5 in the INSIGHT_E report (Pye et al. 2015).

1.5.4 Outcomes

Finally, the conceptual map represents **outcomes** resulting from energy poverty, due to energy costs being a disproportionate share of household expenditure, represented by 'affordability concerns', and the inability to access adequate energy service provision, particularly heating, represented by the

[8] This is based on the 10% metric; the LIHC metric results in some differences to the socio-demographic make-up of fuel poor households.
[9] An example of the interventions in a Member States, in this case England, can be found in the draft fuel poverty strategy (DECC 2014), and from a vulnerable consumer perspective, in Ofgem (2013).

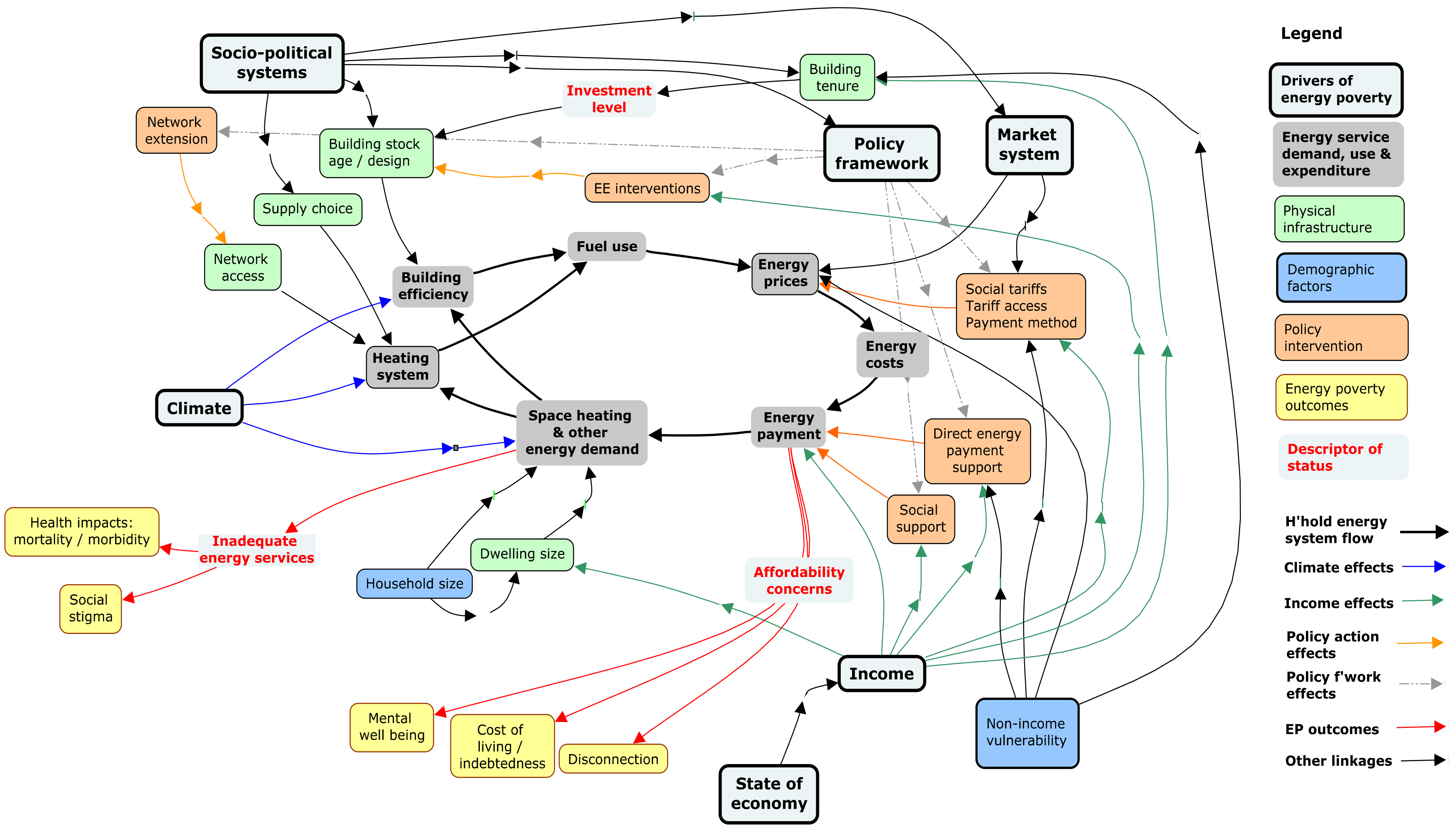
‘inadequate energy serviced’ in the conceptual map. Outcomes can be high indebtedness, disconnection, health impacts, social stigma and mental well-being.

Affordability problems can result in disconnection, high levels of indebtedness, and increased stress, exacerbating challenges already faced by low-income households. This can force households into inadequate purchasing of energy services to meet their needs, with resulting health impacts.

The Marmot Review Team (2011) highlighted the strong relationship between colder homes and excess winter deaths but also increased incidence of other health problems. They found that 22% of excess winter deaths in the UK could be attributed to cold housing. Healy (2003) explored the different factors that could help explain the variation in excess winter deaths across different Member States. The analysis found that countries with the poorest housing (e.g. Portugal, Greece, Ireland, and the UK) demonstrate the highest excess winter mortality; concluding that a key preventive intervention could be improving building thermal standards, which would also alleviate energy poverty. Fowler et al. (2014) note that energy poverty could be one factor in the variation in excess winter deaths across the EU, and that understanding the relative importance of different factors is important. Such factors include low GDP, low national spending on healthcare, inequality, deprivation, cold housing, low income and urban dwelling.

In the following section, two examples illustrative of conditions that might exist in Member States are provided, as a way to demonstrate the process by which the conceptual diagram captures the interactions that lead to energy poverty.

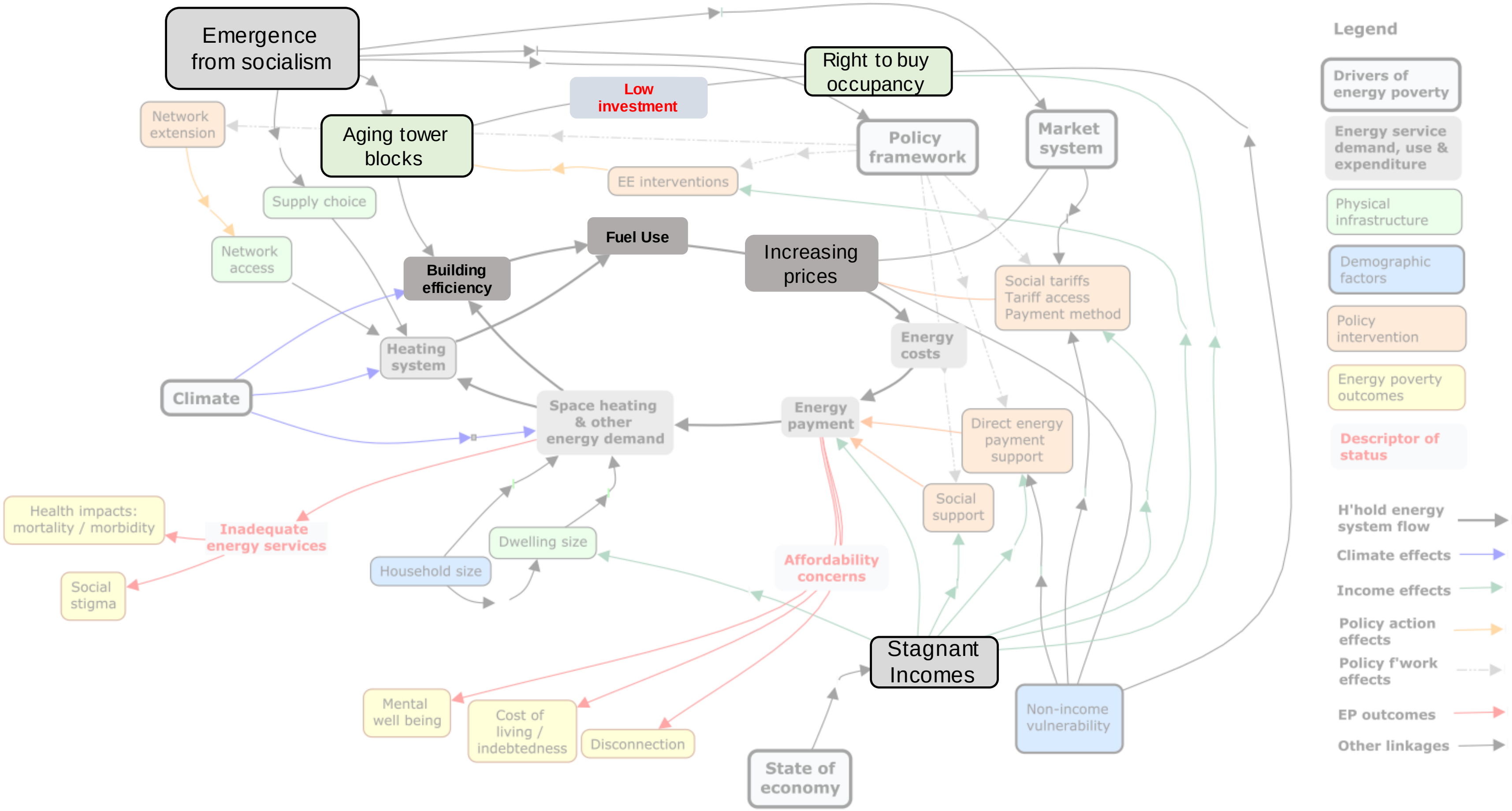
Figure 1-1 Conceptual map of the drivers, causes and effects of energy poverty



Energy poverty in former Soviet Union & Eastern and Central European states

The risk of living in energy poverty in post-socialist states has increased for many households, as a multitude of infrastructural, institutional and economic mechanisms changed. This arose as these countries emerged into a democratic market-based economy (Buzar, 2007b). In these settings, there may be existing socio-economic and socio-technical factors that interact to create conditions that are conducive to living in energy poverty. For example, as markets are liberalized and de-regulated, and their ownership structure changed, there could be increases in energy prices that outpace the rise in living standards of low-income households. Coinciding with these could be ageing built environments, such as tower blocks, which are in need of investment to improve their energy performance and heating systems. The resulting effect of quickly rising prices, low or stagnant incomes, and the ageing buildings and heating systems could result in lower income households being unable to heat their dwellings to a socially or materially accepted standard. Within the conceptual diagram, this example is captured along the pathways highlighted in Figure 1-2.

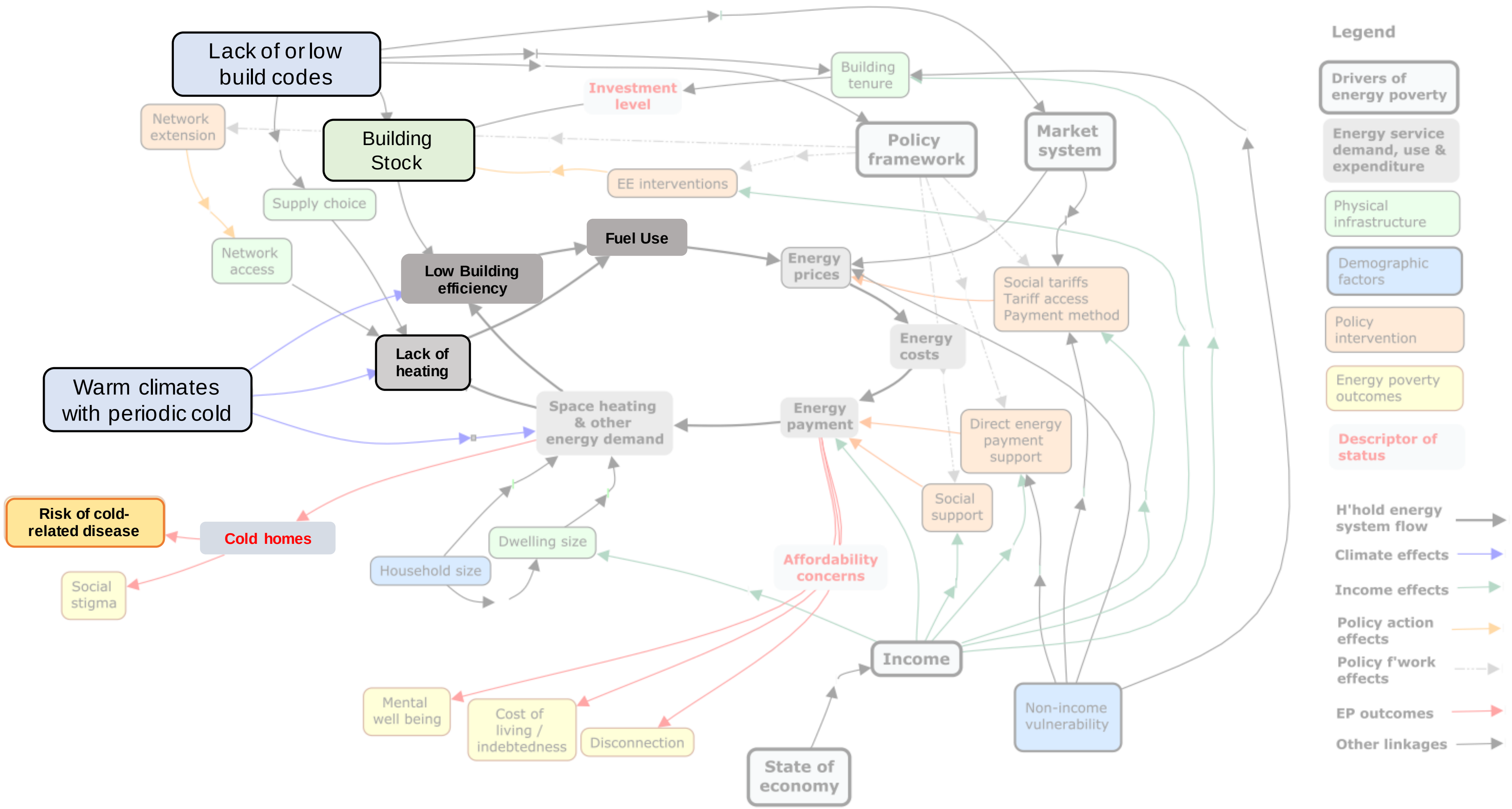
Figure 1-2 Illustration of energy poverty interactions in former Soviet Union and Eastern and Central European states



Warm climates, cold homes: Living in energy inefficient housing in Southern European climates

The energy performance of dwellings in European countries with warmer climates tends to have comparatively lower energy performance standards than colder climates (IEA, 2013; UNDP, 2013). However, many of these countries still experience seasonal temperatures below levels that would be considered comfortable or necessarily safe for health and wellbeing (Healy, 2003; Healy and Clinch, 2004). Furthermore, the presence of room- or central heating systems may be limited, as these systems may be seen as being infrequently used. However, the interaction of historically low energy performance requirements for dwelling construction and low-levels of heating system presence would leave many households with a high risk of exposure to colder temperatures. Within the conceptual diagram, this example is captured along the pathways highlighted in Figure 1-3.

Figure 1-3 Illustration of energy poverty interactions in Southern Europe



2 Energy Poverty Indicators

This chapter provides first a theoretical overview of existing approaches towards measuring and monitoring energy poverty in the EU, based on literature. In this project, an “approach” means a theoretical framework to deal with the measuring of energy poverty. A conceptual understanding of the definition of energy poverty needs to be somehow operationalised using different metrics.

For the purpose of this report, an **energy poverty metric** is an indicator that allows for the measuring and monitoring of energy poverty. It is not a basis for focusing on-the-ground interventions but rather an indicator that provides policy makers with an understanding of the severity of the problem at Member State level, and allows for cross-comparison across the EU Member States. In general, there is a need to combine data within the energy poverty metrics and to even provide different energy poverty metrics to capture the multi-faceted nature of the problem.

Next to the main metrics we also selected supporting indicators for energy poverty. A **supporting indicator** is an individual indicator that can be used alongside the metric of choice to provide additional information on the profile of the households who are defined as energy poor. These supporting indicators, which are not metrics of energy poverty per se, may help in identifying a number of factors correlated to energy poverty and influencing the experience of being energy poor, and may provide a basis for monitoring and/or targeting policy interventions. In this chapter, an overview of the different metrics for measuring and monitoring energy poverty is provided.

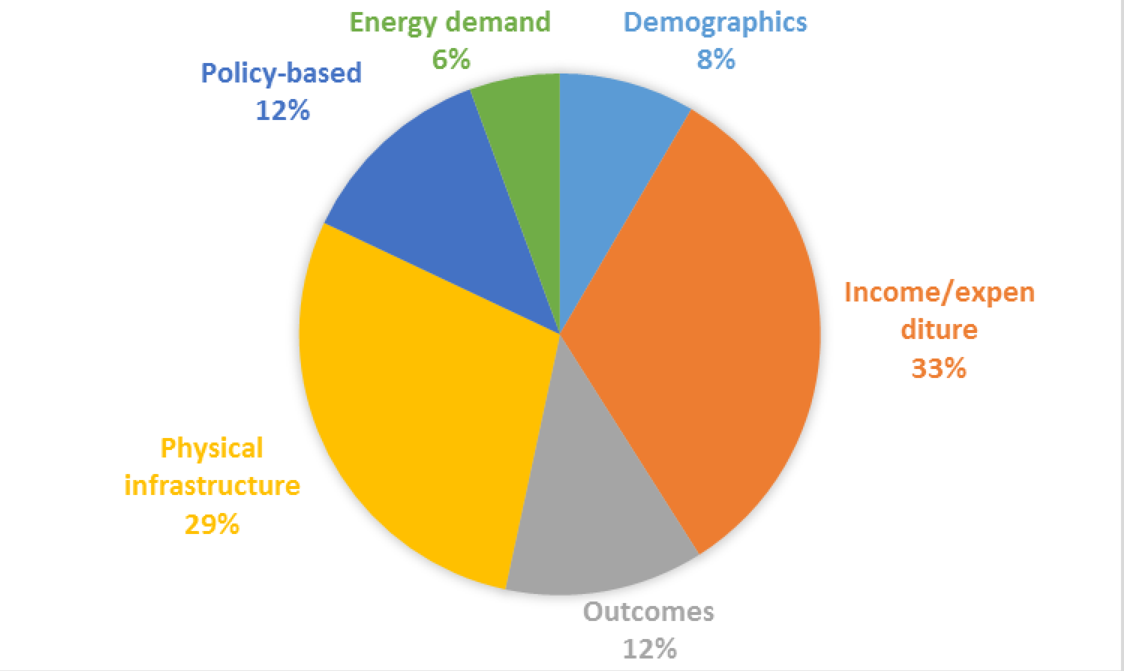
2.1 Classification & Assessment of Energy Poverty Indicators

Indicators suited for regular and systematic assessment of energy poverty in the EU, including the impacts of changing economic conditions and developments in the energy sector, were identified based on existing literature and review of data sources.[10] The identified indicators were classified across several aspects including, for example, what the indicator aims to measure (driver, outcome, etc. as defined in the conceptual map), whether data is readily available, whether the indicator is objective or subjective, etc.[11] Together, these aspects provide sufficient information per indicator to perform a qualitative assessment. The detailed list of indicators, their classification and assessment is presented in Annex 2 while a more detailed explanation of the methodology and results are included in Annex 1 as part of the Technical and Methodology Report.

178 indicators were assessed. 42 of which were selected based on the work from the EU Building Stock Observatory, which takes into account existing statistics and other databases available at EU level. 12 additional indicators have been selected from Eurostat and another 7 from SILC.[12] The remaining indicators have been gathered from other EU projects, country level statistics and literature (see Figure 2-1).

[10] These include the EU Building Stock Observatory (which takes into account the projects Odyssee, ZEBRA, ENTRANZE, as well as EUROSTAT statistics and official national statistics), and the INSIGHT E country reports which led to further MS literature.
[11] Aspects include: Indicator category; method of application to the energy poverty issue; indicator type; comparability; quality and robustness; experience of application to energy poverty issue; and data availability.
[12] While SILC is also presented by EUROSTAT, the surveys are run by national statistical offices.

Figure 2-1 Indicators assessed per category



Of the 178 indicators assessed, 58 were related to income or expenditure while 51 were linked to physical infrastructure. Indicators related to energy demand and demographics only amounted to 10 and 15 respectively. 139 are single metric indicators while 39 are combinatory or constructed indicators, representing 22% of the total and mostly falling under the category of income/expenditure indicators. Among the identified energy poverty metrics, 10 were consensual-based; 42 expenditure-based and 11 outcome-based; while another 14 energy poverty metrics had different approaches (i.e. combination of metrics or other approach). The remaining 101 were supporting indicators.

Indicators were appraised as regards to their effectiveness and suitability for a systematic assessment of energy poverty in an EU-wide framework (for more detail, see Chapter 5 of Annex I – Methodological and Technical Report). A matrix with several criteria was used, making direct use of the information gathered in the identification and classification stage. Indicators were scored using a traffic light reporting system which was translated to a score of 1 – 3, where 3 is the highest score. Indicators that have an average assessment score of 2.0 or below were not shortlisted, as their application would run into several problems (e.g. the indicator is not selected if it has the lowest score for comparability between MS and the lowest score for quality and robustness, or very limited data availability and a complicated method). Further, qualitative criteria such as the strengths and weaknesses (considering those found in the literature review) were taken into account in the indicator selection and a quick scan was performed to avoid duplication.

Key metrics to measure and monitor energy poverty

As mentioned above, a number of relevant energy poverty metrics were reviewed, with the most relevant listed in Table 2-1. The diversity of these metrics reflects the challenge of understanding and conveying the multi-faceted problem of energy poverty in different contexts. Even more challenging than attempting to capture the extent of it within a country, is trying to do so across such a broad region as the EU.

Table 2-1 Key energy poverty metrics in the EU

Initiative	Energy poverty metrics	Approach
ONPE	• 10% energy cost ratio	Expenditure-based
	• Low Income High Costs (LIHC)	Expenditure-based
	• Survey data on lack of heating discomfort	Consensual-based
EU Fuel Poverty Network	• % of households unable to afford to keep their home adequately warm;	Consensual-based
	• % of households in arrears on utility bills	Consensual-based
	• % of households living in dwellings with a leaking roof, damp or rot.	Consensual -based
Insight_E Observatory	• % energy expenditures	Expenditure-based
	• share of energy cost in low income household revenue	Expenditure-based
UK Fuel Poverty Statistics Report	• LIHC	Expenditure-based
Belgian Energy Poverty Barometer	• **Measured Energy Poverty (MEP) extent**: households in the lower five deciles of equivalised incomes whose energy expenditures were higher than threshold • **MEP depth**: energy poverty gap (in €) *above* "acceptable" energy bill	Expenditure-based
	• **Hidden Energy Poverty (HEP) extent**: households whose energy bills are "abnormally low" • **HEP depth**: energy poverty gap (in €) *below* "acceptable" energy bill	Expenditure-based
	• **Perceived Energy Poverty (PEP)**: number of households that report having financial difficulties in heating their homes sufficiently	Consensual-based
Energie-Control Austria	• Households below established poverty "risk" threshold AND with above-average energy costs[13]	Expenditure-based
Report "Energy Poverty in Spain"	• MIS (Minimum income standard)	Expenditure-based

Based on this review, the following section further considers the role of different metrics, their strengths and weaknesses, and the basis for choosing a given metric.

2.2 Two Main Approaches to Monitoring Energy Poverty

We have identified two main approaches in the literature to define energy poverty metrics, i.e. Expenditure-based and Consensual-based. Expenditure-based metrics define energy poverty based on information about the household's expenditure in energy, and often compares it with the household's income. Consensual metrics, on the other hand, are metrics that identify those households that declare to face difficulties in order to meet basic energy services ("perceived deprivation").

Besides these two approaches, Thomson (2013) describes a third one[14]: Temperature-based metrics. This approach relies on internal temperature measurement. However, due to lack of data and

[13] Similar to LIHC but using actual instead of required expenditure
[14] The term used is 'fuel poverty'. For the purposes of this report, we simply use the term 'energy poverty', with no distinction in meaning between the two.

application, this approach is not further explored. Interestingly, some experts argue it may be a poor indicator in itself in the context of specific regions; for example, Tirado Herrero and Ürge-Vorsatz (2012) note that in some Central and Eastern European countries where dwellings use district heating systems, there is limited control of heat consumption, meaning that internal temperatures are "*typically adequate, or in some cases even too high*".

A fourth approach, also not explored in this study, is the outcome-based approach. The metrics of this approach have a limited footprint in the literature. These are metrics based on the outcomes associated with energy poverty e.g. disconnections, arrears, cold-related mortality. However, their use may be problematic due to lack of consistent national levels statistics, limited access to utility based data, and a causality problem, where outcomes are the results of many different factors, energy poverty being one but not the only factor.

This diversity in approaches reflects different approaches undertaken across the EU, each of which have different strengths and weaknesses (presented in the table below, Table 2-2), and are therefore increasingly used in combination. For instance, **expenditure-based metrics** may build an exhaustive picture of actual or required expenditure level but do not reflect consumers' motivation for expenditure levels and cannot assess whether consumers reduce expenditure because of budget constraints or due to other factors.[15] **Consensual-based metrics** can capture wider elements of energy poverty and may be easier to implement but can be highly subjective and difficult to compare across Member States.

Table 2-2 Overview of energy poverty approaches

	Rationale	Justification & challenges
Expenditure-based	Expenditure-based metrics capture affordability of adequate energy services for those on low income. ('Adequacy' only captured if using 'required' expenditure)	✓ Captures key features of energy poverty ✓ Applied / tested in a number of MS ✓ Capture severity by use of different thresholds - Problematic to implement across all MS (if based on required household energy due to the need for detailed modelling) - Sensitive to energy price rises
Consensual-based	Self-reported indicators can provide an effective way of understanding perceived energy poverty and more explicit insights than quantitative metrics. This family of indicators could be a 'backstop' or complementary to other indicators.	✓ Main basis to date for assessment ✓ Can be used as a complementary indicator (FR, BE examples) ✓ Survey infrastructure in place, just needs improvement (see Thomson) - May not adequately allow for effective quantification - Survey may not have any associated income dimension
Outcome-based	This family of indicators provides a proxy for energy poverty based on outcomes. There are two possible approaches - using utility data or focus on health outcomes - (see Thomson in literature review + EuroMOMO)	✓ Measure of actual outcomes ✓ For utilities, brings utilities in as key stakeholder to help provide solutions - Access to utility may be difficult - Narrow proxy measure - Many different factors impact health outcomes in addition to energy poverty (see Healy 2003)

The following sections focus on the two main approaches (i.e. Expenditure-based and Consensual-based).

[15] If energy poverty is calculated using required energy, then it is possible to take account of improvements on energy efficiency because of energy efficiency investments.

2.2.1 Expenditure approach

Expenditure-based indicators for energy poverty are derived from the level of expenditure on energy. They can be defined as a percentage of income or in absolute terms. In practice, assessing energy poverty consists of comparing the expenditure metric (share of energy expenditure relative to income or absolute expenditure in monetary terms) to a normative threshold. A household can thus be considered energy poor if its expenditure metric is too high (above a certain threshold) or too low (below a certain threshold). Three kinds of metrics that use thresholds can be distinguished, see Table 2-3.

1. **High share of energy costs metrics** which refers to those that capture households that have above the norm energy expenditure patterns. Therefore, it considers households as energy poor where energy costs (as a share of income or in absolute terms) lie ***above*** a certain threshold. This kind of metric is extremely common in the literature and in policy-making.
2. **Low available income metrics** which classify as energy poor those households who have little income left after their energy costs. These metrics capture households whose available income, after energy costs, lies ***below*** a certain threshold.
3. **Insufficient energy spending metrics** which only looks at energy expenditure, comparing it to a minimum level that is considered necessary for a household to enjoy basic services. These metrics classify as energy poor those households whose energy costs lies ***below*** a certain threshold. This is the key concept of HEP, calculated in the Belgian Energy Poverty Barometer (KBF 2015).[16] Ideally, this measure should exclude homes with highly efficient energy performance. In the Barometer, the threshold to determine if energy expenditure was "abnormally low" was based on the consumption patterns of "*the lower five income deciles and what would be adequate energy expenditure considering the number of people in the household and the size of the dwelling.*"

Table 2-3. Three kinds of expenditure-based metrics

Kind of metric	Description	Components
High Share of Energy Costs	Household is energy poor if its share of income spent on energy is above a certain threshold.	• Threshold definition • Energy expenditure definition • Income definition
Low Available Income	Household is energy poor if its available income after accounting for energy costs is lower than a certain threshold.	• Threshold definition • Energy expenditure definition • Income definition
Insufficient Energy Spending (Hidden Energy Poverty)	Household is energy poor if its absolute energy spending is below a certain threshold.	• Threshold definition • Energy expenditure definition

There are a number of issues relating to the use of such an approach, each of which requires important methodological decisions:

Setting the threshold

For all three kinds of expenditure-based metrics, the issue of setting the threshold is not easy to resolve. For the High Energy Costs metrics, for example, there is a debate as to the basis on which the

[16] The Energy Poverty Barometer defines HEP as households whose energy bills are "abnormally low" according to what would be considered adequate according to the number of people in the household and the size of the dwelling and taking into account energy efficiency of the building

threshold should be set, and to what level. Should it be a fixed absolute threshold at all, or rather one that is relative to each country's characteristics? An absolute threshold may be 10% of income, while a relative threshold takes into account the distribution of income and energy expenditures in the population. For example, one can classify a household as energy poor if its share of income spent on energy is ***more than twice the national median share***. Hills' (2012) LIHC indicator, as another example of a relative approach, classifies a household as energy poor if the share of income spend on energy is ***above the national median***, ***and*** their residual income net of fuel cost spend falls ***below the official poverty line***, which is defined as 60% of the national median income. Due to the asymmetry of fuel expenditure,[17] the use of the medians to set the threshold is preferred, as the mean can be problematic, overly influenced by extreme values in the distribution tail.

Moore (2012) states that a relative definition "*seems right in principle*" but highlights the concern that this can mask the impact of increasing energy prices. When energy prices rise for the whole population and the median shifts upwards, these indicators will not capture almost any change in the number of households in energy poverty. Hills (2012), on the other hand, argues that a relative definition is preferable because a 10% threshold (or other absolute threshold) is too sensitive to energy prices. When energy prices move upwards, for example, making households as a whole increase their spending on energy, the use of an energy poverty metric with a fixed absolute threshold will show an almost mechanic increase in energy poverty. On the other hand, one could argue that relative metrics measure inequality rather than energy poverty itself. By setting thresholds that are dependent on the income and spending distribution in a given country, relative thresholds focus on those households that are in most need of policy support.

As documented in Liddell et al. (2012), a 10% threshold was first proposed by Brenda Boardman in 1991, and was based on an approximation of the mean expenditure on energy in the 30% of households with the lowest incomes in England. The 10% threshold is also close to twice the median expenditure on energy estimated by Isherwood and Hancock (1979). But while the 10% threshold might reflect the median expenditure of poor households in England, it may not be appropriate in other countries. Liddell et al. (2012) notes that the twice-median threshold in Northern Ireland is 18%, so the use of 10% would result in an overestimation of the problem. Thomson (2013) also cites a number of European studies that have applied the 10% metric incorrectly, or without consideration of the national expenditure / income statistics in determining an appropriate threshold.

Finally, it is also worth noting the approach considered by Moore (2012): the budget standard approach. This is based on establishing a minimum income standard (MIS), an income level "*needed by different household types in different locations to participate in society*." In this approach, energy poverty is where net income after housing costs is insufficient to meet fuel costs after minimum living costs (under MIS) have been met. Moore argues that it is a more direct and relevant measure of need. The difficulty in operationalising this approach at the EU level is the need to estimate required household energy, and determining the MIS.

Table 2-4. Options of thresholds for the expenditure-based metrics

Threshold	Unit	Observation
10% of income	% of income	Before the LIHC concept was adopted in the UK, an energy expenditure of more than 10% of household income was the key indicator of energy

[17] This refers to the fact that there are a small percentage of high consuming households that influence the mean value. This results in the mean being considerably higher than the central value (in the household distribution).

Threshold	Unit	Observation
		poverty. This is a simple indicator, easy to communicate and measures an absolute value for energy poverty (Economics for Energy, 2014). This corresponded with roughly twice the median energy spending in 1991 (Boardman, 1991), but is nevertheless fairly arbitrary and highly dependent upon price fluctuations
Above the median share	% of income	The LIHC measure considers "high cost" expenditure to be that which is above the national median level. It only applies to households whose income after energy costs fall below the poverty line.
Twice the national median (and other 2M indicators)[18]	% of income or euros	This threshold adopts the rationale of the UK's 10% threshold without committing to a fixed figure. This allows for recalculation each year and accountability for fluctuation conditions (prices, climate, etc.). However, these moving (relative) measures have implications for political commitment (Pearson et al., 2012). By multiplying the median by two, an effort is made to distinguish the most excessive expenditure while including situations still deemed "acceptable." However, this measure has the drawback of potentially concealing energy poverty if the income/spending distribution shifts in the population as a whole. In fact, a general drawback from the 2M metrics is that when increasing the energy expenditure of all households, the number of households in energy poverty would decrease, which is counterintuitive and goes against Sen's rule for poverty indicators[19].
Budget standard approach or Minimum Income Standard (MIS)	Euros	For some metrics, a MIS or standard budget is used. MIS refers to the minimum income a household needs to allow the household members to be actively integrated in society. This refers to the income after deducting housing costs and other minimum living costs (food, clothing, cultural participation, child-rearing, etc.)(Moore, 2012). Such a measure is highly relative and difficult to ascertain – requiring a participative approach. If a household's income is lower than its housing and energy costs and the MIS, then it is considered energy poor. Such a metric is also useful to assess the level of vulnerability of each household which would allow not only for corrective actions (aimed at those already considered energy poor) but also preventive actions for those who are vulnerable to becoming energy poor (Economics for Energy, 2014). A proxy, as used in the case of Spain, could be national or regional social insertion income (Economics for Energy, 2014).
No threshold	-	The INSIGHT_E observatory's measure of energy poverty does not define a distinct threshold, but does present a scale of severity of energy expenditure for low-income households (below 5%, 5-8%, 8-10%, 10-14%, above 14%). It could then be suggested that only the higher levels of expenditure are truly energy poor, while very low expenditures could be an indication of hidden energy poverty.

Actual versus required expenditure

When calculating the expenditure-based metric, one needs a precise definition of what is considered as energy expenditure, and what that should be compared to. Studies of energy poverty focus on energy use for household services. Household surveys usually provide estimates of what households have ***actually*** spent on energy in a specific period. However, Liddell et al. (2012) highlight the importance of

[18] This group of indicators include: Twice the median of energy expenditures; Twice the mean of energy expenditures; Twice the median of the share of energy expenditures; Twice the mean share of energy expenditures. When comparing the mean and the median, the metrics based on the median are more appropriate statically since the mean is more sensitive to atypical values and change in habits. Economics for Energy (2014)

[19] Sen rule: Every poverty indicator should increase when the income of a person decreases. (Economics for Energy, 2014)

moving from actual expenditure to a 'needs to spend' basis. This is because households in energy poverty often don't purchase what is actually required to provide adequate energy services (like heating and electricity services). An earlier fuel poverty report from DECC (2011) highlights that in England the needs to spend on energy services was 21% higher than actual spend in 2009.

Moore (2012) also admits that actual expenditure is a poor indicator to use. However, in order to estimate required expenditure one needs detailed knowledge of the building stock, and its energy efficiency. This is done in the UK, but may be problematic where extensive datasets are not available. In the UK, the key source of information is the English Housing Survey, which provides a comprehensive picture of the type and condition of housing in England, the people living there, and their views on housing and their neighbourhoods (DECC, 2014b).[20] Thomson (2013) concludes that such metrics are not easily applied at the EU scale. Two key problems are evident: i) lack of data to underpin 'required expenditure'; and ii) absence of standardised data on household energy expenditure. To some extent the relative strengths and weaknesses of different indicators are often a trade-off based on data availability and other factors.

Due to these shortcomings, we concluded that using actual expenditure at the EU level is the most 'pragmatic' way forward, while the metrics based on required expenditure *demand a great deal of technical and financial effort*. This approach is taken in various studies, which then compare the share of actual energy expenditure to a threshold.[21] **Due to the difficulties of estimating "required household energy expenditure", this study will adopt the pragmatic approach of defining the expenditure-based metrics with *actual observed energy expenditure*, highlighted in Table 2-5.**

Table 2-5. Choices of energy expenditure definition

Energy expenditure concept	Observations
Estimation of required expenditure	Required expenditure must be estimated based on a series of variables related to the composition of the household, climate conditions and infrastructure. It reflects the level of services that a household should have access to in order to enjoy a decent consumption standard[22].
Actual energy expenditure	These indicators reflect the actual expenditure with energy for household services (it does not include transportation costs). This has the advantage of being collected from surveys. However, the use of actual expenditure makes it difficult to assess whether a certain level of energy expenditure reflects a bad financial circumstance or a voluntary choice of the household.

Household income

When referring to income in relation to measuring energy poverty, it is important to be clear with what precisely is meant, as this has a significant influence on results. Thomson (2013) notes three points of contention in determining income: i) what benefits should be included in the income definition; ii) the use of income before or after housing costs; and iii) whether income should be equivalised.[23]

[20] The survey uses both surveys and physical inspections. From the EHS 2011-12, each year around 13,300 interviews are conducted with householders, and around 6,200 of these households have a follow up physical survey of their dwelling.
[21] This approach is taken by the Austrian authorities in their estimates of energy poverty. To this end, they also consider the following thresholds for energy expenditure that are above average – i) 140% based on the difference of 40% between average income and the at-risk-of-poverty threshold (60%), which are added to average energy costs to receive above-average expenses, and ii) 167% which uses the reciprocal of 60% to receive above-average energy costs, amounting 10/6 of the median expenses.
[22] The definition of a decent standard is normative, and often Member States establish their own criteria (the UK for instance assumes heating regimes in order to calculate required energy expenditure levels). In general, a decent consumption level of energy would entail being able to consume basic services, such as warming their homes in the cold season, having hot water and light. For example, see the approach in England, set out in DECC (2014b). This shows the calculation methodology for determining required energy service levels across the different household types, based on building stock, climatic zone etc. For example, space heating requires an indoor temperature of 21 ^{0}C for the primary zone (main living area) and 18 ^{0}C for the secondary zone.
[23] Made comparable e.g. incomes are adjusted to recognise that larger households need a higher income to provide the equivalent energy services of a smaller household.

Regarding the first point, it is important to define income in the broadest sense possible. Against that, Thomson (2013) describes how including such benefits effectively increases incomes, even though those benefits are specific to disability needs. However, for simplicity, not only labour income, but also financial income, social aid and pension benefits should be considered to the definition of gross income. A concept used in European Statistics is that of "**disposable income**". It refers to income minus taxes and social contributions. This is calculated in the SILC survey, and refers to a part of income over which the household has little or no influence. Where possible, then, taxes should be subtracted from the income of the household.

On housing costs, Moore (2012) argues that the income definition should be based on 'after housing costs'[24], as it would better represent the income on which a household has power to decide over its allocation. However, we have identified two shortcomings to this approach. Firstly, it assumes that households cannot choose how much they pay for their rent or other housing costs, which is a very strong assumption. Moreover, it brings up the difficult issue of how to define housing costs: should it incorporate only rents and mortgages? Should it include the opportunity cost of renting a house that is owned by the family that inhabits it? In defining income for the expenditure-based metrics, this study will not deduct housing costs.

This study takes an approach of transforming the household's "disposable income" in order to obtain what is conventionally called "equivalised disposable income". Hills (2012) argues in favour of this, to ensure that all households are comparable, given the different sizes of households. Others argue that this suggests smaller households have higher incomes, and larger ones lower incomes, which may not be appropriate.

Equivalising the households means making them comparable by taking into account the different energy services needs for different household sizes. The OECD has a standard rule for equivalisation, where the first adult in the household counts as 1, any additional adults count as 0.5 and children count as 0.3. This formula takes into account the fact that there are "economies of scale" of having more than one person sharing a household. That is, two people consume less than twice as much as one single person.

The following table (Table 2-6) summarises measures that have been used previously to define the "purse" from which energy expenditures are deducted.

[24] This includes, in the UK context, rent, water rates, mortgage interest payments, buildings insurance payments and ground rent and service charges.

Table 2-6. Choice of income definition

Measure of income	Observation
Equivalised disposable income	According to EU-SILC (and used in energy poverty calculations of the Insight-E Observatory), is the total income of a household, after tax and other deductions that is available for spending or saving, divided by the number of household members converted into equalized adults. The income refers to income from work (employee wages and self-employment earnings); private income from investment and property; transfers between households; and all social transfers received in cash including old-age pensions. This income is then equivalised for household size and composition according to the OECD-modified scale[25].
Equivalised disposable income (minus housing costs)	Income as a function of household composition after deduction of cost of housing (rent, etc.), as in the Belgian case (KBF 2015).

Focus on low income groups

It is important to consider whether or not energy poverty is experienced at all income levels, as this ultimately influences the policy response. This methodological definition relates to the debate whether energy poverty should be considered as a specific phenomenon within the general income poverty problem, or as distinctive and applicable across any households irrespective of income level. In the latter case, there could be households that are energy poor even though they are not considered poor under standard definitions of poverty. Similarly, there could be low income households that are not considered energy poor. There are several approaches to this, which may incidentally overlap. The table below summarises them (Table 2-7).

Table 2-7. Choices of income groups

Income group eligible for the energy poverty metric	Observations
Poverty threshold after energy costs	According to the LIHC measure, a household is considered energy poor if their energy expenses are above the national median level *and* spending this amount pushes them below the poverty line. In the UK the poverty line is define as 60% of the median of equivalised income after housing costs and the modelled energy requirements.
Poorest income quintile	The INSIGHT_E observatory differentiates between energy poverty as high expenditures among the **poorest 20%** of the population, and the population as a whole, whereby the higher income quintiles may also have high energy expenditures but do not suffer from energy poverty *per se*
Deciles of equivalised incomes	In the Belgian case, ten income categories were created to understand why some households with higher incomes can also be considered energy poor, but only the poorest five were retained in the final measures of HEP and Measured Energy Poverty (MEP). Equivalising household income allows for consideration of the household composition, as larger households do not have the same purchasing power.
“At-risk of poverty” threshold	Eurostat’s “at risk of poverty” (AROP) indicator defines the poverty line as 60% of the median of equivalised disposable income (i.e. income minus taxes). In the Austrian case, only the households with an income below an at-risk-of-poverty threshold *and* with above-average energy costs are considered energy

[25] Eurostat (2015). Metadata: Income and Living Conditions. Accessed March 2016: http://ec.europa.eu/eurostat/cache/metadata/en/ilc_esms.htm

Income group eligible for the energy poverty metric	Observations
	poor. The concept of “poverty risk” is well established in Austria, and is defined as households or individuals whose income amounts to 60% or less of the weighted Austrian median income. This amounts to approximately €1066/month, which is still above the €800/month Austrian minimum income welfare provision (the poverty line). With the Austrian metric, households can still be above the established poverty line and be energy poor because they are at *risk* of poverty and have above-average energy costs

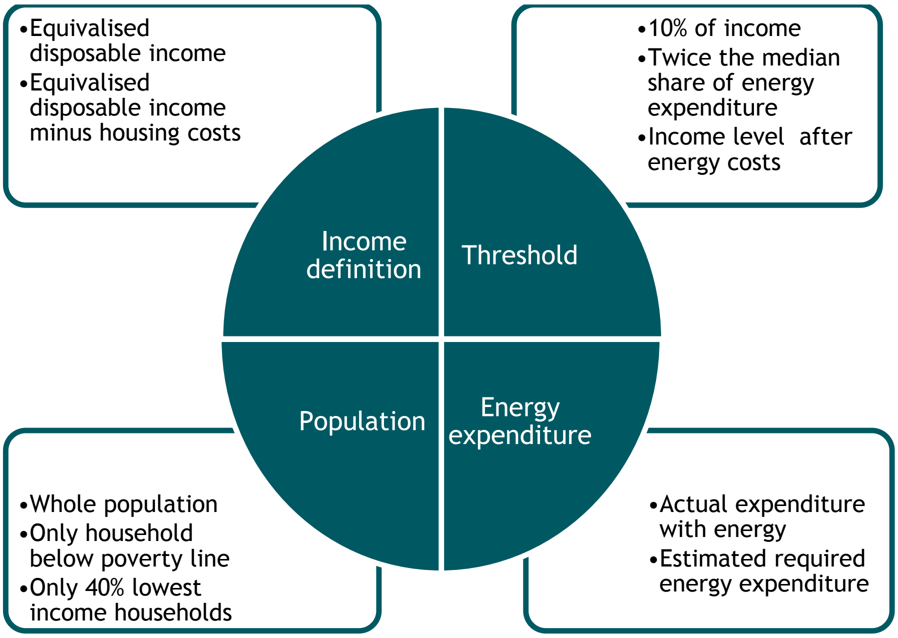
Summary

Expenditure-based metrics of energy poverty have the advantage of being objective measures based on data that is fairly comparable across time and locations. However, as seen above, the definition of the metrics depends on methodological decisions to which the metrics are extremely sensitive: the definition of income, the definition of the threshold, whether to use actual or estimated required energy expenditure and whether to restrict energy poverty to a specific income group. As discussed previously, in what follows, this study will only consider metrics that consider the concept of “equivalised disposable income” (thus, not excluding housing costs) and actual observed energy expenditure (thus, disregarding the metrics that require estimation of required energy consumption). As for the different thresholds and income group focus, all their different combinations have been tested, and their results and conclusions are shown in the next chapter.

With any measure of energy poverty, it is helpful to obtain both a measure of its extent and severity. With expenditure-based metrics, it is possible to calculate the severity of energy poverty of a household relative to the threshold, that is, how much financial support a household would need not to be in energy poverty. In the KBF Belgian report, this concept is called “poverty gap”. This allows for an understanding of how severe the problem is across households in energy poverty. It can therefore help provide an understanding of the level of support; is it a small percentage of households with an extremely severe problem, based on a large gap between expenditure and need, or a large number of households only just in energy poverty, based on a relatively small gap. The LIHC metric also considers this energy poverty gap, calculated as the difference between the required fuel costs for each household and the median required fuel costs. These figures can then be aggregated to produce a measure of the energy poverty gap at the national level.

The following figure (Figure 2-2) summarises the main elements of expenditure-based metrics and the possible choices that are related to them.

Figure 2-2. Summary of elements for the expenditure-based metric and possible choices



2.2.2 Consensual approach

Another approach of assessing whether people are in energy poverty is by asking them. Using survey-based approaches, consensual indicators tend to ask households to make subjective assessments of their ability to maintain an adequately warm home and pay their utility bills on time. Such indicators can be used as proxies of energy poverty prevalence.

The majority of analyses of energy poverty at the European level use consensual indicators (BPIE, 2014; Thomson and Snell, 2013; Tirado Herrero and Bouzarovski, 2014). This reflects the availability of a consistent pan-European survey, the Survey on Income and Living Conditions (EU-SILC). This survey has three questions of interest for measuring energy poverty: it asks whether the household is able to keep home warm during winter days, whether the household has had arrears in its utility bills but also asks whether the house has leakages or damp walls, etc.

There are a range of strengths associated with the consensual approach. It can be less complex to collect than expenditure data, at least as has been demonstrated at the European level. Secondly, the EU-SILC dataset has provided an important basis for identifying the problem, and recognising differences across Europe. And finally, such indicators provide the possibility to capture wider elements such as household experiences and their perceived impacts of being in energy poverty. However, Thomson and Snell (2013) recognise some weaknesses of EU-SILC, which was not designed to measure energy poverty. These include the sampling procedure, which only covers specific household types, some anomalies with the data, subjectivity due to self-reporting, and limited understanding of the intensity of the issue due to the binary character of the metrics. Another potential weakness is the assumption that participants in a survey view such judgements like 'adequacy of warmth' in a similar way. These differences may be particularly strong across Member States, making comparability difficult. In addition, SILC includes all utilities together, not allowing for explicit understanding of energy specifically in the 'arrears' indicator. The 'arrears' indicator is, thus, mostly an indicator for general poverty rather than energy poverty. On the other hand, the indicator regarding households with leaks, dampness, etc. measures efficiency more than energy poverty.[26] Table 8 in Thomson (2013) provide more details of the issues across the three EU-SILC indicators that tended to be used. By themselves these metrics do not seem to be sufficient to capture energy poverty.

Waddams Price et al. (2012) compare how the results of self-reported subjective measure of energy poverty compares to the official expenditure-based 10% indicator used in the UK. It found that 28% of households spend more than 10% expenditure on energy, and therefore would be considered fuel poor. However, only 16% of the sample felt unable to sufficiently heat their homes. Of this group, less than half were fuel poor based on the expenditure-based indicator. As the paper concludes "*many households who spend more than 10% of their income on energy do not feel fuel poor, and not everyone who feels fuel poor spends more than 10% of their income on fuel.*" One explanation of the latter disconnect is that the 10% threshold is not met because these household are not sufficiently heating their homes, due to lack of affordability. The paper therefore argues for self-reported measures as a valuable indicator, in addition to expenditure-based metrics. Weaknesses of the consensual approach are also discussed in Thomson (2013). These have the potential for self-exclusion, whereby households do not identify themselves as fuel poor, even though they are defined under objective measures. (This is also true in reverse, as per the analysis of Waddams Price et al. 2012). There are also concerns that the self-reported indicators often have limited overlap with the objective measures (Deller and Waddams, 2015).

2.3 Choosing an Indicator for the EU-28

What indicator or set of indicators might work best at the EU level? This is, of course, determined by a range of factors, which we begin to tease out in the following sections. However, it is probably worth thinking about the specific purpose of the indicator broadly along two main factors – measuring and monitoring only, or measuring and monitoring, with policy targeting. The difference between the two is that the former simply provides a basis for measuring the problem, while the latter measures also encompass further information that allows for orientating effective policy action.

Consensual indicators can help to monitor the situation of energy poverty based on survey responses. Their strength is that they reflect actual household experience. However, beyond understanding such experiences, the causes of those experiences are less obvious, although surveys can further develop this understanding. This potential deficit in not understanding the causes may make targeting action less effective, which is an important objective in supporting MS action.

Knowledge of expenditure on energy by income group helps to build a picture of expenditure level. The need to help target policy requires indicators which will help understand the key drivers. For example, building-based indicators combined with socio-economic determinants may provide an understanding of the type of buildings that should be targeted, which have low income households and poor energy efficiency. For example, this is what the LIHC does in England.

As we will discuss in later sections, whatever type of energy poverty approach is taken, the development of so-called 'supporting indicators' (which may help in identifying a number of factors correlated to energy poverty and capturing the impact of policies) is vital to better determine the characteristics of those in energy poverty. Preston et al. (2014) provides a useful overview of the

[26] Economics for Energy (2014)

demographic, spatial and physical building characteristics across households in energy poverty, critical information for policy makers in relation to how they target resources.

The table below (Table 2-8) provides a summary from the literature findings regarding energy poverty metrics, which are listed in the table according to a selection hierarchy, i.e. the best metrics come first. Note that we start with idealised metrics, as we recognise the EC's interest in understanding the additional requirements for developing metric datasets further. Further consideration is then given to alternatives for testing based on data availability.

Table 2-8 Overview of energy poverty metrics and related data needs

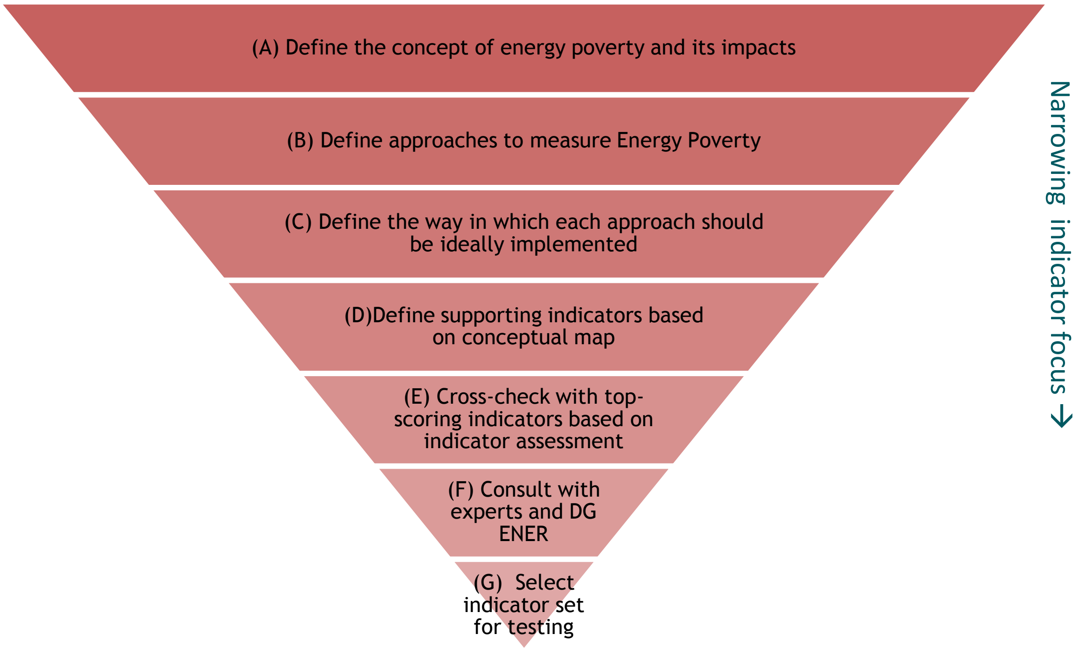
	Energy Poverty Metrics	Data needs
Expenditure-based	1) Required expenditure on household energy services above a specified share of total income after ensuring comparability e.g. household occupancy and 'after housing costs' to adjust household income 2) As above but with 'Actual' as opposed to 'required' [if used, may need supporting indicators to consider 'adequacy' issues 3) 'Actual' plus no adjustments of household income	For **'required'** - • Modelled household energy use by income group and dwelling type, the latter Determined by building type and efficiency. • Typical energy costs by income group • Household budget information to determine other costs e.g. 'after housing' costs For **'actual'** - • Household budget survey information For **both**, define country-specific energy expenditure threshold level, typically twice median used. Also consider low income threshold (if included)
Consensual-based	1) Self-reported inability to adequately cool or heat household, by income group, combined with supportive indicators such as adequacy of heating systems (by income group and for those that follow), poor building condition, limited access to main or alternative supply, limited ability to switch to cheaper tariffs, etc. 2) As above, but with no understanding of income dimension 3) As above, but with fewer supporting additional survey-based indicators 4) Self-reported arrears	• Improved survey-based information from EU-SILC (see Thomson in Lit Review), ideally the inclusion of a question on energy expenditure • Survey based information from EU-SILC • Enhanced information at the MS level (see BE Energy Poverty Barometer, French Observatory) Note that consensual indicators could be kept as 'portfolio' of indicators or developed into composite - see Thomson in review

2.3.1 Energy poverty metrics

The general approach for indicator selection is presented in Figure 2-3. In order to select the energy poverty metrics tested at MS level, we made use of the findings from the previous sections, including:

1) The conceptual map presenting the drivers, outcomes and other factors relevant to energy poverty;
2) The literature review regarding the main approaches to measure energy poverty; and
3) The individual assessment of the identified indicators.

Figure 2-3 Selection method



In addition, Table 2-9 shows the shortlisted set of metrics which were selected based on the review of the indicators explained previously. They were chosen, taking into account their overall score in the individual assessment (See indicator scores on Annex 2), their simplicity, and feasibility to be applied in a EU-wide scale. Overall, the selected metrics aim to give a complex picture of energy poverty, covering different aspects of the phenomenon (namely, high energy costs burden, insufficient energy spending, consensual based indicators). All the metrics listed below were calculated for the four selected MSs (i.e. Spain, Italy, the Netherlands, and Slovakia), and from this exercise a set of four indicators was finally suggested. This proposition will be explained later.

Table 2-9 Selected energy poverty metrics for testing

Group	Name of metric	A household is energy poor when:	Justification
Expenditure-based metrics & monetary gap[27]			
Energy expenditure above the threshold	Twice the national median share (2M)	Share of energy expenses relative to its disposable income (income minus taxes) is more than twice as large as the national median in the current year (**threshold changes each year**).	This allows for recalculation each year and accountability for fluctuation conditions (prices, climate, etc.). By multiplying the median by two, an effort is made to distinguish the most excessive expenditure while including situations still deemed "acceptable." Percentage based metrics in this group are expected to better capture energy poverty, since they take into account the income component.
	Twice the national median expenditure (2M Exp)	Expenses in energy are more than twice as large as the national median in the current year (**threshold changes each year**).	
	10%	Share of energy expenses relative to its disposable income (income minus taxes) is higher than 10% (threshold is fixed and independent of country specific patterns)	This is a simple indicator, easy to communicate and measures an absolute value for energy poverty which does not shift depending on the changes in the population. It has been used by many researchers – although it is highly arbitrary.
Minimum Income Standard	Low income, high cost (using actual expenditure) (LIHC)	Actual energy costs are above the median level and if they spend this amount, their residual income is below the official poverty line. (Obs: in the original LIHC proposed by Hills, "required energy costs" were used instead of "actual energy costs". As explained above, this study only uses actual expenditure data).	This measure is helpful in distinguishing energy poverty from generalized poverty as the household is not considered poor before deduction of energy costs (poverty *due to* energy costs).
	MIS as median expenditures of poorest 40% (MIS Low income)	Disposable income (income minus taxes) after energy costs is below or the same as MIS (after median housing and energy costs), using MIS as the median equivalised per capita overall consumption for the two quintiles with lowest income	This measure is more descriptive than LIHC regarding the extent to which quality of life declines given burdensome energy costs, especially if amounts for minimum life expenses are provided such that substitution can be estimated (e.g. given X increase in energy costs, food expenses fall below nutritionally recommended level).
	MIS as half the national median overall expenditures (MIS M/2)	Disposable income (income minus taxes) after energy costs is below or the same as MIS (after median housing and energy costs), where MIS = 50% of equivalised national median per capita overall consumption	

[27] The amount of money that would be necessary to spend so that all households that are energy poor under the specific metric would be precisely at the threshold.

Group	Name of metric	A household is energy poor when:	Justification
	MIS as a quarter of the national median expenditures (MIS M/4)	Disposable income (income minus taxes) after energy costs is below or the same as MIS (after mean housing and energy costs), where MIS = 25% of equivalised national median per capita overall consumption	
Hidden Energy Poverty: Energy expenditure below a threshold	HEP 5 EUR	Equivalised energy costs is below € 5 per month.	Reflects how actual expenditures are not necessarily indicative of needs being met, focuses on energy services, and accounts for the coping strategy of energy restriction.
	Half the national median share (HEP M/2)	The share of energy expenses relative to disposable income (income minus taxes) is less than a half of the national median in each year (**threshold changes each year**).	
	HEP M/4	The share of energy expenses relative to disposable income (income minus taxes) is less than a 25% the national median (**threshold changes each year**).	
	Half the national median expenditure (HEP M/2 EXP)	The absolute per capita spending on energy is less than half of the median equivalised spending.	
	Half the national median expenditure (HEP M/4 EXP)	The absolute per capita spending on energy is less than 25% of the median equivalised spending.	
Consensual-based metrics			
Consensual-based	House not warm (Warmth)	The household declares the inability to keep the house warm.	Descriptive of perceived reality, regardless of income level
	Arrears in utility bills	The household declares to have had to delay its payments of utility bills.	Unique measure of non-payment coping mechanism (rather than limiting energy use or absorbing costs and subsequent decline in quality of life)
	Severe arrears	The household declares to have had to delay its payments of utility bills **more than once.**	Unique measure of non-payment and severity thereof

Metrics should also be considered as allowing for measurement over time. The prevalence and severity of energy poverty within and across MSs is not static. While the key drivers of energy poverty - low disposable incomes and poor quality housing stock - can change slowly over time, interventions can reduce severity while other factors can increase them e.g. recessionary impacts. Energy prices, another key factor, can also see large and frequent changes and can become less predictable under the kind of institutional changes (energy market liberalisation) that some MSs are working towards. In addition to the temporal dimension, spatial factors are also critical to consider. There can be significant variation in housing quality, and access to supply e.g. rural communities being off-grid.

2.3.2 Supporting indicators

The energy poverty metrics above can be complemented by supporting indicators to help enrich the picture of factors correlated to the prevalence of energy poverty. These supporting indicators enhance the picture provided by the metrics above and could help provide a focus for policy action in MS as they measure factors that *contribute* to the social experience of energy poverty. The key distinction is that they are not in themselves considered appropriate for measurement of energy poverty. As one would expect the conceptual map of the drivers, causes and effect of energy poverty has been central in the identification of these indicators –as is our understanding of different regional factors e.g. Tirado Herrero and Bouzarovski (2014), who show distinct characteristics across different regions of Europe.

Our selection of supporting indicators includes ideally indicators from each of the categories in the conceptual map, namely: 1) Demographics; 2) Energy demand; 3) Income/expenditure (covered by primary indicators); 4) Outcomes; 5) Physical infrastructure; and 6) Policy-based. Some of the indicators' categories are strongly represented, while others only to a limited extent.

Table 2-10 Overview of set of supporting indicators and their data needs

Conceptual map element	Supporting Indicator	Data needs
Demographic factors	Size of household and information regarding the household members to identify vulnerability (e.g. children, single parents, older adults)	Type of family (e.g. single parent); household size; number of children, number of adults above 65; tenure status; urban/rural
Energy prices	Prices paid by different socio-economic groups	Level of energy prices, access to / choice of tariffs
Income	Income levels	Available income; income after taxes; households at risk of poverty; households in severe material depravation
Kind of household	Identifies if a household is a single parent with children. This may be a kind of household more vulnerable to financial problems in general, and energy poverty particularly.	Composition of the household.

Conceptual map element	Supporting Indicator	Data needs
Heating systems	Type of heating by income group. Often inadequate heating systems can leave houses under-heated, e.g. Low income households who can't afford the investment for the short cold season (e.g. Southern Europe).	Categorical variable: None vs. room vs. central heating; availability of hot water; fuels used to warm the water/house
Supply choice	Energy supply by income group to reflect access and/or choice	System lock in e.g. urban dwelling on DH system; Lack of choice e.g. off-grid, oil use for heating
Building efficiency and building stock data	Building efficiency by income group to identify if lower income households live in poorer efficiency buildings	Efficiency proxy based on overall SAP rating, U-value (unlikely to obtain data per income groups), type of housing stock, glazing, air-tightness, HVAC systems' type and efficiency, age of the building, amount of rooms, dwelling type, main fuel used, self-reported leaks, rot, etc.
Policy intervention	Level of social assistance by income group to identify households receiving social support	Income from social assistance; unemployment benefits and other social benefits

Several of these supporting indicators capture the quality of the domestic housing stock that impacts the level of spend on energy. As discussed earlier, such factors are critical to our understanding of energy poverty, and the necessary policy interventions. Tenure is another indicator, which can also inform interventions in respect of the level of control and influence in improving building quality.

Average domestic energy prices is also an important factor in energy poverty, and therefore a potentially important indicator to consider. Ideally, this indicator would capture the energy commodities consumed most in a given country, as an index. Coal would be weighted more heavily in the index in Poland, gas more heavily in the UK. Every index should include the dominant energy types to some extent. Energy prices can of course be tracked over time, to better understand their change and the impacts this potentially has on the level of energy poverty, as measured by the above metrics.

2.3.3 Validation of the selected metrics and the results

13 experts from different MSs were contacted with a proposal to validate the used theoretical framework and energy poverty metrics. It is important to note that this was prior to the testing phase, which provided key insights into the application of different metrics. The names of the experts and their relevance to the topic of energy poverty are listed in Annex 4, along with the approved minutes of the interviews.

Summary of comments to theoretical framework

In general, stakeholders agreed that the energy poverty definition presented[28] is suitable. An important comment made regarding the proposed definition was that "*a common mistake in the literature across Europe is to say that energy poverty only refers to heating, when in fact it refers to all energy services in the home, including cooling; by saying all energy services in the home, there is no room for confusion or misinterpretation*." (Harriet Thomson)

Regarding the different approaches to monitor and measure energy poverty, the expenditure-based approach was mentioned by all the interviewees as the most suitable to measure energy poverty at present, although it has certain disadvantages. The rationale set out for using different approaches was agreed.

Summary of comments to energy poverty metrics

Supporting indicators are important to measure energy poverty, even though they are not easily compared across Member States. The set of supporting indicators could be broader and could include the indicators related to energy market liberalisation, competition in energy market, frequency of tariff switching by users, social assistance aspects, and buildings' energy efficiency. The supporting indicator help explain the phenomenon of energy poverty and are thus also correlated with the energy poverty metrics that are studied in this report. Chapter 3 performs a systematic statistical analysis of these correlations by means of econometric regressions.

The main strength of the **expenditure based metric** is that it accurately captures the extent of energy poverty, referring to "required" expenditure approach. As stated by interviewees, its main weakness is that it takes many data to produce a "required" expenditure metric. Overall, expenditure based metrics also have some further disadvantages:

- The approach is not standardized;
- The metrics are not comparable across Member States;
- They do not cover hidden energy poverty[29];
- They do not consider general living conditions[30] and evolution of energy prices; and
- They do not take into account actual energy needs of the households[31].

Regarding expenditure thresholds for these metrics, the 10% approach does not appear to be objective and comparable across MSs. There is no preference regarding threshold, as income levels differ greatly across MSs, and change over time. As such, the threshold should probably not be fixed and might be different for different MSs or MS groups. There is a value in using relative thresholds (i.e. twice-median expenditure). Also using a threshold related to minimum income could be comparable across Member States.

Consensual based metrics have an advantage of easier implementation, as there is a standardized survey basis across MSs (SILC). It provides an insight of the energy poverty issues, based on information about actual energy needs of households. Its main weaknesses are that it is difficult to interpret because of its subjective nature, the survey is not detailed enough, the answers can underestimate

[28] Energy poverty was defined as a situation in which individuals or households are not able to adequately heat or meet other required energy services in their homes at affordable cost.
[29] This was an expert opinion, though in the context of this study hidden energy poverty is one of the expenditure-based metrics considered. Further, it is important to note that accounting for hidden energy poverty (and similar issues such as self-disconnections) is one of the main advantages of using required energy expenditure.
[30] This was an expert opinion, though in the context of this study MIS indicators do take into account general living conditions.
[31] This was an expert opinion, though in the context of this study expenditure-based metrics could take this into account if based on detailed building stock information.

energy poverty, because the households are not willing to admit they are in a difficult situation with paying for energy services, and it depends on the group of households chosen for the survey.

Outcome based approach is the least preferred as the primary metric of energy poverty. Its main weakness is the difficulty of implementation. It is difficult to identify clearly the energy poverty outcomes; further, health and social related outcomes are too complex to measure. Also, there is an uncertainty concerning capturing the actual state of the issue, as it is concentrated only on the outcomes, and does not consider the causes of energy poverty.

Hidden energy poverty could be included with the use of consensual based indicators, for example the temperature level of household. In places where temperatures are milder (relative to the national median), household energy expenditure is expected to be lower, but that should not be necessarily seen as a problem. A comprehensive indicator of hidden energy poverty is presented in the Belgian Energy Poverty Barometer. The households whose energy expenditures were too low were identified by taking into account energy expenses of similar households (household composition and housing size). The relative threshold for hidden energy poverty is defined for each household as half of the energy expenses of similar households with the same composition and housing size.

General conclusions:

- Expenditure based approach is probably at the moment best suited (with some reservations) to measure energy poverty across MSs, but experts argue that the ideal indicator would be an estimated amount of required energy, which is usually not feasible.
- Consensual based approach can be used to measure energy poverty as well, if the quality of survey will be improved.
- It is important to include supporting indicators when measuring energy poverty. The most important ones are those related to housing stock energy efficiency and energy market.
- When using expenditure based metrics, the threshold should be set relative to the actual distribution in the MS.
- It is reasonable to apply the selected indicators not only to low-income households.

3 Application of the Energy Poverty Metrics

In the previous chapter, energy poverty metrics and supporting indicators were chosen based on the literature and their use across MSs. However, this preliminary, qualitative analysis is not enough to conclude which indicators are the most suited for a wide application in the EU.

In order to decide which indicators are most adequate, these metrics and indicators were tested in selected MSs across various years and in different income groups using household-level data. The testing phase allowed an assessment of whether the list of indicators can be supported at EU-28 level. Moreover, econometric analyses of the relationships between the chosen energy poverty metrics and a group of supporting indicators allowed us to decide which ones are more strongly associated with the phenomenon of energy poverty in each of the MSs analysed.

The analysis was performed for four MSs with various energy poverty situations, climates and policy approaches: Spain, Italy, the Slovak Republic and the Netherlands. The selected four MSs take into account the differences in regulatory environments. Thus our choice includes one country with highly regulated end-user electricity tariffs (SK), one with completely market-based pricing for retail electricity (NL), and one with semi liberalized retail market (ES).

Different regulatory environments

In particular, the electricity market in the Netherlands has been fully open to competition since 2004, with four major players in the country. As such, the electricity market in this country can be seen as a liberalized retail market. Furthermore, the retail prices of electricity are not regulated in the Netherlands per se but suppliers are obligated to report all price changes. In this regard, the authorities have the power to reduce prices as suppliers cannot provide sufficient justification for the amounts charged.

A similar energy market is seen in Slovakia, where the wholesale activities were fully liberalized in 2005. As such, there are no price regulation at this level. Furthermore, in 2012, Slovakia adopted laws for the further liberalisation and harmonisation of the energy market in the country. Nevertheless, the largest power generating company (Slovenské elektrárne) had still a market share of almost 78 percent in 2011. Moreover, the retail prices in Slovakia are still regulated through “price caps” for all households and small industrial users. The regulatory cycle in Slovakia is 5 years, the elaboration phase of which includes a consultation process including all market participants which represents additional step to enhance the transparency and predictability of the regulatory framework.

On the contrary, Italy has a free market which aims for free electricity trading for all commercial clients since July 2004 and a complete opening of the market for private customers from July 2007. However, the standard offer market remains concentrated, despite the numerous active suppliers, with three main operators.

Lastly, Spain has a highly regulated end-user electricity tariff. The electricity market in Spain was integrated with the Portuguese electricity market in 2007. There is a relatively high degree of concentration and vertical integration in the Spanish electricity market as a few players have a dominant role.

Source: EC, country reports; European Energy Market Reform, country profiles

The analysis was two-fold:

1. Testing the viability of the set of indicators based on data availability and the possibility to calculate the selected indicators at MS level; and
2. Analysing the data and assessing whether the chosen set of indicators is optimal. On this phase, we assessed 1) how energy poverty metrics correlate with each other, and 2) how different measures are influenced by a number of supporting indicators.

3.1 Data Availability

The first part of the evaluation of indicators assesses the viability of applying the energy poverty metrics in EU MSs. The data necessary to calculate the selected metrics was gathered for the selected MSs. The following issues were assessed during this step:

- Availability and/or accessibility of data;
- Comprehensive coverage and periodicity of data collection; and
- Whether data is likely or not to be gathered regularly for the next 10 years.

The main data sources used for the assessment are the microdata from both the Household Budget Survey (HBS) (and the Woon-Onderzoek for the Netherlands) and the Survey on Living Conditions (SILC). These are described in Table 3-1 for each of the four countries under assessment. With respect to the supporting indicators, these surveys unfortunately do not offer the same array of variables. This means that different supporting indicators were used to estimate relationships with expenditure-based and consensual based metrics. However, we tried to keep consistency of the econometric models to the extent possible.

For both the national HBS and SILC datasets we dispose of yearly datasets with household answers to the survey questionnaires. However, these surveys did not follow the same households in different moments in time. In this case we speak of a “repeated cross-sections” dataset, as opposed to a “panel dataset”, in which the same individual/household is followed in various periods.[32] This has implications for the kind of econometric strategy that can be applied for the estimation. The solution that was employed, as can be seen later in this report, was to produce a “pseudo-panel”, a technique used in econometrics that enables the use of the variability in repeated cross-sections to obtain better estimations.

Table 3-1 Main data sources in all countries

Spain	Survey on Living Conditions	Household Budget Survey
Period	2008-2014	2006-2014
Frequency	Annual	Annual
Spatial unit	Province	Province
Expectations on future collection	Expected to be available annually	Expected to be available annually
Observation unit	Households and individuals	Households and individuals
Number of observations	11 600 (in 2014)	22 146 (in 2014)
Data access	Microdata freely available	Microdata freely available

[32] The design of the SILC survey imposes that some families are followed over more than one year. However, we did not use this panel-data aspect of the survey but adopted more general solutions to the “repeated-cross-section” problem.

Italy	Survey on Living Conditions	Household Budget Survey
Period	2004-2014	Not used
Frequency	Annual	
Spatial unit	Province	
Expectations on future collection	Expected to be available annually	
Observation unit	Households and individuals	
Number of observations	19 663 (in 2014)	
Data access	Microdata freely available after registration	
Netherlands	**Survey on Living Conditions**	**WOON Onderzoek (Households survey)**
Period	2006-2012	2006, 2009 and 2012
Frequency	Annual	Every three years
Spatial unit	Province	Province and municipality
Expectations on future collection	Expected to be available annually	Expected to be available annually
Observation unit	Households and individuals	Households
Number of observations	24,949 (2012)	60,191 (2012)
Data access	Microdata available after specific request at Dutch Statistical Bureau. This process is paid.	Microdata available after specific request at Dutch Statistical Bureau. This process is paid.
Slovakia	**Survey on Living Conditions**	**Household Budget Survey**
Period	2005-2013	2004-2012
Frequency	Annual	Annual
Spatial unit	Province	NUTS 1 and province
Expectations on future collection	Expected to be available annually	Expected to be available annually
Observation unit	Households and individuals	Households and individuals
Number of observations	5,403 (in 2013)	4,704 (in 2012)
Data access	Microdata freely available, after specific request at Slovak Statistical Bureau	Microdata freely available, after specific request at Slovak Statistical Bureau

3.2 Assessment of the Energy Poverty Metrics and Supporting Indicators

The second part of the evaluation assesses the meaningfulness of the indicators, looking at the values of the indicators by assessing: 1) how different energy poverty metrics correlate with each other, and 2) how the different metrics are influenced by a number of supporting indicators. Comparing the different metrics against one another will allow us to identify the added value of having multiple metrics of energy poverty. Roughly, the smaller the correlation, the more value in having multiple metrics. On the other hand, estimating the relationships between the energy poverty metrics and the supporting indicators allowed us to explore and assess to which degree the set of chosen variables is really informative about the phenomenon of energy poverty.

3.2.1 Comparing the different energy poverty metrics

Calculating the metrics for the selected countries is a first step of testing their quality. Household-level data has been used to calculate these metrics across all four countries, which allows for an informative analysis to the results. It shows whether the indicators are time-variant, have reasonable levels and whether certain specifics of the MS situations affect the results. This section provides information on the different energy poverty metrics for each country, i.e. Spain, Italy, Slovakia, and the Netherlands. Energy poverty metrics were grouped based on the type of metric:

- ✓ **Expenditure-based metrics**[33]**:**
  - **Above Threshold**: These metrics highlight the share of energy relative to its disposable income above a certain threshold. These percentage-based metrics are expected to better capture energy poverty, since they take into account the income component;
  - **Minimum Income Standard (MIS)**: These measures check if the disposable income after energy expenditure is below or the same as a MIS;
  - **Hidden Energy Poverty (HEP)**: These indicators take into account households that potentially restricted spending, given their low energy expenditure;
- ✓ **Consensual-based metrics**: These are self-reported metrics for energy poverty, i.e. Arrears, Severe Arrears, and Warmth.

These groups of metrics were applied for the total population and for each income group: (1) the lowest income group of the population, i.e. 0% - 20%; (2) the income group between 20% - 40% of the population; (3) the third group exist of the income group from 40% - 60%; (4) the group of the population with incomes between 60% - 80% of the total population; and (5) the highest income group: i.e. 80% - 100%.

The selected metrics were applied and assessed for Spain, Italy, Slovakia and the Netherlands. Detailed results are presented in Annex 1. After evaluating and testing all indicators for the different countries, we chose a combination of four main indicators. These complementary indicators are chosen as they are simple and easy to communicate. The following discussion justifies the selection of the different indicators, based on the analysis performed.

Indicators above the threshold: 10%, 2M and 2MExp

These indicators classify a household as energy poor if its energy expenditure is above a certain threshold. Three different thresholds were used to calculate this kind of metric in the four Member States: 10% of the household's income (10%), twice the national median income share spent on energy (2M) and twice the absolute national median energy expenditure (2M Exp). Of these three metrics, the one chosen as most appropriate was **2M,** thus being subject to yearly changes and national patterns. In the 10% metric, the threshold is fixed and highly arbitrary. Further, it may not reflect specific characteristics of each country's economy and income distribution. The 2Mexp metric does not use shares, but absolute spending.

It is, however, useful to leave it up to policy-makers to choose an evidence-based threshold that they find most adequate when analysing the problem. Therefore, in the proposal for a tool (see Chapter 5), we suggest that policy makers and researchers should be able to change parameters (including the thresholds) of the metrics and adapt them to their specific context.

The 10% metric may provide very different coverage in across MSs, e.g. while it includes between 10 - 20% of the population in three of the countries, it covers up to 60 - 80% in Slovakia. While it is

[33] All these metrics use actual expenditure data, and not estimated values of required expenditure.

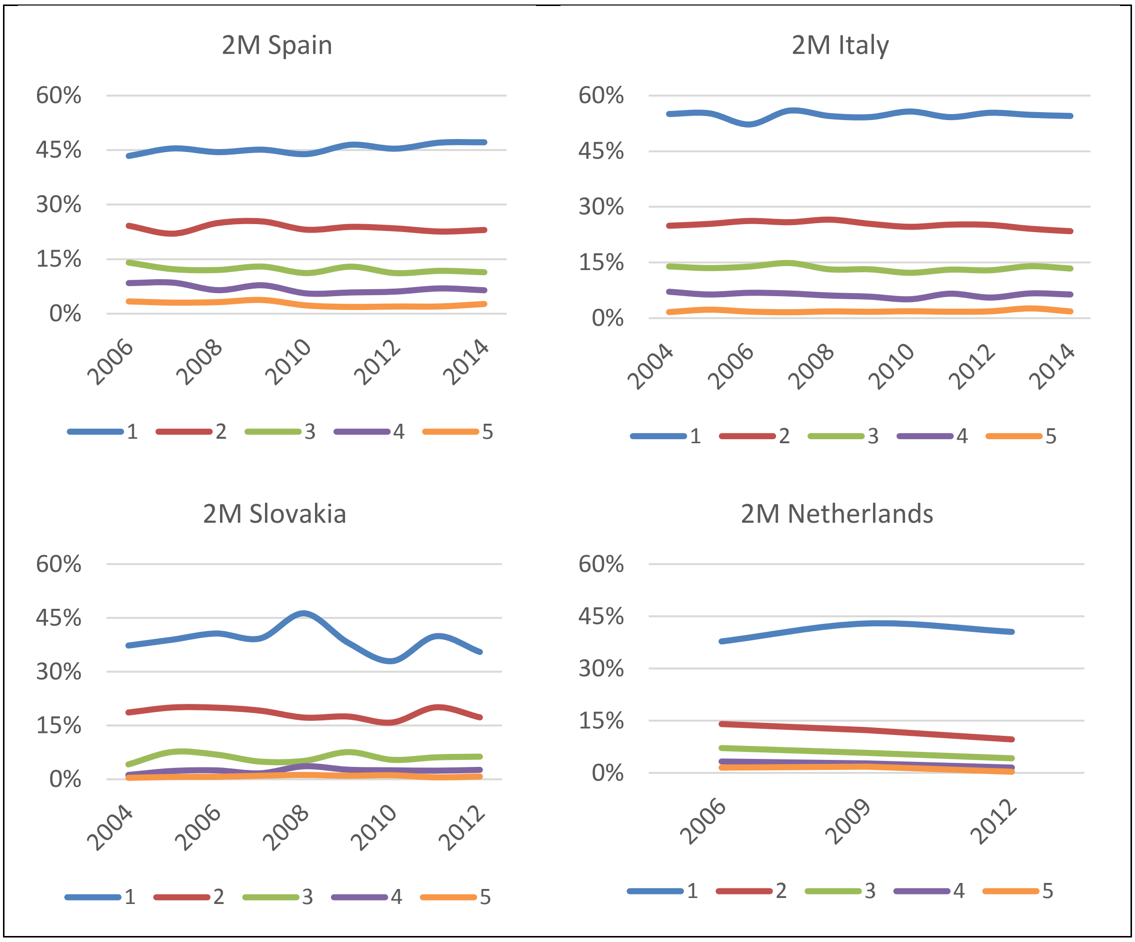
arbitrary, it is simple and easy to communicate. It also gives an absolute and normative value for energy poverty, which remains the same even if there are changes in the population and its income level. This allows for a clear policy target as well. It gives a clear distinction between the different income groups, even though it can be high for the higher income groups. It has the potential for higher income households to be defined as fuel poor somewhat misleadingly (Preston et al., 2012). It also gives a visible change over time, particularly due to energy cost increases and / or recessionary impacts, and reflects clearly the changes of the disposable income within the different countries.

The **2MExp** metric uses twice the national median of absolute energy expenditure in the current year as threshold. This metric may capture those households that are too energy inefficient, spending an excessive amount in energy per equivalised adult. However, it shows a higher percentage for the highest income groups, as they spend in general more money on energy. This is mainly because they have the means to spend more than the national median on energy expenses. Only in the Netherlands do households in the first quintile have the highest percentage under this metric, but the richest quintile comes very close. This suggests that this metric is capturing more people that simply have more money to spend on energy than those that are energy inefficient and have to spend excessively. This makes the 2M Exp metric an unreliable indicator to measure energy poverty.

In contrast, the 2M metric uses twice the national median share of income spent on energy as a threshold. Contrary to LIHC, this indicator shows energy poverty in all income groups. The threshold is related to the national mean, which makes it possible to recalculate the indicator each year. In this regard, it is not a static measure and allows fluctuations within the conditions that are taken into account to calculate the indicator. This metric has two main advantages: high income households are rarely captured by this metric and it takes into account country-specific patterns. The graphs below (Figure 3-1) show this metric per income quintile. The fifth quintile, representing the highest income group, has an extremely low percentage of households in energy poverty according to this indicator. This is consistent with the assumption that the richer a household is, the lower the average share of income dedicated to energy expenditure. This assumption is consistent with the data, as discussed in the section 4.2.2.

Moreover, the choice of the threshold is dependent on the distribution of income and expenditure in the population, rather than set arbitrarily. This is important, because the energy poverty metric is very sensitive to the choice of threshold (as discussed in section 4.2.3).

Figure 3-1 Households whose energy expenditure share is above twice the national median share

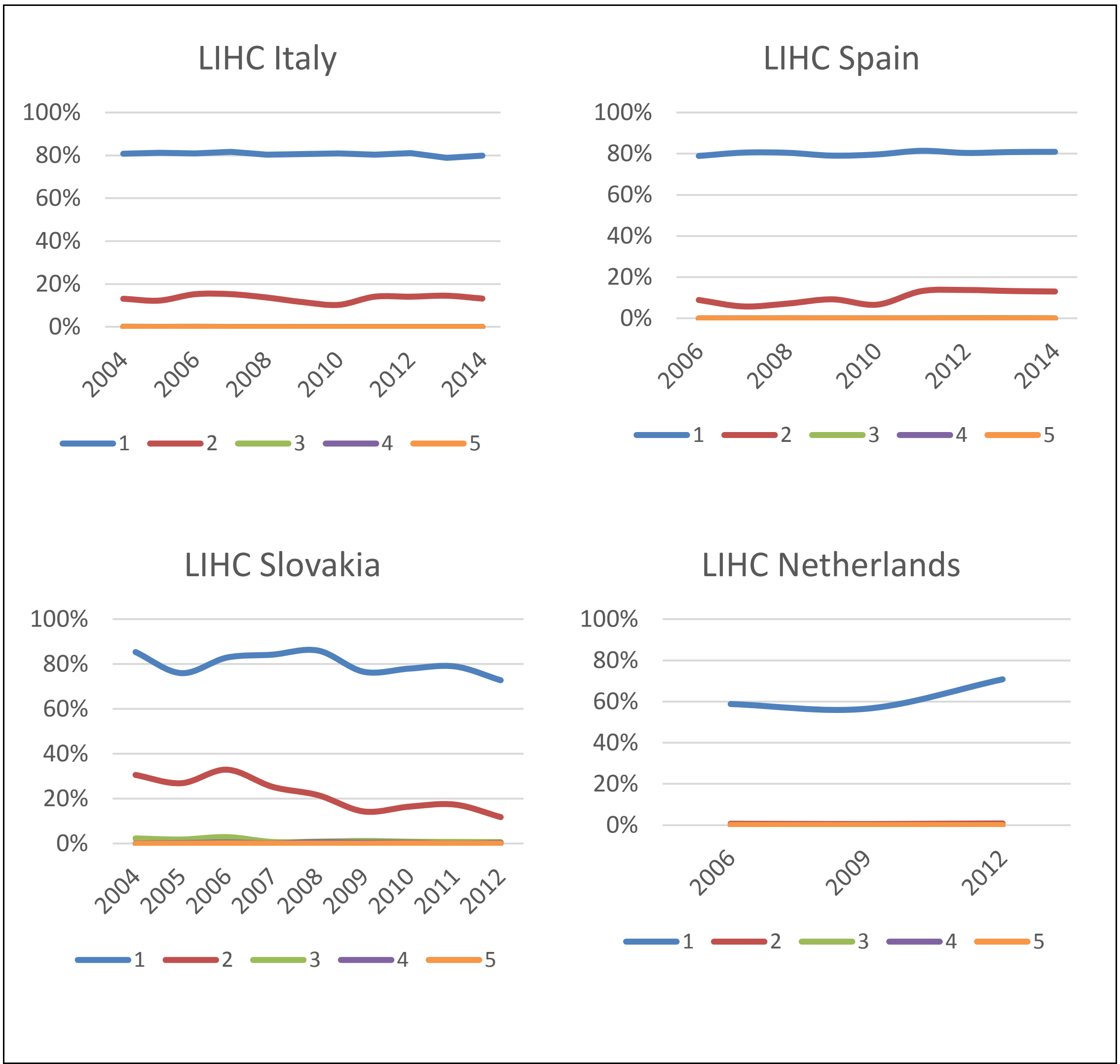


Indicators below the threshold: LIHC, MIS 40%, MIS M/2 and MIS M/4.

These indicators classify a household as energy poor if its energy expenditure is below a certain threshold. Given the assessment below, the **LIHC** is suggested as part of the set of indicators.

LIHC (Low Income High Costs) is a metric initially proposed by Hills (2012). In this study, this metric defines as energy poor those households that have high energy costs (share of income spend on energy is above national median), *and* low income after energy costs (income after energy costs is below the national poverty line). LIHC is better than 2M at excluding higher income groups, as the graphs below (Figure 3-2) depict. It shows a rather high percentage of energy poverty for the lowest income groups and is zero for the higher income groups, which clearly reflects that energy poverty is dependent on income. Furthermore, it is a helpful measure to distinguish energy poverty from generalized poverty.

Figure 3-2 Households whose energy expenditure share is above the national median and whose income after energy expenses is below the poverty line



MIS 40% classifies as energy poor those households whose disposable income after energy costs is below the median of the poorest 40% households. Interestingly, for all countries and years, this metric of energy poverty was always around 20%. We discarded this metric because of its low variability and complicated logical structure.

MIS M/2, which classifies as energy poor those households whose income after energy costs is below half the median. It highlights a visible change over time and captures almost exclusively households in the lowest income quintile. The behaviour of this metric is very similar to LIHC. MIS M/2 is also a better representation of the reality when it is compared with MIS 40% (low income) and MIS M/4. For example, MIS 40% (low income) is almost constant at 20% for all countries. On the contrary, MIS M/4 is rather low, capturing only extreme cases. In this regard, MIS M/2 is a better representation when looking at the disposable income and the overall consumption. However, due to its similarities to LIHC and LIHC's extended use in the literature, MIS M/2 does not add much value to the diagnosis of energy poverty.

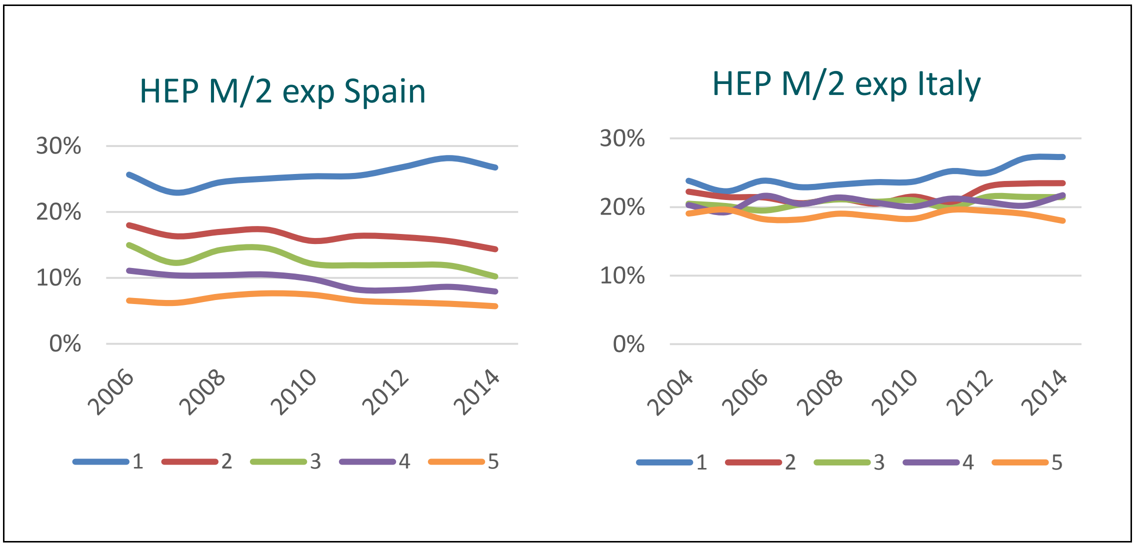
Hidden energy poverty indicators: HEP M/2, HEP M/4, HEP M/2 exp, HEP M/4 exp and HEP 5 euros

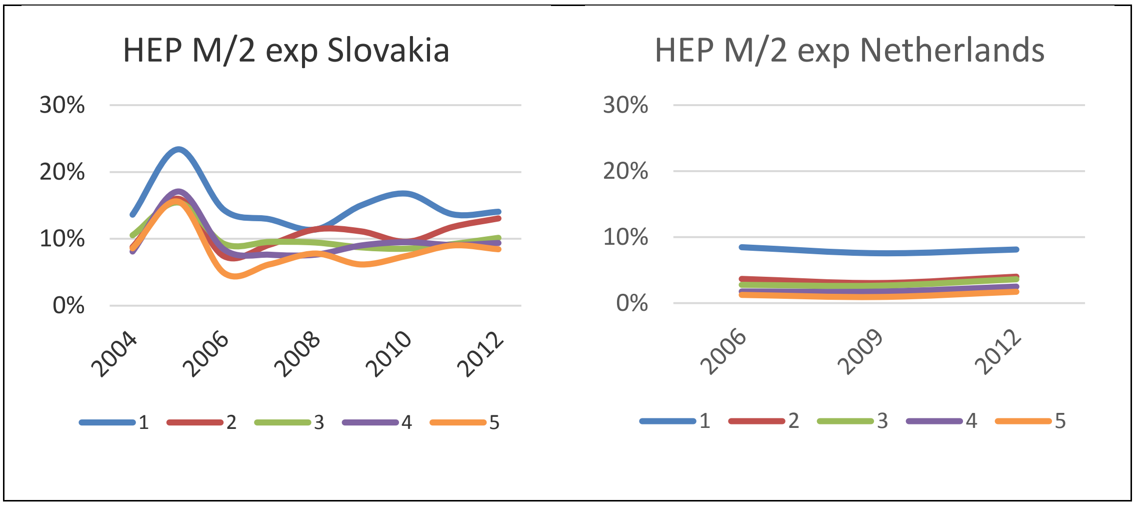
The hidden energy poverty (HEP) metrics identify those households whose energy expenditures are abnormally low. The most interesting measure among all five metrics tested is the **HEP M/2 exp**, which classifies a household as energy poor if its absolute energy expenditure is below half the median absolute energy expenditure.

In fact, HEP is only appropriate when using the absolute monetary expenditure rather than the share income spent on energy (such as HEP M/2 or HEP M/4). This happens because higher income households generally spend more on energy in absolute values, but less as a share of their income. Therefore, any metric that considers as energy poor a household that has an extremely low share of income dedicated to energy will have high proportion of high income households. This is indeed what was observed when testing metrics HEP M/2 and HEP M/4, which are based on share of energy expenditure.

On the other hand, using absolute spending provides an absolute indication of consumption of energy services, thus allowing to observe which households are spending an abnormally low amount (remember that all values were used in equivalised terms). Of the three HEP metrics that were based on absolute expenditure values, HEP M/2 Exp appeared as the most meaningful and interesting.
HEP 5 Euro has the disadvantage of being an arbitrary indicator as it highlights all the households that have an energy expenditure that is below 5 Euro/month. Moreover, it has the same problem as HEP M/4 Exp, namely of being too low and capturing only very extreme situations. Figure 3-4 shows how the chosen hidden energy poverty metric (i.e. HEP M/2 Exp) performed in the four selected countries. It is also worth mentioning that the HEP 5 Euro-metric brings the problem of comparability of monetary values across countries, which would require taking account of Purchasing Power Parity.

Figure 3-3 Households whose absolute energy expenditure is below half the national median energy expenditure





Consensual based Indicators: Arrears, Severe Arrears, and Warmth

Consensual based metrics are those based on self-declared status of household members. These metrics are based on questions of the SILC survey. Three metrics were tested: arrears in utility bills, severe arrears in utility bills and inability to keep households warm. All results are reported here, but the metrics of arrears are not part of the final choice of metrics. In Annex I (Methodological and Technical Report) we show how each one of the teste metrics behave for each one of the five income quintiles.

The presence of **arrears in utility bills** is a unique measure and highlights when a household declares a delay in its payments of utility bills. This indicator clearly reflects the social environment of the country at a certain time, e.g. the global financial crisis of 2008 is evident in the country overview of Italy. Similar results can be seen in the analysis of **Severe Arrears**, which underlines if the household declares to have had to delay its payments of utility bills more than once. As such, it goes a step beyond the previous metric and highlights the severity thereof. Both “arrears” metrics indicate whether utility costs are a large burden that households cannot cope with. However, they are not directly related to energy poverty, as these utility bills also include water, for example. ***These metrics can be used only in a very indirect way for monitoring energy poverty***. Therefore, they were dropped from the final recommendation.

The third indicator, **Warmth,** shows whether the household declares the inability to keep the house warm. This indicator is closer-related to the idea of hidden energy poverty, that is, the fact that households are not meeting required energy expenditure at all, thus harming their welfare in an important way.

Whereas the “arrears” metrics had the disadvantage of being too general, the “warmth” metric is too specific, as it only refers to one kind of energy services, namely heating. However, as it is directly related to the problem of energy poverty, it was kept as a meaningful metric for the suggested set of metrics in this study. The graphs below show how each of the three metrics behaved in the four MSs studied. Data was extracted from the SILC surveys.

Figure 3-4: Overview 'Consensual' Indicators Spain (Arrears, Severe Arrears, Warmth), with on X-axis time [Years] and on Y-axis Energy Poverty [%].

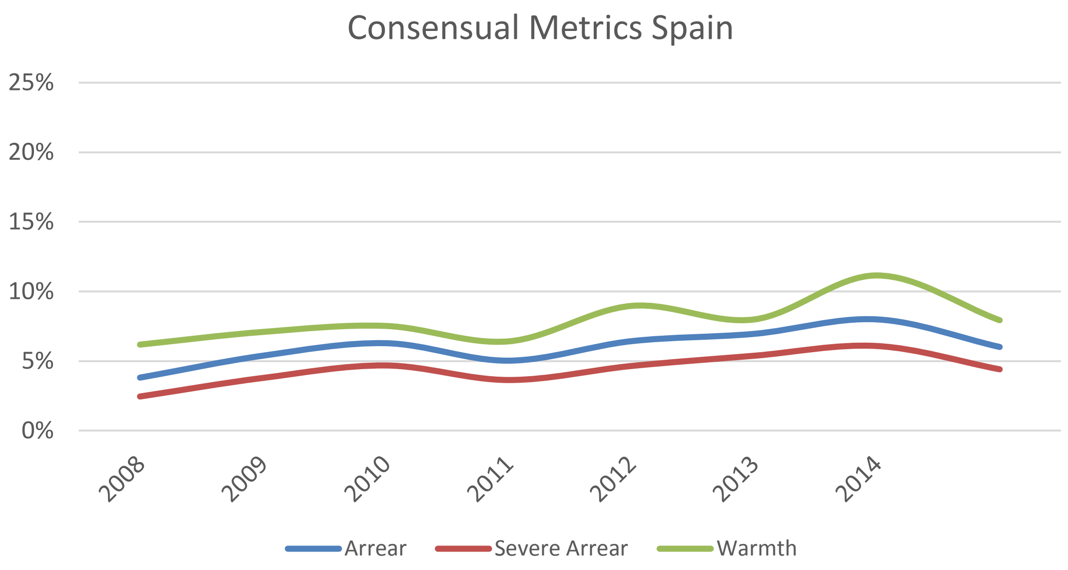


Figure 3-5: Overview 'Consensual' Indicators Italy (Arrears, Severe Arrears, Warmth), with on X-axis time [Years] and on Y-axis Energy Poverty [%].

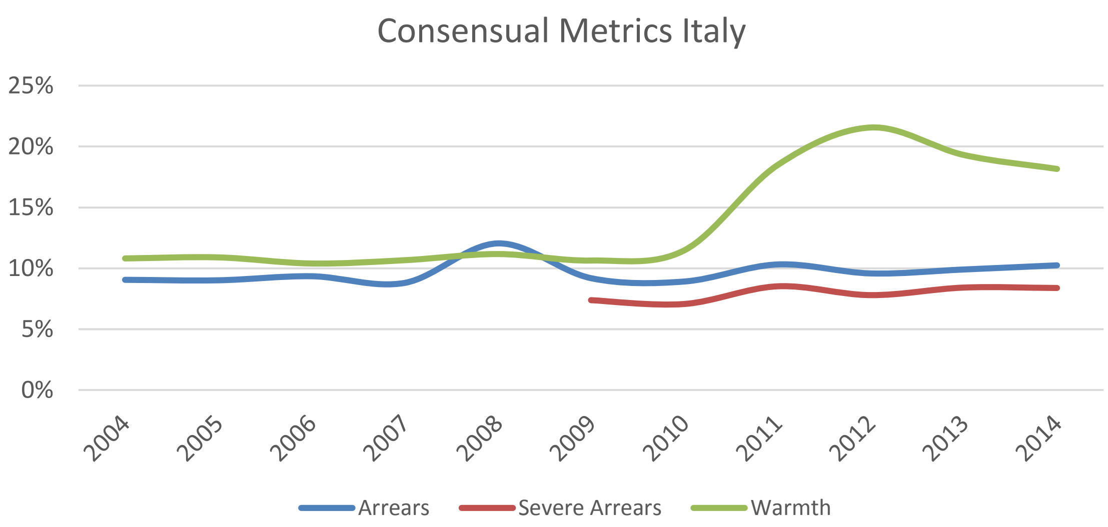


Figure 3-6: Overview 'Consensual' Indicators Slovakia (Arrears, Severe Arrears, Warmth), with on X-axis time [Years] and on Y-axis Energy Poverty [%].

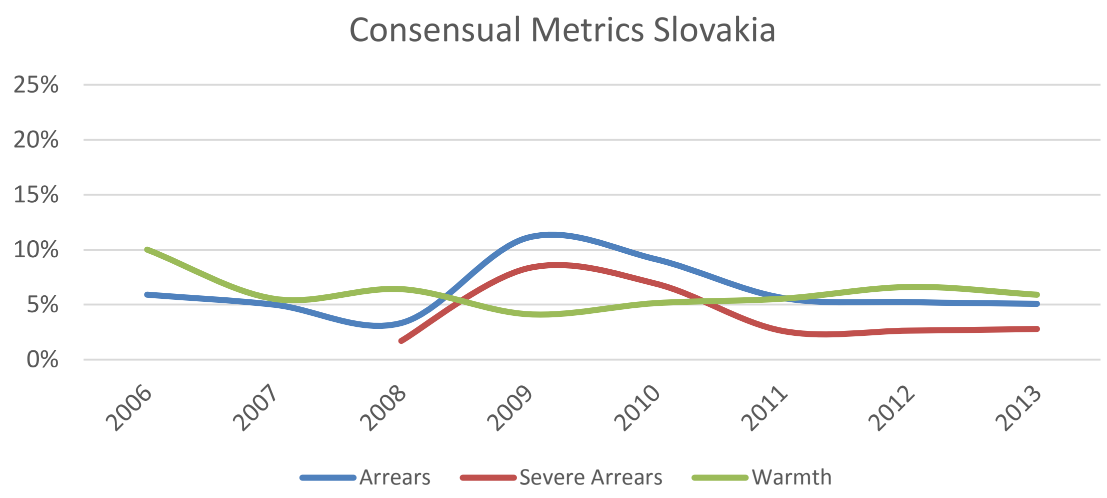
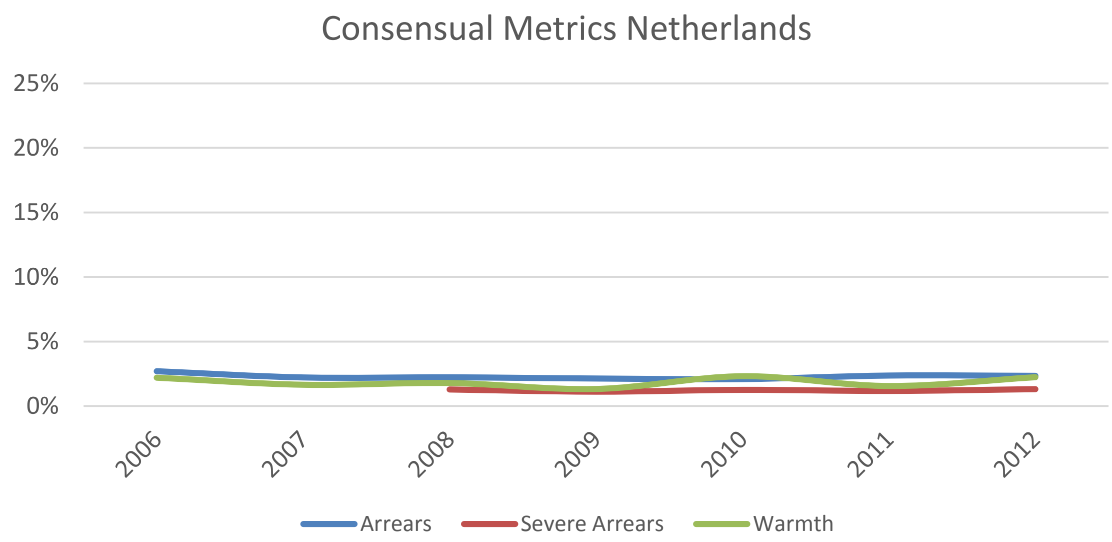


Figure 3-7: Overview 'Consensual' Indicators the Netherlands (Arrears, Severe Arrears, Warmth), with on X-axis time [Years] and on Y-axis Energy Poverty [%].



While we only present results for the most interesting indicators above, all the metrics described in Table 3-2 were tested in the four selected MSs. The detailed results are presented in detail in Annex 1 (Methodological and Technical Report) and the table below provides an overview of the assessment performed, which informs the recommendations provided at the end of this chapter.

Table 3-2 Overview of set of energy poverty metrics and their strengths and weaknesses

Group	Metric (or threshold)	Strengths	Weaknesses
Energy expenditure above a threshold	10%	✓ Visible change over time; ✓ Clear distinction between income groups; ✓ Simple measure and easy to communicate.	× Rather high percentage of energy poverty for the highest income groups (e.g. Group 5); × Threshold is arbitrary.
	Twice the national median expenditure (2M Exp)	✓ Identifies households with abnormally high equivalised expenditure on energy, which may suggest very low energy efficient housing.	× Looks at the absolute expenses in energy and shows in this regard a higher percentage for the highest income groups, as they have the means to spend more on energy; × Gives a decrease for energy poverty for the lowest income groups and an increase for the highest income groups.
	Twice the national median share (2M)	✓ Clear distinction between the different income groups; ✓ The measure allows for fluctuations; ✓ Possible to recalculate the indicator each year	× It follows a rather straight path - not informative; × Sometimes a high energy poverty percentage for the higher income groups.
Minimum Income Standard Indicators (MIS)	Low income, high cost (using actual expenditure) (LIHC)	✓ Clear distinction between the different income groups; ✓ High percentage for the lowest income group and low percentage for the higher income groups; and ✓ Helpful measure to distinguish energy poverty from generalized poverty.	× Follows a rather straight path over the years.
	MIS as half the national median overall expenditures (MIS M/2)	✓ MIS is a more descriptive measure than LIHC; ✓ It shows a visible change over time; ✓ It gives a clear distinction between the different income groups; and ✓ It highlights a good representation of the reality	× Shows a rather straight path for the higher income groups.
	MIS as median expenditures of poorest 40% (MIS Low income)	✓ Gives a clear distinction between the different income groups.	× Energy poverty percentage is probably an over exaggeration of the reality for the lowest income group.
	MIS as a quarter of the national median expenditures (MIS M/4)	✓ It shows a visible change over time.	× The energy poverty is rather low for the lowest income group and is in this regard probably not representative for the reality.
Hidden Energy Poverty: Energy expenditure below a threshold	Half the national median share (HEP M/2)	✓ There is a clear distinction between the different income groups.	× Follows a rather straight line; × The highest income group shows the highest energy poverty. In this regard, this measure is not a good representation of the reality.
	Half the national median expenditure	✓ It gives a clear distinction between the different income groups; ✓ The measure reflects how actual expenditures are not necessarily	× The higher income groups also show a rather high percentage of energy poverty.

Group	Metric (or threshold)	Strengths	Weaknesses
	(HEP M/2 EXP)	indicative of needs being met; and ✓ It highlights the absolute per capita spending on energy.	
	A quarter of the national median share (HEP M/4)	✓ NA	× The highest income groups have the highest energy poverty; and × The share of energy expenses relative to the disposable income is not representative.
	5 Euros (HEP 5 EUR)	✓ Simple and easy to communicate.	× It is an arbitrary measure; × No clear distinction between the different income groups; and × No visible change over time.
Consensual based metrics	Arrears in utility bills	✓ Reflects if a household is having financial problems to meet its obligations regarding energy consumption.	× This variable does not refer only to energy bills, but to utility bills. × One arrear may be caused by specific income shocks
	Severe arrears (more than once)	✓ Reflects if a household is systematically having financial problems to meet its obligations regarding energy consumption	× This variable does not refer only to energy bills, but to utility bills.
	House not warm	✓ Reflects if the household is not able to consume a required adequate level of energy.	× Only refers to heating expenditure/consumption

3.2.2 *Assessing the influence of supporting indicators*

This section highlights the different supporting indicators that are used for the analysis of the different metrics. They were evaluated for the four different countries, i.e. Spain, Italy, the Netherlands and Slovakia, and for the selected indicators, i.e. share of energy expenditure above twice the median (2M), LIHC using actual expenditures and energy expenditures below half the median (HEP M/2 Exp). Nevertheless, the analysis is done for all indicators and an overview of the outcomes can be found in Annex 1: Methodology and Technical Report. The following table, Table 3-3, gives a detailed overview of the supporting indicators that are used during the analysis, which gives more information on the different supporting indicators. These supporting indicators were picked for their availability in the data sources used (namely, SILC surveys, Household Budget Surveys and the WoonOnderzoek). These choices were based on the wider number of supporting indicators suggested by the literature, and reviewed in the first phase of this study.

Table 3-3: Overview Supporting Indicators

Supporting Indicator		Comment / Initial assessment
Eq. income	*Household's available Income per capita*	It highlights the equivalised income per capita in the household. Since expenditure-based metrics are used, richer households were expected to be less likely to suffer from energy poverty, that is, spend a smaller share of their disposable income with energy.
Social Aid	*Receives social aid*	It captures whether the household receives any kind of social aid (including unemployment benefits). On the one hand, it is a proxy for the fact that the family suffers from economic poverty or is in a vulnerable situation, which suggests that its share of spending with energy as a proportion of income will be larger. On the other hand, it is supposed to be partially a solution to the problem of insufficient income, reducing the share of expenses with energy.

Supporting Indicator		Comment / Initial assessment
Number of people	*Number of members in the household*	A household with more people has more energy needs. If relatively few people are bringing income into the house, the share of energy expenses may easily go up. However, it is possible that when more people live together, the average consumption of energy per capita falls, reducing the share of energy expenses.
Age of building	*Age of the building where the household is living in*	The assumption is that if a building is rather old, it might suggest insufficient housing insulation, older electrical appliances which have a lower energy efficiency, less isolating windows, etc.
Age of main provider	*Age of main provider*	Older people tend to stay more indoors and be more sensitive to temperature changes. Therefore, the older the population in the household, the larger will the share of energy expenses. The age of the main provider is a rough approximation of that.
Number of rooms	*Number of Rooms*	A larger household (with more rooms) was expected to have a higher energy demand for heating and other energy services. Since income is being controlled for, this variable was expected to increase the energy expenditure (and its share), thus increasing the likelihood of being in energy poverty.
Single parent	*Single parent in the household*	Being a single parent, might suggest a lower overall income which is expected to be more likely in energy poverty.
Leak	*Dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor*	This measure indicates whether cold feeling or excessive spending (which may cause arrears in bills) is related to the fact that the home does not have a proper infrastructure.
Number of old people	*Number of old people in the household*	This indicator is related to 'Age of main provider', with the difference that this covers all older people in the household and not just the age of the main provider.
Energy Price	*Household Energy Price Index*	This indicator highlights the Household Energy Price Index, which reflects the prices typically paid by residential customers in cities around the EU.

Taking into account the information from the previous table, the different econometric regressions of the energy poverty metrics on a series of socio-economic supporting indicators were carried out using household-level data. The aim was to assess the meaningfulness of the indicators, estimating the relationship between the selected metrics and the supporting indicators that are assumed to be linked to the phenomenon of energy poverty. A particular strength of the analysis is the fact that it is done with microdata at household level, and thus the number of observations is very large and it is possible to identify correlations between specific characteristics and energy poverty status for each single household. The main results are shown in three tables presented below which provide details on the estimated relationships between the supporting indicators (explanatory variables) and the metrics (dependent variables). Results are presented in three different tables due to the nature of the metric used to measure energy poverty and the different methodologies required to conduct the analysis with:

- Table 3-4 showing the results from non-linear probabilistic models (logit) to explain binary variables (with value zero or one) constructed from household level data;
- Table 3-5 describing the estimation results of the models using 'Equivalised Energy Expenditure' and 'Share of Energy Expenditure' as explanatory variable. These are the underlying variables for the selected energy poverty metrics. Linear regressions were used

here (as opposed to logit models in Table 3-4). In order to make use of the time variability across years, a pseudo-panel was created from the repeated cross-sections, and conventional panel data models (fixed effects and random effects) were applied.

- Table 3-6 displaying the outcome from non-linear probabilistic models (logit) to explain the consensual based metrics.

The tables below present the findings of a statistical analysis of the datasets with the aim of identifying broad relationships between a number of energy poverty metrics and factor which they are likely to be correlated with. This knowledge is useful to policy makers who can target these underlying factors correlated although not necessarily causing the experience of being energy poor. Our analysis adopts two different modes, i.e. the common linear model used for continuous variables, and the logit model which is used to explain factors correlated to binary data, i.e Yes/ No, 0/1, used to build energy metrics. It is worth mentioning that in a number of instances we also had binary variables describing factors correlated to energy metrics. The full analysis of the regressions is in Annex 1: Methodology and Technical report. The cells in the tables below are painted in blue when the explanatory variable was a binary variable.

Table 3-4: Overview outcomes of regressions for the selected indicators (2M, HEP M/2exp, LIHC), with: * = Significant under 1% level; ** = significant under 5% level; and * = significant under 10% level; 'm' refers to a different model being used during the calculations.**

	2M				HEP M/2 exp				LIHC			
	NL (1)	ES (2)	IT (3)	SK (4)	NL (5)	ES (6)	IT (7)	SK (8)	NL (9)	ES (10)	IT (11)	SK (12)
	1	2	3	4	9	10	11	12	13	14	15	16
Eq. income	.995***	.997***	.999***	.992***	.999***	.999***	.999	.999*	1.000	.987***	.999***	.975***
Social aid	.689***	1.164**	1.000***	1.002***	1.279***	1.220***	.999***	.997***	1.354	.844*	.999	1.00*
Number of people	.307***	.736***	.628***	.805	2.047***	1.162***	1.306***	1.486**	1.796***	.934*	.719***	1.012
Age of building	1.004***	.674***	-	-	.998	2.007***	-	-	1.006	.599***	-	-
Age of main provider	.997	1.011***	-	-	.985***	.983***	-	-	.973**	1.016***	-	-
Number of rooms	1.446***	1.342***	1.543***	-	.634***	.791***	.733***	-	.749*	1.278***	1.202***	-
Single parent	.881	1.564***	1.108	1.343	1.155	.966	1.150*	3.791***	.966	1.386	.915	1.638***
Leak	-	-	1.175**	-	-	-	..906*	-	-	-	1.219***	-
Number of old people	-	-	1.036	1.153	-	-	.908***	1.101	-	-	.272***	1.281**
Year	2012	2014	2014	2012	2012	2014	2014	2012	2012	2014	2014	2012
Country	NL	ES	IT	SK	NL	ES	IT	SK	NL	ES	IT	SK
Observations	60,191	21,925	19,501	4,704	60,191	21,925	19,501	4,704	60,191	21,925	19,501	4,704

Table 3-5: Overview outcomes of regressions for the selected countries (Netherlands, Spain, Italy, Slovakia), with: * = Significant under 1% level; ** = significant under 5% level; and * = significant under 10% level.**

	Dependent variable: Share of energy expenditure (1 unit = 1%)							Dependent variable: Eq. Energy Expenditure						
	NL (pseudo panel) RE (1)	ES (2)	ES (pseudo panel) FE (3)	IT (4)	IT (pseudo panel) FE (5)	SK (6)	SK (pseudo panel) RE (7)	NL (pseudo panel) FE (8)	ES (9)	ES (pseudo panel) FE (10)	IT (11)	IT (pseudo panel) FE (12)	SK (13)	SK (pseudo panel RE (14)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Eq. income	-.000***	-.000***	-.003***	-.0***	-.000***	-.000***	-.000***	-.007**	.009***	.010***	.003***	.005***	.013***	.081***
Social aid	-.139***	.008***	2.053***	.0***	-.0***	.000***	.001***	-17.249***	.320	12.603***	.001***	-.0	.000***	.144***
Number of people	-.0636***	-.005***	-.341***	-.006***	.473	.001	3.759***	-22.729***	-4.976***	-2.503***	-107.85***	-52.81	-2.739***	132.400
Age of building	.0	-	-	-	-	-	-	-.914	-	-	-	-	-	-
Age of main provider	.0	.000***	.190***	-	-	-	-	-.763	.154***	2.339***	-	-	-	-
Number of rooms	.019**	.005***	.435***	.007***	1.12***	-	-	3.463	6.016***	2.552***	140.45***	109.18***	-	-
Single parent	.091	.014***	5.465***	.018***	-.919	.035***	1.938	-34.876	6.252***	8.050	120.13***	-78.45	-.305	-130.639
Leak	-	-	-	.009***	.735	-	-	-	-	-	81.08***	84.47***	-	-
Number of old people	-	-	-	.002***	-1.163**	.015***	3.094***	-	-	-	40.29***	-24.02	5.126***	90.667
Energy Price	.003***	-	-	-	-	--	-	-	-	1.694**	-	-	-	-
Country	NL	ES	ES	IT	IT	SK	SK	NL	ES	ES	IT	IT	SK	SK
Adjusted R^2	0.7140	0.1822	0.1834	0.1124	0.1417	0.1815	0.6658	0.1329	0.1518	0.1791	0.1734	0.0681	0.0910	0.8196
Observations	491	194243	166	222144	3096	43683	250	491	194243	166	222144	3096	43683	250
Year	2006,2009 and 2012	2006-2014	2006-2014	2004-2014	2004-2014	2006-2012	2006-2012	2006,2009 and 2012	2006-2014	2006-2014	2004-2014	2004-2014	2006-2012	2006-2012

Table 3-6: Overview outcomes of regressions for the selected Consensual indicators (Arrears, Severe Arrears, Warmth), with: * = Significant under 1% level; ** = significant under 5% level; and * = significant under 10% level.**

	Arrears				Severe Arrears				Warmth			
	NL (1)	ES (2)	IT (3)	SK (4)	NL (5)	ES (6)	IT (7)	SK (8)	NL (9)	ES (10)	IT (11)	SK (12)
	1	2	3	4	5	6	7	8	9	10	11	12
Eq. income	.999	.999***	.999***	.999***	.999	.999***	.999***	.999***	.999	.999***	.999***	.999***
Social aid	1.000*	1.000	.999***	1	1.000	1.000	.999***	.999***	1.000**	1.000***	1.000	1.000***
Number of people	4.456***	1.262***	1.302***	1.233***	2.328***	1.264***	1.326***	1.126***	3.287***	1.078	1.033	1.058*
Age of building	-	-	-	-	-	-	-	-	-	-	-	-
Age of main provider	1.001	-	-	-	1.000	-	-	-	.997	-	-	-
Number of rooms	.843	-	.841***	.850***	.918	-	.827***	.861***	.971	-	.957	1.008
Single parent	-	.641**	.924	1.179*	-	.655*	.867	1.131	-	1.163	1.366***	1.802***
Leak	5.597***	1.871***	3.388***	2.388***	2.955***	1.772***	3.379***	2.243***	1.848*	2.152***	2.765***	3.242***
Number of old people	-	.676***	.873***	.921**	-	.686***	.856***	.952	-	.765***	.896***	.998
Year	2012	2014	2014	2014	2012	2014	2014	2014	2012	2014	2014	2014
Country	NL	ES	IT	SK	NL	ES	IT	SK	NL	ES	IT	SK
Observations	1196	11927	19501	26666	1088	11927	19501	26666	1167	11927	19501	26666

As expected, households in all countries are less likely to be in energy poverty if they have a higher (equivalised disposable) **household income**, which can be seen in Table 3-4. This is true across all countries and all the energy poverty metrics chosen. The strongest relationship is observed in Slovakia when using the LIHC metric, where a household with an equivalised income of €1100 is 100 times less likely to be in energy poverty than a household with equivalised income of €1000, everything else constant.

These results are consistent with the correlations of income with the underlying variables of the energy poverty metrics, estimated in Table 3-5. For example, results of this table show that as income increases, average absolute energy expenditure increases in all countries (see positive sign of coefficients in columns 8-14). However, the share of income spent on energy decreases (see negative sign of coefficients in columns 1-7). This is especially visible in Spain and Slovakia, which might suggest that energy poverty is more strongly related to general poverty in these countries. An increase of € 100 in monthly income in Spain, everything else constant, is associated with a decrease in the share of energy expenditure of 0.3 percentage points (Column 3) and an increase of €1 in equivalised energy expenditure.

Receiving **social aid** has a more diverse effect on the different countries and selected indicators. In general, receiving social aid is *positively* correlated with being in energy poverty, in all countries and for all metrics. This is in line with the fact that social aid is targeted in some instances at those suffering from energy poverty and that receiving social benefits is a condition for being eligible for policies addressing energy poverty. However, there are exceptions. For the 2M metrics (Table 3-4), for example, a household in the Netherlands that receives social aid (binary variable) is 31.1% less likely to be in energy poverty (Columns 1). On the contrary, when using HEP M/2exp metric, a household in the Netherlands receiving social aid is more likely to be energy poor by 27.9% (Column 9), as well as in Spain, whereas in Italy and Slovakia, energy poverty decreases if the household receives social aid. The effect of receiving social aid is indeed ambiguous: on the one hand, these households are receiving financial support that should help them overcoming a distressful situation, so that they would not be in poverty anymore (*remedy effect*). On the other hand, this support is given to people who are already in poverty, so that receiving aid can be seen as a proxy for poverty (*proxy effect*). The data indeed seems to confirm this ambiguity, though the *proxy effect* prevails in most cases.

The **number of people in a household** has an ambiguous effect on the likelihood of being in energy poverty. Table 3-6 shows that an additional person in the household is associated with less equivalised expenditure and a lower share of expenditure in energy, which are consistent findings. Results for Slovakia were qualitatively opposite to this finding, but statistically insignificant. This suggests that there are efficiency gains from having more people in a household in terms of energy use. This also means that for the 2M metric, which compares the share of energy spending to a threshold larger households are on average less likely to be energy poor (see Table 3-4). The effect was ambiguous in the LIHC metric, the number of people being negatively correlated to LIHC in Spain and Italy, but positively correlated in the Netherlands and Slovakia. The Hidden Energy Poverty Metric, though, was positively and strongly correlated with the number of people in the household. This means that on average, controlling for income, social aid and other factors, smaller households are more likely to have an abnormally low consumption of energy per (equivalised) person. This is in line with the positive correlation between the size of household and difficulty in keeping house warm (Table 3-6), though this effect was very small.

Living in an old dwelling (**old building**) in Spain (infrastructure older than 25 years old) is negatively correlated with all expenditure-base metrics except HEP. This is somewhat surprising, as it means that older houses have a lower equivalised expenditure on energy (this could not be estimated). Households living in old dwellings are twice as likely to be in hidden energy poverty (HEP M/2 Exp) than newer dwellings. On the opposite, in the Netherlands, households in older dwellings are more likely to be energy poor according to 2M and LIHC, and less likely to be in hidden energy poverty (thus, consistent results). However, the results are only statistically significant for 2M (Column 2, Table 3-4). An increase in energy poverty can, in this regard, be explained due to the fact that the share of energy expenditure can increase if the household is living in an older house due to insufficient insulation or older, less efficient, electrical appliances. A more appropriate supporting indicator would a measure of the building's energy efficiency rather than its age.

During the initial analysis, we also expected that the **age of the main provider** would have a positive impact on energy poverty, as older people tend to stay more indoors and be more sensitive to temperature changes. However, the results relating the age of the main provider of the household and the energy poverty status is ambiguous. This might reflect older people, especially pensioner living in houses with considerably different levels of energy efficiency from the houses where younger households reside, a factor that was not considered in the analysis. It is important to mention that the age of the main provider provides additional pathway for age to influence energy poverty metrics, additional to the fact that older people might have a lower income (if above pensionable age) which is already taken into account by the income variable in the regression. Only for Spain is there a positive correlation between age and energy poverty, measured by 2M and LIHC. If the age of the main provider increases by 1 year, then that household is respectively 1.1% more likely to be energy poor (Column 2, Table 3-4) and 1.6% (Column 10, Table 3-4). For Italy and Slovakia, we used the **number of old people** (above 65) in the house, also finding ambiguous effects (positive correlation in Slovakia, negative in Italy). Most surprising, households with old people are less likely to declare to have trouble warming their houses (see Table 3-6).

The **number of rooms in the households** has also a positive effect for all countries in 2M and for Spain and Italy in LIHC. This is in line with was expected previously, as a larger household requires more energy spending to be heated or for the supply of energy services. Therefore, it is expected that households in larger houses are *less* likely to be in Hidden Energy Poverty, as this metric classifies as energy poor those households with abnormally *low* equivalised energy spending. Indeed, the number of rooms has a negative effect on hidden energy poverty measured by HEP M/2 Exp. In particular, using the odds-ratio calculated in Columns 5-8 of Table 3-4, the probability of a three-rooms house being in hidden energy poverty is lower than the probability of a two-room house being in energy poverty by relative to a two-rooms house by 5 percentage points in Spain, 7 percentage points in Italy and 9 percentage points in the Netherlands, everything else constant.

Another variable used in the regression identifies whether the household is a **single parent with children**. This type of household is often considered to be vulnerable, but the results are somewhat ambiguous. In Italy, and Spain, single households have clearly a higher energy expenditure and share of expenditure, also being more likely to be in energy poverty according to 2M. Results for other metrics are statistically insignificant. In Slovakia, though single parent households are almost four times as likely to be in hidden energy poverty, i.e., spending abnormally low amounts on energy, than other households.

Lastly, the presence of **leaks or dampness in the house** seems to have a positive effect on energy poverty, given that cold feeling or excessive spending (which may cause arrears in bills) has a positive and strong correlation to a lack of proper infrastructure. Households with leaks are twice as likely to declare being unable to warm adequately in the Netherlands and Spain, and around three times as much in Italy and Slovakia. It was also positive to relate the presence of leaks with the expenditure-based metrics in Italy. The results showed indeed that houses with leaks present on average € 84.47 more on energy spending, thus being more likely to be energy poor under 2M (17% more likely), LIHC (22% more likely) and less likely to be in hidden energy poverty.

Although this exercise was done as an exploratory analysis. Our choice of metrics for energy poverty and the factors correlated with them seem to yield consistent results with common-sense expectations of how these metrics relate to the supporting indicators. Table 3-7 summarises briefly the results explained above. Although this falls short of providing rigorous information on the causality between indicators and metrics, the quantitative assessment provides useful information on the nature of the relationship between metrics and supporting indicators. We firmly believe that a more in depths analysis could draw more interesting insights about reasons why supporting indicators appear to be correlated with energy poverty metrics or explain the difference nature of relationship across countries or energy poverty metrics.

Table 3-7: Summary of the supporting indicators and their effect on energy poverty

Indicator	Main Results
Equivalised income	• Higher income households are less likely to be in energy poverty, no matter the chosen metric (including hidden energy poverty) • The higher the income of the household, the higher the level of absolute spending on energy, but the lower the share of income spent on energy.
Social aid	• Ambiguous effects on energy poverty: in some cases, it is associated with higher probability of being in energy poverty, in other cases, with lower, and in others, there is not statistically significant effect.
Number of people	• Households with larger number of inhabitants are less likely to be in energy poverty as measured by 2M • An additional person in the household means a reduced share of income spent on energy AND a reduced absolute equivalised energy expenditure, suggesting that there are strong energy efficiency gains from additional people in the house. • However, hidden energy poverty is associated with more densely populated houses, as larger households are a substantially likelier to be in hidden energy poverty.
Age of building	• In Spain, a household is less likely to be in energy poverty when living in a house of one year older for 2M and LIHC • In the Netherlands, a household has more probability to be energy poor for 2M when living in an older dwelling
Age of main provider	• The age of main provider only has a small but positive effect on absolute equivalised spending and on the share of income spent on energy • Not much data was available (only ES and NL), and results were not significant for the Netherlands
Number of rooms	• Significant impact 2M and LIHC • One extra room leads to an increase in energy poverty while controlling for other factors such as income

Indicator	Main Results
	• Houses with more rooms have higher absolute energy expenditure and higher share of energy expenses
Single parent	• Single parent households have significantly higher probability to be energy poor for Spain in 2M and Slovakia in LIHC • This type of households has higher absolute expenses and higher share of energy expenditure
Leak	• Existence of leaks has significant impact on energy poverty • A leak in the house will also increase the absolute energy expenses and has a significant impact on the consensual based metrics

3.3 Final Recommendation

3.3.1 Energy poverty metrics

Based on the desktop review, testing and validation of a large number of energy poverty metrics, a small set of four metrics came out as a broad and non-redundant assessment of energy poverty. This set of indicators is the most adequate to measure, compare and track energy poverty, its drivers and effects across the EU. The four metrics of energy poverty suggested are shortly described the table below. They are:

- 2M, which classifies as energy poor a household whose share of income spent on energy is above twice the national median: this metric captures households that dedicate an unusually high share of their income to energy expenditure.
- LIHC, which classifies as energy poor a household whose income after housing costs is below the poverty line *and* whose share of income spent on energy is above the national median: this metric also captures households that dedicate a high share of income to energy expenditure, but focusses on those households that have low absolute income after energy costs.
- HEP M/2 Exp, which classifies as (hidden) energy poor a household whose equivalised energy expenditure is below half the median equivalised energy expenditure: this metric captures households whose energy expenditure is unusually low for national standards, which is crucial when using actual expenditure data. This metric suggests whether the household are forgoing a basic level of consumption.
- Warmth, which classifies as energy poor a household that declares having difficulties warming up the house during the cold season: this metric goes directly to one of the problems of energy poverty.[34]

As explained in the conceptual chapters, energy poverty is a situation in which households are not able to adequately heat their home or meet other required household energy services at an affordable cost. This phenomenon can materialize in different ways, and a single metric will always miss an important part of the story. Households that cannot meet required energy services at an affordable cost may be compromising on other kind of important expenditure (which is captured by 2M and LIHC), or else they might be compromising on energy expenditure (which is captured by HEP and warmth).
Given the pragmatic approach taken to use actual expenditure as available in national survey data, these metrics can be updated annually without excessive effort or cost. Further, these surveys allow each metric to be calculated at province/region level, providing spatially-disaggregated understanding of the energy poverty problem below the MS level.

[34] As discussed in sub-section 4.2.1, the "arrears" metrics were dropped from the final suggested set because they do not relate directly to energy costs, but to utility costs more broadly.

Table 3-8 Set of recommended energy poverty metrics

Approach	Metric	Data requirements
Expenditure-based using actual expenditure	**2M: Share of energy expenditure** (compared to equivalised disposable income) **above twice the national median**	<u>HBS:</u> • Equivalised income • Taxes • Energy expenditures
	Low Income High Cost (LIHC): If the energy expenditures are above the median level and if they spend this amount, their residual income is below the poverty line	
	HEP M/2 Exp (Hidden energy poverty): Absolute energy expenditure below half the national median	
Consensual-based	Inability to keep the house warm **(Warmth).**	<u>SILC</u>

The following graphs show how the chosen metrics behaved in each of the four countries in the last years (i.e. Figure 3-8, Figure 3-9, Figure 3-10, Figure 3-11). Furthermore, an overview of the different indicators per country is also highlighted (i.e. Figure 3-12, Figure 3-13, Figure 3-14, Figure 3-15).

Figure 3-8: Overview 2M for Spain, Italy, Netherlands, and Slovakia, with on X-axis time [Years] and on Y-axis Energy Poverty [%].

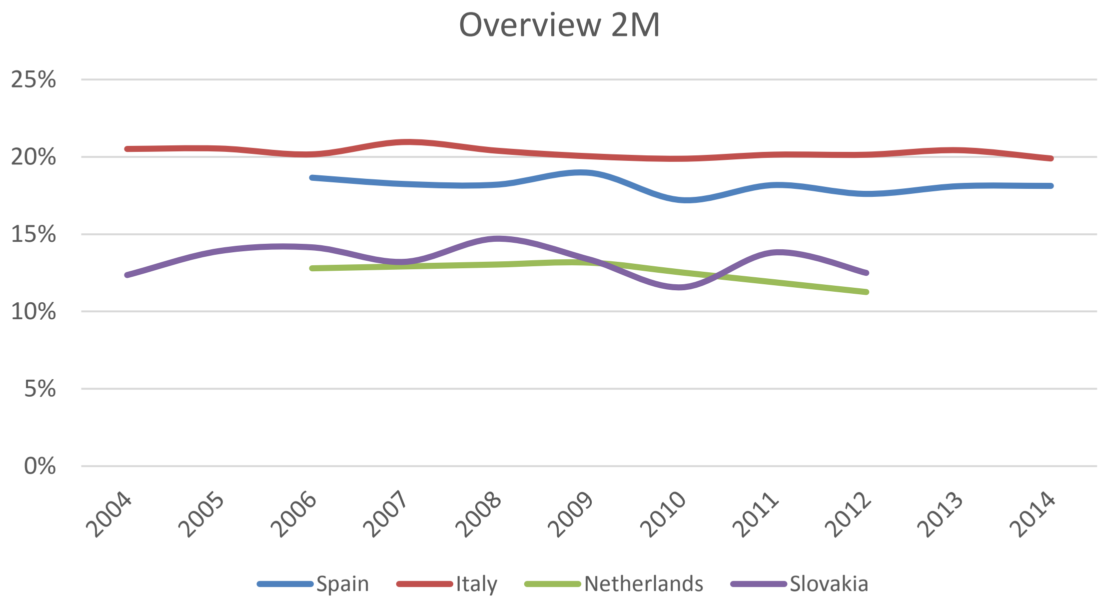


Figure 3-9: Overview LIHC for Spain, Italy, Netherlands, and Slovakia, with on X-axis time [Years] and on Y-axis Energy Poverty [%].

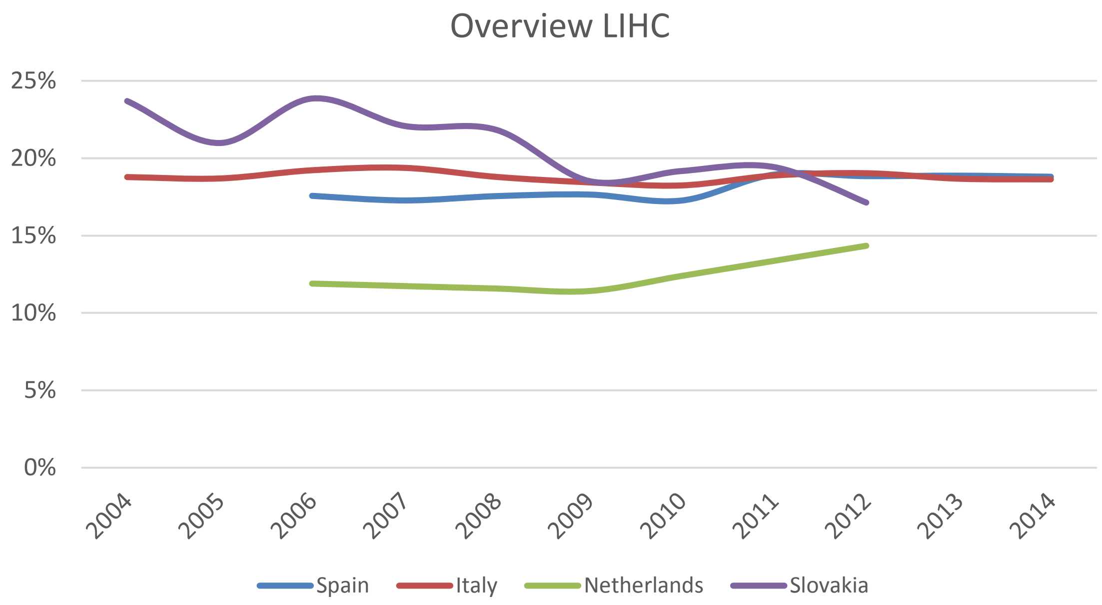


Figure 3-10: Overview HEP M/2 Exp for Spain, Italy, Netherlands, and Slovakia, with on X-axis time [Years] and on Y-axis Energy Poverty [%].

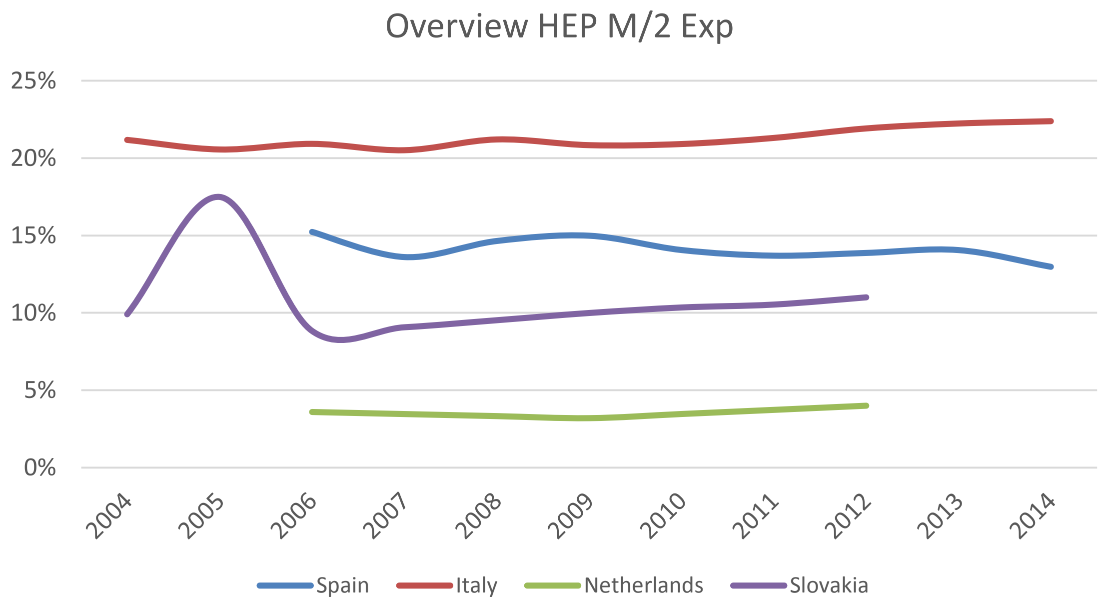


Figure 3-11: Overview Warmth for Spain, Italy, Netherlands, and Slovakia, with on X-axis time [Years] and on Y-axis Energy Poverty [%].

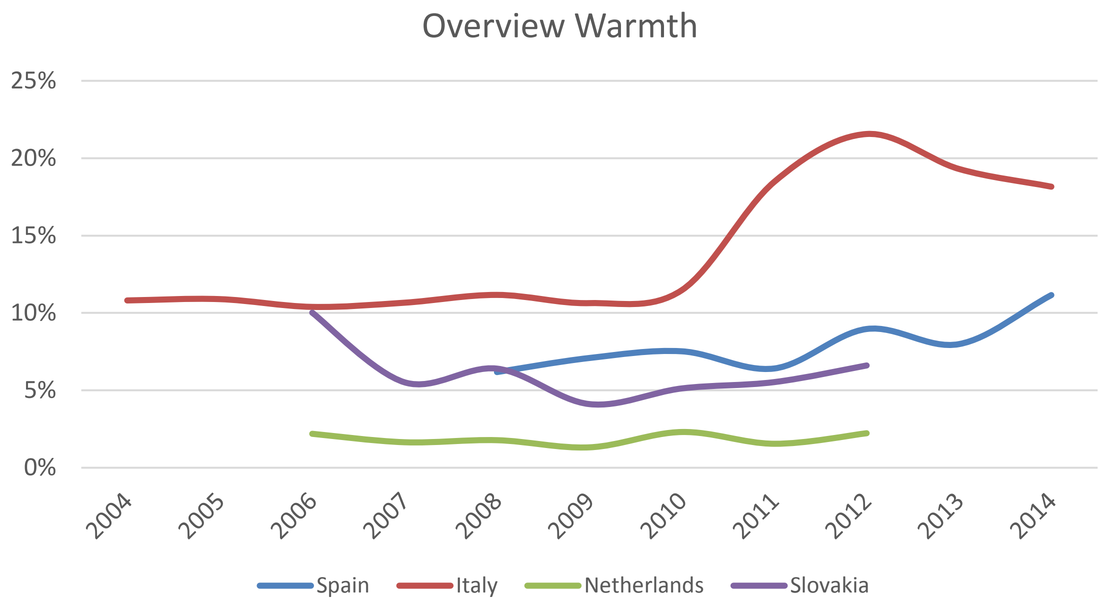


Figure 3-12: Overview of selected Indicators (2M, LIHC, HEP M/2 Exp, Warmth) for Spain.

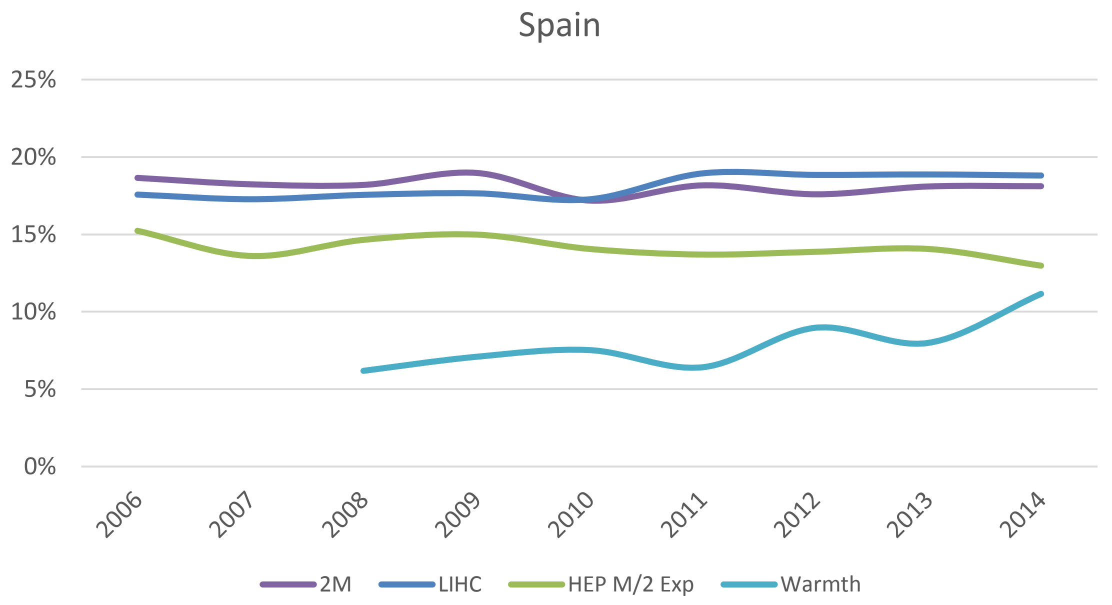


Figure 3-13: Overview of selected Indicators (2M, LIHC, HEP M/2 Exp, Warmth) for Italy.

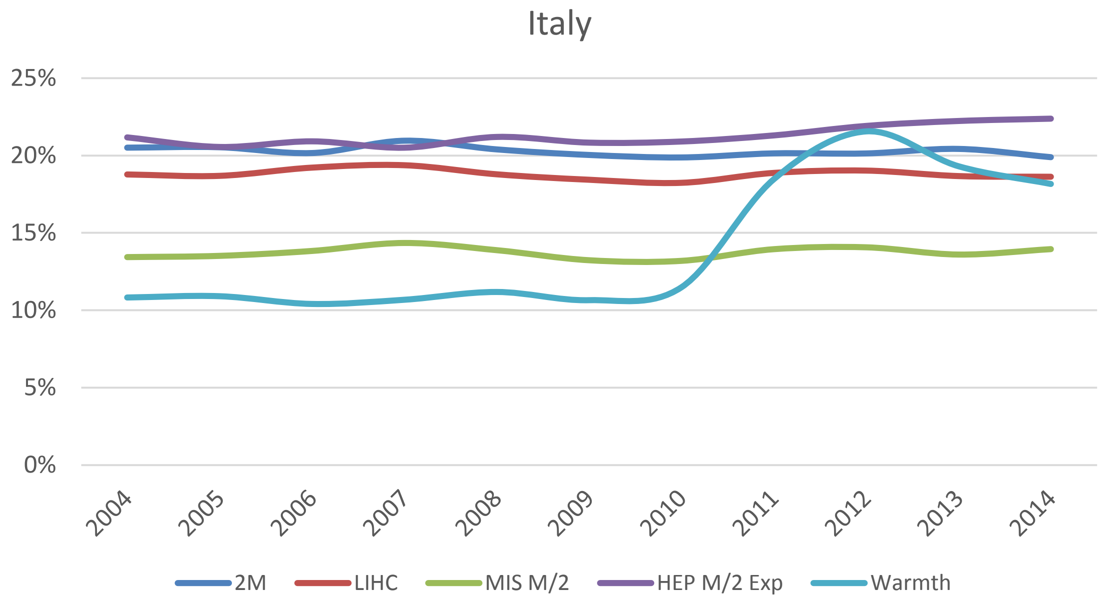


Figure 3-14: Overview of selected Indicators (2M, LIHC, HEP M/2 Exp, Warmth) for the Netherlands.

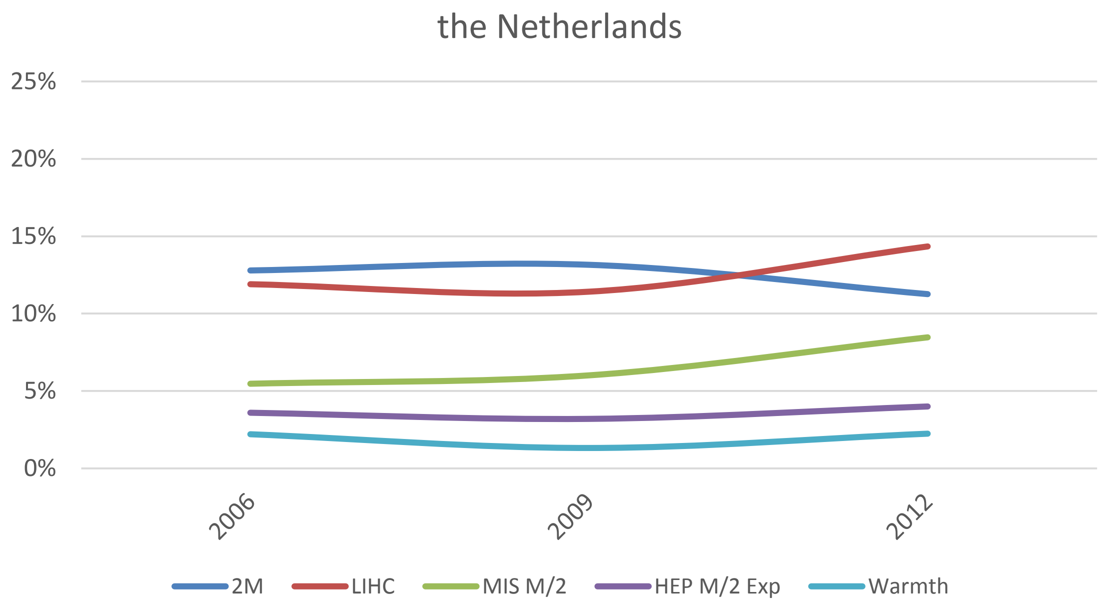
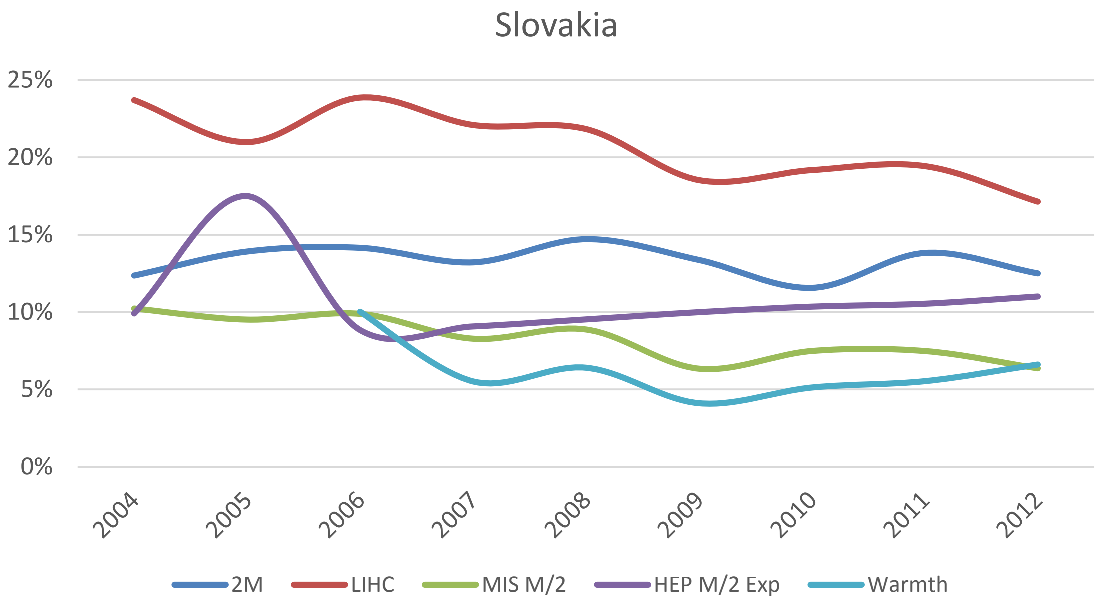


Figure 3-15: Overview of selected Indicators (2M, LIHC, HEP M/2 Exp, Warmth) for Slovakia.

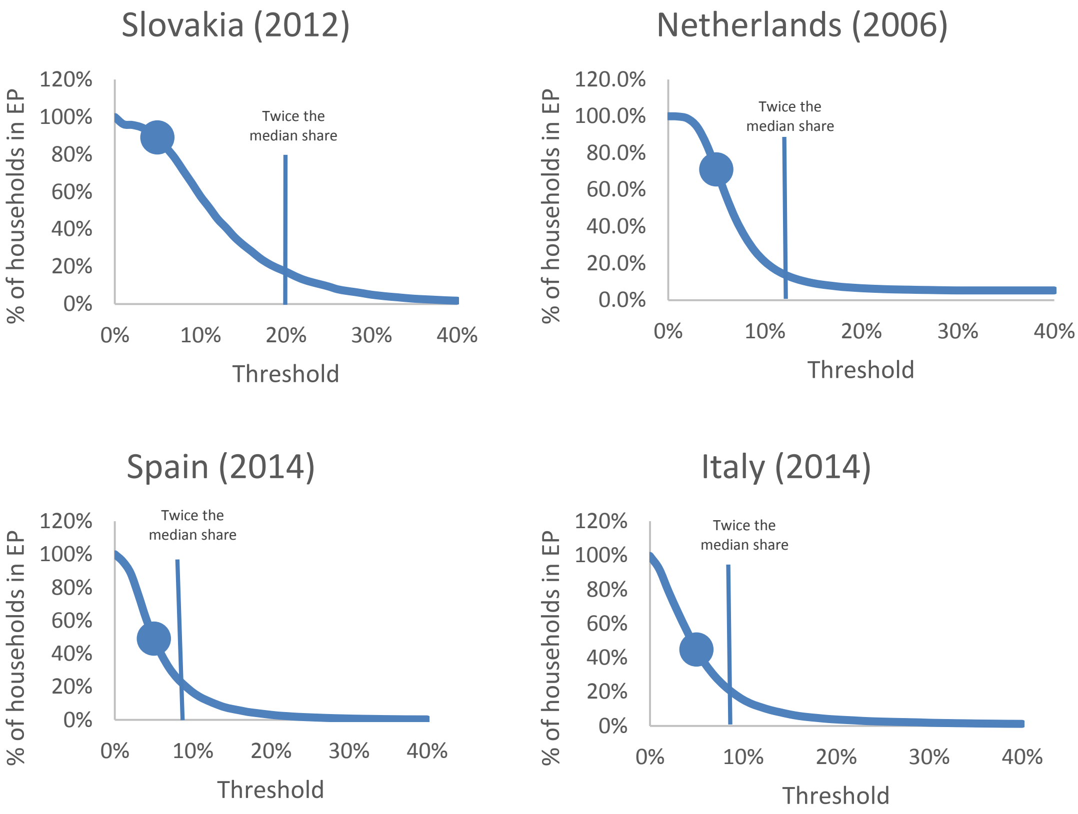


However, as mentioned earlier in this report, these metrics are not ideal. Researchers and policy-makers may have good reasons to adapt the structure of the metric to a specific situation that they encounter, in particular expenditure-based metrics. These metrics all have the structure of comparing a certain expenditure variable to a threshold. This threshold is by definition normative, and the indicators are often very sensitive to how they are chosen.

As examples, sensitivity analyses of energy poverty metrics to the threshold were performed. In the Figure 3-16, for example, we show how the percentage of households in energy poverty in the four analysed MSs, depending on the threshold that is chosen for the above-the-threshold metric. The figure shows that if the threshold for the share of income spent on energy is set at 9%, 27% of Dutch households would be energy poor (i.e. spending more than 9% of their income on energy). If the threshold is set at 11%, however, 17% of Dutch households would be energy poor, a different of 10 percentage points. In fact, any threshold in the area between 8% and 14% would be problematic, as small changes in that choice could bring about large differences in the results.

The advantage of using twice the median as a threshold in this case is that it already incorporates the distribution of energy spending patterns in the population, reducing the risk of picking a threshold that is close to this high sensitivity area. In Italy, the high sensitivity area is at a much lower threshold, which illustrates how different countries may have substantially different energy spending patterns. In Italy, the percentage of energy poverty starts to stabilize at a threshold levels above 5%. In both the Netherlands and Italy, the twice the median threshold is depicted by the straight line. The straight line marks the threshold corresponding to ***twice the median*** for all countries.

Figure 3-16. Sensitivity analysis of above-the-threshold metric to threshold



Source: HBS (Slovakia), WoonOnderzoek (Netherlands), HBS (Spain), SILC (Italy).
Obs: The large round dot represents the share of households that spend more than 5% of their income in energy. The straight line represents what is the share of income that is equivalent to twice the median share of energy expenditure in each country.

The choice for the metrics presented in this section is based on their theoretical simplicity, ease of implementation and data availability across the EU. More sophisticated metrics could be implemented, but they would also require additional and more detailed data. In particular, more sophisticated metrics include those that estimate *required* energy spending (taking into account the building characteristics and occupancy), building efficiency (to inform HEP metric), and minimum income standards (which should ideally be defined at the sub-national level in a participatory manner). External experts interviewed often pointed out that such estimates may yield interesting results.

3.3.2 *Energy poverty gap*

The metrics suggested above are status indicators: they state whether a household is in energy poverty or not. They are interesting metrics in order to show the ***extent*** of the problem, but inadequate to evaluate its ***intensity*** or ***severity***. It is possible to measure the severity of energy poverty as measure by each of the expenditure-based metrics (it is unfortunately not possible to do that for the consensual based metrics).

In fact, a complete analysis of energy poverty according to expenditure-based metrics should always be accompanied by an “energy poverty gap” metric. The energy poverty gap is a measure of the distance from the actual status of the family and the threshold of energy poverty. Therefore, it measures how much it would cost to bring that specific energy poor household to the threshold of being or not energy poor. The energy poverty gap provides the size of the problem in monetary terms, suggesting how much it would cost to solve it.

This study also produced estimates of energy poverty gap for each of the expenditure-based metrics suggested above. The following table, Table 3-9, shows the size of the energy poverty gap per capita for all the households *in energy poverty*, in each of the four analysed Member States. This can be interpreted as the average monetary quantity per capita that would be needed to solve the problem of energy poverty according to the different metrics.

It is important to notice that the definition of the gap is much different for each indicator, and should also be interpreted differently.

- 2M Energy Poverty Gap: the energy poverty gap here represents how much lower the energy bill should be so that the share of energy expenditure would be equal to the threshold (twice the national median). In other words, how much the government should subsidize the energy bill of that household (as opposed to increase the household's income), in absolute or per capita terms. For example, if the government in Spain subsidised the energy bills of all ***individuals*** in energy poverty by € 19.09 every month, the problem would be solved.
- LIHC Energy Poverty Gap: in these two cases, the interpretation of the energy poverty gap can be either the amount by which the income of the household should increase or the amount by which the energy bill should decrease, so that the after energy costs-income is on the threshold. Since these two measures use absolute values, these two ways of looking at it are equivalent. The values of the gap in these cases are substantially higher than the gap of 2M or the Hidden Energy Poverty gap. Still using the example of Spain, the estimates mean that the government would have to increase the *income* of each individual in energy poverty by € 137.66 in order to solve energy poverty in this case.
- Hidden Energy Poverty Gap: here, the gap means how much *higher* spending on energy should be so that it would be equal to the threshold (half the national median). The interpretation here is similar to 2M, but in the opposite direction. Still taking Spain as an example, (hidden) energy poverty would be solved if the consumption of each person in that situation were increased by € 5.64 per month.

Table 3-9: Overview Energy Poverty Gap for Spain, Italy, Netherlands, and Slovakia, in monthly terms.

	2M		LIHC		HEP M/2 Exp	
	Per capita	Total	Per capita	Total	Per capita	Total
Spain (2014)	€ 19.09	€ 149.19 mln	€ 137.66	€ 1,317.65 mln	€ 5.64	€ 36.93 mln
Italy (2014)	€ 27.4	€ 271.57 mln	€ 222.0	€ 2,450.41 mln	€ 7.4	€ 109.51 mln
Netherlands (2012)	€ 62.13	€ 11.59 mln	€ 345.75	€ 39.89 mln	€ 11.44	€ 6.07 mln
Slovakia (2012)	€ 26.32	€ 65.15 mln	€ 55.25	€ 510.91 mln	€ 9.16	€ 11.05 mln

This type of analysis conveys a different type of information than the one performed earlier. For example, the percentage of households in the Netherlands that is in energy poverty is generally lower than in the three other countries for all four metrics. However, the average per capita "price" to get the households in energy poverty out of energy poverty is substantially higher than in the other countries. This can suggest that in the Netherlands, the phenomenon of energy poverty is relatively more concentrated in lower extremes in the income distribution than in the other countries, which explains a lower percentage of households in energy poverty and a higher severity of it.

3.3.3 *Full scale data collection*

The selection of these metrics was made taking into account the need for a full scale data collection and metric calculation for EU-28. All metrics are based on data that is already collected at MS level via the SILC or HBS surveys.

- The **Statistics on Income and Living Conditions (EU-SILC)** aims to collect data on income, poverty, social exclusion and living conditions. The EU-SILC project was launched in 2003 in six Member States[35] and Norway, and expanded to EU15[36] and Estonia, Norway and Iceland by 2004.
- The **Household Budget Surveys (HBS)** were launched at the beginning of the 1960's. Eurostat collates and publishes these survey data every five years since 1988. However, Eurostat recognises that "even though there have been efforts for harmonisation, differences remain". There are differences on frequency, timing, content and structure.

An important point to be made is that the SILC survey conveys highly detailed and harmonised information about households, but since it does not have data on energy expenditure, it cannot be used to calculate expenditure-based metrics. ***Adding a question on energy expenditure solve this problem, and SILC alone would be needed to calculate all the metrics proposed in this report***. However, obtaining precise information on energy expenditure may not be such a simple thing. The Italian SILC survey does include information on energy expenditure, but it is not easy to obtain the total value of energy expenditure of a household when energy prices are included in rents or condominium fees, for example.

As neither of these surveys have been designed to measure energy poverty, the set of recommendations in Thomson and Snell (2014) could be used to improve datasets at the EU level to further enhance the measurement of energy poverty. These recommendations, which can be seen in the table below, Table 3-10, include developing existing household surveys so that they can be more effectively used for energy poverty analysis, and the collection of new datasets.

Table 3-10 Recommendations for improving EU-level datasets. Source: Thomson and Snell (2014)

Recommendations	Description
1. Amend and harmonise existing surveys	Make existing survey more relevant for measurement and analysis of energy poverty.
Amend the EU Statistics on Income and Living Conditions (EU SILC)	EU-SILC was not designed for analysis of energy poverty issues. Detailed recommendation suggests inclusion of new variables that capture issues of energy expenditure, payment method, efficiency measures and heating systems. Existing variables should be modified to help differentiate between issues of affordability and technical characteristics of building / heating systems. Changes to EU SILC would need to be considered by the Indicators Sub-Group of the Social Protection Committee, in consultation with MS statistical agencies, so could be a lengthy process.

[35] Belgium, Denmark, Greece, Ireland, Luxembourg and Austria
[36] Except Germany, the Netherlands, the United Kingdom

Recommendations	Description
	However, most importantly it should be pointed out that adding a specific variable on total energy expenditure of a household would make SILC a sufficient source of data in order to calculate all expenditure-based metrics proposed in this report.
Harmonise Household Budget Surveys (HBS)	Another approach is to harmonise national household budget surveys and create a pan-EU dataset of actual fuel expenditure across Europe. This would entail reducing variation in sampling, design and frequency. It would be a major effort, and would require cooperation across MSs. The limitations of using these data are that actual consumption is not necessarily a good indicator of energy poverty, due to under-expenditure in energy-poor households.
Pan-European monitoring of cold-related morbidity and mortality	A final approach is to monitor health and well-being impacts of energy poverty via cold-related illnesses and deaths. An approach to this has been developed under the EuroMOMO project, as an example of best practice for standardising the measurement across Europe.
2. Collect new data	Develop new datasets requires a large investment in resources to establish new surveys but provides the basis for improved understanding of the critical issues of energy poverty.
Dedicated EU-28 household survey of energy poverty	Types of data that would be needed include – + Sociodemographic, including income and household composition. Actual energy expenditure (all fuel types), and payment methods and tariffs. + Technical energy efficiency and housing quality data to allow estimation of required household energy expenditure (comparable to the English Housing Survey) + Self-assessed health and wellbeing + Self-perceived affordability/burden, thermal comfort and shivering, with focus on keeping warm during cold winter months (or cool during hot summer months). + Inclusion of heating and cooling degree days to control for variations in climate.

From a more practical perspective, the following issues have been identified regarding the data collection:

Undervalued and non-harmonised income values from HBS

The Household Budget Survey's main aim is to assess the different household expenditures. The survey asks for different expenditures while it asks for total income as one value. This difference in the level of detail of the questions might lead to undervalued level of income (due to forgetfulness). Furthermore, because of this, the income values are less precise than expenditure values. In addition, HBSs are not harmonised: the definition and measurement of income and what it entails is not always clear.

SILC survey aims, among other things, to estimate household income. It includes one variable named disposable income, which can be consistently used. In the future, an alternative would be to combine these surveys or to find a way in which SILC values are used to cross-check the HBS income values and/or make adjustments. **Another alternative would be to add one question to SILC regarding energy expenditure, which would allow the calculation of all metrics using only this survey.**

Accessing microdata from SILC and HBS

During the testing phase, data was accessed directly from MS statistical agencies (both for HBS and SILC). While for Spain and Italy the process was easy and straightforward, this was not the case for the Netherlands and Slovakia, were the data access process was complex and long. According to Regulation 223/2009 EU-SILC micro-data are available to researchers carrying out statistical analyses for scientific purposes.[37] The datasets for most EU-28 MSs (all except Romania and Germany) are released in the User Database twice a year on March 1st and August 1st for the year Y-2. This would allow comprehensive, comparable, easy to access data for most MSs.

However, this is not the case for the Household Budget Surveys. Countries have again different frequencies for carrying out the surveys. Further, the microdata can only be accessed through the national statistics organisations. In many cases this requires long timelines and high costs.[38]

Considerations on required energy expenditure

Ideally, the metrics should use required energy expenditure instead of actual energy expenditure. However, neither SILC nor HBS surveys gather information on the required energy expenditure. In order to be able to apply a model (such as the one used by the UK) to estimate required energy consumption and expenditure, the following information would be needed:

- Heating system and fuel(s) used;
- Dwelling characteristics;
- The economic circumstances of householders (e.g. are they unemployed/retired and thus at home for longer periods of the day);
- Regional climate variations.

These data, especially the one related to the dwelling characteristics, is rarely available at household level. While the EU Building Stock Observatory project ("Support for setting up an observatory of the building stock and related policies") aims to tackle this issue, it will only be done at an aggregated level (not on a household level) and the data will not be connected to SILC and/or HBS survey results, limiting its use to calculate energy poverty metrics using household data.

3.3.4 Validation and summary

The objective of this chapter was to suggest a set of metrics that metrics of energy poverty giving a rich, non-redundant picture of the phenomenon of energy poverty. The suggested set of metrics is made of four metrics (i.e. 2M, LIHC, HEP M/2 Exp, and Warmth), which can be implemented in a European scale in a relatively easy and harmonised manner with available data.

In the end, there are four main indicators, which are chosen after thorough analysis. All of them are MS-specific and, yet, they can be implemented in all countries:

- 2M uses twice the median national share of energy expenditure as a threshold and looks in this regard at the population as a whole. It is chosen for two main advantages: high income households are very rare in this metric and it takes into account country-specific patterns.
- LIHC: this metric defines households in energy poverty as those that have high energy costs (income after energy costs is below the national poverty line). It is a helpful measure to

[37] http://ec.europa.eu/eurostat/documents/203647/771732/How_to_apply_for_microdata_access.pdf

[38] Austria: Free of charge for scientific purposes; CZ & SK: Free only for (registered) research organisations and state authorities (others have no access); IT: Registration (1-2 days) and free download; NL: Registration (over a month) and high fees required; ES: No registration, free download; GR: Registration (over two months) and no fees required.

distinguish energy poverty from generalized poverty and it clearly reflects that energy poverty is dependent on income. In this regard, it brings he low income focus.

- HEP M/2 Exp identifies those households whose energy expenditures are abnormally low. In particular, HEP M/2 Exp classifies a household as energy poor if its absolute expenditure is below half the median absolute energy expenditure. Moreover, this measure is only appropriate when using the absolute monetary expenditure, which makes it critical for capturing low expenditure and crucial when using actual expenditure.
- Warmth shows whether a household declares the inability to keep the house warm. It is in this regard closer related to the idea of hidden energy poverty. Besides only looking at one kind of energy services (heating), it is directly related to the problem of energy poverty, which makes it a useful indicator.

With regards to the expert consultations, there is no one common opinion among experts regarding an indicator best suited across MSs to measure energy poverty according to the testing results evaluation. For example in Spain, there were very different views on indicators with MIS threshold. On the one side, these indicators are least suited as they can apply very low MIS thresholds (not covering the cost of basic goods and services) and possibly capture households not being able to afford neither domestic energy nor all other essential household items. On the other side, that they are best suited indicators and can be used across Member States with defining an objective “minimum income” for every country. The suggested indicators LIHC uses a standard threshold used Europe-wide: the poverty threshold.

10% threshold is suitable for the Spanish case where median share of income spent on energy ranged between 3 to 5%, so that 10% would be close to twice the median. However, this is clearly inadequate for other countries, where median shares are much different. Therefore, the use of thresholds that are relative to the country’s distribution was seen as a reasonable solution by the interviewees.

Many interviewees also argued that, instead of using *actual expenditure* data, which already reflect actual choices of households based on their budget constraints and needs, ideal indicators should use *estimated required energy expenditure*, based on technical characteristics of the households. However, as explained earlier in this chapter, such estimates require models and assumptions which may be complicated to apply with the available data.

Finally, several interviewees appreciated the fact that energy poverty is a complex phenomenon that can be seen from different viewpoints (namely excessive costs on energy or insufficient spending on energy). The versatile approach taken in this study, which suggested a set of four different and non-redundant metrics, was explicitly praised by one of them[39]

[39] Interview with Josefine Vanhille

4 Tool to Monitor Energy Poverty

This chapter describes the functionalities that a tool[40] would need to perform in order to advance understanding of energy poverty at EU-scale and to facilitate policy action to prevent and address it at that level. The main objective of the tool is to **monitor and compare energy poverty, its drivers and outcomes, gather and disseminate information on policy measures developed by Member States, research and initiatives on energy poverty, and steer and advance the understanding of energy poverty**. Functionalities have been distilled from the terms of reference of this assignment, the conceptual discussion above, from the consultants' interviews with EU energy poverty experts on the priorities for addressing energy poverty in the EU through policy. The functionalities were also practically grounded in the strategies to address the issue currently being taken by founders and managers of existing tools. They include:

- **Measuring and monitoring energy poverty** by quantitatively describing its intensity and extensity by geographic area or income level systematically across the EU-28 using data, graphs, maps, analysis and reporting.
- **Information dissemination and outreach**:
    - Consolidating and organising practical examples of energy poverty policy.
    - Recognising and connecting established experts on the topic.
    - Facilitating actions and events that aim to proactively influence the issue via policy influence (not just awareness).
- **Technical assistance on demand**, e.g. to provide ad-hoc reporting and/or help public bodies who try to either measure or tackle energy poverty.

This chapter describes several tools for addressing energy poverty that already exist in the EU (and elsewhere) and evaluates which of the necessary functionalities they do and do not fulfil. Practical issues related to actually setting up and running these existing tools are discussed here based on information gathered through interviews with the tool founders or managers. The practical issues covered are: (a) the individuals involved and intended audience for the tool, (b) the tool's main functionalities, (c) the cost of setting it up and running it, (d) the entities carrying overall responsibility for it and (e) the underlying governance structure. The final section proposes several options for the design of a new tool based on this practical information, the tool functionality gaps that currently exist in the EU, and DG Energy's unique capabilities and resources to fill them.

4.1 Review of existing tools

Six existing tools related to energy poverty and related issues were reviewed for their general origin and purpose, intended audience, main functionalities, running cost, responsible individuals and governance.

[40] In this context a 'tool' refers to a collection of policy documents, statistical data, expert publications and interpretation, news and event announcements related to energy poverty, its drivers and consequences. It is likely to be web-based or have a strong web-based component. The tool is taken to perform the functions of gathering and sharing data and information.

4.1.1 French National Observatory of Energy Poverty - ONPE[41]

The **French National Observatory of Energy Poverty** (ONPE, *Observatoire National de la Précarité Énergétique*) was launched as a result of the Convention for a National Engagement against Energy Poverty of 2010. The observatory aims to provide "reliable and shared understanding of energy poverty in France, informing and contributing towards public policies"[42].

The Observatory has links to legislation, definitions and publications on energy poverty in France. In 2015, the observatory launched its channel on YouTube with short videos with explanations and recordings of events[43]. The Observatory has organised several events (debates and workshops). Data on energy poverty in France can be accessed only through the studies that are published by ONPE. These studies include regional reports for every French region, with the description of policy tools for local authorities.

The Observatory is intended to be used by institutional and policy-making individuals to take policy action, by researchers to write research papers, and by journalists to raise awareness through media outlets. Its main functionalities include:

- Coming up with a definition of energy poverty that is fitting to the French context. The Observatory has a specific mandate to do this and is achieving it partly by facilitating public debate on for example what the appropriate poverty threshold should be (currently around 6-7 percent of household income for mobility and 7-15 percent for housing).
- Consolidating, 'mutualising' and reporting different streams of data being produced by different organisations as well as producing its own data via regular surveys.
- Using data and other resources to spot in the French territory existing zones of energy poverty.

In terms of costs, the Observatory is a EUR 1 million project running over three years. Half the money comes from the energy agency of the state (ADEME) while the other half comes from a consortium of contributing partners including EDF[44] and others, both state-run and private.

At the time that the Observatory was being set up there were three options for an organisational status: housing it within an existing organisational structure as a new capability, creating a new independent association, or organising an informal arrangement of members. An informal arrangement was chosen because it allowed for new partners and co-funders to appear as the organisation grew and its financial needs and possibilities changed. Currently the governance of the Observatory is evolving because the funders want more involvement in decisions and strategic direction. Currently, governance is organised around two committees. The piloting committee is responsible for organisational structure and for the overall strategic direction, while a technical committee is responsible for day-to-day work flow and management issues.[45]

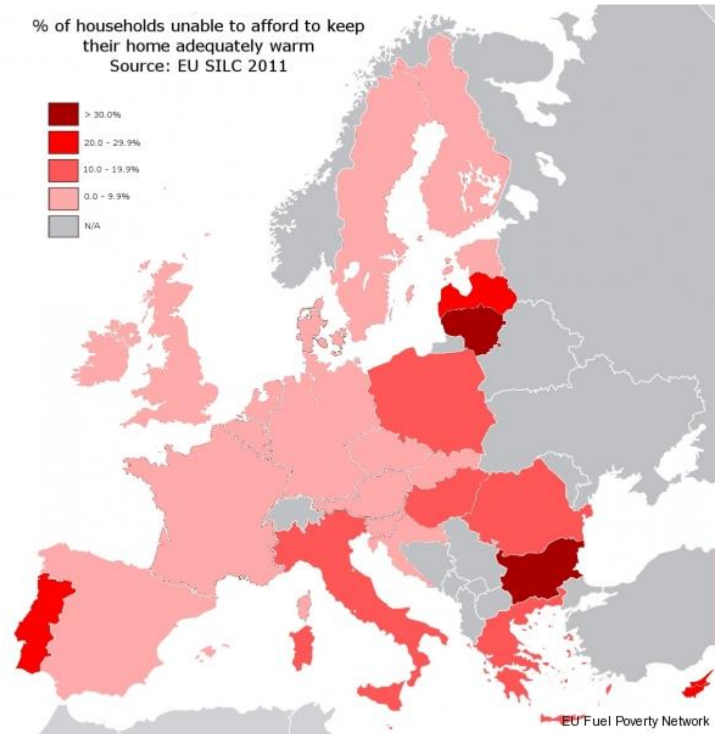
[41] http://onpe.org/
[42] Translated from http://onpe.org/quest_ce_que_lonpe
[43] https://www.youtube.com/channel/UCbc5Q1HyqPMI3qXYpWPZDzg
[44] Electricite de France (https://www.edf.fr/)
[45] Information for this section was obtained from an interview with Didier Chérel, Secrétaire de l'ONPE / Agence de l'Environnement et de la Maîtrise de l'Énergie (ADEME), held on 11 March 2016.

4.1.2 *EU Fuel Poverty Network*[46]

The **EU Fuel Poverty Network** is an online portal for information about EU energy poverty. Its aim is to raise awareness and to further the dialogue on energy poverty across the EU.

The EU Fuel Poverty Network does not provide a database of indicators but it does provide a geographic representation of three indicators from EUROSTAT/SILC at national level (% of households unable to afford to keep their home adequately warm; % of households in arrears on utility bills; and % of households living in dwellings with a leaking roof, damp or rot).

Figure 4-1 Geographic representation of the Eurostat indicators from the EU Fuel Poverty Network



The main intended audiences for the tool are researchers, practitioners and journalists from across Europe. The EU Fuel Poverty Network was launched as a response to the need to improve the network of people researching fuel poverty in different countries, as the research community was small and fragmented. The functions of the website have evolved to encompass raising awareness of fuel poverty as a policy issue, and furthering the dialogue on fuel poverty across Europe. To this end, it provides a platform for disseminating information, mainly via guest blog articles. Influencing policy is an associated function, and there is evidence that decision-makers are using this resource to inform their work.[47]

Originally, this website was launched with support from the Social Policy and Social Work Department at the University of York, and later received seed financial support (£774) from Eaga Charitable Trust. Dr Harriet Thomson is the founding editor and has independently updated the website since 2011. A formal governance structure was only recently established with the addition of a new Deputy Network

46 http://fuelpoverty.eu/
47 Interview with Harriet Thomson

Coordinator, to guide the role of different volunteers, expectations around contributing to the EU Fuel Poverty Network, guidelines for updating social media accounts, etc.

The EU Fuel Poverty Network website (www.fuelpoverty.eu) was set up in November 2011. Initially a wordpress.com format was used as it was a user friendly and low-cost way to get started.

Early on, a poll was run asking visitors to suggest new features, which led to the addition of a publications/resources database and the migration from wordpress.com to wordpress.org. This is a more advanced and powerful website system and required hiring a web developer.

4.1.3 INSIGHT_E Observatory[48]

INSIGHT_E is a European, scientific and multidisciplinary think-tank for energy which provides policy advice and informs the European Commission and other stakeholders. The INSIGHT_E project is a Coordination and Support Action funded by the European Commission under FP7 running from 2014 to January 2017. The website of the Observatory includes an interactive section on “Energy Transition Indicators” providing a dynamic map (see image below) and tables for download. This section provides indicators related to: Economy; Climate & Environment; Society; and Security. Regarding Society, key indicators are:

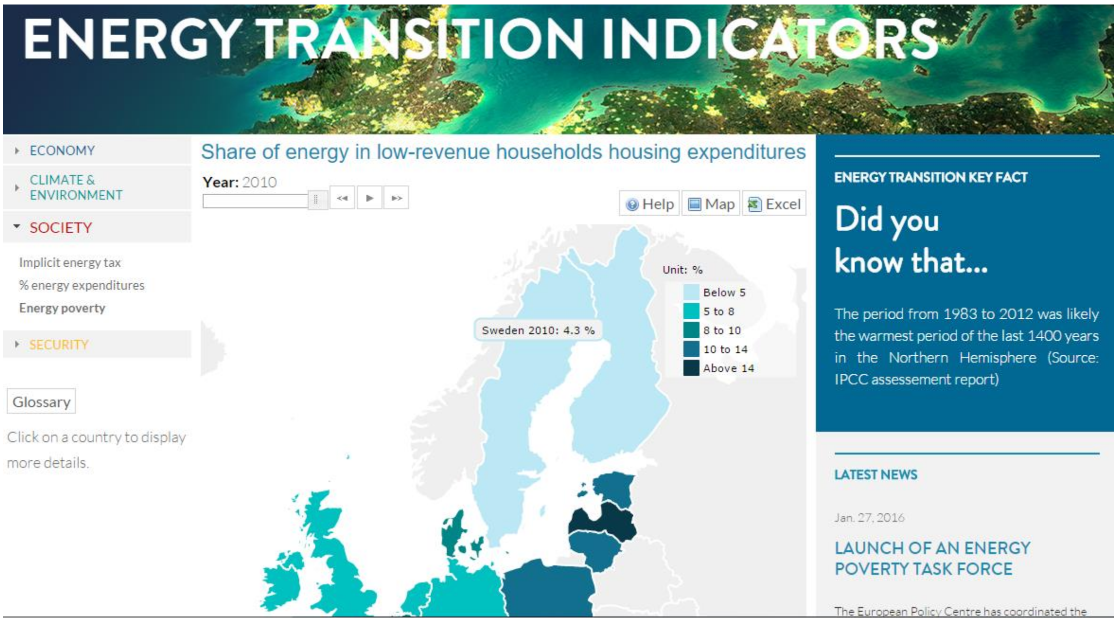
- **Implicit tax rate on energy:** Ratio between energy tax revenues (inflation adjusted) and final energy consumption (expressed in tonnes of oil equivalent) calculated for a calendar year. Energy taxes are environmental taxes and include energy excises and CO2 taxes; VAT is not included here.
- **Share of energy in households housing expenditures** - This takes into account electricity, gas and other fuels for housing purposes; this indicator doesn't include fuel expenditures for transport.
- **Energy poverty** (Share of energy in low-revenue households’ housing expenditures) – It is similar as the previous indicator, for low-revenues households of the first quintile, i.e. the 20% of households with the lowest revenues.

INSIGHT_E’s main function is to provide scientific support to policymakers and the policymaking process. Although most reports include policy recommendations, the organisation’s main aim is to produce high quality scientific and technical materials. To this end it aspires to house all data, models and assumptions that are used in its work and to provide these to others as a scientific foundation.

The main audience for INSIGHT_E’s work is policy officers at the EC. It acts as a body that informs officers within the Commission. About 80 percent of the intended audience are policy officers at the Commission while the remaining 20% would be professional engineers or researchers at research institutes. There is also a search tool on INSIGHT_E’s website that is more oriented towards the general public, but this is not considered a significant target audience.

[48] http://www.insightenergy.org/

Figure 4-2 Energy Transition Indicators for Society in the INSIGHT_E Observatory



INSIGHT_E's budget is approximately EUR 650K per year (based on an overall allocation of EUR 2 million over three years). About EUR 75K of this went to set-up costs, namely creating the IT infrastructure and an intranet for partners to store data, documents and models. IT costs consume very little of the annual budget on an ongoing basis. Personnel is by far the biggest running cost at between 60 and 80 percent of the annual budget. Other costs include overheads and travel. A recently produced 'Energy poverty toolbox' involved time from 5 of 12 partner organisations. The report took between 8 and 16 person months to produce at a cost of approximately EUR 5K per person-month for a total cost of EUR 40K – 80K. The consortium's funding comes entirely from the European Commission.

The governance structure includes 12 institutional partners and 7 work packages. An Executive Committee is made up of the heads of the 7 work packages. KTH is the institutional centre and coordinator across the 12 institutional partners. There is also a General Assembly that meets twice a year to vote on the direction of the consortium, new research topics, issue positions that need to be taken, and to deal with larger issues affecting the entire consortium.[49]

4.1.4 *The Belgian Energy Poverty Barometer[50]*

The Energy Poverty Barometer is an initiative in Belgium of the Platform Against Energy Poverty, managed by the King Baudouin Foundation, based on research by Antwerp University and the Free University of Brussels. The first barometer was published as a report in 2015 identifying three different types of energy poverty for Belgium as:

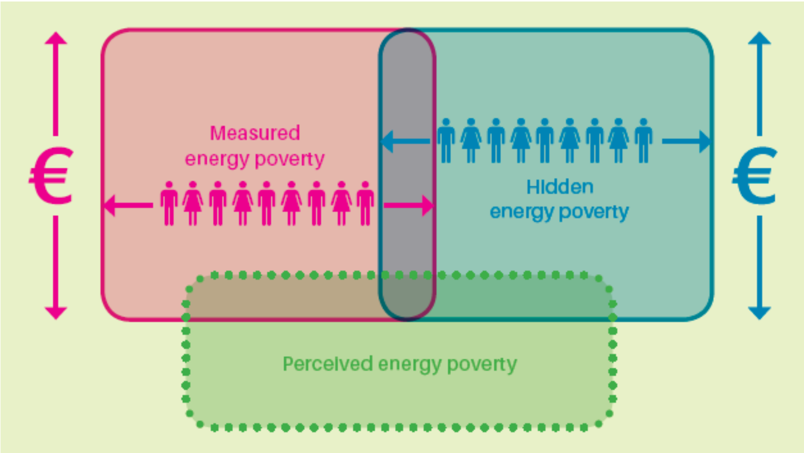
- **Measured energy poverty (MEP)**, is the proportion of households which devote too high a percentage of their disposable income on energy expenditures.
- **Hidden energy poverty (HEP)**, is the proportion of households which have a low energy expenditure due to the fact that they restrict their energy spending below what is necessary to meet their needs. HEP and MEP can occur simultaneously when a household spends a high percentage of its income on energy and still cannot meet its energy needs.

[49] Information for this section was obtained from an interview with Abhishek Shivakumar, KTH Project Manager for INSIGHT_E, held on 11 March 2016.
[50] https://www.uantwerpen.be/nl/onderzoeksgroep/oases/onderzoek-en-publica/onderzoeksprojecten/energiearmoede/

- **Perceived energy poverty (PEP)** is defined as households which report to experience financial difficulties in paying their energy bills, not all of whom would be included in the above indicators.

The expenditure threshold for MEP is equivalent to twice the median ratio between the energy expenditure and the overall incomes[51]. HEP considers "too low expenditure" to be half the expenditure of similar households, calculated as the average expenses between the median of households of the same composition (number of people) and size (number of rooms). Both calculate the measure of the number of households affected as well as the "energy poverty gap" (in €) that separates each household from the threshold regarded as an acceptable limit. These indicators focus on the poorest five deciles and are compared regionally as well as across household types, and vulnerability to generalized poverty, to determine those most at risk.

Figure 4-3 Key indicators of the Energy Poverty Barometer



The main intended audience of the Barometer are several stakeholders: policy makers and administrations, associations, scientists, energy providers (all kind of energy vectors), network managers, members of the different public centres for social action, etc. (nearly all of them are represented in the Platform against Energy Poverty and see the Barometer as a major supporting tool).

Main functions of the Barometer are dissemination of information, raising awareness of stakeholders about the complexity and extent of the issue, provision of analysis of the trends (evolution of the indicators), influence to policy in such a way that the results are in line with the field experiences, sharing and discussion of recent findings in the topic with a large number of stakeholders.

The Platform against Energy Poverty is responsible for the Barometer. Results are presented and discussed with stakeholders, who are taking part in the Platform. Stakeholders from different fields of activity (private market, associative world, social support, administrations, energy network managers, scientists, etc.) are involved.

4.1.5 *Wakefield Observatory*[52]

[51] Delbeke, B. and Meyer, S. (2015).
[52] http://observatory.wakefield.gov.uk/dataviews/view?viewId=445

The Wakefield Observatory is a small initiative of Wakefield Council, a local authority, near Leeds in England. Building on the Low Income High Cost (LIHC) indicator, the Wakefield Observatory of the Wakefield District, UK, provides relevant local data to the public on households living in energy poverty in several formats, including a map of the district showing the regional concentrations of affected households.

The main audience for the tool is public authorities including local government officers working within the local authority area and partner organisations. The tool is also used by community groups interested in finding funding or trying to get projects off the ground, as an evidence base. Wakefield Council has a fuel poverty team and runs the Observatory as one of several measures to address the issue in a complete way rather than to respond to any specific demand for fuel poverty information. Even from the concept stages of the Observatory it was envisaged that the audience would be broad. What the organisers have found in practice is that the people who use the council's services in this area tend to be people who do not have a lot of analytical capacity in their own organisations. This includes smaller charities and NGOs, but also government offices that do not have a lot of support who want to understand local conditions.

A main functionality of the tool is to consolidate scattered data and organise information for Wakefield. Visualisation is an important function and the Observatory's maps are often used to allocate government money, for insulation for example, as it is possible to pinpoint the districts that are most fuel poor and would benefit most. Wakefield is a district with significant levels of general deprivation so there is substantial demand for information about poverty generally. A key functionality of the Observatory for Wakefield Council is showing where inequalities exist.

Set up costs for the Observatory were between £20K and £50K. This included buying the software and licenses to operate the website and paying for staff time to manage the set up. The Observatory was set up with central government money under a program to improve regional efficiency and governance. Running costs are less than 10K per year for contractual fees (software, maintenance, hosting) plus £10-£15K per year in local government officer time. Running costs are paid for out of Wakefield Council's core fund. It took approximately 18 months from the time the funding arrived from the central government until the full Observatory was up and running. The Observatory has been running for 7 years now, and costs have not increased.

Responsibility for running the tool is distributed between Wakefield Council and external data service providers. Wakefield Council uploads some of the data itself but it also has a contract with a data provider who produces data quarterly. Wakefield Council holds final responsibility for keeping the data up to date and for governance activities. The external data provider is a spin off organisation from Oxford; OCSI – Oxford Consultants for Social Inclusion. OCSI searches and filters central government data and aggregates it into geographies of interest. They are paid a fixed amount per year for the data. There is also an external organisation that provides hosting services and software.

4.1.6 ODYSSEE-MURE

The Odyssee-Mure platform provides indicators, policy measures per MS, and publications on the topic of energy efficiency. It is a tool funded by the Intelligent Energy for Europe program, launched by the French environmental agency ADEME with support of Enerdata, Fraunhofer, ISIS and ECN. While the online database does not include a direct measure of energy poverty, several relevant indicators at household level are provided such as energy efficiency gains per year, and total energy consumption. It is also a useful example of how complex data sets can be shared with the public in an interactive and visually appealing format, allowing for comparison across countries and sectors.

The main functionalities include information gathering and data visualisation and dissemination. The site is intended as a 'one stop shop' where both data and analysis are available. There is a minor function of influencing policy but really only to the extent of providing good quality information. One intended audience for ODYSSEE-MURE is policymakers at the national level and EU level. Another audience is energy analysts at consulting companies and universities who use energy data. Today policymakers use it more intensively than was initially intended. The team has made an effort in the last two years to simplify access to the site's features for a broader audience.

The total project budget is EUR 1.6 million over 2.5 years. Salaries constitute over 90 percent of the project budget and go to individuals responsible for updating the data and adapting the tool as its user base and capabilities evolve. The information technology component costs less than 10% of the budget.

In terms of management structure and responsible agents there is a clear hierarchy in management. ADEM (France) is the overall coordinator, with the French company ENERDATA running the technical aspects. The technical coordinators are responsible for the smooth operation of data collection, site updates, and quality control. When issues arise, this is the coordinator's job to fix. This clear hierarchy helps in running such a large project. The governance function is performed through regular seminars with project partners and stakeholders. In these seminars ideas are presented and discussed – it is an interactive process of governance. External events are run in the form of workshops so that additional feedback can be incorporated into the website functionality. This includes feedback from members of the EC. Outside of the seminars and workshops, there are technical coordination groups. These are smaller, made up of 6-7 people who bring together stakeholder feedback and consolidate it into new concepts and directions for the project.[53]

4.1.7 Other existing tools and annual reports

We are aware of other relevant tools; the ones reviewed were deemed the most relevant. Others we are aware of include the Multi-dimensional Energy Poverty Index (MEPI) and the UK's Annual Fuel Poverty Statistics Report.

The **MEPI**[54] is a tool developed by UN-Energy to assess energy-related deprivation, with a focus on the developing world. It is an index combining both a measure of the incidence of energy poverty (headcount), and a quantification of its intensity by region or country. This kind of breakdown is

[53] Information for this section was obtained from a telephone interview with professor Wolfgang Eichhammer, Project Lead for Odyssee-Mure, Fraunhofer Institute on 22 March 2016

[54] http://www.un-energy.org/measuring-energy-access

intended to allow for greater understanding of the problem, such that policymakers can develop their own appropriate response.[55] The MEPI is created based on a number of weighted indicators from household surveys. Each of these sub-indicators reflects a set of energy deprivations in a key area of basic energy services (e.g. cooking, lighting, household appliances, entertainment/education, and communication).[56] It is evident with the MEPI that a much more severe form of energy poverty is being measured compared to what would be necessary to capture energy poverty on a European scale.

While it is not an online tool, the **UK's Annual Fuel Poverty Statistics Report** aims to provide a comprehensive view of the statistical trends and analysis of energy poverty in England every year. The UK uses the Low Income High Costs (LIHC) indicator, calculated using data from the English Housing Survey (EHS) and the Building Research Establishment Domestic Energy Model (BREDEM) methodology to model household energy consumption. LIHC measures both the number of households and the intensity of energy poverty (fuel poverty gap). The report also provides information on the following drivers for energy poverty: Income, fuel prices, energy efficiency of households (as indicated by the Standard Assessment Procedure - SAP 12). Furthermore, results on energy poverty are broken down by dwelling characteristics (e.g. SAP, tenure, wall type, loft insulation, boiler type, main heating type), household working status, and household characteristics (composition, age of oldest occupant, size, method of payment for gas and electricity).

4.1.8 Overview of the functionalities of existing tools

Table 4-1 summarizes some key findings regarding the functionalities of these initiatives.

Table 4-1 Review of initiatives and their functionalities

Functionalities	ONPE	EU Fuel Poverty Network	INSIGHT E	BE energy poverty Barometer	Wakefield Obs.
1. Measuring and monitoring energy poverty					
Indicator database	×	×	×	×	✓
Reporting on energy poverty metrics	✓	×	✓	✓	✓
2. Information dissemination and outreach					
Policy measure database	✓	×	✓	✓	✓
Best practice case studies	×	✓	×	×	×
Interactive platform for experts (e.g. webinars & events)	×	✓	✓	×	✓
Research and studies	✓	✓	✓	✓	✓
Outreach (e.g. newsletter, events agenda, blog, social media)	✓	✓	✓	×	✓
3. Ad-hoc technical assistance on demand	×	×	×	×	×

[55] For example, Country Y may have a small population of extremely energy poor people, while Country X has a large population with a low level of energy poverty.
[56] Nussbaumer, Patrick, Morgan Bazilian, and Vijay Modi. 2012. "Measuring energy poverty: Focusing on what matters". Renewable and Sustainable Energy Reviews. 16 (1): 231-243.

Added value of an EU tool and anticipated impacts

As shown by the sections above, the third sector and groups behind existing tools have come so far with mapping and bringing data to the issue. However, none of the tools available provide all the functionalities required. Three of the initiatives assessed have a limited geographical focus. A really rich and complete EU level dataset would be something these third sector groups could not easily produce themselves, which DG Energy has the resources to create, and which could add a lot of value to understanding the issue. Further, none of the initiatives provides ad-hoc technical assistance to support public bodies who try to either measure or tackle energy poverty.

An ideal tool for measuring energy poverty at the EU level would therefore build on the insights from the existing efforts, drawing upon data which can be scaled to the EU level, while contributing to a more nuanced understanding of the problem. Thus, this section explores the unique selling points and anticipated impacts of such an energy poverty tool developed by the EC's DG Energy:

- To link government offices responsible for the energy poverty issue in each country / region.
- To provide a common approach towards energy poverty at EU level, providing guidelines to Member States while still giving them freedom to calculate energy poverty metrics.
- To assemble a first-rate **yearly updated** longitudinal **dataset** that researchers can use to study the energy poverty, its causes and consequences.[57]
- To provide spatially-disaggregated **understanding of the energy poverty problem** below the MS level and to allow the comparison and analysis of different energy poverty metrics in time and across Member States, using relevant supporting indicators.
- To support policy makers in targeting energy poverty policy to those most in need.
- To provide **ad-hoc support** to Member States in measuring and monitoring energy poverty.

4.2 Design options for the tool

This section proposes three options for how an energy poverty tool might function and generate the above impacts. In developing the tool options several things were considered, including the functionalities of tools that already exist and do not exist, as well as the evidence about the best way to systematically and quantitatively measure energy poverty across EU MSs, and the practical aspects of getting an effective tool up and running in a reasonable period of time and at reasonable cost.

The options presented depend on the target group that will use the tool. There is a range of audience types that could be served by the tool. Initially, the focus has been set to policy makers and authorities who are on the front lines of the issue today, with an eye to including other potential user groups as appropriate (researchers, experts and practitioners, students and journalists, etc.).

4.2.1 Main options for the tool

The main three options for the tool differ principally in the way they handle governance, e.g. how responsibilities for running it are distributed and managed. These options are listed below, from the least involved to the most complex governance approach:

- **A. Web-app tool integrated into an existing platform**
- **B. New energy poverty platform**
- **C. New energy poverty platform with MS involvement**

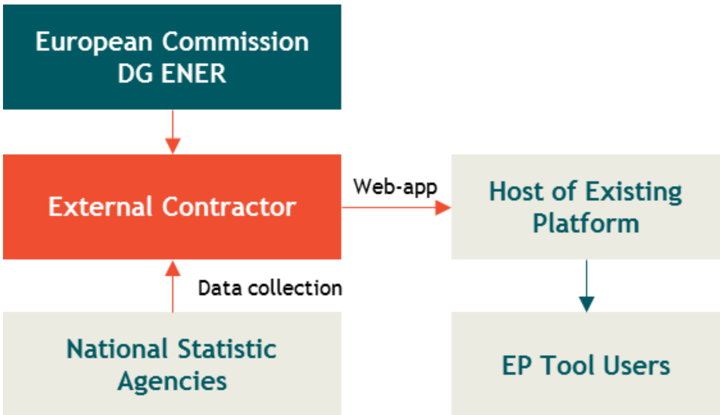
[57] In a similar way as PATSTAT, which is an EU database of patents available to economics of innovation researchers.

These options are further explained below, along with their main strengths and weaknesses. The content for the tool itself will be modular and is presented in Section 5.3.2. The main governance options can be combined with different modules according to the EC's preferences to create the final options.

A. Web-app tool integrated into an existing platform

The first, least-involved option is expected to be the most affordable, but does not include a full range of capabilities. The tool would be a web application interface that could be integrated into an existing website or platform and there would be no dedicated communication except that initiated by the host website/organization. Further, this governance structure does not allow for ad-hoc support to MS authorities. Annual updates would be done by an external contractor who would deal with data collection and indicator calculation at MS level.

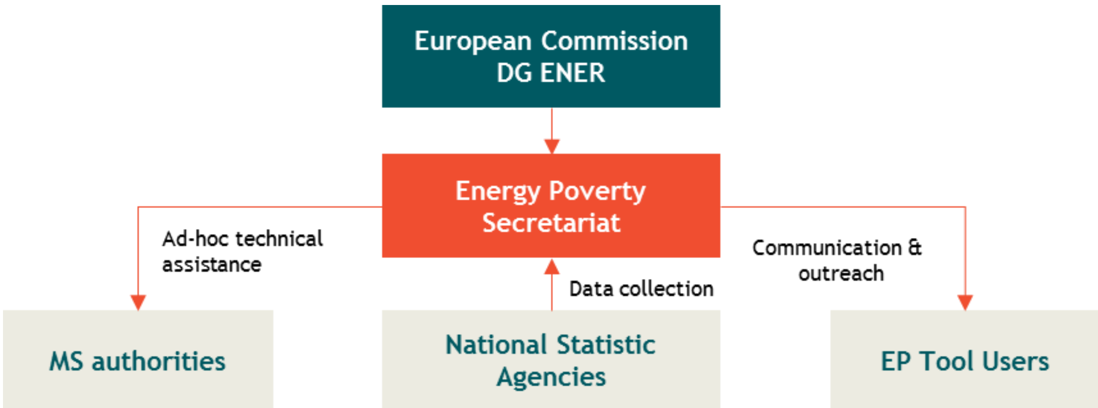
Figure 4-4 Option A. Governance structure for a web-app integrated into an existing platform



B. New EU energy poverty platform

The second option would involve a new EU platform to deal with energy poverty, run by a dedicated secretariat formed by experts on the topic. This would streamline the implementation and allow for adequate follow-up and guidance to give the tool direction and utility. Data collection would have to be done by the Secretariat itself or an external contractor.

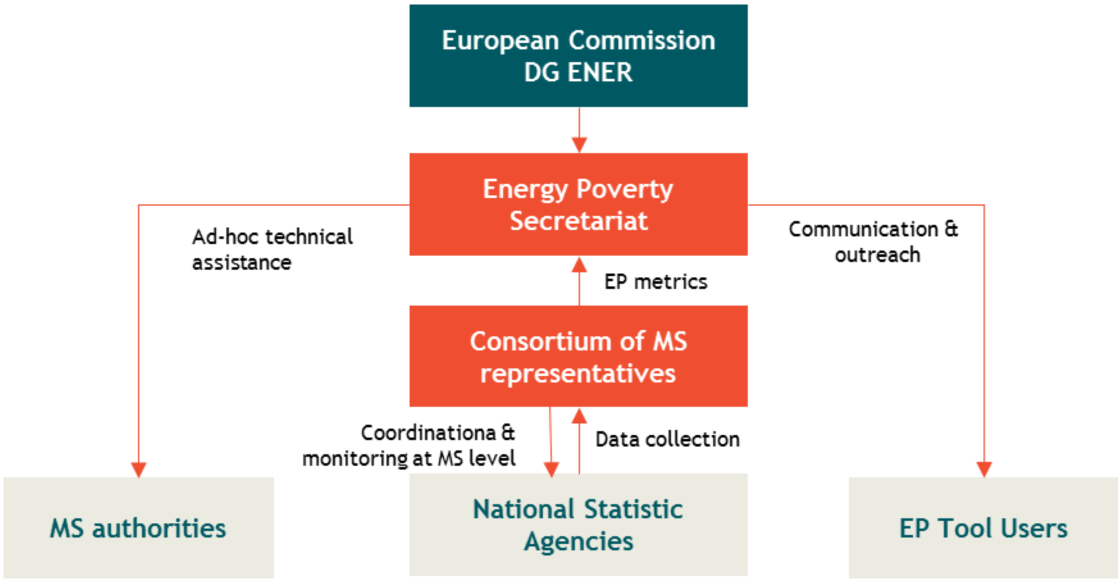
Figure 4-5 Option B. Governance structure for a new energy poverty platform



C. New energy poverty platform with MS involvement

This option is the most "involved" with regard to the level of engagement, but would elevate the tool towards being an independent authority on the topic of energy poverty in the EU. Besides the set-up in option B, it would also include contact to all MSs via a Consortium of MS representatives (e.g. from energy agencies or statistic agencies). This would allow for coordination of monitoring in all MS and the possibility to implement the same methodology for measuring energy poverty across MS. This would also facilitate data collection at MS level and integration into the tool, as well as dealing with confidentiality issues. However, the process to get all Member States involved would be complex and time consuming.

Figure 4-6 Option C. Governance structure for a new energy poverty platform with MS involvement



There are two key issues related to the options that are further discussed below.

Annual data collection

In order to update the energy poverty metrics, microdata at household level should be collected annually. Ideally, this should be done via Eurostat in a streamlined and consistent process, which would allow the EC to have timely access to accepted, reliable and comparable data. However, the Household Budget Surveys (HBS) are not yet reported to Eurostat annually or at household level. **An alternative, which would allow to gather all data directly from Eurostat, would be to include a question regarding energy expenditure as part of SILC.**

Given that these options would only be available in the future, the available options at the moment require accessing Member State microdata for HBSs. With option C, this accessing national data should be fairly straightforward via the national representatives; while with options A and B this would have to be done either by the Secretariat or an external contractor. This would require – in many cases – a long registration process as well as high fees (per survey and per year required) with several statistics agencies to get access to microdata. Registration would only be required the first year, which is also where the highest costs should be expected, since payment is often done per year of data. The first data collection would be done for a period of 10 years, and then only for the latest year available.

A new vs existing platform

Options B and C involve the development of new independent websites or platforms to host the tool while Option A aims to use an existing platform. While it is a costly and timely endeavour, the main advantages of a new platform are that it will be independent and tailored to the specific requirements, allowing to include information as needed and to target selected audiences. While, on the other hand, integrating the tool to an existing website has lower costs as well as faster implementation and outreach (making use of the existing network and communication platform). However, the existing initiatives are dependent on other organisations with all the restrictions that this might imply (such as limiting the content development).

As shown earlier in this chapter, there are several platforms and initiatives in the field of energy poverty both at the national and at the EU level. Most countries have a group of experts working on the national studies, strategies or programmes monitoring or reducing the impact of energy poverty. While it is possible to build a new platform, such a tool could also build upon the existing platforms and networks, especially:

Options	Assessment
The INSIGHT_E observatory	× FP7 project with limited time/budget × Not focused on energy poverty, it's only one of the topics it covers ✓ Covers EU28
The EU Fuel Poverty Network	× Seems to have limited outreach ✓ Focused on energy poverty
French National Observatory of energy poverty - ONPE	× Only covers France, limited outreach ✓ Focused on energy poverty
Building Stock Observatory	× Not focused on energy poverty ✓ Still under development, could consider this at development stage ✓ DG Digit will be responsible for further operation of the web
Odyssee Mure	× IEE project, with limited time/budget × Focused on energy efficiency and RES indicators (not energy poverty) ✓ Cover EU28 ✓ Includes a communication platform

4.2.2 *Content Modules*

For each of the options different content modules can be implemented as presented in the table below with their advantages (✓) and disadvantages (×). These modules can be added to each of the different tool options providing more or less functionality. The modules are structured in four main sections: 1) energy poverty metrics, 2) energy poverty policy, 3) dissemination, and 4) technical assistance.

Energy poverty metrics

Modules / Options	Assessment
Factsheets or reports with energy poverty metrics	× Compiled and aggregated presentation ✓ Comparable across MS
Regularly updated, spatially-rich energy poverty indicators database & dashboard (Static content and limited user interaction via filters e.g. year, MS, metric)	× Member States cannot decide/implement their own energy poverty definitions ✓ Comparable across Member States ✓ Allows countries to see and choose from the different metrics defined by the EC

Modules / Options	Assessment
Regularly updated, spatially-rich energy poverty indicators database & dashboard (Strong user interaction including option to also choose the population affected and threshold for expenditure based metrics)[58]	✗ Need a household level database included for each country to be able to calculate energy poverty metrics based on user input ✗ No clear message regarding the amount of energy poverty, acknowledging the complexity of the issue ✓ Users have the ability to choose certain parameters to adapt the metrics to their MS definitions ✓ Allows to target the results in a specific part of the population if so required
Inclusion of country-defined indicators as calculated by others e.g. UK LIHC, ONPE & Belgium's Fuel Poverty Barometer	✓ Provides indicators measured at national level, with higher level of detail than what can be obtained by the tool ✓ Improves legitimacy of the tool by incorporating existing standards ✗ Assumptions between country data and the calculations from the tool could differ, leading to differences in the results ✗ Some data will be available only for certain countries and will not be comparable ✗ Additional effort to contact national points and to make data compatible with the tool
Mapping function	✓ Interactive map with MS and regional values ✓ Allows for comparison within MS

Note that there are two main choices behind the database on energy poverty metrics, depending on the way in which the metrics are calculated:

- **Web-based application** which allows to use all input data from SILC and HBS at household level to calculate the metrics directly as part of the tool. While this allows for automatic calculation of metrics, transfer of data and display of the results, it requires a more complex approach when developing the website. Further, it might run into confidentiality issues, since the calculations require household-level data which statistic agencies are sometimes reluctant to share.
- **Separate statistical calculation software** which requires a two-step approach where first the metrics are calculated using statistical software[59] and then the aggregated results are uploaded into the tool. This approach would allow for standardised calculation of metrics by different stakeholders (e.g. could be done by national statistics agencies, country experts, external contractor, etc.) avoiding any potential confidentiality issues.

In either case, the calculation tool should be combined with additional manual QA to ensure that results are adequate. This combines fast automated calculation performance with the opportunity for manual corrections. QA review of the results will be performed by the organisation responsible for tool management.

[58] The following user choices could be given:
- **Population**: All households, selected quintile(s), selected decile(s), households at risk of poverty.
- **Income (equivalised for household size):** Total after-tax income plus social benefits per household/person, Income minus housing costs per household/person, Income minus all minimum living costs per household/person
- **Energy Expenditure Threshold**: Fixed threshold, e.g. above 10% of income; 2x national median; No threshold
- **Hidden Energy Poverty Threshold**: Fixed threshold, e.g. below 5% or €5/capita; Below 'adequate' energy expenditure share according to household size/composition; Half of national median
- **Unit**: Headcount (# or % of population); Intensity (€)

[59] Such as STATA which was used for this assignment

Energy poverty policy

Options	Assessment
Searchable archive of policy reports from the European Commission, Member States, academia and other stakeholders	× Limited comparability across Member States ✓ Least cost ✓ Builds on existing research and limits additional work ✓ Own research could be added as well
Country factsheets on MS energy poverty policy & best practices	× Increased amount of work to gather MS info in a comparable way ✓ Comparable factsheets for Member States ✓ Best practices which can be replicated across MS ✓ Work could build on INSIGHT_E national reports
Policy section with full database of energy poverty measures at MS level	× Increased amount of work to create database of policies × Need for additional application/database to be included in the tool ✓ Complete and detailed information for stakeholders ✓ Comparable information at MS level ✓ Work could build on INSIGHT_E national reports ✓ In the future could be linked to information regarding impact of policies on energy poverty

Dissemination

Options	Assessment
Events section	× Events need to be checked before being posted ✓ Allows for participants to include their own events ✓ Opportunity for direct discussion and feedback
Stakeholder network	× Additional costs × Dedicated follow-up to maintain network activity needed × Requires content check to ensure accuracy and credibility of the contributions ✓ Tailored outreach for relevant topics ✓ Support professional discussions about the published data ✓ Sharing of information among researchers and practitioners in the EU enables discussion on energy poverty and how to tackle it ✓ Allows for the creation of a dedicated list of stakeholders
Expert contact database	✓ Limited time needed for set-up ✓ Useful for dissemination, validation, plan activities, etc. × Confidentiality issues
Newsletter	× Time consuming × Requires a dedicated person to prepare content ✓ Fast and regular way of actual information and news dissemination
Consolidated news feed	✓ Consolidated news portal with stories on energy poverty policy developments from around the EU28, updated daily such as a Bloomberg or RSS feed. ✓ The most actual information provided regularly on one place ✓ Allows comparison of latest policy aspects across member states × Time consuming × Requires a dedicated person to prepare content and daily updates
Educational section	✓ Video or other high-level educational section on how energy poverty comes into existence in the EU, through a combination of electricity market reform, poor housing stock, ordinary poverty, and energy price variability ✓ Accessible for all users ✓ Efficient way of information dissemination among households × Not relevant for all audiences and for decision makers × Has to be clear for laypersons as well
Social media (e.g. Twitter, LinkedIn, YouTube channel, etc.)	× Time consuming × Requires a dedicated person to prepare content ✓ Increases outreach of the tool ✓ Very fast dissemination

Technical assistance

A section, focused on assisting public authorities with preparation and planning for monitoring energy poverty or policy measures addressed to it, will be available. This section will assist state, regional or local authorities in understanding the current state of the issue and support their planning of appropriate actions. Besides the possibility to submit technical assistance requests, the following will be available:

Options	Assessment
Regularly updated list of local authorities responsible for dealing with energy poverty directly and national authorities responsible for policy	✗ Time consuming for set-up ✓ Could build upon existing projects ✓ Can increase collaboration among different member states' authorities
Register of firms, energy auditors, efficiency companies, equipment manufacturers that have products or services that would alleviate aspects of energy poverty	✓ Facilitate search of required service/product ✓ Increase awareness of audience in such products/services availability

4.3 Roadmap

Based on the recommendations provided, a step-by-step roadmap for the implementation of the tool was drafted. It includes key activities for each step: planning, testing[60], implementation, monitoring and evaluation.

4.3.1 *Planning and development (Estimated 12 months)*

During the planning stage, a detailed design of the tool is developed and programmed – taking into account simplicity and user friendliness. The main activities include:

- **Define target group:** First it's important to identify users more closely: it can be done using user interviews, stakeholder interviews and the "shadowing" method of observation.
- **Define functionalities and design elements of the tool** based on the information provided in the previous sections and an in-depth analysis of the requirements of the target audience.
- **Choose statistical calculation software and purchase of licence if needed** which is aligned with the common approaches used by the EC and national statistical agencies.
- **Define operating rules, user profiles and accessibility:** This includes defining which party will be responsible for the tool operation and its contents, as well as any legal issues regarding accessibility and confidentiality. Contents should be accessible at different levels: public results and private section of the tool (e.g. for EC and national agencies). There should be defined roles and rights for administrators, operators and registered users (if any). Security could be ensured through user authentication.
- Validate via stakeholder consultation exercise to be carried out by consultant.

[60] The testing phase should be highlighted. We consider it to be of great importance that such a tool is tested with stakeholders / end-users before going live, to make sure that the tool is user friendly and also to avoid unnecessary complexity. This step focuses on optimising the tools devised to manage the functionalities and make sure they are user friendly and dynamic.

- **Develop structure and interface of the web-app (Option A) or the platform (Options B and C):** This step includes the development of the graphical user interface (GUI) design in line with EC guidelines. The design process includes sketching and creating prototypes that will simulate the real application (done in parallel with the testing phase). The next step is programming the graphical user interface, as well as preparing it for the output of results. The developer should also recommend at this stage the most appropriate type of physical storage of data for the input data, results of calculation, database of policy measures (if applied), etc.
- **Develop manual:** The developer of the tool will also develop a detailed manual for its correct maintenance, update and further development.

4.3.2 Testing (Estimated 3 months)

This stage aims to test the web-app or platform at different levels and to optimise it based on the feedback received:

- **Testing** will be done while programming as well using technical/automated tests and also via a focus group. The most important stakeholders will be recruited experts in the field of energy poverty evaluation and who have been involved in the development of the existing energy poverty tools discussed in previous chapters. Key aspects to be qualitatively checked during testing include design, functionalities, consistency across the platform or web-app, user friendliness & convenience, content, navigation, presentation of results. Additional testing, from an operation perspective, would include checking for input of data, calculation of metrics, and reviewing results. Further testing will be performed during the first month of operations (pilot version).
- **Optimisation** of the interface based on feedback from testing. Further optimisation, e.g. code quality, site speed, metadata will also be performed at this stage.

4.3.3 Operation (Continuous, quarterly and annual updates)

This phase includes operation of the tool, including data collection and calculation of the energy poverty metrics. Main steps during the operation phase include:

- **Annual data collection:** Performed by an external contractor, an energy poverty Secretariat, or a consortium of Member States in cooperation with national statistical offices and Eurostat. We recommend having updates at least once a year with a continuous errata system (corrections of errors when they are found).
- **New content** will be developed and uploaded into the web-app or platform.
    - **Annual update of energy poverty metrics** based on new data collected.
    - **Annual update on energy poverty policy content**. If possible, the governing organisation should explore and develop the tool to link data to policy measures, financial support and potential side-effects and co-benefits (e.g. impacts on the environment and health, economic effectiveness, etc.).
    - **Communication and outreach at EU level** (if selected).
- **Ad-hoc technical assistance:** The EP Secretariat will also receive ad-hoc requests from MS authorities for technical assistance. This can include among other things:
    - Recommendation on appropriate energy poverty metrics for the specific MS;
    - Calculation and analysis of energy poverty metrics using household-level data and country specific parameters;
    - Design, impact assessment and evaluation of energy poverty policies.
- **Training:** Training is required at different levels.

- **Responsible stakeholders:** Training for data updates, quality control of results and content, as well as training on operation of the tool to be provided by the tool developer. In order to limit costs this could be done via webinars. Alternatively, especially for Option C a one-day workshop is suggested.
- **Training of users:** Training of new users will be provided as well by the tool developer. This should be done via webinars and e.g. interactive guidelines or helpful comments/hints available in the platform/web-app itself.

- **Operation of independent web/integrated tool:** Operation of an integrated tool would be overseen by the organisation operating the host website. In the case of an independent website, the EC via an external contractor or EP Secretariat would take on this role.

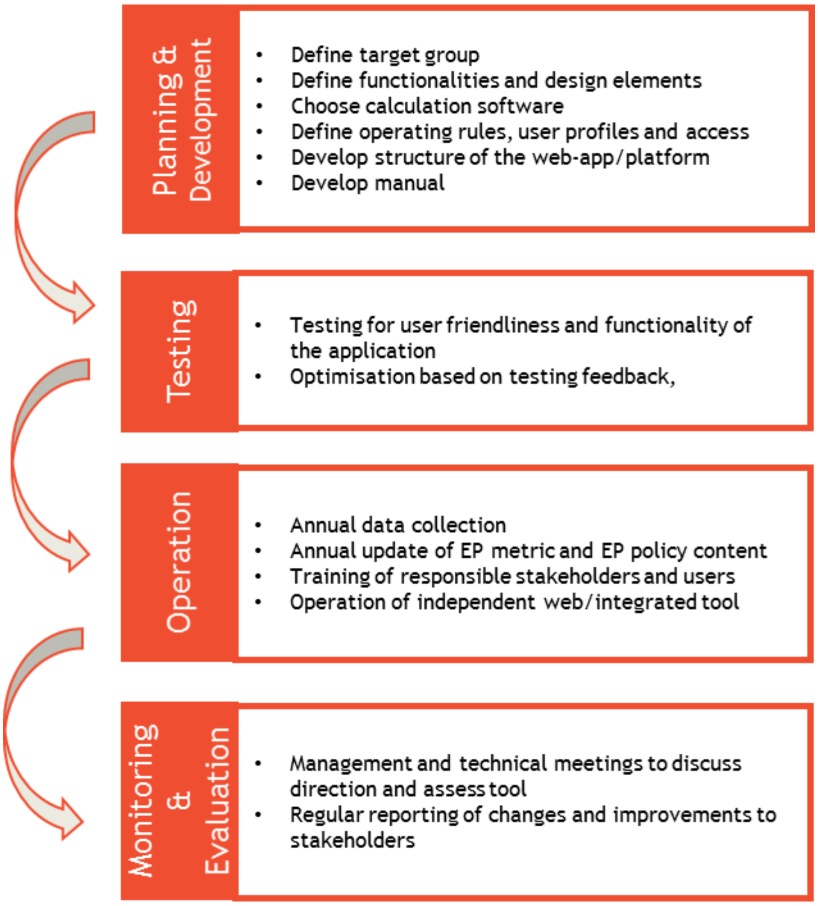
4.3.4 Monitoring and Evaluation (Continuous)

Monitoring and evaluation should be performed continuously. This includes the following:

- **Review of impact metrics** using a simple service such as Google Analytics, to observe article reads, site hits, newspaper mentions of the site, experts registered, etc. This will allow proper follow-up and improvement. An additional option such as a systematic user survey function to gather user experience of website, preferences, what documents viewed, hit rate per week could also provide relevant metrics to constantly monitor and improve the site.
- **Management and technical meetings** to discuss direction of the tool and to assess the tool. This can also include review of the metrics and input data available, as well as discussion of additional functionalities or user requirements. Based on feedback from the users during operation, design and functionality changes can be proposed at this stage, the new design (in case of changes) will be tested again. Information quality will be regularly evaluated to ensure that the content is of high quality, accurate and has a full coverage of the presented aspects. Depending of the governance option these meetings can be more or less frequent.
- **Regular reporting of changes and improvements to stakeholders:** The governing organisation should inform stakeholders regularly about changes and improvements (e.g. via the website or newsletters).

The diagram below provides a summary overview of the issues that should be considered at each stage.

Figure 4-7 Overview of the roadmap for tool implementation



5 Conclusions and Recommendations

As explained in the conceptual chapters (2-3), energy poverty is a situation in which households are not able to adequately heat their homes or meet other required household energy services at an affordable cost. This research concludes that energy poverty is a **complex and multi-dimensional concept** that is not adequately captured or measured in empirical reality by any single quantitative indicator. Because the *idea* of energy poverty is itself multi-faceted, it is adequate to monitor is from a set of few, but conceptually different indicators. We suggested four different metrics in this study: share of income spent on energy is above twice the national median (2M), share of income spent on energy above the median *and* income after energy costs is below poverty line (LIHC), expenditure on energy is below half the national median (HEP) and inability to warm house appropriately (warmth). These metrics can assist MS measuring energy poverty.

A wide range of indicators was assessed in the study in order to capture aspects of a basic dimension of energy poverty within households. The principal challenge in developing a reliable set of indicators was to identify key components of income and energy expenditure that are either measures of energy poverty in themselves (poverty metrics) or that will complement them (supporting indicators). The number of energy poverty metrics and supporting indicators tested was limited to the most suitable (according to the assessment in Chapter 4) in order to keep time and cost requirements of set of indicators in terms of data collection and analysis relatively low.

Based on the desktop review, testing and validation, we conclude with the list below of recommended indicators, that reflect powerfully on different aspects of energy poverty and for which credible information can be relatively quickly and inexpensively obtained via existing surveys. The four metrics of energy poverty suggested in the table below capture a very broad and versatile idea of energy poverty. Households that cannot meet required energy services at an affordable cost may be compromising on other kind of important expenditure (which is captured by 2M and LIHC), or else they might be compromising on energy expenditure (which is captures by HEP and warmth).

Table 5-1 Primary energy poverty metrics

Approach	Metric	Data requirements
Expenditure-based using actual expenditure	**Share of energy expenditure** (compared to equivalised disposable income) **above twice the national median (2M)**	<u>**HBS:**</u> • Equivalised income • Taxes • Energy expenditures
	Low Income High Cost (LIHC): If the energy expenditures are above the median level and if they spend this amount, their residual income is below the poverty line	
	Hidden energy poverty (HEP): Absolute energy expenditure below half the national median	
Consensual-based	Inability to keep the house warm **(Warmth)**	<u>**SILC**</u>

All expenditure-based metrics should and can be expressed both in number of households (extent) and as energy poverty gap (depth). The energy poverty gap aims to show the amount of financial support needed so that these households are no longer energy poor.

The choice for the metrics presented above is based on their theoretical simplicity, ease of implementation and data availability across the EU. More sophisticated metrics can be implemented, but they would also require additional and more detailed data. Particularly regarding *required* energy spending (which would require having information about the energy efficiency of the building) and minimum income standards (which should ideally be defined at the sub-national level in a participatory manner). It would also be possible to further improve the data available from existing surveys. As mentioned in the report, while there have been efforts for harmonisation, differences remain in frequency, timing, content and structure of the Household Budget Surveys. A number of recommendations are available to improve datasets at the EU level to further enhance the measurement of energy poverty. One specific simple recommendation is to include a variable in the SILC survey that refers to the total energy spending. If this were the case, it would be possible to calculate all energy poverty metrics from this survey.

However, these metrics are not ideal and policy-makers may have good reasons to adapt the structure of the metric to a specific situation that they encounter, in particular expenditure-based metrics. This would require changing the thresholds to which energy expenditure is compared. The energy poverty metrics are very sensitive to these choices. Small changes in the threshold choice, could in fact, bring about large differences in the energy poverty metric results. The advantage of using thresholds that are based on actual medians is that it incorporates the distribution of energy spending patterns in the population, reducing the risk of picking a threshold that is close to the high sensitivity area. Such relative metrics are used in the three recommended expenditure-based metrics: 2M (twice the median share), LIHC (40% median disposable income and median share) and HEP (half the median absolute expenditure).

Refining the parameters and main design requirements of an online energy poverty tool is the main next step recommended by this report in terms of next practical steps for DG Energy on the issue. Such a tool should be sensitive to DG Energy's unique capabilities and responsibilities on the issue, existing civil society activity on this issue, and the needs of expected tool users and broader stakeholders.

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7 Annexes

Annex 1 Methodology and Technical Report

See separate document.

Annex 2 Database of relevant indicators

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Population at risk of poverty or social exclusion	%	share of people below the poverty threshold or in a situation of severe material deprivation or living in a household with very low work intensity	Supporting	Demographics	2.8
RHPI	-	Regional human poverty index (RHPI) comprising four dimensions: social exclusion, knowledge, a decent standard of living, and a long and healthy life.	Supporting	Demographics	2.2
AROP	%	At risk of poverty or social exclusion rate. Measured as the share of people with an equivalised disposable income (after social transfers) below the at-risk-of-poverty threshold.	Supporting	Demographics	2.3
Population unable to make ends meet	%	Percentage of population unable to make ends meet (source: SILC) [ilc_mdes09]	Supporting	Demographics	2.8
Demographic division of the tenants	Age	Includes the shares of tenants in given demographic categories (preproductive, productive, postproductive). The demographic categories are 0-4. 5-9 etc.	Supporting	Demographics	2.8
Ownership & tenure	%	Breakdown by ownership & tenure among low income households	Supporting	Demographics	2.6
The percentage of under-occupied households	%	Under-occupancy is defined in terms of the 1968 Parker Morris standard and the bedroom standard which gives a minimum floor area for a home depending upon the number of occupants. The calculated standard for the household is then compared with the actual number of bedrooms available for its sole use.	Supporting	Demographics	2.5
Tenure status	Qualitative	Tenure status	Supporting	Demographics	2.1
Proportion of children, working age adults and pensioners living in households with low incomes	Number & %	It consists of the percentages of children, working-age adults and pensioners living in households with equivalised income below 60 per cent of median (before housing costs). Net equivalised income before housing costs (BHC) consists of income from all sources net of National Insurance Contributions, Income Tax, Council Tax, private/occupational pension contributions, child maintenance payments, parental contributions to students living away from home, and student loan repayments.	Supporting	Demographics	2.6
Elder population (main tenant above 65)	Number	Reflects the share of dwellings with predominant retired tenants. The characteristic is described through the age of the tenant (above 65).	Supporting	Demographics	2.8
Household type (family composition)	Qualitative	A common classification was developed by Eurostat constructed by reference to the numbers of adult members, their age and gender, and the numbers of dependent children living with them.	Supporting	Demographics	2.5
HH020: Occupier's status	Qualitative	HH020: Occupier's status	Supporting	Demographics	2.8
Customers on prepayment meters for gas and electricity	Number of customers (m)	Customers on prepayment meters for gas and electricity is one indicator to measure the mumber of customers on pre-payment meters	Supporting	Demographics	2.5
DEGURBA (DB100)	Qualitative	The degree of urbanisation of the area where the respondent's household belongs is recorded in the basic SILC variable DB100. The following degrees of urbanisation are considered: DEG1 (Densely populated area); DEG2 (Intermediate density area); DEG3 (Thinly-populated area)	Supporting	Demographics	2.5
HH010: Type of accommodation	Qualitative	HH010: Type of accommodation	Supporting	Demographics	2.7
fuel mix used in production of heat	%	fuel mix used in production of heat	Supporting	Energy demand	2.4
fuel mix of final energy consumption (residential sector)	%	fuel mix of final energy consumption (residential sector)	Supporting	Energy demand	2.5

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
fuel mix of total energy consumption	%	fuel mix of total energy consumption	Supporting	Energy demand	2.5
Final energy consumption per end use per carrier	ktoe	This indicator will reflect the total final energy consumption by end use and per energy carrier. Household energy end use: the use of energy commodities by a household, in order to obtain certain energy service (heating, cooling, how water, etc.). The energy will be divided in different energy carriers: natural gas, fuel oil, coal, electricity, biomass, on-site renewable energy and district heat. Disaggregation of the final energy consumption by carrier will be provided for space heating and domestic hot water.	Supporting	Energy demand	2.6
Theoretical energy use	ktoe	The theoretical energy use is defined as the amount of energy required in a dwelling with an average family using energy for space and water heating, lighting, cooking for an adequate level of warmth. It tends to be much higher than actual energy use due to occupant behaviour, especially for older buildings. This specific consumption is often given for existing dwellings by age bands.	Supporting	Energy demand	2.3
Share of space heating in total residential consumption	%	Share of space heating in total residential consumption	Supporting	Energy demand	2.6
District heating by carrier	ktoe	This indicator will reflect the mix of fuels used for district heating.	Supporting	Energy demand	2.8
Energy consumption for space heating	ktoe	energy consumption for space heating in residential and non-residential sectors	Supporting	Energy demand	2.1
Energy consumption for space cooling	ktoe	This indicator will reflect the total energy consumption for space cooling Space cooling: refers to the use of energy for cooling in a dwelling or building by a refrigeration system and/or unit	Supporting	Energy demand	2.6
Energy consumption for domestic hot water	ktoe	This indicator will reflect the total energy consumption for domestic hot water. Water heating: This energy service is referred to the use of energy to heat water for hot running water, bathing, cleaning and other non-cooking applications. Swimming pool heating is excluded and should be included in other uses.	Supporting	Energy demand	2.6
Rent value	Euro/m2	Average rent value per energy class and building type	Supporting	Income/expenditure	2.3
Average rent value	euro/month	Covers average prices for rental housing. Price average rent € for m2 for rental housing. It also includes the energy costs.	Supporting	Income/expenditure	2.7
Rent growth	%	Annual growth of rent in %, separately for social and private rents	Supporting	Income/expenditure	2.5
Breakdown of rents	%	Percentage of social and private rents	Supporting	Income/expenditure	2.6
energy-related investments for renovation	Euro/m2	Average volume of energy-related investments for renovation	Supporting	Income/expenditure	2.3
Average energy cost savings per retrofit	Eur/kWh	amount of kWh saved on delivered energy, multiplied by respective tariff. Energy price developments need to be taken into account. Reflecting the regulation on cost optimal buildings performance requirements under EPBD, energy priced developments should reflect a period of 30 years (residential buildings)	Supporting	Income/expenditure	2.1
Costs of energy building renovation	€/m²	This indicator will reflect the unit costs of energy buildings renovation according to different level of retrofitting	Supporting	Income/expenditure	2.3
Total volume of investments renovation	Mio EUR/a	This indicator will reflect the total volume of total investments (energy related and non-energy related) in renovation	Supporting	Income/expenditure	2.3
Energy tariffs	Eur/kWh	Energy tariffs (marginal costs, variable component average costs per kWh). Reflects the energy prices per energy carrier for households	Supporting	Income/expenditure	2.6
Average domestic energy prices	EUR	Average domestic energy prices in real terms are used to assess fuel prices	Supporting	Income/expenditure	2.4

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Average District Heating price	EUR/GJ	Average District Heating price	Supporting	Income/expenditure	2.5
Average Annual Gas and Electricity Bills by Payment Method	Pounds	Average Annual Gas and Electricity Bills by Payment Method is one indicator to measure the mumber of customers on pre-payment meters	Supporting	Income/expenditure	2.5
Share of households expenditures on housing	%	final consumption expenditure of households devoted to housing, water, electricity, gas and other housing fuels	Expenditure-based	Income/expenditure	3.0
% of income spent on heat, power and light	%	It can be compared to different thresholds: 10-15% is fuel poor, 15-20% is severe fuel poverty and >20% is extreme fuel poverty	Expenditure-based	Income/expenditure	2.6
Actual expenditure on fuel	%	Percentage of income spent on fuel for households in the lowest and highest 30 per cent income groups	Expenditure-based	Income/expenditure	2.8
Energy expenditure greater than 10% of total expenditure	%	Energy expenditure greater than 10% of total expenditure. Where E: energy expenditure (electricity + heating) and D: disposable income	Expenditure-based	Income/expenditure	2.0
Energy expenditure > twice average/mean	%	(DE: Share of expenditure twice as high as mean)	Expenditure-based	Income/expenditure	2.2
Energy expenditure greater than twice the conditional median	%	(DE: Share of expenditure twice as high as median)	Expenditure-based	Income/expenditure	2.2
Energy costs equal or above twice the median relative energy expenditure	%	Energy expenditure equal or above twice the median relative energy expenditure (i.e. share of energy expenses in the total household expenditure). The median is estimated as an average of medians of 2 years.	Expenditure-based	Income/expenditure	2.4
Energy costs are larger than food and non-alcoholic beverage costs	%	Energy costs are larger than its food and non-alcoholic beverage costs	Expenditure-based	Income/expenditure	2.4
Energy costs >= median relative energy expenditure of the 3 lowest income deciles	%	Energy costs equal or above the median relative energy expenditure of the three lowest income deciles	Expenditure-based	Income/expenditure	2.4
Minimum quantities of energy (expenditure) required by household	%	Absolute measure expenditure-based criterion: Households that consume less energy than the minimum required where E: expenditure; m: based on the number of persons in the family (in a range between 1.1 – 2.4 MWh); n: based on the type of dwelling and number of persons in the family.	Expenditure-based	Income/expenditure	1.6
Disposable household income before & after energy expenditure for adequate space heating	EUR/household	average income per household before and after energy expenditure for adequate space heating (theoretical energy demand)	Expenditure-based	Income/expenditure	2.1
Proportion of disposable household income spent on adequate energy for space heating	%	Share of energy expenditure for space heating out of the disposable household income (using theoretical energy demand)	Expenditure-based	Income/expenditure	2.1

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Average energy spending for adequate space heating per household)	EUR/household	average cost of energy consumption for adequate space heating for residential buildings (theoretical energy demand	Expenditure-based	Income/expenditure	2.1
Exact amount of the monthly net income of the household	€	Household Budget survey (HBS) indicator. A household's income is determined through the variable "Exact amount of the monthly net income of the household" (IMPEXAC in Spanish), which is then multiplied by 12 to calculate the annual amount. IMPEXAC does not include extraordinary income (e.g. from lottery, inheritance) but it does include other regularly (but not necessarily monthly) perceived income (bonus pay, income from rented properties e.g. every summer).	Supporting	Income/expenditure	2.5
Disposable income	%	It measures year-on-year (annual) change in real disposable household income. This indicator shows real disposable income and is based on the Real Disposable Income series, using calendar years.	Supporting	Income/expenditure	2.6
MIS (SGBII) Minimum Income Standard	€ , %	Minimum income standard	Supporting	Income/expenditure	2.2
HY020: Household's available income	Euro	HY020: Household's available income	Supporting	Income/expenditure	2.5
Percentage of income spent for energy (or heating)	%	Expenditure on energy services greater or equal to 10% of income.	Expenditure-based	Income/expenditure	2.5
Proportion of annual income of a household allocated into paying energy costs	%	Indicator Household Budget survey (HBS). Expenditures in energy are calculated summing expenses in the category COICOP04.5 (Electricity, gas and other fuel) for the first and (when applicable) second house of the household. Only monetary costs are taken into account, that is, things like firewood is excluded. For electricity and gas concretely, the calculations are made based on the latest payed bill. In accordance with the temporary raising factor, the registered quantity is multiplied by the number of times that such an invoice has been paid in the previous 12 months.	Expenditure-based	Income/expenditure	2.6
% of disposable income used for energy (gas, electricity) expenditure	%	Called "energy quote". By year, by age group, by income group, by size of household, by type of building (rent/bought; standalone/ maisonette/ flat/ etc; energy label A-G)	Expenditure-based	Income/expenditure	2.6
Energy Effort Rate (EET)	%	Percentage of households that spend more than 10% of their income on energy expenses.	Expenditure-based	Income/expenditure	2.4
Energy expenditure >10% of disposable income	%	Energy expenditure greater than 10% of disposable income In RO: assuming the household living with appropriate levels of thermal condition and the corresponding expected consumption	Expenditure-based	Income/expenditure	2.4
Percentage of total expenditures on energy (>10% of income)	%	Energy expenditure is equal or above to 10% of the income	Expenditure-based	Income/expenditure	2.5
More than x% of disposable income spent on energy services	%	If the household spends more than 10% of its disposable income, it is considered poor. If more than 15% it is severely poor. If more than 20% if its extremely poor.	Expenditure-based	Income/expenditure	2.5
Percentage of total income spent on energy costs (>34%)	%	380.000 Hungarian households (8-10 % of households) spent at least 34 % of their income for electricity and gas. According to the experts this percentage represents a threshold of energy poverty	Expenditure-based	Income/expenditure	2.3

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Electricity (5%) and gas expenditure (10%) vs disposable income	%	Electricity expenditure greater than 5% of disposable income and heating/gas expenditure above 10% of disposable income	Expenditure-based	Income/expenditure	2.0
households that need to spend > 10% of income on fuel to heat their home to an adequate standard of warmth	%	Proposed revision to Directive 2002/91/EC, used in the UK. Share of households which spend more than 10% of their income in heating their home to an acceptable standard identified by the WHO (21C in living room and 18C in other occupied rooms)	Expenditure-based	Income/expenditure	2.3
TEE more than twice median	%	Energy Effort Rate more than twice the median, excluding the richest vulnerable households.	Expenditure-based	Income/expenditure	2.5
Percentage of income household spent on heating compared to average % in EU	%	Percentage of income household spent on heating compared to average % in EU	Expenditure-based	Income/expenditure	2.5
% of household budget spent on gas and electricity by households with low incomes	%	The percentage is compared to the national average	Expenditure-based	Income/expenditure	2.4
Low Income High Expenditure Indicator (BRDE)	%	Considers that a household is in a situation of energy poverty if the two conditions of low income and high energy expenditures are met.	Expenditure-based	Income/expenditure	2.5
HCLI EI BHC: High cost, low income equivalised income before housing costs	%	Low Income High Cost approach	Expenditure-based	Income/expenditure	2.2
Households below an "at risk of poverty" threshold AND above-average energy costs	k	Preferred definition of energy poverty in Austria. "Poverty risk" well defined and differs from national poverty line (approx 1066 EUR/month vs. 800/EUR/month welfare guarantee).	Expenditure-based	Income/expenditure	2.4
LIHC: Low income high cost indicator (UK, 2013)	%, n	Measure developed by Professor Hills as a response to the weaknesses of the Fuel Poverty Gap Indicator. Adopted by the UK Government for defining fuel poverty in England only. Individuals and the households they live in (both are tracked) are fuel poor based on two criteria – i) fuel costs above the median level, and ii) net of fuel cost spend, their residual income is below the official poverty line. (60% of median equivalised household income after housing costs)	Expenditure-based	Income/expenditure	2.6
Households in fuel poverty	Absolute number	It measures the number of households in fuel poverty. Households with required fuel costs that are above average (the national median level) are calculated by: 1. Taking required fuel costs for the household from the fuel poverty dataset (the "fuelexpn" variable) 2. Applying the corresponding equivalisation factor for each household. 3. Dividing the required fuel costs by the equivalisation factor to get the equivalised required fuel costs for that particular household. Equivalising effectively increases the bills of single person households, and decreases the bills of multiple person households, with the aim of making them comparable. 4. To calculate the fuel cost threshold, simply take the weighted median of all of these equivalised	Expenditure-based	Income/expenditure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
		required fuel costs. Half of all households should have "high costs" i.e. above the threshold, and half should have "low costs" i.e. below the threshold.			
% households below the poverty line after energy cost for adequate space heating	% of households	percentage of households that would be left with a disposable income below the poverty line after covering the cost for adequate space heating (theoretical energy demand)	Expenditure-based	Income/expenditure	2.1
(net household income - housing costs - energy costs) > minimum living costs (MIS)	%	Household is considered poor if housing and energy costs are higher than the minimum income standard (MIS), which is the minimum income for different household types that is needed to participate in society. In Dutch this is called 'not-much-but-sufficient budget (NVMT-budget)'	Expenditure-based	Income/expenditure	2.2
SAP rating of households in the lowest 30 per cent of income groups and the average SAP rating	Absolute number	SAP (Standards Procedure Assessment) rating of households in the lowest 30 per cent of income groups and the average SAP rating for England indicates about the energy efficiency (SAP rating) of the housing stock. The Standard Assessment Procedure (SAP) is adopted by Government as the methodology for calculating the energy performance of dwellings. The SAP rating is based upon the energy costs associated with space heating, water heating, cooking and lighting in a dwelling. It is adjusted for floor area so that it is essentially independent of this for a given built form. SAP ratings are expressed on a scale of 1 to 100, with higher numbers contributing to lower energy costs. This indicator is based on SAP05, to allow comparability with previous years. SAP09 data is also now available.	Other energy poverty metric	Income/expenditure	2.4
% of total expenditures on energy for households with expenditures < 40% of median expenditures	%	Percentage of total expenditures on energy for households with expenditures below 40% of the median expenditures	Expenditure-based	Income/expenditure	2.0
Average district heating cost for old buildings compared to average earnings per month	EUR	Average district heating cost for old buildings compared to average earnings per month	Expenditure-based	Income/expenditure	1.9
Weight of household energy products in HICP	%	Weight of household energy products in the Household Index of Consumer Prices	Expenditure-based	Income/expenditure	2.3
MEP extent	Absolute number	households in the lower five deciles of equivalised incomes whose energy expenditures were higher than acceptable threshold	Expenditure-based	Income/expenditure	2.3
MEP depth	EUR	energy poverty gap (in EUR) above "acceptable" energy bill	Expenditure-based	Income/expenditure	2.3
HEP extent	Number	Hidden energy poverty: households whose energy bills are "abnormally low" according to what would be considered adequate according to the number of people in the household and the size of the dwelling	Expenditure-based	Income/expenditure	2.3
HEP depth	EUR	Hidden energy poverty: energy poverty gap (in EUR) below "acceptable" energy bill	Expenditure-based	Income/expenditure	2.3
Fuel poverty gap indicator	Absolute number	The fuel poverty gap is the additional spend required between actual spending and necessary spend to ensure a household is no longer fuel poor. In other words, the extent to which assessed energy needs of fuel poor households exceed the threshold for reasonable costs. The threshold is set at 10%.	Expenditure-based	Income/expenditure	2.5
Average Level of Customer Debt	Number (Pounds)	Average Level of Customer Debt is used to estimate fuel debt. 'Debt' refers either to customers who have a PPM set to collect a debt or customers who are on a rescheduled debt repayment programme due to last longer than 91 days/13 weeks. Direct debit customers would only fall within this definition if they have specifically set up a direct debit in order to repay a debt	Outcome-based	Outcomes	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Amounts owed by gas customers on a debt payment arrangement (as in the final quarter of each year)	% of customers in debt	Amounts owed by gas customers on a debt payment arrangement (as in the final quarter of each year) are used to estimate fuel debt	Outcome-based	Outcomes	2.6
Arrears on utility bills	%	percentage of households/persons out of the total population who are in the state of arrears on utility bills, expressing the enforced inability to pay their utility bills on time	Consensual-based	Outcomes	3.0
Disconnection rates	%, n days	Number (share) of households experiencing disconnection of power/gas/district heat due to not paying the bills. Average number of days/a with disconnection	Outcome-based	Outcomes	2.9
customers disconnected due to debt	Absolute number	Number of customers disconnected due to debt are used to estimate fuel debt	Outcome-based	Outcomes	2.6
disconnections from gas or electricity supply	Absolute number	Used to calculate consequences of poverty related to energy. Number of disconnections of electricity supply due to non-payment of electricity bills (households consumers)	Outcome-based	Outcomes	2.8
Self-disconnection	%	Self-disconnection is usually assessed among pre-payment customers. The indicator measures the share of houses that self-disconnect one or more than one time among prepayment energy customers	Outcome-based	Outcomes	2.0
inhabitants unable to keep home adequately warm (HH050)	%	share of the total population who perceive are not able to keep their home adequately warm	Consensual-based	Outcomes	3.0
Cold Indicator	%	Relies on testimonials about how warm people feel in their households.	Consensual-based	Outcomes	2.5
inhabitants who are living in a dwelling not comfortably cool in summer	%	share of the total population who live in a dwelling not comfortably cool in summer	Consensual-based	Outcomes	2.9
Households that cannot afford enough fuel for water heating and cooking needs	%	Share of Households that feel cannot afford enough fuel for water heating and cooking needs	Consensual-based	Outcomes	2.1
Can you afford to keep your house at an adequate temperature during the cold months?	Open answer	One of the three indicators on Spanish Survey on Income and Living Conditions (SILC) which is therefore carried out with harmonised criteria to allow for comparability.	Consensual-based	Outcomes	2.5
Excess winter mortality/deaths	%	expected deaths in winter are higher than the rest of the year % of excess deaths in winter compared with the non-winter months (based on the formula: EWD = {[winter deaths (Dec-Mar)]-0.5[Non-winter deaths (Aug-Nov, Apr-Jul)]}/(Average of non-winter deaths)	Outcome-based	Outcomes	2.8
Excess Winter Deaths	Absolute number	Excess Winter Deaths in countries of the UK. Excess winter deaths are defined as the difference between the number of deaths which occurred in winter (December to March), and the average number of deaths during the preceding and subsequent four month periods (August to November and April to July). The temperature data used for this indicator relates to the average temperature during the months of December to March and is consistent with the temperature data used in the indicator on cold weather payments.	Outcome-based	Outcomes	2.8
Additional death rate in winter (tasa de	Absolute number	statistical information that allows one to assess the effects of energy poverty on health and the benefits in terms of public health that can be obtained by reducing or eradicating such. It calculates the number of	Outcome-based	Outcomes	2.5

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
mortalidad adicional de invierno (TMAI))		premature deaths of old people that could have been avoided if energy poverty would not exist. In the period 1997-2010 Spain has calculated this following the method of Johnson & Griffiths (2003) and Healy (2004). This consists of comparing the amount of deaths in the months december - march with the number in the four previous and posterior months, all to obtain a total number of additional deaths and the percentage that corresponds to that difference.			
Estimated number of vulnerable households in fuel poverty	Number of households (m)	It measures the number of households in fuel poverty. Estimates of fuel poverty at aggregate UK level should be treated as a broad approximation as different data collection periods and methods are used across countries.	Outcome-based	Outcomes	2.6
Composite indicator using Eurostat data	Absolute number	Assuming the 3 Eurostat metrics ("People living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor" (M1); "Inability to keep home adequately warm" (M2); "Arrears on utility bills" (M3)) , it is possible to examine the fuel poverty making use of a simple composite measurement multiplying each by a weight (Healy & Clinch, 2002), whose sum is 100%.	Consensual-based	Outcomes	2.5
Delay from multi-apartment communities to switch on heating	Number of days	Delay from multi-apartment communities to switch on heating The delay between the national legislation about the start of the heating season (temp <10 degrees for 3 consecutive days) and multi-apartment communities switching on the heating. The delay is based on majority vote in the multi-apartment community	Other energy poverty metric	Outcomes	1.9
vulnerable consumers contacted by DSO due to nonpayment	Absolute number	Number of vulnerable households informed by the DSO regarding the urgency to get a new supplier or possibility of supply of last resort in case of nonpayment, prior to disconnection.	Other energy poverty metric	Outcomes	1.9
What temperature is your household at during the day when you are home and the heating is on?	number	The Encuesta de Hogares y Medio Ambiente (EHM) is the variable module of the European Households Survey, whose purpose was to collect information about the habits, consumption patterns and attitutes of households with regards to the environment (energy and water savings, waste separation) and investigate the households' equipment and use thereof. Information compiled with regards to heating and the temperature inside the house is relevant for energy poverty.	Consensual-based	Outcomes	2.5
changed behaviour with regards to expenses after crisis	Open answer	Since the economic crisis, in order to save money, has your household changed behavior with regards to food, transport, clothing, vacation, medical treatments, energy expenses or energy supply control? Los Barómetros del Centro de Investigationes Sociologicas (CIS) (the Barometer of the Center for Sociological Research) measures changes in public opinion and political attitudes (particularly, the intended vote) are measured based on some questions. The sample is 2500 people.	Consensual-based	Outcomes	2.5
MEPI	Index	Multidimensional Energy Poverty Index (MEPI) - focuses on the deprivation of access to modern energy services. It captures both the incidence and intensity of energy poverty	Outcome-based	Outcomes	2.3
Building stock decomposition by building or dwelling type	Mm^2	This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type	Supporting	Physical infrastructure	2.8
Building stock decomposition by size	Mm^2	This indicator will reflect the distribution of the household's size. The unit will be number of dwellings and related floor area (when available)	Supporting	Physical infrastructure	2.8
Building stock decomposition by ownership status	%	This indicator will reflect the share of buildings/building units in the total stock by the ownership status	Supporting	Physical infrastructure	2.8
Building stock decomposition by occupancy level	%	This indicator will reflect the share of buildings/building units in the total stock by the occupancy levels. There is two types of residence: Primary residence and Secondary residence	Supporting	Physical infrastructure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Breakdown of dwelling stock by energy used for space heating	%	Breakdown of dwelling stock by energy used for space heating	Supporting	Physical infrastructure	2.6
Disaggregation of buildings according to heating device capacity	Absolute number	This indicator will reflect the number of the building/buildings units according to the heating device capacity. Following the EPBD provisions on inspections of heating systems, the heating devices will be disaggregated according to their capacity, in the ranges as follows: <20kW; >100 kW.	Supporting	Physical infrastructure	2.0
Breakdown of dwellings according to heating systems	%	Breakdown of dwellings according to heating systems	Supporting	Physical infrastructure	2.6
Buildings/building units with central steam/hot water space heating system	Absolute number	This indicator will reflect the number of buildings/building units with central steam/hot water space heating system. Central steam/hot water space-heating system: It provides steam or hot water to radiators/convectors or pipes (including under-floor heating) in a dwelling. (Eurostat).	Supporting	Physical infrastructure	2.8
Buildings/building units with a built-in electric system	Absolute number	This indicator will reflect the number of buildings/building units with a built-in electric system. Built - in electric system: A system of electrical resistances (usually as under-floor heating) providing heat to individual rooms; the system is part of the building electrical installation. (Eurostat)	Supporting	Physical infrastructure	2.8
Buildings/building units with heat pumps	Absolute number	This indicator will reflect the number of buildings/building units with heat pumps. Devices that bring heat in the dwelling from the environment using a compressor (mechanical work). Two main types of heat pumps are used in household sector and commercial applications: air-source heat pumps (by far the most common) and ground-source (or geothermal) heat pumps. (Eurostat)	Supporting	Physical infrastructure	2.8
Buildings/building units with condensing boilers	Absolute number	This indicator will reflect the number of buildings/building units with condensing boiler. Condensing boilers are water heaters fuelled by gas, coal, oil or biomass. They achieve a high efficiency (typically greater than 90% on the higher heating value) by using waste heat in fuel gases to pre-heat cold water entering the boiler.	Supporting	Physical infrastructure	2.6
Buildings/building units with conventional boilers	Absolute number	This indicator will reflect the number of buildings/building units with conventional boilers. Conventional boilers are water heaters fuelled by gas, coal, oil or biomass.	Supporting	Physical infrastructure	2.6
Buildings/building units with combi boilers	Absolute number	This indicator will reflect the number of buildings/building units with combi boilers. A combi boiler provides heated water for both space heating and domestic hot water heating.	Supporting	Physical infrastructure	2.6
Disaggregation of type of glazing	Absolute number	This indicator will reflect the number of buildings/buildings units by type of the window/glazing. The type of glazing can be as follows: single, double, high performance double, triple and quadruple. The disaggregation will be done per age band and building type.	Supporting	Physical infrastructure	2.3
Disaggregation of type of window frame	Absolute number	This indicator will reflect the number of buildings/buildings units by type of window frame. Type of window frames can be as follows: wooden, plastic, metal or other materials like composites. The disaggregation will be done per age band and building type.	Supporting	Physical infrastructure	2.3
Disaggregation of buildings according to heating system level	Absolute number	This indicator will reflect the number of dwellings served by heating systems. Collection of data on heating system level as follows: individual and collective heating. This indicator will be expressed in %. The collective space heating system is serving more than one dwelling: multiple dwellings in one building (boiler room for the whole building), several buildings, community, district (local, community or district heating plants). An individual space heating system provides heat to a single dwelling. (Eurostat)	Supporting	Physical infrastructure	2.6
Disaggregation of space heating devices	Absolute number	This indicator will reflect the number of buildings/building units using below mentioned energy sources. Heating systems can generate heat using a different number of energy sources such as electricity, natural gas, coal, fuel oil, liquefied petroleum gas, kerosene, biomass and solar thermal energy. (Eurostat)	Supporting	Physical infrastructure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
according to the energy source					
Disaggregation according to space cooling equipment coverage	No. of	This indicator will reflect the number of buildings/building units supplied with air conditioning systems (central or local). Central and local air conditioning systems Equipment used for a space cooling can be divided into two broad categories: central cooling systems or local (room dedicated) cooling systems. Central air conditioning systems have ducts to bring cooled air in the individual rooms of the dwelling. Local air conditioning system: electrically driven individual units that provide cooling to single room of a dwelling (wall air conditioners, split systems). (Eurostat)	Supporting	Physical infrastructure	2.6
Disaggregation of heating system according to the age of the space heating equipment	years	Age of the main heating system of the household	Supporting	Physical infrastructure	2.3
Buildings/building units with mechanical ventilation (with heat recovery)	Absolute number	This indicator will reflect the number of buildings/building units with mechanical ventilation (with heat recovery) Partly ditto as above. This is always balanced ventilation; it means there are both mechanical supply and exhaust of ventilation and/or heating air. Part of the heat from the exhaust air is recovered in a heat exchanger.	Supporting	Physical infrastructure	2.3
Building stock decomposition by climatic zone	Absolute number	This indicator will reflect the number of buildings/ building units on the building stock by the climatic zones defined at national level. Climatic zones are usually represented as homogenous zones in terms of climate-based on heating or cooling degree-days; climatic areas are defined in national in thermal regulations. Climatic zones can be defined at EU level	Supporting	Physical infrastructure	2.4
Building stock decomposition by construction period	Mm^2	This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type and by construction period	Supporting	Physical infrastructure	2.8
Average floor area per person	m2 per person	Indicator of the living comfort, describes average floor area per person (dweller) according to the type of building in division to family houses and apartment buildings.	Supporting	Physical infrastructure	2.6
DB100: Living area		Degree of urbanisation	Supporting	Physical infrastructure	2.8
Average number of rooms per person	no. of person	This indicator includes average number of rooms per person (dweller) according to the type of building in division to family houses and apartment buildings.	Supporting	Physical infrastructure	2.8
Average performance level reached after renovation	kWh/m^2	This indicator will reflect the average performance level achieved in the refurbished buildings by type of building and type of renovations	Supporting	Physical infrastructure	2.3
Energy performance of households	Classification letters	Poor energy performance: households classified F or G	Supporting	Physical infrastructure	1.9
Average efficiency rate of technical system for space heating	%	average efficiency rate for space heating of all installed systems	Supporting	Physical infrastructure	2.1
Average efficiency rate for space heating	%	This indicator will reflect the average efficiency rate for space heating of all installed systems.	Supporting	Physical infrastructure	2.4
Average energy performance of new construction	kWh/m^2	average energy performance of new construction per building type	Supporting	Physical infrastructure	2.1

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
thermal condition		maximum value of 100 kWh/m2-y. In practise, values of actual specific requirements would be inferred from the construction type and age, taking into account of any energy efficiency interventions made	Supporting	Physical infrastructure	1.9
Average U-value for overall building envelope	W/m2°C	average U-values for overall envelope, which will be provided per age band and building type	Supporting	Physical infrastructure	2.3
Average U-value of doors	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of external walls	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of floors	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of roofs	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of windows	W/m2°C	Ditto. The U-value is calculated for window pane and frame together.	Supporting	Physical infrastructure	2.6
Air tightness	dm3/s/m2	This indicator will reflect the airtightness values provided by age band and per building type. Airflow through the construction at a given building-to-outside reference pressure, typically at 50 pascal (Q50). The unit is m3/(m2·h) or dm3/s/m2.	Supporting	Physical infrastructure	2.5
Cumulative numbers of gas and electricity transfers	Number of transfers (m)	Cumulative numbers of gas and electricity transfers indicate the number of customers switching supplier	Supporting	Physical infrastructure	2.5
Time series of homes with cavity wall insulation and loft insulation	Absolute number	Time series of homes with cavity wall insulation and loft insulation in Great Britain indicates the number of insulated homes. The estimates for this statistical series are produced by using the 2008 English Housing Survey as a baseline, and then adding known changes from the Carbon Emissions Reduction Target (CERT), the Community Energy Saving Programme (CESP), and Warm Front schemes. This is supplemented with data on house building from Communities & Local Government.	Supporting	Physical infrastructure	2.1
Number of Local Authority-owned dwellings receiving insulation and central heating	Number and Pounds	Dwellings in receipt of more than one type of measure are counted under each category of works, e.g. a dwelling counted as having new insulation installed may be counted again as having central heating installed. Therefore, the dwellings receiving new insulation cannot simply be added to those receiving central heating as an estimate of the number receiving either measure.	Supporting	Physical infrastructure	2.5
Percentage of vulnerable costumers with/without heating installations	%	Without: heating is done mainly using solid fuel	Supporting	Physical infrastructure	1.9
system inefficiencies	Qualitative	Driver (Homes with poor energy efficiency)	Supporting	Physical infrastructure	2.0
high energy costs due to poor thermal performance	Absolute number	the occupied dwelling has poor thermal performance; lack of access to reasonable priced energy sources; lack of an effective / adequate heating system.	Expenditure-based	Physical infrastructure	2.0

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Household-level fuel poverty indicator	Absolute number	A 'hybrid' approach, integrating both physical and household characteristics. Integrates data from a large household survey (N = 1595) with datasets (including GIS), and is based on the UK's Standard Assessment Procedure(SAP), but making several adjustments to account for household size, electricity consumption, occupancy patterns and up-to-date, local fuel prices. Household data were collected using a questionnaire, based largely on the WZ survey (53 questions including: property information, space and hotwater heating system, energy suppliers and payment methods, levels of insulation, and occupant details).	Other energy poverty metric	Physical infrastructure	2.0
Energy renovation	k,Mm²	This indicator will reflect the number of the buildings and floor area that undergoes annually thermal building renovation	Supporting	Physical infrastructure	2.6
Stock of nZEBs	Absolute number	This indicator will reflect the total number of buildings that meet the nearly Zero-Energy Building (nZEB) standards defined at national level. Each country defines its nZEB standard according to New construction and Building renovation	Supporting	Physical infrastructure	2.6
Wall insulation improved from the original state	%	This indicator will reflect the share of the number of the buildings with an wall insulation inpoved from oridinal state. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Improvements to at least thermal protection double glazing	%	This indicator will reflect the share of the number of the buildings with improvements to at least thermal protection double glazing. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Roof insulation improved from the original state	%	This indicator will reflect the share of the number of the buildings with an roof insulation inpoved from oridinal state. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Population living in a dwelling with leaking roof or damp walls, etc.	% of households	percentage of households living in a dwelling either with a leaking roof or damp walls/ floors/ foundation.	Consensual-based	Physical infrastructure	2.7
Percentage of dwellings built before the thermal regulation	%	Indicator to be built based on the year national regulation war put in place. And the data on building stock age or construction year.	Supporting	Policy-based	2.0
Ability of consumers to switch tariffs	yes/no	The maximum frequency of switching the tariff and average duration of the switching is key. The new tariff should be better for the customer than the old one.	Supporting	Policy-based	2.8
Existence of the market regulation of the rental housing	yes/no	There is a regulated price for housing by building type. The regulated price aims to the specific social groups of tenants. This indicator describes the existence of the market regulation in the rental housing including its future expected development (e.g. year when the regulation will be/was terminated) and provides a short description of the target group.	Supporting	Policy-based	2.6
Dwellings with voluntary certification schemes.	No of	This indicator will reflect the number of buildings/building units with a voluntary certification scheme: Passive House, Minergie, LEED, BREEAM, DGNB, HQE and others	Supporting	Policy-based	2.3
Date of market liberalisation	Year	Number of years since market liberalisation (electricity and gas) available in ACER report 2013 table 29	Supporting	Policy-based	2.6
communal agreements on heating levels	Qualitative		Supporting	Policy-based	2.0
system governance	Qualitative	E.g. privately owned or not	Supporting	Policy-based	1.9
households helped through Warm Front, England	Pounds and	Expenditure and number of households helped through Warm Front, England	Other energy	Policy-based	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
	Absolute number		poverty metric		
Successful claims for National Fuel Scheme payments	number	Social aid for households in energy poverty	Other energy poverty metric	Policy-based	2.4
Winter fuel payments	Pounds &number	The Winter Fuel Payments started in 1997/98 and are payable to all eligible individuals who have reached state pension age for women. Annual number of payments and total expenditure on Winter Fuel Payments	Other energy poverty metric	Policy-based	2.6
Cold weather payment	Pounds & number	Total Expenditure and annual number of payments on Cold Weather Payments. The Cold Weather Payment season runs from 1st November to 31st March. The temperature data used for this indicator relates to the average winter temperature during the months of December to March, and is consistent with the temperature data used in the indicator on excess winter deaths.	Other energy poverty metric	Policy-based	2.6
Households that apply for the right of the status of vulnerable gas/electricity consumer	number	To transfer the cost of necessary supply to the System Operator (postponed payment). Energy Law 17/14, Ordinance on Gas Market (95/07), and Conditions for the supply and consumption of electricity from the electricity distribution network (126/07). Vulnerable consumer is a household customer, which due to its financial circumstances, income and other social circumstances and living conditions cannot obtain an alternative source of energy for heating, which could result in the same or lower costs for residential space heating	Other energy poverty metric	Policy-based	2.4
number of customers that has acquired the status of vulnerable customer	number	HR: Energy Act: a household in which members have been declared by social welfare authorities as socially vulnerable and have a certain degree of disability or have special needs or have degraded health, where curtailment or disconnection may lead to endangerment of life or health (not yet available because the criteria for attaining the status of vulnerable energy costumer are not yet determined). LT: List of socially vulnerable consumers protected from disconnection (Law of Electricity)	Other energy poverty metric	Policy-based	2.1
recognition of energy poverty in government documents	y/n	recognition of energy poverty in government documents (strategy docs, legislation)	Supporting	Policy-based	2.1
number of applicants/beneficiaries of EE scheme for low-income households	number	Energy efficiency measures for households that face the problem of energy poverty. The measures will be aimed at investments as well as advice and action to change energy consumption behavior.	Other energy poverty metric	Policy-based	2.1
number of beneficiaries of social aid	number	It is assumed that the minimum number of energy vulnerable consumer amounts to the number of beneficiaries of social allowance (family and single)	Supporting	Policy-based	2.2
population that receives subsidies for heating and hot water supply services	%	For district heating (Law on Cash Social Assistance for Poor Residents) based on the evaluation of received income and owned property, permanent residents only	Other energy poverty metric	Policy-based	2.6
amount of bill support for heating and hot water for recipients of social benefits	EUR	Amount of bill support provided for heating and hot water supply services via municipalities for recipients of social benefits. For district heating (Law on Cash Social Assistance for Poor Residents) based on the evaluation of received income and owned property, permanent residents only	Other energy poverty metric	Policy-based	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
number of households that require support to pay energy bills	number	number of households that requires social support to pay its energy bills	Other energy poverty metric	Policy-based	2.4
financial aid during the cold season for vulnerable customers	EUR	% of district heating bill, fixed amount for the gas (heating) bill. Emergency Ordinance no. 70/31	Supporting	Policy-based	1.9
number of beneficiaries of permanent / temporary financial social assistance	number	Financial social assistance is designed to meet the minimum living needs, including energy. When household is a beneficiary of financial social assistance it is automatically considered as a vulnerable consumer. It is assumed that the real minimum number of potential energy vulnerable consumer amounts to at least the number of beneficiaries of financial social assistance.	Supporting	Policy-based	2.0
number of households that receive material need support	number	The households that receives the material need (social allowance) are foreseen to have a risk of energy poverty	Supporting	Policy-based	2.0

Annex 3 Conceptual Maps

See separate zipped files and power point with summarised version. The map can also be provided in other image file versions as requested. To select parts of the map, this has to be done using CMAP software.

Annex 4 Interview notes

External validation was carried out via semi-structured discussion with individuals with energy poverty expertise, as well as expertise in the test countries. The table below provides an overview of the interviews.

Name	Interview date	Organisation (MS)	Relevance
Jose Carlos Romero, Pedro Linares	01 March, 2016	Instituto de Investigación Tecnológica (ES)	Energy poverty in Spain. Economic analysis and proposals for actions. Executive Summary 2014 (In Spanish)
Josephine Vanhille	01 March, 2016	University of Antwerp (BE)	Using reference budgets to assess energy expenditure
Sandrine Meyer	03 March, 2016	University of Antwerp (BE)	Fuel poverty Barometer. They have a view on operationalising at Ms level of ideal primary expenditure based indicator
Slavica Robić	02 March, 2016	DOOR (HR)	REACH project
Harriet Thomson	26 February, 2016	CURE[61], Univ. of Manchester	Coordinator of the EU Fuel Poverty Network
Jaroslav Pavlica	23 February, 2016	State Environmental Fund (CZ)	Consultant for renewable energy technologies and energy policy issues in CZ
Martin Vajčner	10 March, 2016	Ministry of regional development (CZ)	Involved in housing policy development, as well as analysis of energy poverty issue in CZ
David Deller	29 February, 2016	Centre for Competition Policy / University of East Anglia (UK)	Affordability of utilities' services for Centre on Regulation in Europe (CERRE),
Lidija Zivcic and Slavica Robić	04 February, 2016	Focus (SI) & DOOR (HR)	REACH project
René Schellekens	21st Abril 2016	Rijkswaterstaat	Participated in a project to measure energy poverty in the Netherlands
Ing. Ján Magyar		Slovak Innovation and Energy Agency	Policy maker in the area of energy
Sergio Tirado Herrero		RMIT Europe	Expert in energy poverty and urban policy

See minutes in separate document.

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