Global Transitions 1 (2019) 226–240

Contents lists available at ScienceDirect

Global Transitions

journal homepage: www.keaipublishing.com/en/journals/global-transitions/

Sustainable energy transitions and social inequalities in energy access: A relational comparison of capabilities in three European countries

Françoise Bartiaux [a, *], Mara Maretti [b], Alfredo Cartone [b], Philipp Biermann [c], Veneta Krasteva [d]

[a] Fund for Scientific Research, and Institute of Analysis of Contemporary and Historical Societies, Université catholique de Louvain, Belgium
[b] Department of Law and Social Sciences, University "G. D'Annunzio" of Chieti-Pescara, Chieti, Italy
[c] Otto-von-Guericke University, Magdeburg, Germany
[d] Department "Public Policies and Social Changes", Institute for the Study of Societies and Knowledge, Bulgarian Academy of Sciences, Bulgaria

ARTICLE INFO

Article history:
Received 18 July 2019
Received in revised form
8 November 2019
Accepted 8 November 2019
Available online 25 November 2019

Keywords:
Energy transitions
Social inequalities
Capability
Accountability
Energy poverty

ABSTRACT

The influences of energy transitions on social inequity are multidimensional in their attributes and connections. For adequate accountability of their social correlates, policies aiming to implement a transition towards sustainable energy supply and demand have also to be evaluated regarding their influences on social inequalities, namely in terms of energy access and consumption. A capability-based and relational approach is used to monitor the social correlates of the governance of energy transitions. This accountability model is applied to three different European countries: Austria, Belgium, and Bulgaria. They have different characteristics in terms of levels and inequalities regarding material deprivation and energy access as well as patterns of energy transitions. The proposition here is that the capability approach could be usefully adopted to evaluate future implementation of energy transitions and to assess how they could influence inequalities in various aspects of citizen's daily life. In such a framework, the focus is on potential links between energy transitions and energy inequalities that can be channelled by their respective relations to the capabilities. Data used to quantify the inequalities regarding various capabilities are from the Generations and Gender Programme (GGP).

1. Introduction

Given the adverse consequences of climate change, the depletion of non-renewable energy sources, and the demands for both energy security and energy justice, sustainable energy transitions are now seen as a necessity.

Energy transitions are considered here as multidimensional issues and may be defined as transformations toward a more sustainable system of energy production and demand. There are many possible energy transitions (whether involving increased supply, with renewables or without, and/or reduced demand) along with corresponding social and political processes [1].

But what are sustainable energy transitions? And how can their governance be monitored? The propositions of this contribution are summarised in this introduction and developed in the paper. There has been general agreement since the Brundtland report [2]; that sustainability should be considered as having three dimensions: economic, social, and environmental. To be sustainable in the social and economic dimensions, energy transitions have to be fair, in other words need to reduce inequalities between social groups – including the energy poor – in their access to affordable energy: the proposed approach is therefore relational in that it compares different social groups, defined according to their access to affordable energy, energy poor households being the least favoured group. Furthermore, energy transitions need to be sustainable in the environmental sense. Indeed, the IPCC Special Report published in October 2018 [3] warns that it is crucial for our planet

* Corresponding author.
E-mail addresses: francoise.bartiaux@uclouvain.be (F. Bartiaux), mara.maretti@unich.it (M. Maretti), alfredo.cartone@unich.it (A. Cartone), philipp.biermann@uni-oldenburg.de (P. Biermann), vkrasteva@bas.bg (V. Krasteva).

Production and Hosting by Elsevier on behalf of KeAi

https://doi.org/10.1016/j.glt.2019.11.002

not to exceed an increase of 1.5° Celsius over pre-industrial levels, and therefore global greenhouse gas emissions must, by 2030, be reduced by 40–50% below 2010 levels. Because of these environmental constraints, energy transitions policies cannot aim at equalising the energy consumption of all social groups at the level of the richest group because of its unsustainable character.

It is, therefore, appropriate to examine whether, and how, low-carbon technologies and innovations do indeed generate, maintain, or increase inequalities between social classes, as some research has already indicated such new or reinforced inequalities (in China: [4]; in Portugal and Belgium: [5]).

In the process towards fair and sustainable energy transitions, the capability approach provides a good theoretical framework, and a relevant accountability model for reporting on the progress made or not made in reducing social inequalities, as explained in the conceptual section. The capability approach indeed is not focused only on the material well-being of persons but also on their opportunities to live a good life according to their own criteria. The capability approach is used here as a methodological guide, as was done recently by Ref. [6], who proxied many capabilities with a multi-scope survey.

In this paper, we extend the approach of [6] in order to develop a model of accountability, based on the capability approach, in the fields of energy policies and energy transitioning. Since accountability has become a favourite element of policy responses to the current economic crisis, a deeper debate on the extent of the accountability model is vital. Models of accountability can be framed to establish the main components of accountability, especially: "who is accountable; for what; to whom (or to what); through what mechanism; and with what kind of accountability outcome" ([7]: 466). This paper aims to define a model of accountability in the field of energy policies and energy transitions. The target is to improve the focus on correlates of energy policies on equity, using single capabilities indicators. To clarify the correlates of those actions on society, measures related to different capabilities are calculated for different categories of households, according to their access to energy.

To illustrate how our model works and what kind of outputs it can produce, three applications of the model are realised for three European countries – Austria, Belgium, and Bulgaria. These countries are compared in terms of the greatest inequalities evidenced by their respective capability profiles. In the following sections, a set of results are discussed as outputs of this model. Countries are chosen according to three criteria: energy-access inequalities proxied by the prevalence of energy poverty; characteristics of energy transitions; availability and comparability of data. The applications are carried on to show how the capability approach could enable a deeper insight into different policy instruments, shedding more light on the complexity of mechanisms that lead to energy injustice in an energy transition framework.

It is important to stress that this model is not a causal model, as its aim is heuristic: the application of the model presented in section 5 aims at showing associations, not causal relations, between energy transition policies and social inequalities. The results help to indicate the new research that would be necessary in order to understand the processes underlying such associations and to devise new policies if considered necessary.

The outline of the paper is as follows: in the next section, the conceptual framework first outlines the capability concept and the relational approach used here positing energy poverty as an energy injustice. This is followed by a literature overview of the conceptual relations between energy transitions and the ten capabilities listed by Nussbaum (2000: 78–80) [8]. Subsequently, using the methodology of the case study, the characteristics of the three different countries are presented in terms of energy poverty and energy transition. The data and methods used in this research are then explained, before a presentation of the results obtained in the application of the model for three countries with the aim of testing the capability approach as a social accountability instrument. The concluding discussion summarises the relevance of this accountability model and proposes further steps for its development.

2. Conceptual framework

2.1. The capability approach

A capability is defined as the possibility to live a good life as defined by the persons themselves in a reasonable way given their context of life. The concept of capability was developed during the eighties by economist Amartya Sen and philosopher Martha Nussbaum (*e.g.* Refs. [9–11]. Contrary to Sen, Nussbaum (2000:78–80) [8] has established a list of ten capabilities that she holds as universal and that she names as follows: life of normal length; bodily health; bodily integrity; senses, imagination, and thought; emotions; practical reason; affiliation; other species; play; and control over one's environment on both a political sense and a material one. These ten capabilities are defined with Nussbaum's words in Appendix 1. As other researchers point out, the capability approach is a "useful conceptual framework for elucidating the multiple implications that energy systems may have" because it provides tools for assessing what is valuable in human life and this helps to analyse the complex relation between energy and social systems [12].

To realise outcomes valued by the person, freedom of choice among different opportunities is prioritised in the capability approach. Therefore, it is important to question whether different social groups of a country are provided with the same opportunities. This is where a relational approach is useful to compare the most deprived group with the more advantaged one in a given country.

2.2. A relational approach

In this paper, a comparison is made between energy poor and energy richer households in Austria, Belgium, and Bulgaria. These subpopulations are defined in subsection 4.2.1 below. This comparison is called a relational approach, following [13] who shows that differences between social groups derive "from socio-economic priorities, political decision-making and cultural constructions", including moral estrangements ([13]: 62). The argument of this relational approach is that people who live in energy poverty are disadvantaged for many capabilities, in two senses: firstly for themselves (for example, they have more health problems than people who have no difficulty affording the energy they consume, see Refs. [6,14]); secondly, and as a supplementary difficulty, in their comparison with more favoured social groups (for example when people living in energy poverty compare themselves with other groups having less difficulty, or no difficulty at all, with their access to affordable energy). This social comparison may engender anger or sadness among the least favoured groups [15].

Although capability deprivation cannot be equated solely to income poverty, it is clear that material deprivation prevents the achievement of the last capability (10B) defined by M. Nussbaum (2000: 80). In this respect, and in line with the relational approach, an index of inequality of income distribution is regularly published by Ref. [16]: the income quintile share ratio (S80/S20), that is defined as "the ratio of total income received by the 20% of the population with the highest income (top quintile) to that received by the 20% of the population with the lowest income (lowest quintile). Income must be understood as equivalised disposable

income." The levels of this index are very different across European countries: in 2017, the average for the 28 European countries was 5.1, while the index was 3.8 for Belgium (the fifth lowest figure, after 3.4 in both the Czech Republic and in Slovenia, and 3.5 in Slovakia and in Finland), 4.3 for Austria, and 8.2 in Bulgaria, the highest figure among the 28 European Member States. This relational index of inequality of income distribution exhibits what the sociologist [13] calls the relative 'poverty of capabilities'.

In our accountability model, self-perceptions on income poverty and on the affordability of warmth are combined with numerous indicators, proxying a variety of capabilities, in order to highlight social inequalities, especially between energy poor and energy rich households (as explained in the fourth section). With its comparisons, a relational approach highlights the inequalities that exist between social groups; some (as shown below) will call these inequalities injustice.

In a more comprehensive approach to analyse what he calls an "accountability crisis" in the changing energy sectors [17]: 10) proposes "a relational understanding of accountability that focuses on relations between entities rather than on essentialist, fixed definitions of entities themselves". For him, these entities are namely intergovernmental bodies, business and politics, civil society organisations, traditional ministries. In our accountability model, however, we focus on different social groups within a society that are not constituted in organised entities.

2.3. Fair energy transitions: improving the capabilities of individuals

2.3.1. Energy poverty: definition and measurements

[18: 33] define energy poverty at the household scale as "a lack of adequate energy services in the home, with its associated discomfort and difficulty". Several indicators are used to measure energy poverty. [19]differentiate objective measures, based on energy expenditures, from subjective measures, based on consumers' perceptions reported on in quantitative surveys.

As also done by Ref. [14] in their quantitative study on energy poverty and health issues, the 'subjective measures' are selected here: laypeople's perceptions are trusted and considered as credible. Indeed, many qualitative surveys have shown the relevance of this bottom-up approach (*e.g.* in Austria: [20]; in Belgium: [15]; in Bulgaria: [21,22]; in France: [23]; and in the United Kingdom, [24,25]. Section 4 of this paper presents the data and methods used in this research to operationalise the capability concept in this relational approach, *i.e.* to compare the deprivation of capabilities among energy poor households and other types of households defined according to their energy access.

2.3.2. Energy poverty as an energy injustice

In parallel with the growing literature on energy transitions, with practically no intersection as noted by Ref. [26], environmental justice thinkers such as [27] frame justice and injustice along three different but interconnected dimensions: distributional injustice concerned with the unequal distribution of income, procedural injustice relating to processes (namely those producing unequal distributional outcomes), and injustice in terms of cultural and political respect, and recognition of vulnerable and marginalised social groups (for a good synthesis, see Ref. [28]). Later, energy justice is also conceptualised along the same three dimensions and applied to "energy policy, energy production and systems, energy consumption, energy activism, energy security and climate change" ([29]: 174). These authors provide a conceptual review of this concept of energy justice based on these three dimensions of distributional justice, procedural justice, and recognition justice [29]. As mentioned by Ref. [30], Sovacool et al. [31] use eight principles to describe a decision-making framework in energy justice: availability, affordability, due process, transparency and accountability, sustainability, intragenerational equity, intergenerational equity, and responsibility.

Following [28,32,33]; and other scholars subsequently, energy poverty is increasingly regarded as an energy injustice.

2.3.3. Studying energy poverty through capabilities

Only a few authors apply the capability approach to the study of energy poverty. [34] propose a sequential relationship between energy sources, power supply, energy services, and capabilities. While linking these last two concepts is a valuable contribution from Ref. [34]; we tend to agree with [25] who show that, on the one hand, the division of capabilities ('basic' or 'secondary') is far from clear, and, on the other hand, that the relationship between energy services and capabilities is much more complex than the sequential one suggested by Ref. [34].

In their quantitative study on Belgium, [6] demonstrate that the capability approach makes clear the inequalities that exist between energy poor households and other groups of households. These inequalities pertain to not only housing, health and mental well-being, as already shown in previous studies, but also to emotions management, leisure, and social relations.

[25] focus on the connection between two sets of capabilities: capability to create social relations and capability to access energy services. In their analysis, the authors present a model for explaining the connection between these two capabilities and conclude that the connection is bidirectional. On the one hand, social relations can ease access to energy services, as people make use of help from friends, family, and various representatives of government or NGOs for support, advice, or information on access to energy resources. On the other hand, better social relations can be a result of already having better access to energy resources. The limitations that define poverty (various structural factors) therefore affect both social relations and the capability to access energy services. Although Middlemiss et al. examine only the connection between one capability (in Nussbaum's terms: Capability 7, affiliation) and energy poverty, their analysis shows that the capability approach is a valuable basis for studying this area, as it reveals simultaneously the opportunities for agency and the structural barriers to energy poverty.

In our article, we expand on this idea and demonstrate that the capability approach can be a useful theoretical lens for analysing energy transitions and the ways by which they relate to inequalities in various aspects of people's lives. Starting with the assumption that energy transitions need to be fair and as a result should reduce inequalities between social groups in their access to affordable energy, we propose a model whereby people's capabilities can be used as a basis to evaluate the progress made in reducing social inequalities during energy transitions.

Even though energy poverty is a multidimensional issue (because it relates to various aspects of daily life) most studies of the social impact of energy transitions focus only on income-related effects caused by the high cost of the transition process. [35], however, has investigated relationships between social justice and energy transitions, while energy poverty, energy justice, and low-carbon energy systems have recently been conceptually framed together by Ref. [36]. [37], for their part, focus on the connection between the use of energy derived from fossil fuel, mitigation of climate change, and the attainment of well-being. Using the concept of capabilities, the authors present a model that demonstrates how misinformed and misguided climate change mitigation can compound injustices in well-being.

In order to make an empirical contribution to this debate, the present paper investigates energy inequities and other social

inequities and analyse relations between them in three countries having different paths of energy transition.

2.4. Sustainable energy transitions and the capability approach

Following the list of ten capabilities established by Nussbaum (2000: 78–80) [8], this part of the theoretical framework reviews the literature on the consequences of energy transitions on each of these capabilities (presented in Appendix 1).

The effect of energy transitions on life duration (Capability 1) and on bodily health (Capability 2) has been studied extensively in terms of the health effects connected to local pollution and its reduction through sustainable transport means [38] and through energy efficient and sustainable urban planning [39].

Capability 3 (bodily integrity) is namely defined in relation to the ability to move safely from place to place. Connecting this to energy transition, one can argue that aiming at a sustainable transportation system requires increasing both the frequency and the safety of public transportation [40]; this makes it easier to move from place to place, especially for disadvantaged population groups such as people living in energy poverty.

Capability 4 is entitled "Senses, imagination and thoughts" and is namely determined by education. The influence of a transition in the energy sector is to be seen positively in this respect. The need for technical innovations on a large scale can help to create international spillovers of knowledge through cooperation on the one hand and through competition on the other hand [41]. Developing this capability in the population may also permit the development of alternative narratives that present energy transitions in positive ways [42].

Capability 5 is devoted to emotions, including attachment, as well as fear and anxiety management. Emotions management is a neglected issue in energy transitions policies. But there is some work, for example, an experience with smart energy monitors was found to have triggered negative emotions and depression amongst some older adults surrounding electricity usage, potentially leading to dangerously cold homes ([43]: 218).

Capability 6 is about "Practical Reason. Being able to form a conception of the good and to engage in critical reflection about the planning of one's life" ([8]: 79). Enhancing this capability while governing sustainable energy transitions requires developing a normative frame to account for the welfare of present and future generations without "placing the burden of high energy consumption, and the change thereof, solely on individuals in such a way that policy makers and their political parties have no other responsibility than to device "acceptable" policy" [44]: 364; see also [45]; and [46].

Regarding Affiliation (Capability 7), people form new kinds of communities to fight for/against the implementation of renewable energy infrastructure. Whether people are fighting for or against is subject to the degree of acceptance of the respective pathway or energy policy scheme [47]. As an example, the Energy Renewable Community (ERC) refers to communities of users (private, public, or mixed) in which citizens, entrepreneurs, public administration, market players (utilities, etc.), designers, and politicians actively cooperate to develop high levels of "smart" energy supply. The advantage of ERC is to facilitate the optimisation of the use of renewable sources and technological innovation in distributed generation, in order to obtain benefits on cost effectiveness, sustainability, and energy security at local level. Several such communities have been formed in the Netherlands, Germany, the United Kingdom, and Italy as early as 2012 [48–50].

"To live with concern for and in relation with (...) nature" ([8]: 80), the eighth capability, is obviously related to concerns for climate change and necessary energy transition policies [3].

The effects of renewable energy production sites have a connection with Capability 9. The ability for recreational activities, laugh, and play are influenced by the negative effects of, e.g. windmills, which are subject to the NIMBY problem [51].

The connection between energy transitions and Capability 10 is straightforward. The political control over one's environment is determined by the degree of political participation and acceptance of energy policies [52]. On the other hand, control over one's material environment can be linked to the need for infrastructural changes in the sense that energy transitions require huge infrastructural changes [53]. Those new renewable energy production facilities need to be built on land, which is scarce in many countries. Therefore, the energy transition brings along the risk for people to be expropriated for the benefit of building energy infrastructure [54]. The degree to which this affects the individual is influenced by the level of compensation paid to landowners.

The following case study examines five capabilities that illustrate different dimensions of the capability approach: health; 'practical reason' (critical reflexion about the planning of one's life); affiliation; recreational activities; control over one's material environment (Capabilities 2, 6, 7A, 9, and 10B). These dimensions can be seen as a worthwhile summary of the capability approach. Certain other capabilities (such as Capability 1: living a life of normal length, or Capability 7B: protection against discrimination) are not suitable to be studied by means of multi-scope surveys.

3. The case study

3.1. Introduction to the case study method

The methodology chosen is a case study approach that largely adheres to qualitative research procedure in that it takes into account the description of a specific empirical case.

The object of investigation is to arrive at an 'analytical generalisation' [55] but without seeking to establish general causal connections or operational generalisation laws applicable to an entire population. This procedure, by interpreting a specific situation and producing a localised interpretation, leads to a better understanding of the phenomenon that is under examination. The method of multiple case study is useful to achieve a strategic triangulation of the data [56,57] which occurs when the researcher checks whether the data remains the same in different contexts to allow validation of the theoretical-methodological model.

As already specified we choose three European countries: Austria, Belgium, and Bulgaria, considering three dimensions: 1) the different prevalence of energy poverty in the population as a good indicator of energy access inequalities; 2) the energy transitions characteristics; 3) but also considering the data availability in GGP.

3.2. Background information and selection criteria

3.2.1. Socio-economic conditions

The countries under study differ significantly in terms of their socio-economic indicators (all values are for 2007 and are drawn from Ref. [58]). Referring to total population, the countries were comparably populated (Austria, Belgium, and Bulgaria having 8.3, 10.6, and 7.5 million inhabitants, respectively). Regarding the macro-economic circumstances, Austria and Belgium performed similarly having per capita (p.c.) GDP of 39 392 and 36 872 in purchasing power parity dollars (PPP$), respectively. Bulgaria was far behind that figure with a GDP p.c. of 12 800 PPP$. This picture is also reflected by low inflation rates in the two countries (Austria: 2.1%, Belgium: 1.8%) and a relatively high rate in Bulgaria (8.4%). Austria had the lowest unemployment rate (4.8% of the labour

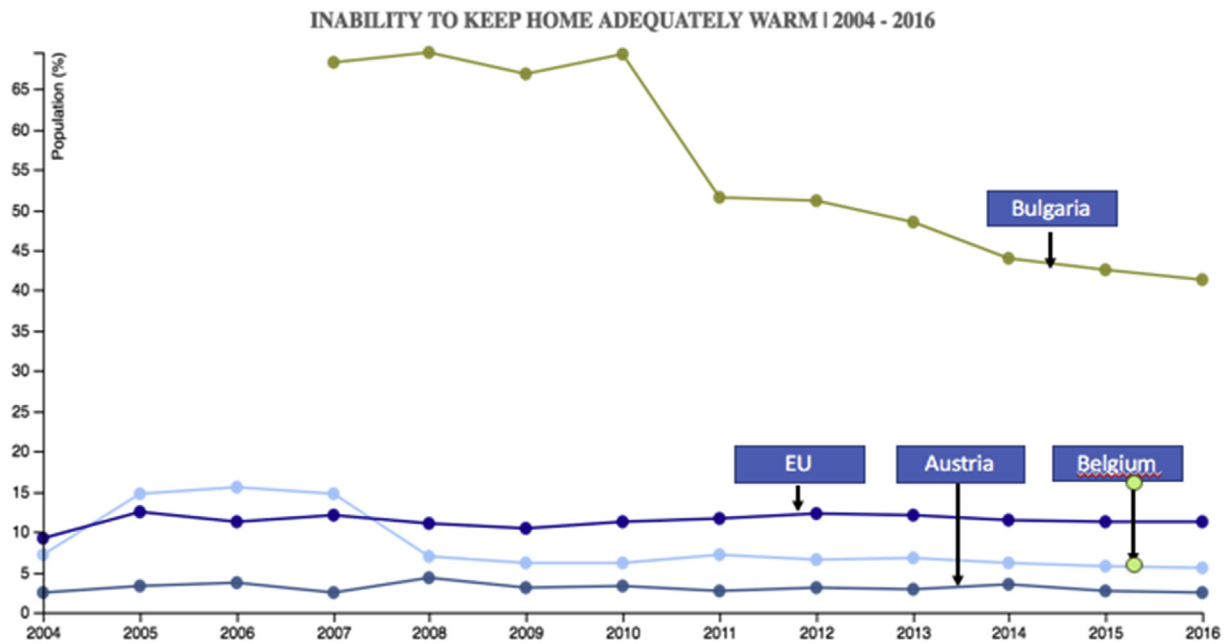

Fig. 1. Proportion of households not able to keep their home adequately warm. Based on the answers to the question "Can your household afford to keep its home adequately warm?"
Source: EU_SILC Survey data for Austria, Belgium, and Bulgaria.

force) whereas both Belgium (7.5%) and Bulgaria (6.8%) performed worse concerning this indicator. Income inequality measured by Gini coefficient was highest in Bulgaria (36.1) and lowest in Belgium (29.2) while Austria was almost at the same level as Belgium (30.6). The CO_2 emissions of Bulgaria were the lowest with annual emissions of 6.9 metric tons per capita in 2007. In the same year, the emissions of Austria and Belgium were higher with 8.4 and 9.7 metric tons per capita, respectively.

3.2.2. Energy poverty prevalence

One of the most striking energy inequalities is usually referred to as "energy poverty" which contrasts with having less or no problems regarding energy consumption. Energy poverty is often proxied from quantitative survey data by variables related to the inability to keep home adequately warm, and arrears on utility bills in the last 12 months. Figs. 1 and 2 below report the corresponding proportions of households experiencing these problems in the three countries selected for this study. Austria exhibits the lowest figures, and is followed by Belgium, while Bulgaria's proportions are much higher than the European average.

Energy poverty in Bulgaria is indeed a severe problem – the country is in the top rank in Europe for this issue. Similar is the situation about the income polarisation (40.2% in 2017 measured by Gini coefficient) and material deprivation (43.8% in 2017).[1] Electricity energy prices in Bulgaria are the lowest in the EU. Nevertheless, they are quite high in relation to the income and purchasing capacity of the population. The growth of prices outpaces the growth of incomes. A new report of the World Bank [59] on the electricity sector in Bulgaria shows that electricity is the main source of energy for most households in Bulgaria, regardless of type of settlement, income, or poverty status. For 69% of the population, electricity is the main source of heating, followed by solid fuels – about 19% (but much higher share in the small towns and villages), district heating – about 10% (mainly in big cities), and gas (less than 2%). One other indicator – homes with leaks and moist walls – also reach alarmingly high values in Bulgaria [60]. The poor quality of housing creates problems too; these include an aged building stock, a large share of prefabricated multi-family apartment buildings, and the bad living conditions of certain groups of the population ([61]: 14).

3.2.3. Energy transition related indicators

The three countries also differ significantly in the way they deal with transitioning towards a sustainable use of energy resources. The following paragraphs present some indicators of their energy systems described from the supply side. A complete picture of ongoing energy transitions is not offered to correspond to the analysis made in section 5.

Fig. 3 shows the differences in the energy end use of renewable and non-renewable sources. While in relative terms, Bulgaria almost represents the EU-average, Belgium and Austria are below and above this average, respectively. This represents the differences in the strategies to lower the CO_2 emissions from energy production and consumption. The year 2007 was chosen being in the range of the observation period of the GGP data used for the case study. Bulgaria started significant effort toward an energy transition after 2007 when it became a member of the EU, whereas Austria and Belgium began the transformation towards a low-carbon economy long before that date, although the perceived goals to reach the objective differ significantly. This picture becomes clearer when we look at the total primary energy supply of the three countries in Fig. 4. While Austria profits from its favourable geographical conditions using a high share of hydropower (mainly for electricity generation), Belgium relies on the use of nuclear power. Both strategies are a way of reducing CO_2 emissions in energy production relative to fossil fuels while representing

[1] The percentage of population with an enforced lack of at least three out of nine material deprivation items in the "economic strain and durables" dimension (following nine items: to pay their rent, mortgage or utility bills; to keep their home adequately warm; to face unexpected expenses; to eat meat or proteins regularly; to go on holiday; a television set; a washing machine; a car; a telephone), EU-SILC, code [tessi082].

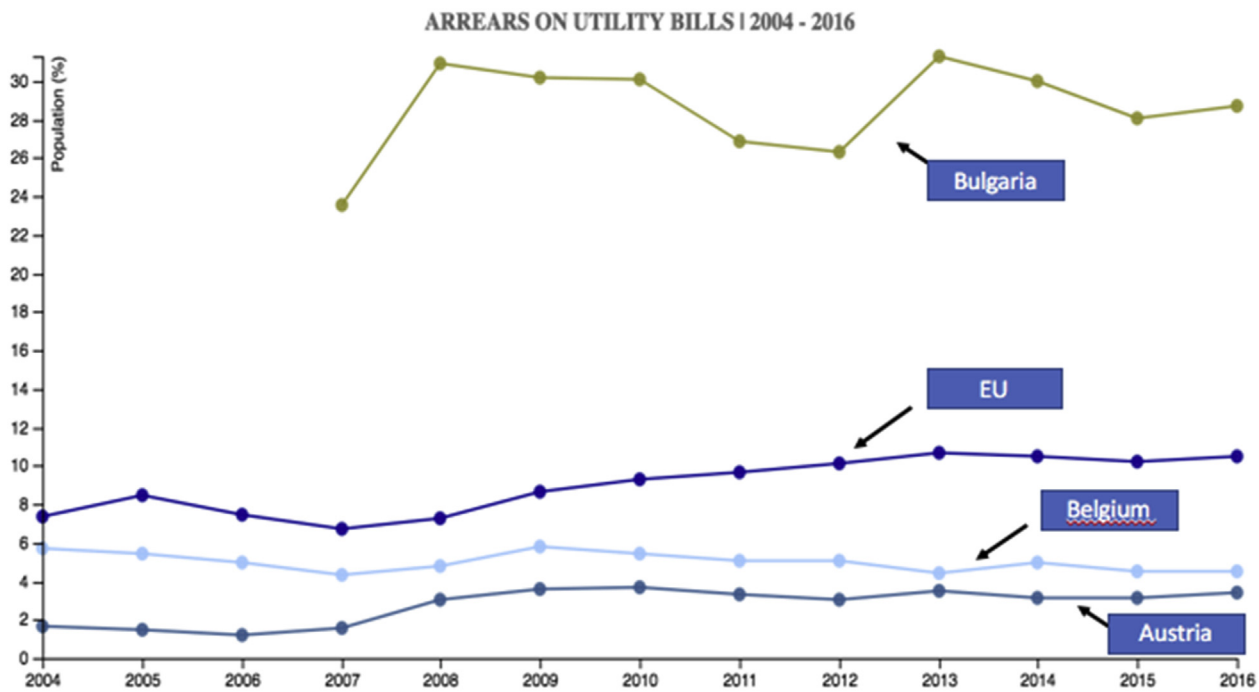

Fig. 2. The proportion of households having arrears on utility bills
Source: EU_SILC Survey data for Austria, Belgium, and Bulgaria.
Based on the answers to the question "In the last twelve months, has the household been in arrears, i.e. has been unable to pay on time due to financial difficulties for utility bills (heating, electricity, gas, water, etc.) for the main dwelling?"

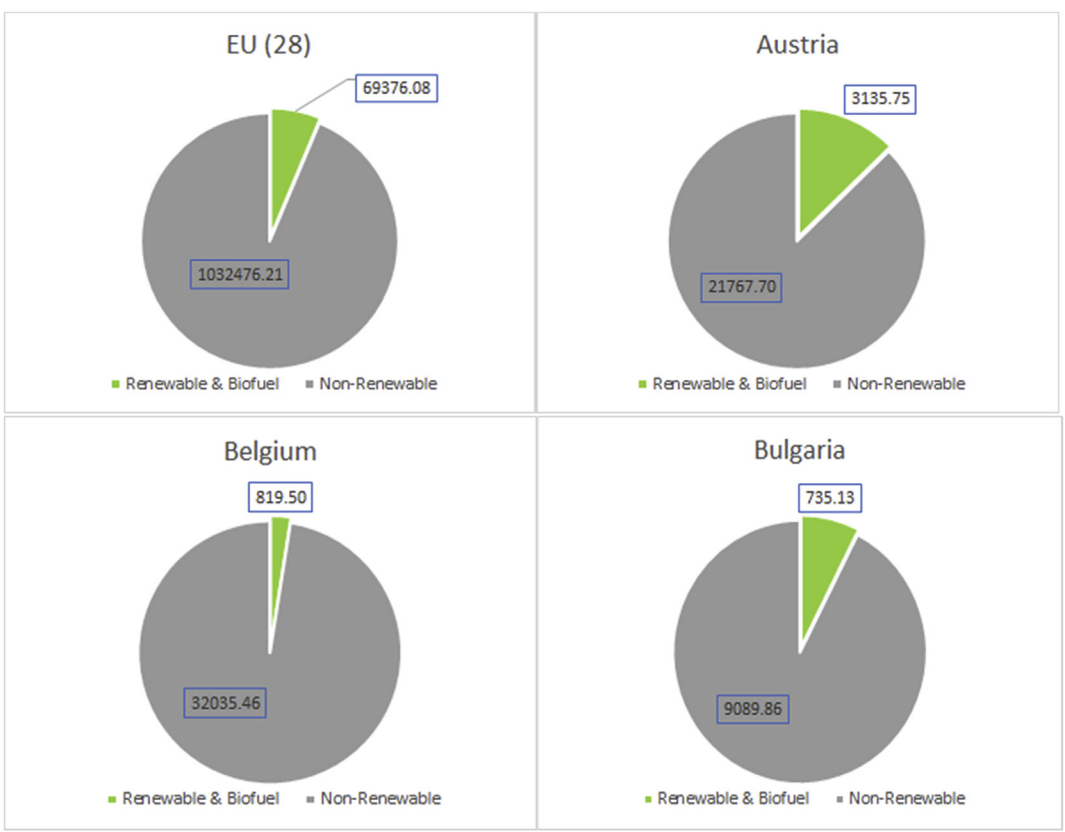

Fig. 3. Energy end use of households in 2007 by source distinguished between aggregate end use from renewable sources and non-renewable sources.
Source [65].

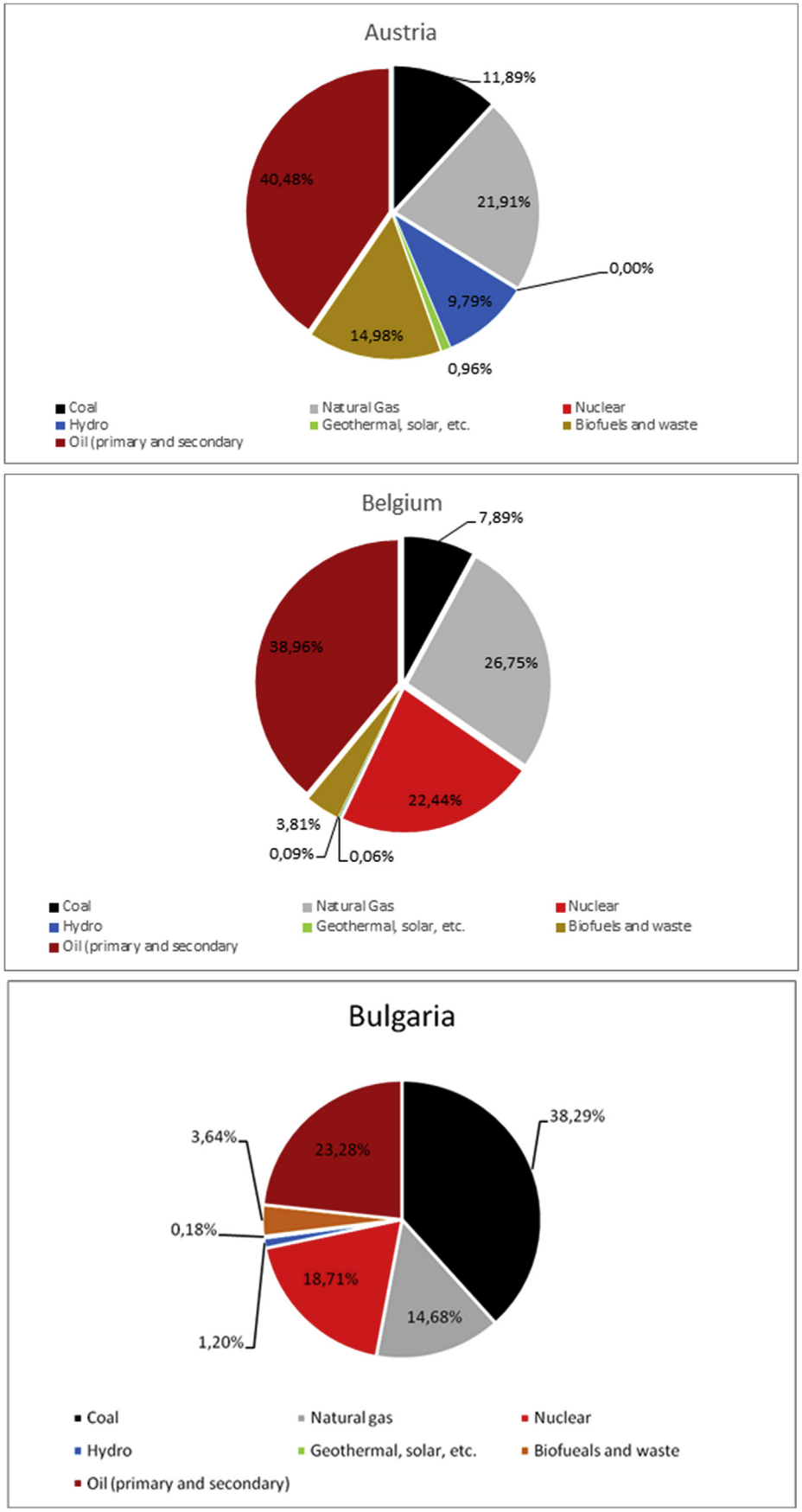

Fig. 4. Total Primary Energy Supply (TPES) by source.
Source: [66].

various economic and social advantages and drawbacks [62]. [63,64] compare the use of renewables and of nuclear power in electricity generation to reduce CO_2 emissions.

The figures presented here on energy poverty measurements and some energy transition indicators show that the three countries differ significantly in their strategies to perform successful transitions towards low carbon economies and in the social aspects as represented by the differences in energy poverty indicators.

4. Application of the accountability model: three European countries case studies

4.1. Data from the gender and Generation Programme

After reviewing some of the available surveys offering data on access to affordable energy and capabilities, we opted for the Generations and Gender Programme (GGP) surveys. The latter, in contrast to other surveys (e.g. EU-SILC and European Social Survey), was the only one supplying information about a broad range of capabilities, allowing a robust analysis of capabilities in the categories of energy conditions. The Generation and Gender Programme fields the same questionnaires across many countries (15) across different continents, and in general, for several waves of the survey in a same country. Therefore, these databases emerge as a very interesting source of data to monitor the social aspects associated with energy transitions, namely the evolution of the social discrepancies in fulfilling valued practices.

However, digging into several countries' databases showed that the comparability of the questions asked in the surveys is lower than expected, whether for the variables used in the households' typology on affordable warmth, or for the variables useful to proxy most of the ten capabilities listed by Nussbaum (2000: 78–80). Therefore, a detailed application of [6]'s analysis turned to be possible only for a few countries because of data unavailability for key variables.

Wave 1 of GGP surveys have been utilised in this analysis in order to guarantee a comparison between Austria, Belgium, and Bulgaria among a sufficient number of indicators. Data for Austria cover a sample of 5000 respondents, and for Belgium, a sample of 7163, including partial responses. Both surveys were conducted over the period 2008–2010. GGP survey data for Bulgaria offers 12858 records collected in 2005. In each survey, one respondent per household is invited to answer, so a sample of households is created. Respondents' age ranges from 18 to 80. Private households made of one or two elderly aged above 80 are thus not included in the surveys: therefore, the proportions of energy poor households presented below are probably slightly underestimated. The databases for the three countries have been weighted according to the methodological suggestions offered by the GGP regarding countries' specific weights.[2]

4.2. Methods

4.2.1. A typology on access to affordable warmth

In order to analyse possible correlations between self-perception of material deprivation, access to energy, and capabilities, among the households located in the three countries under investigation, it was necessary to define a common typology of households. We took three variables in conjunction: it is rather/very difficult to make ends meet; the household has affordability problems in keeping home adequately warm; the household has been in arrears on energy bills in the last 12 months. These are combined as set out in Table 1 to create four categories of households. Two of these (energy poor households and other self-perceived poor households) regard themselves as living in a state of (acute) poverty whereas the other two (energy vulnerable and energy rich households) do not, but energy-vulnerable households consider themselves to have affordability problems in keeping their home adequately warm.

4.2.2. Proxying five capabilities

Austria, Belgium, and Bulgaria's databases allow all to analyse five capabilities: Bodily Health (Capability 2); Practical Reason (Capability 6); Affiliation (Capability 7A), Play (Capability 9), Control over One's Material Environment (Capability 10B). The proxies available in the three countries' surveys are reported in Table 2.

Capability 2 is related to bodily health for which three proxies are considered: being in very bad health, being in permanent disability, and a variable related to protein intake ("Can your household afford: eating meat, chicken or fish every second day"). Capability 6 is called "Practical Reason" and connected to the "locus" of control in one's life, including perceived control ("How much control do you feel you will have in the following three years on your work, housing, income, and family?"). Capability 7 is called "Affiliation" by Ref. [8] and the selected proxies cover different feelings of the respondents related to sense of emptiness, loneliness, isolation, and opinion on the number of people close to rely on. Capability 9, "Play", evaluates the lack of recreational moments or activities whether during holidays or with family or friends at home. Finally, Capability 10B, "Control over one's material environment" is related here to the affordability of a car or of household appliances (e.g. Household "would like but cannot afford" a dishwasher, a car, a washing machine, or a computer).

4.2.3. A variability index

To examine how energy inequalities and different capabilities are associated (or not) in these countries, and to offer a comparison across these countries, we adopt the Variability Index calculated as in Ref. [6]. Firstly, we compute the share in each households' category affected by the lack of a capability as expressed by their corresponding proxies as in Table 2. Secondly, the mean of the shares for each households' category on energy access is calculated (in %). Thirdly, the variability index is calculated as follows:

$$Variability\ index = \frac{Mean_{energy\ poor}(\%) - Mean_{energy\ rich}(\%)}{\left(Mean_{energy\ poor}(\%) + Mean_{energy\ rich}(\%)\right)/2}$$

The variability index expresses the level of variation among the extreme categories of the typology in terms of different capabilities, so that the larger the variability is, the higher the differences are between the energy poor households and the energy rich ones. Hence, a high variability index gives the researcher the ability to sense of a high level of inequalities affecting a given capability in a given country. It is important to note that if for a given capability, the mean proportions deprived thereof are low and roughly the same for the two most and least deprived categories (energy poor households versus energy rich ones), the variability index is low (as there are little differences between the two categories), but this does not mean that there is no concern regarding the weak opportunities for the deployment of that capability for *both* categories.

This observation holds true as well in the comparison of capabilities attainments between countries: this variability index tells

[2] Results for Belgium presented in this paper are therefore slightly different from those published in Ref. [6] where an original and complex weighting procedure was developed and applied.

Table 1
Variables used in a typology on affordable access to energy.

	Energy poor	Other self-perceived "poor"	Energy vulnerable	Energy rich
It is (rather/very) difficult to meet ends	Yes	Yes	No	No
Affordability problems to keep home adequately warm	At least one 'Yes'	No	Yes	No
Arrears on energy bills in the last 12 months		No	Yes or No	Yes or No

Source: Adapted from Ref. [6]: 1224–5.

Table 2
Variables adopted for comparison of three European Countries adopting [6]'s approach.

Capability 2	Capability 6	Capability 7A	Capability 9	Capability 10B
Bodily Health	Practical Reason	Affiliation	Play	Control over one's Material Environment
In very bad health	Financial (control)	Experience a general sense of emptiness	Household cannot afford a week of annual holiday away	Household cannot afford a dishwasher
Long-standing illness or chronic condition	Work (control)	I don't have many people I can count on completely	Cannot afford having friends or family for a drink or meal at least once a month	Household cannot afford a car
Household cannot afford: eating meat, chicken or fish every second day	Housing (control)	I don't have enough people I feel close to		Household cannot afford a washing machine
	Health (control) Family (control)	Felt lonely		Household cannot afford a computer

Table 3
Shares and number (in brackets) for the four categories of the typology on access to affordable warmth in Austria, Belgium, and Bulgaria.

	Austria	Belgium	Bulgaria
Energy poor	0.07 (352)	0.09 (594)	0.36 (4422)
Other self-perceived poor	0.19 (953)	0.22 (1520)	0.56 (7058)
Energy vulnerable	0.11 (584)	0.06 (417)	0.01 (70)
Energy rich	0.63 (3098)	0.63 (4431)	0.07 (855)
Total sample size	4987	6962	12405

Source: GGP surveys, Austria, 2009, Belgium, 2009, and Bulgaria, 2005.

about inequalities, not about absolute situations.

5. Outputs of the accountability model for Austria, Belgium, and Bulgaria

5.1. Inequalities in access to affordable warmth

Table 3 presents the figures for the four categories of the typology on access to affordable warmth in the three countries analysed. This preliminary analysis itself offers some initial interesting evidence in terms of distribution of energy poverty across Europe.

As expected, energy poverty affects Bulgaria more severely (36% of the households according to our definition) than Belgium (9%) and Austria (7%). In the three countries, energy poor households are (much) less numerous than the category of other self-perceived poor. In Austria, there are somewhat more 'energy-vulnerable' households than energy poor ones (11% versus 7%) whereas the reverse is observed in Belgium (6% versus 9%). These results motivate the need for deeper insight of the main differences between countries, not only in terms of access to affordable warmth but also in terms of capabilities. Accordingly, the current work extends [6] to new countries, Austria, and Bulgaria.

5.2. Capability profiles

5.2.1. Austria

The results for Austria are displayed in Table 4. Comparing the energy rich households with the energy poor ones, the variability index indicates that the capability gap is largest between the two groups for Capability 10B (Control over one's material environment). The affordability issues of the energy poor are significant in size. While a washing machine being a standard equipment in Austrian households, it cannot be afforded by 3.6% of energy poor households, and other appliances (dishwasher, car, and computer) cannot be afforded by 14–21% of the energy poor.

Another severe problem of the energy poor compared to the energy rich is related to the capability called "Play", represented by going on holiday and entertaining friends and family. In fact, 54% of energy poor households are restricted in the frequency of going on holiday, while almost none (6.9%) of the energy rich households are confronted with this issue.

Practical Reason does not divide the population in terms of energy access (the variability index is only 46), but uncertainty on various aspects (finance, work, and so on) is rather widespread across all categories of households, which should be underlined. Affiliation – and therefore emotional issues – are distributed differently between energy poor and energy rich. Around three to four times as many energy poor individuals (in relative terms) feel isolated or lonely as compared to the energy rich.

Another important difference between energy poor and energy rich is subsumed by the capability "Bodily Health". Less than 1% of the population in Austria is in very bad health in general. But in terms of long-standing illness and protein intake, there are huge differences between the energy poor and the energy rich. While the share of long-standing illness or chronic condition is 25% among the energy poor, it is only 10% for the energy rich. The highest inequality shows up in the case of protein intake. Almost none of the energy rich (2.9%) have affordability problems in protein nutrition. At the same time, almost one out of four energy poor households cannot afford a proper protein nutrition.

The results show that in addition to material issues (Capability 10B), energy poor households in Austria face various problems. Nutrition and free time activities in particular divide energy poor and energy rich households by the largest extent.

These results deliver especially important information for policy makers in Austria, where the debate around energy poverty is

Table 4
Proxies of five capabilities in Austria according to households' access to affordable warmth.

	Energy poor	Other self-perceived poor	Energy vulnerable	Energy rich
Capability 2: Bodily Health				
In very bad health	0.64	0.87	0.58	0.11
Long-standing illness or chronic condition	25.26	15.86	11.68	10.46
Household cannot afford: eating meat, chicken or fish every second day	23.13	15.91	3.79	2.89
Mean	*16.34*	*10.88*	*5.36*	*4.49*
Variability Index		*113*		
Capability 6: Practical Reason				
How much control do you feel you will have over the following areas of your life in the next three years? Answer: Not at all or a little				
Financial (control)	58.80	46.37	34.07	35.60
Work (control)	57.54	49.37	33.40	36.75
Housing (control)	49.73	43.67	31.05	28.96
Health (control)	43.07	35.25	28.49	28.95
Family (control)	27.27	23.85	20.65	16.17
Mean	*47.28*	*39.70*	*29.53*	*29.29*
Variability Index		*46*		
Capability 7A: Affiliation				
Experience a general sense of emptiness	11.47	7.38	2.79	2.48
I don't have many people I can count on completely	11.79	8.89	6.73	5.47
I don't have enough people I feel close to	14.48	8.90	4.60	4.64
Felt lonely	5.25	3.51	2.47	1.12
Mean	*10.75*	*7.17*	*4.15*	*3.43*
Variability Index		*103*		
Capability 9: Play				
Not Going on Holiday	54.01	37.48	6.65	6.93
No Drink with Friends/Family	35.26	23.22	3.47	4.50
Mean	*44.63*	*30.35*	*5.06*	*5.72*
Variability Index		*154*		
Capability 10B: Control over one's material environment				
Household wishes but cannot afford				
A dishwasher	20.08	9.33	3.30	1.14
A car	21.46	10.05	2.62	2.25
A washing machine	3.61	0.91	0.45	0.32
A computer	13.65	6.29	1.54	0.58
Mean	*14.70*	*6.64*	*1.98*	*1.07*
Variability Index		*172*		

Source: GGP survey, Austria, 2009.

almost exclusively about the affordability of energy services. Our results show that problems related to everyday life and self-fulfilment are actually significant issues and exclusionary factors for energy poor households in comparison to energy rich ones.

5.2.2. Belgium

Table 5 displays the results for Belgium. As indicated by the highest variability index, energy poor households are the most disadvantaged, as compared to the energy rich ones, for the capabilities called "Play" (9) and "Control over one's material environment" (10B). The latter relates to the ownership of a car, or appliances, or a computer that the household would like to have but cannot afford for financial reasons. The corresponding figures for the energy poor households are rather high in 2009, ranging from 4.65% for a washing machine to 21% for a dishwasher. Access to leisure and holidays, and the frequency of inviting family or friends at home are clearly restricted for energy poor households—but also for the energy-vulnerable ones, which is an unexpected result.

Many respondents to the survey who are living in energy poverty are also deprived from the capability related to "Bodily health", including protein intake, as also shown by Table 5.

The capability "Practical Reason" refers to the ability "to engage in critical reflection about the planning of one's life" ([8]: 79). The respondents to the Belgian GGP survey seem to negatively evaluate their sense of control in various areas of their lives for the next three years; however, this lack of agency clearly decreases with better access to affordable warmth, especially so for the housing situation, which is of course related to their access to affordable warmth. The only exception is between energy-vulnerable households and energy rich ones regarding the respondents' health situation, with close figures, about 18%. Among energy poor households, uncertainty about their financial situation and their work for the next three years is particularly widespread, with more than two out of five energy poor households being uncertain for these aspects.

The "Affiliation" capability refers to social isolation and loneliness, that both decreases according to the household's category regarding its access to affordable warmth. Nevertheless, as indicated by the variability indexes in Table 5, the differences between energy poor households and the energy rich ones are less dramatic for the affiliation capability than for the capabilities "Play" and "Control over one's material environment" discussed previously.

5.2.3. Bulgaria

In line with the two previous countries, for the capabilities "Play" and "Bodily Health", energy poor show relevantly higher shares compared to the energy rich (Table 6). Nonetheless, the group classified as energy poor is significantly more affected by higher shares, also when compared to the self-perceived poor. In

Table 5
Proxies of five capabilities in Belgium according to households' access to affordable warmth.

	Energy poor	Other self-perceived poor	Energy vulnerable	Energy rich
Capability 2: Bodily Health				
In very bad health	5.01	1.73	2.40	1.10
Long-standing illness or chronic condition	37.83	30.45	23.45	19.65
Household cannot afford: eating meat, chicken or fish every second day	30.78	5.11	49.29	1.38
Mean	*24.54*	*12.43*	*25.05*	*7.37*
Variability Index		*109*		
Capability 6: Practical Reason				
How much control do you feel you will have over the following areas of your life in the next three years? Answer: Not at all or a little				
Financial (control)	42.92	24.14	11.03	8.59
Work (control)	42.88	28.52	18.20	15.45
Housing (control)	28.69	14.12	6.82	5.81
Health (control)	36.07	26.56	18.28	19.32
Family (control)	21.36	12.97	7.31	6.10
Mean	*34.38*	*21.26*	*12.33*	*11.05*
Variability Index		*102*		
Capability 7A: Affiliation				
Experience a general sense of emptiness	20.42	15.18	8.10	6.02
I don't have many people I can count on completely	17.44	13.95	6.92	6.06
I don't have enough people I feel close to	27.74	19.81	16.59	10.83
Felt lonely	11.69	7.21	2.37	2.31
Mean	*19.32*	*14.04*	*8.49*	*6.30*
Variability Index		*101*		
Capability 9: Play				
Not Going on Holiday	66.44	40.18	48.80	5.84
No Drink with Friends/Family	44.67	14.77	49.41	1.49
Mean	*55.55*	*27.48*	*49.11*	*3.66*
Variability Index		*175*		
Capability 10B: Control over one's material environment				
Household wishes but cannot afford				
A dishwasher	21.09	8.57	1.90	1.65
A car	15.55	7.53	1.38	0.91
A washing machine	4.65	1.83	0.48	0.16
A computer	13.41	6.32	1.21	1.07
Mean	*13.67*	*6.06*	*1.24*	*0.95*
Variability Index		*174*		

Source: GGP survey, Belgium, 2009.

fact, focusing on Capability 2 ("Bodily Health"), people in the energy poor category face major difficulties in ensuring a diet with a balanced level of proteins. Concerning Capability 9 ("Being able to enjoy recreational activities with friends and family, to go on holiday …") a high variability index stresses a relevant divergence between the two extreme categories, energy poor and energy rich households. More than 92% of the energy poor households cannot afford going on holiday, compared to almost 20% in the energy rich group. In addition, these figures are quite higher than the corresponding figures in Austria and Belgium.

Somewhat differently from Austria and Belgium, Bulgaria does not account for a very high level of the variability index when it comes to the Capability 10 ("Control over one's material environment") because at the time of the survey (2005), the energy rich were rather numerous to report that they wanted but could not afford a car (7%) or some appliances.

This study returns for Bulgaria a picture in which some capabilities are strongly characterized by high evidence of divergence between groups when it comes to material and health deprivation (e.g. Capability 2) while there are less differences regarding affiliation (Capability 7A). A lower level of variability is also seen for Capability 6 ("Practical Reason"), even if the sense of agency decreases significantly with a better energy access, especially for the financial and housing situation, which are both closely related to the access to affordable warmth. The reason for these lower differences can be found in the high levels of precariousness for the whole Bulgarian society.

5.3. Overview across Austria, Belgium, and Bulgaria

Additionally, to summarise the results obtained by this accountability model and to offer a straightforward visualization of the cross-country differences, results from Table 7 are plotted in a radar chart (Fig. 5).

The picture highlights that Austria, Bulgaria, and especially Belgium are majorly characterised by a higher social variability of Capability 9 ("Being able to laugh, to play and to enjoy recreational activities") and 10B ("Control over one's material environment"), less so though for the latter in Bulgaria. It is also evident that Bulgaria is affected by a higher level of variability for Capability 2 ("Bodily health"), versus Austria and Belgium. Lastly, higher variability characterizes Belgium in terms of Capability 6 ("Practical reason"). In the following paragraphs, an attempt is made to connect these results with some characteristics of the energy systems outlined above for these three countries.

In 2007, end use of renewable energy was highest in Austria and lowest in Belgium; for the same year, inequality in Bodily Health (Capability 2) was lowest in Belgium and highest in Bulgaria: this has probably more to do with the organisation of the public health system and the budget dedicated to it than with the system of

Table 6
Proxies of five capabilities in Bulgaria according to households' access to affordable warmth.

	Energy poor	Other self-perceived poor	Energy vulnerable	Energy rich
Capability 2: Bodily Health				
In very bad health	6.39	3.07	2.85	0.31
Long-standing illness or chronic condition	34.37	26.19	18.12	16.14
Household cannot afford: eating meat, chicken or fish every second day	73.72	46.38	7.72	5.29
Mean	*38.16*	*25.21*	*9.56*	*7.24*
Variability Index		*136*		
Capability 6: Practical Reason				
How much control do you feel you will have over the following areas of your life in the next three years? Answer: Not at all or a little				
Financial (control)	81.70	71.53	44.28	37.42
Work (control)	49.73	43.16	36.30	26.21
Housing (control)	54.27	41.76	26.21	24.00
Health (control)	71.23	64.21	37.12	44.36
Family (control)	33.28	25.78	21.06	15.45
Mean	*58.04*	*49.29*	*32.99*	*29.49*
Variability Index		*65*		
Capability 7A: Affiliation				
Experience a general sense of emptiness	14.58	7.90	2.88	4.35
I don't have many people I can count on completely	13.65	7.14	3.14	4.30
I don't have enough people I feel close to	33.02	22.37	12.47	17.19
Felt lonely	7.82	3.75	1.39	1.96
Mean	*17.27*	*10.29*	*4.97*	*6.95*
Variability Index		*85*		
Capability 9: Play				
Not Going on Holiday	92.68	79.15	26.42	19.75
No Drink with Friends/Family	73.91	46.79	10.82	6.65
Mean	*83.30*	*62.97*	*18.62*	*13.20*
Variability Index		*145*		
Capability 10B: Control over one's material environment Household wishes but cannot afford				
A dishwasher	35.58	29.66	19.55	19.90
A car	33.43	19.00	11.74	6.92
A washing machine	22.69	9.90	6.14	2.39
A computer	34.95	30.89	22.24	14.38
Mean	*31.66*	*22.36*	*14.92*	*10.90*
Variability Index		*97*		

Source: GGP survey, Bulgaria, 2005.

Table 7
Variability indices for five capabilities.

Capability	Austria	Belgium	Bulgaria
Bodily health (2)	113	109	136
Practical Reason (6)	46	102	65
Affiliation (7A)	103	101	85
Play (9)	154	175	145
Control over one's material environment (10B)	172	174	97

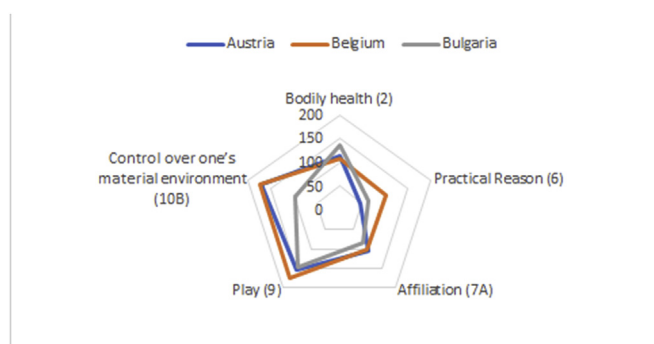

Fig. 5. Variability indices for 5 different capabilities.
Source: GGP surveys, Austria, 2009, Belgium, 2009, and Bulgaria, 2005.

energy provision. Equality in low scores in Practical Reasoning (Capability 6) coincided with a higher share of renewables in energy end use: Belgium, which had the lowest share, also had the highest inequality in this capability. Without arguing for a causal relation (in one direction or the other) between these phenomena, further research would be desirable to investigate a possible direct or indirect relation between a higher share in renewable energy use and the opportunities to engage in critical reflection about the planning of one's life.

Regarding affiliation, although the three countries differ in their supply structure for renewable energy, the differences in the variability index in capability 7A (Affiliation) were fairly low between the countries, indicating that the inequality in affiliation opportunities was not (at that time) directly related to energy supply but may be connected to the social organisation of collective life. Whether or not this is enhanced by the type of energy transitions depends rather on factors (such as participation in the transition process) which were not analysed in our study.

Capability 9 ("Play") in our framework is measured by indicators (going on holiday and having drinks with friends) that relate to the respondents' economic situation rather than to their perceptions of energy transitions (such as environment or air pollution). For this capability, this shows the necessity for data on indicators related to

environment or energy use. The indicators from the present study can only indirectly be connected to justice issues arising from energy transitions. The ability to enjoy recreational activities in the regional neighbourhood would be one possible indicator to relate the inequality to (for example) the above-mentioned NIMBY problem.

Regarding capability 10B (proxied here by the affordability of energy consuming appliances and goods), our results show that inequality was high in Austria and Belgium. The high primary energy supply in oil represents the high share of privately owned cars in both countries. With a change in the system of mobility (e.g. car sharing or a better provision of public transport services), the desire to own a private car might decrease and therefore the affordability issues of the energy poor might decrease as well, resulting in lower inequality in this capability.

6. Concluding discussion

The aim of this article was to propose an accountability model to evaluate the social correlates to energy transitions, especially on energy-access inequalities, by using the capability approach. Nussbaum's capability list (2000: 78–80) is useful, as it identifies a number of dimensions through which energy transition and energy inequalities may be connected.

This accountability model was applied here for Austria, Belgium, and Bulgaria, three countries having different profiles regarding their energy systems and inequalities in the access their households have to affordable warmth, namely in their prevalence of energy poverty.

In addition to data from Eurostat and other international agencies, the data used in this research derived from the Generation and Gender Programme. Data availability represents an important limit on the proposed aim to obtain a complete empirical application and to improve accountability. Despite data limitations, developing surveys such as GGP could enable increased opportunities to analyse dynamics in time that would increase significantly the accountability of energy transition. Therefore, our applications showed that building on the concept of energy inequality through capabilities is a feasible way to develop informative outcomes. We are aware that the outcomes of our applications in terms of different capabilities should be compared in time. In this direction, our study could represent a first stage in promoting a broader accountability process of energy transition based on capabilities. However, future waves, with the same variables, could provide a very valuable database for such a longitudinal monitoring: indeed, no other standardised large-scale survey undertaken in European countries provides such a range of variables on daily practices, emotions, sociability, housing, and affordability of various goods. The third wave of the GGP planned in some countries could lead to new interesting and promising results to monitor social inequalities related to energy transitions within a sufficiently long timeframe.

This heuristic model and its application to Austria, Belgium and Bulgaria open the way to new research and new policy developments. Regarding research, it would be interesting for example to study whether and to which conditions Energy Renewable Communities develop the affiliation capability at the local scale. Regarding policy instruments, our results clearly indicate that affordability of energy is crucial to reduce inequalities related to several capabilities: therefore, policy instruments that enhance this affordability without increasing energy consumption to limit climate change should be developed, such as progressive tariffs for gas and electricity, or better provision of public transport services. Furthermore, efforts should be made to avoid the 'heat or eat' trap [67–69], because the inequality regarding the health-related capability is so high, especially but not only in Bulgaria. In this country, nearly three households out of four households in energy poverty cannot afford eating meat, chicken or fish every second day. In Belgium and in Austria, the corresponding figures are 31% and 23% respectively.

Guaranteeing more socially equitable energy transitions should represent a key issue in the policy agenda at both country level and European level, and for this reason, it is important to widen the debate about models of accountability to include social disparities and energy policies. Our results underline numerous inequalities in each country studied here, not only between energy poor households and energy richer ones, but also between energy poor households and other households perceiving themselves as poor. Given the intention to reduce these inequalities and to provide all citizens with better opportunities for living the life they value – in other words, to deploy their capabilities – the accountability model proposed in this article may be a first step in describing the complexity and the interconnected dimensions that give rise to energy injustice.

Acknowledgements

This article is based on work carried out during the COST Action CA16232 'European Energy Poverty: Agenda Co-Creation and Knowledge Innovation' (ENGAGER). The authors who participated in the Lisbon meeting (22–23 February 2019) would like to thank S. Sareen and J.P. Gouveia for creating a friendly and intellectually stimulating workshop where this paper began to take shape. We are also grateful to Ute Dubois (ISG International Business School, Paris) for her suggestions, and to Christophe Vandeschrick (Université catholique de Louvain) who shared his codes to produce some of the results presented above. We also thank S. Sareen and H. Haarstad for their comments on a first version of this paper and for organising the Bergen meeting in May 2019, where this paper received helpful comments. Thanks are also due to the two anonymous reviewers for their comments.

Appendix 1. Nussbaum (2000)'s list of capabilities

1 Life. Being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living.
2. Bodily Health. Being able to have good health, including reproductive health; to be adequately nourished; to have adequate shelter.
3. Bodily Integrity. Being able to move freely from place to place; having one's bodily boundaries treated as sovereign, i.e. being able to be secure against assault, including sexual assault, child sexual abuse, and domestic violence; having opportunities for sexual satisfaction and for choice in matters of reproduction.
4. Senses, Imagination, and Thought. Being able to use the senses, to imagine, think, and reason – and to do these things in a "truly human" way, a way informed and cultivated by an adequate education, including, but by no means limited to, literacy and basic mathematical and scientific training. Being able to use imagination and thought in connection with experiencing and producing self-expressive works and events of one's own choice, religious, literary, musical, and so forth. Being able to use one's mind in ways protected by guarantees of freedom of expression with respect to both political and artistic speech, and freedom of religious exercise. Being able to search for the ultimate meaning of life in one's own way. Being able to have pleasurable experiences, and to avoid non-necessary pain.

5. Emotions. Being able to have attachments to things and people outside ourselves; to love those who love and care for us, to grieve at their absence; in general, to love, to grieve, to experience longing, gratitude, and justified anger. Not having one's emotional development blighted by overwhelming fear and anxiety, or by traumatic events of abuse or neglect. (Supporting this capability means supporting forms of human association that can be shown to be crucial in their development.)
6. Practical Reason. Being able to form a conception of the good and to engage in critical reflection about the planning of one's life. (This entails protection for the liberty of conscience.)
7. Affiliation.
   A. Being able to live with and toward others, to recognize and show concern for other human beings, to engage in various forms of social interaction; to be able to imagine the situation of another and to have compassion for that situation; to have the capability for both justice and friendship. (Protecting this capability means protecting institutions that constitute and nourish such forms of affiliation, and also protecting the freedom of assembly and political speech.)
   B. Having the social bases of self-respect and non-humiliation; being able to be treated as a dignified being whose worth is equal to that of others. This entails, at a minimum, protections against discrimination on the basis of race, sex, sexual orientation, religion, caste, ethnicity, or national origin. In work, being able to work as a human being, exercising practical reason and entering into meaningful relationships of mutual recognition with other workers.
8. Other Species. Being able to live with concern for and in relation to animals, plants, and the world of nature.
9. Play. Being able to laugh, to play, to enjoy recreational activities.
10. Control over One's Environment.
    A. Political. Being able to participate effectively in political choices that govern one's life; having the right of political participation, protections of free speech and association.
    B. Material. Being able to hold property (both land and movable goods), not just formally but in terms of real opportunity; and having property rights on an equal basis with others; having the right to seek employment on an equal basis with others; having the freedom from unwarranted search and seizure." [8]:78–80)

References

[1] M. Eames, M. Hunt, Energy justice in sustainability transitions research, in: K. Bickerstaff, G. Walker, H. Bulkeley (Eds.), Energy Justice in a Changing Climate – Social Equity and Low-Carbon Energy, Zed Books, London – New York, 2013, pp. 46–60.
[2] G. Brundtland, Report of the World Commission on Environment and Development: Our Common Future, United Nations General Assembly document A/42/427, 1987.
[3] IPCC, Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Preindustrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty, 2018.
[4] D. Curran, D. Tyfield, Low-carbon transition as vehicle of new inequalities? Risk-class, the Chinese middle-class and the moral economy of misrecognition, Theory Cult. Soc. (2019), https://doi.org/10.1177/0263276419869438. OnlineFirst.
[5] F. Bartiaux, L. Schmidt, A. Horta, A. Correia, Social diffusion of energy-related practices and representations – patterns and policies in Portugal and Belgium, Energy Policy 88C (2016) 413–421, https://doi.org/10.1016/j.enpol.2015.10.046.
[6] F. Bartiaux, C. Vandeschrick, M. Moezzi, N. Frogneux, Energy justice, unequal access to affordable warmth, and capability deprivation: a quantitative analysis for Belgium, in: Applied Energy, Special Issue: 'Low-carbon energy systems and energy justice' 225C, 2018, pp. 1219–1233, https://doi.org/10.1016/j.apenergy.2018.04.113.
[7] P. Barberis, The new public management and a new accountability, Public Adm. 76 (1998) 451–470, https://doi.org/10.1111/1467-9299.00111.
[8] M.C. Nussbaum, Women and Human Development: the Capabilities Approach, Cambridge University Press, Cambridge, 2000.
[9] A. Sen, Inequality Reexamined, Oxford University Press, Oxford, 1992.
[10] M.C. Nussbaum, A. Sen (Eds.), The Quality of Life, Oxford University Press and Clarendon Press, Oxford and New York, 1993.
[11] A. Sen, The Idea of Justice, Penguin Books, London, 2009.
[12] R. Hillerbrand, Why affordable clean energy is not enough. A capability perspective on the sustainable development goals, Sustainability 10 (2485) (2018), https://doi.org/10.3390/su10072485.
[13] T. Fitzpatrick, Climate Change and Poverty. A New Agenda for Developed Nations, Policy Press, Bristol, 2014.
[14] H. Thomson, C. Snell, S. Bouzarovski, Health, well-being and energy poverty in Europe: a comparative study of 32 European countries, Int. J. Environ. Res. Public Health 14 (2017) 584–604, https://doi.org/10.3390/ijerph14060584.
[15] A. Baudaux, J. Coene, B. Delbeke, F. Bartiaux, A. Sibeni, F. Fournier, É. Heymans, S. Oosterlynck, W. Lahaye, Living in energy poverty: a qualitative approach, in: F. Bartiaux (Ed.), Generation and Gender Energy Deprivation: Realities and Social Policies, BELSPO, Brussels, 2019, pp. 38–66 (Forthcoming).
[16] Eurostat, Inequality of income distribution. https://ec.europa.eu/eurostat/web/products-datasets/product?code=tespm151, 2019a.
[17] S. Sareen, Reframing Energy Transitions as Resolving Accountability Crisis, in: S. Sareen (Ed.), Enabling Sustainable Energy Transitions: Practices of legitimation and accountable governance, Palgrave Macmillan, Cham, 2019, pp. 3–14. https://link.springer.com/book/10.1007%2F978-3-030-26891-6.
[18] S. Bouzarovski, S. Petrova, A global perspective on domestic energy deprivation: overcoming the energy poverty–fuel poverty binary, Energy Research & Social Science 10 (2015) 31–40, https://doi.org/10.1016/j.erss.2015.06.007.
[19] C. Waddams Price, K. Brazier, W. Wang, Objective and subjective measures of fuel poverty, Energy Policy 49 (2012) 33–39, https://doi.org/10.1016/j.enpol.2011.11.095.
[20] K.-M. Brunner, M. Spitzer, A. Christanell, Experiencing fuel poverty. Coping strategies of low-income households in Vienna/Austria, Energy Policy 49 (2012) 53–59, https://doi.org/10.1016/j.enpol.2011.11.076.
[21] F. Bartiaux, V. Gosselain, D. Vassileva, G. Stamova, L. Ozoliņa, E. Garā, Knowledge on climate change and energy-saving renovations by apartment owners in Bulgaria and Latvia. A Qualitative Study, Int. Rev. Soc. Res. 1 (3) (2011) 133–154, https://doi.org/10.1515/irsr-2011-0024.
[22] S. Georgieva, Qualitative assessment summaries: Bulgaria, in: World Bank (Ed.), Adapting to Higher Energy Costs: Findings from Qualitative Studies in Europe and Central Asia, The World Bank Group, Washington, 2015, pp. 78–88.
[23] B. Maresca, S. Lacombe, À la rencontre de la précarité énergétique : un éclairage, in: C. Drozd, I. Requena Riuz, K. Mahé, D. Siret (Eds.), La construction du chez-soi dans la transition énergétique : entre conceptions de la performance et pratiques habitantes, Ensan, Nantes, 2015, pp. 49–55.
[24] L. Middlemiss, R. Gillard, Fuel poverty from the bottom-up: characterising household energy vulnerability through the lived experience of the fuel poor, Energy Research & Social Science 6 (2015) 146–154, https://doi.org/10.1016/j.erss.2015.02.001.
[25] L. Middlemiss, P. Ambrosio-Albalá, N. Emmel, R. Gillard, J. Gilbertson, T. Hargreaves, C. Mullen, T. Ryan, C. Snell, A. Tod, Energy poverty and social relations: a capabilities approach, Energy Research & Social Science 55 (2019) 227–235.
[26] S. Sareen, H. Haarstad, Bridging socio-technical and justice aspects of sustainable energy transitions, in: Applied Energy, Special Issue: 'Low-carbon energy systems and energy justice' 228, 2018, pp. 624–632, https://doi.org/10.1016/j.apenergy.2018.06.104.
[27] D. Schlosberg, Reconceiving environmental justice: global movements and political theories, Environ. Politics 13 (3) (2004) 517–540, https://doi.org/10.1080/0964401042000229025.
[28] G. Walker, Environmental Justice: Concepts, Evidence and Politics, Routledge, London, 2012.
[29] K. Jenkins, D. McCauley, R. Heffron, H. Stephan, R. Rehner, Energy justice: a conceptual review, Energy Res. Soc. Sci. 11 (2016) 174–182, https://doi.org/10.1016/j.erss.2015.10.004.
[30] R.J. Heffron, D. McCauley, The concept of energy justice across the disciplines, Energy Policy 105 (C) (2017) 658–667, https://doi.org/10.1016/j.enpol.2017.03.018.
[31] B.K. Sovacool, R.J. Heffron, D. McCauley, A. Goldthau, Energy decisions reframed as justice and ethical concerns, Nature Energy 1 (2016) 16024.
[32] G. Walker, R. Day, Fuel poverty as injustice: integrating distribution, recognition and procedure in the struggle for affordable warmth, Energy Policy 49 (2012) 69–75, https://doi.org/10.1016/j.enpol.2012.01.044.
[33] K. Bickerstaff, G. Walker, H. Bulkeley (Eds.), Energy Justice in a Changing Climate. Social Equity Implications of the Energy and Low-Carbon Relationship, Zed Books, London, 2013.
[34] R. Day, G. Walker, N. Simcock, Conceptualising energy use and energy poverty

using a capabilities framework, Energy Policy 93 (2016) 255–263, https://doi.org/10.1016/j.enpol.2016.03.019.
[35] B.K. Sovacool, M. Burkec, L. Bakerb, C.K. Kotikalapudi, H. Wlokasd, New frontiers and conceptual frameworks for energy justice, Energy Policy 105 (2017) 677–691, https://doi.org/10.1016/j.enpol.2017.03.005.
[36] K. Jenkins, B.K. Sovacool, D. McCauley, Humanizing sociotechnical transitions through energy justice: an ethical framework for global transformative change, Energy Policy 117 (2018) 66–74, https://doi.org/10.1016/j.enpol.2018.02.036.
[37] N. Wood, K. Roelich, Tensions, capabilities, and justice in climate change mitigation of fossil fuels, Energy Res. Soc. Sci. 52 (2019) 114–122.
[38] L.E. Erickson, M. Jennings, Energy, transportation, air quality, climate change, health nexus: sustainable energy is good for our health, AIMS Publ. Health 4 (2017) 47–62, https://doi.org/10.3934/publichealth.2017.1.47.
[39] S. Ahmad, S. Pachauri, F. Creutzig, Synergies and trade-offs between energy-efficient urbanization and health, Environ. Res. Lett. 12 (2017) 114017, https://doi.org/10.1016/j.enpol.2011.11.076.
[40] E. Cox, Assessing long-term energy security: the case of electricity in the United Kingdom, Renewable and Sustainable Energy Reviews 82, Part 3 (2018) 2287–2299, https://doi.org/10.1016/j.rser.2017.08.084.
[41] Y. Kajikawa, F. Tacoa, K. Yamaguchi, Sustainability science: the changing landscape of sustainability research, Sustain. Sci. 9 (4) (2014) 431–438, https://doi.org/10.1007/s11625-014-0244-x.
[42] P.E. Stoknes, Rethinking climate communications and the psychological climate paradox, Energy Res. Soc. Sci. 1 (2014) 161–170, https://doi.org/10.1016/j.erss.2014.03.007.
[43] C.J. Brown, N.O. Markusson, The responses of older adults to smart energy monitors, Energy Policy 130 (2019) 218–226, https://doi.org/10.1016/j.enpol.2019.03.063.
[44] D.S. Byrne, F. Bartiaux, Energy systems and energy-related practices, in: N. Labanca (Ed.), Complex Systems and Social Practices in Energy Transitions: Framing Energy Sustainability in the Time of Renewables, Springer International Publishing (Series: Green Energy and Technology), 2017, pp. 305–320.
[45] E. Shove, Beyond the ABC: climate change policy and theories of social change, Environ. Plan. 42 (6) (2010) 1273–1285.
[46] M.-C. Zélem, Les énergies renouvelables en transition : de leur acceptabilité sociale à leur faisabilité socio-technique, Revue de l'Énergie (2012) n° 610, available on, http://www.global-chance.org/Les-energies-renouvelables-en-transition-de-leur-acceptabilite-sociale-a-leur-faisabilite-sociotechnique.
[47] E. Stigka, J. Paravantis, G. Mihalakakou, Social acceptance of renewable energy sources: a review of contingent valuation applications, Renew. Sustain. Energy Rev. 32 (2014) 100–106, https://doi.org/10.1016/j.rser.2013.12.026.
[48] A.L. Berka, E. Creamer, Taking stock of the local impacts of community owned renewable energy: a review and research agenda, Renew. Sustain. Energy Rev. 82 (2018) 3400–3419, https://doi.org/10.1016/j.rser.2017.10.050.
[49] T. Hoppe, A. Graf, B. Warbroek, I. Lammers, I. Lepping, Local governments supporting local energy initiatives: lessons from the best practices of Saerbeck (Germany) and Lochem (The Netherlands), Sustainability 7 (2) (2015) 1900–1931, https://doi.org/10.3390/su7021900.
[50] J. Hicks, N. Ison, An exploration of the boundaries of 'community' in community renewable energy projects: navigating between motivations and context, Energy Policy 113 (2018) 523–534, https://doi.org/10.1016/j.enpol.2017.10.031.
[51] C.V. Möllendorff, H. Welsch, Measuring renewable energy externalities: evidence from subjective well-being data, Land Econ. 93 (1) (2017) 109–126, https://doi.org/10.3368/le.93.1.109.
[52] V. Bertsch, M. Hall, C. Weinhardt, W. Fichtner, Public acceptance and preferences related to renewable energy and grid expansion policy: empirical insights for Germany, Energy 114 (2016) 465–477, https://doi.org/10.1016/j.energy.2016.08.022.
[53] A. Goldthau, Rethinking the governance of energy infrastructure: scale, decentralization and polycentrism, Energy Res. Soc. Sci. 1 (2014) 134–140, https://doi.org/10.1016/j.erss.2014.02.009.
[54] C. Friedl, J. Reichl, Realizing energy infrastructure projects – a qualitative empirical analysis of local practices to address social acceptance, Energy Policy 89 (2016) 184–193, https://doi.org/10.1016/j.enpol.2015.11.027.
[55] R.K. Yin, Case Study Research and Applications: Design and Methods, Sage publications, Los Angeles, 2017.
[56] N.K. Denzin, Triangulation, in: J.P. Keeves (Ed.), Educational Research, Methodology, and Measurement: an International Handbook, Pergamon Press, Oxford, 1988, pp. 511–513.
[57] C. Lund, Of what is this a case?: analytical movements in qualitative social science research, Hum. Organ. 73 (3) (2014) 224–234.
[58] World Bank, World Bank indicators database. https://data.worldbank.org/indicator, 2019.
[59] World Bank, Distributional impact of tariff adjustment for residential consumers. Bulgaria: Power Sector Stabilization and Market Reform; Reimbursable Technical Assistance. http://www.bfiec.org/uploated_files/252_doc_1_3_0.pdf, 2017.
[60] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, 2015. Brussels, https://ec.europa.eu/transparency/regdoc/rep/1/2015/EN/1-2015-572-EN-F1-1.PDF.
[61] Economic and Social Council, Measures to Overcome Energy Poverty in Bulgaria. Sofia: Work, Income, Living Standards and Industrial Relations Commission, and Commission for Social Policy, 2015.
[62] H. Welsch, P. Biermann, Electricity supply preferences in Europe: evidence from subjective well-being data, Resour. Energy Econ. 38 (2014) 38–60, https://doi.org/10.1016/j.reseneeco.2014.05.003.
[63] J. Kaivo-oja, J. Luukkanen, The European Union balancing between CO_2 reduction commitments and growth policies: decomposition analyses, Energy Policy 32 (13) (2004) 1511–1530, https://doi.org/10.1016/S0301-4215(03)00124-1.
[64] Z.A. Muis, H. Hashim, Z.A. Manan, F.M. Taha, P.L. Douglas, Optimal planning of renewable energy-integrated electricity generation schemes with CO_2 reduction target, Renew. Energy 35 (11) (2010) 2562–2570, https://doi.org/10.1016/j.renene.2010.03.032.
[65] Eurostat, Primary energy consumption of households. https://ec.europa.eu/eurostat/de/data/database, 2019b.
[66] IEA, Energy balances of OECD countries, IEA 2009, http://iea.org/, 2009.
[67] J. Bhattacharya, T. DeLeire, S. Haider, J. Currie, Heat or eat? Cold-weather shocks and nutrition in poor American families, Am. J. Public Health 93 (7) (2003) 1149–1154, https://doi.org/10.2105/AJPH.93.7.1149.
[68] D.A. Frank, N.B. Neault, A. Skalicky, J.T. Cook, J.D. Wilson, S. Levenson, A.F. Meyers, T. Heeren, D.B. Cutts, P.H. Casey, M.M. Black, C. Berkowitz, Heat or eat: the Low Income Home Energy Assistance Program and nutritional and health risks among children less than 3 years of age, Pediatrics 118 (5) (2006) 1293–1302. https://10.1542/peds.2005-2943.
[69] T. Beatty, L. Blow, T. Crossley, Is there a 'heat-or-eat' trade-off in the UK? J. R. Stat. Soc. Ser. A 177 (1) (2014) 281–294, https://doi.org/10.1111/rssa.12013.