Energy Poverty Indicators: Conceptual Issues

Part I: The Ten-Percent-Rule and Double Median/Mean Indicators

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Abstract

Energy poverty, long considered a problem limited to developing countries only, is now widely acknowledged as a challenge for advanced OECD countries as well. How energy poverty is perceived depends on the conceptualization and assessment of the underlying phenomena: inappropriately high costs for the provision of adequate energy services and/or a resulting push into poverty. In Europe, the UK has spearheaded the definition and measurement of such phenomena. The most common way to measure energy poverty is to set a 10 percent threshold of energy-related expenditure relative to net income. At the time this indicator was being developed, it equaled double the median share of energy expenditure relative to the income of all residents. This paper discusses approaches to measuring energy poverty and argues that the double median share threshold endorsed by British researchers is ill-suited for determining energy poverty. A fixed percentage threshold may be more suitable, provided it is empirically confirmed, adequately modified, and regularly updated.

Energy poverty (aka fuel poverty) is a problem that is prevalent even in the advanced economies of Europe. Inaccessibility or the high cost of energy services have long been a predicament of people living in developing countries, but rising energy costs have clearly engendered similar challenges for people living in OECD countries. The UK is in the vanguard of this cognitive process; hence, this paper is essentially an assessment of the UK's indicators of energy poverty. With the exception of the UK, awareness of energy poverty has only recently increased in other EU member states, but primarily with regard to the afflictions of eastern European citizens.[1] German politicians have been rather reluctant to acknowledge that energy poverty might be a problem in their country.[2] Rising inequality, as well as increasing fuel and electricity prices, are gradually changing politicians' attitudes, not least because the media are linking the emerging energy poverty with the *Energiewende*, the transition to green and renewable energy in Germany. This paper starts from these observations. It focuses less on energy poverty in general or on the developing world than it does on indicators and definitions of energy poverty for developed OECD countries.[3] The natural starting point for such an endeavor are indicators from the UK, but the discussion will mainly focus on Germany since the paper is a contribution to the BMBF project "*Sozialpolitische Konsequenzen der Energiewende in Deutschland*".[4] The paper's perspective is conceptual and methodological, but it occasionally uses empirical results to consolidate the conceptual analysis. Throughout the paper, the term "energy poverty" is preferred over "fuel poverty". The terms are often treated synonymously, though the term "fuel poverty" is prevalent in the British debate. However, I argue that "energy poverty" is the more suitable term, particularly for the German context.

Section 1 covers terminology and preliminary considerations, and introduces four methods of measuring energy poverty. Section 2 reviews the most common indicator of

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[1] See Bouzarovski et al. (2012), Brunner, K.-M. et al. (2012), Tirado Herrero/Ürge-Vorsatz (2010), Thomson/Snell (2012).

[2] See Kopatz (2013: 7).

[3] For energy poverty concepts for developing countries, see, e.g., Foster et al. (2000), Guruswamy (2011), Nussbaumer et al. (2011), Pachauri/Spreng (2003, 2011). I do not seek to find a universal definition of energy poverty for developed as well as for developing countries. Such a universal definition can emerge as a result of capturing the diverse realities of the energy poor across the globe based on specific definitions. However, at present, the situation in individual countries such as the UK or Germany seems to call for a plurality of methods to effectively measure energy poverty (see below).

[4] The project will be running from August 2013 to July 2016. For more information, see www.zew.de/soko2013.

energy poverty, the Ten-Percent-Rule. Section 3 discusses other related indicators such as the double median or mean (2M) indicator, and John Hills' suggestion to use the average expenditure to achieve adequate energy services as a threshold for energy poverty. Section 4 draws conclusions from the preceding discussions by dropping the 2M indicator and proposing (simple) refinements of the Ten-Percent-Rule. A major competitor of the Ten-Percent-Rule, the Low Income, High Cost (LIHC) approach, will be evaluated in another paper.

1. Measuring Energy Poverty: Introductory Considerations

1.1 Discussions on fuel poverty and energy poverty began in the 1970s in response to the oil crisis. Although interest in this issue grew gradually, no unified terminology or consensus on the nature and definition of fuel or energy poverty has been developed.[5] In Europe, only the UK has thus far adopted an official approach to measuring fuel poverty. The term "fuel poverty" aptly depicts the UK's focus on heating costs and inefficiencies, insinuating that some households are unable to attain adequate room warmth at affordable costs. In fact, a preoccupation with room warmth pervades the British debate, though other aspects of inadequate provision of energy services are also considered. The official British definition of fuel poverty from 2000/2001 explicitly refers to an "adequate standard of warmth" or not being able "to keep a home warm at reasonable cost".[6] This is the only energy service mentioned in these definitions.

By contrast, Boardman (1991/2009) offers a broader definition according to which a household is fuel poor if it cannot attain adequate energy services for less than 10 percent of its net income.[7] Insofar, fuel poverty has become synonymous for energy poverty, if we understand energy poverty as a term referring to energy services in general. Unfortunately, this understanding of energy poverty is not straightforward. Some authors consider energy

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[5]For a historical overview of British research on fuel poverty, see Berger (2011: 5), Boardman (1991: 1), Moore (2012), Liddell et al. (2011: 18), Liddell et al. (2012). I will not systematically discuss the desiderata for a concept of energy poverty here. This requires a separate investigation. I will therefore focus on issues related to British quantitative methods to measure fuel or energy poverty.

[6]In 2000, the definition was announced in the Warm Homes and Energy Conservation Act; in 2001, it was specified in the UK Fuel Poverty Strategy (Department of Trade and Industry, 2001). Note that Hills (2012: 29) refers to the 2001 definition with adequate energy services as a target. The difference between a warmth-directed and an energy services formulation is not significant for the British debate on energy poverty.

[7]Boardman (1991: 227; 2009: xv). For another definition of fuel poverty referring to all energy services, see Foster et al. (2000: 2).

poverty to be a concept describing problems in developing countries, while fuel poverty is also prevalent in OECD countries.[8] This whole discussion seems moot for the German context, where "*Energiearmut*" translates into both fuel poverty as well as energy poverty.

However, a terminological point must be made here. Empirically, problems related to house heating may have been at the core of the predicament of the UK's fuel poor households in the past, and will possibly remain so in the future as well. In other countries, particularly in Germany, the situation may unfold differently. The *Energiewende* in Germany has shifted public attention away from heating with fossil or renewable fuels to electricity consumption. This may appear as a somewhat overblown response, but unless we have reliable data on the extent to which electricity consumption contributes to energy poverty, it would be rash to discard this perspective. Such data are largely lacking for Germany and the possible reasons for this should be considered further. If, as some studies suggest, households at poverty level spend up to roughly 40 percent of all housing-related energy costs on electricity (mobility costs are usually excluded from consideration), rising consumer prices for electricity (presently a reality in Germany) could indeed become significant drivers of energy poverty in keeping with the British 10 percent criterion. Against this background, it is problematic to lead a discussion on energy prices, energy efficiency and low income with a term that *by definition* focuses our attention on fuel problems.[9]

It therefore seems prudent to use a neutral terminology. As the non-availability and costs to achieve adequate energy services represent the core of the problem, whether in terms of fuels or other means of energy service provision, energy poverty is an appropriately neutral term. Throughout this paper, the term "energy poverty" will hence be preferred over "fuel poverty".

1.2 It is generally acknowledged that there is no single, one-size-fits-all concept for energy poverty. As in the case of poverty itself, researchers have to rely on various indicators to capture the depth of energy poverty and glean a coherent picture from diverse measurements. Moreover, the realities of energy poverty differ across the globe. Phenomena of energy poverty diverge considerably between developed and developing, between rich and poor countries, as well as between different climatic zones. In the following, concepts of energy poverty for OECD countries will be analyzed (in fact, only for middle to high latitude countries of the OECD, and in particular for Germany). Research on energy poverty in the

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[8]See Liddell et al. (2011: 64).
[9]Arguments with phrases such as "as the term implies" are used in the British debate on the definition of fuel poverty (see Moore et al., 2011: 5).

EU, and most prominently in the UK, provides the natural starting point for this endeavor. The disclaimer that concepts of energy poverty only exist in the plural still remains valid under these restrictions. At the present level of research, there is no palpable 'best' concept of energy poverty, even for individual countries like Germany.

We will therefore first examine groups of indicators for which a comparatively close affiliation with energy poverty appears plausible and which have been proposed in prior empirical research in Europe:[10]

(1) Subjective qualitative assessments by affected persons (e.g., "I cannot afford to heat my rooms adequately");

(2) Subjective qualitative assessments by others (e.g., social workers);

(3) Objective non-expenditure-based indicators (e.g., humidity, incidence of mold in housing, epidemiological data);

(4) Expenditure-based indicators (e.g., income share of energy expenditure).

Ideally, all these indicators should play a role in the assessment of energy poverty. It is particularly important to take account of the information derived from indicators (1)–(3). As will become clear, expenditure-based indicators, and not least the notion of adequate energy services, require calibration in order to provide reasonable and reliable empirical information about energy poverty. This is virtually impossible without taking account of indicators (1)–(3). At the same time, however, a conceptual analysis can tell us something about the suitability of certain quantitative instruments to measure energy poverty. For this reason, I will critically evaluate familiar quantitative, expenditure-based definitions of energy poverty.

Research on energy poverty has been ongoing in the UK for quite some time and has produced competing expenditure-based indicators:

- The Ten-Percent-Rule (Boardman 1991, 2009)
- Double Median or Mean indicator (Boardman 1991, Hills 2012)
- Low Income, High Cost (LIHC) indicator (Hills 2012)
- Minimal-Standard indicator (Moore 2012).

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[10]For an analysis of energy poverty in EU countries with subjective and multi-dimensional standards, see also Bouzarovski (2012), Buzar (2007), Healy (2004), Healy/Clinch (2004).

The Ten-Percent-Rule (TPR) and Double Median indicators share a common history. However, I argue that they can and should be differentiated. Both indicators define energy poverty as excess spending on energy beyond a certain threshold, most prominently, a ten percent share or double median share of energy expenditure for all households relative to net income. By contrast, the LIHC indicator assumes that energy poverty (in OECD countries) refers to poverty caused by the costs for adequate energy services. The LIHC indicator maintains that households are energy poor if the costs to achieve adequate energy services push them below the threshold of poverty, and if the energy costs of these households are higher than those of the median household. Minimal standard approaches are also based on a given poverty line. They add up minimally adequate consumption requirements and compare the sum to a household's income. All of the mentioned indicators have their proponents, and it therefore is worthwhile to explore them in detail. In this paper, I will assess the TPR and Double Median (or Mean) indicators. A discussion of LIHC and minimum standard indicators will follow in another paper.

I will also postpone the discussion on follow-up concepts, such as the depth of energy poverty. In poverty research, the incidence and depth of poverty are usually represented by different indicators. For instance, the former refers to households that fall short of the poverty threshold, whereas the latter is measured by the household's distance to the poverty line. Since the depth of poverty in this example and for the discussed indicators of energy poverty depends on the indicator selected, a conceptual analysis of the indicator has to precede the development of a depth metric (which thereafter is often merely a technical problem). The same is true for an equivalence scale for households of different sizes, household occupancy, or deducting rent from the considered income. Such factors are important for the application of indicators of energy poverty, but they play a role for all quantitative indicators and are therefore secondary for a basic assessment of the indicators' merits.

1.3 Quantitative, expenditure-based indicators of energy poverty (such as those discussed in this paper) primarily rely on three variables: energy efficiency, energy prices, and household income.[11] Energy efficiency is often thought to provide the key to an appropriate distinction of energy poverty from general poverty. In OECD countries, poverty thresholds depend on income. However, energy poverty as conceived by the concepts of Sections 2–3 does not stop at a poverty line (or at a particular income level). Even at higher incomes, people may spend too much of their net income on energy services if those same services could be obtained at a

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[11]These variables may be specified in more detail (see Liddell 2011: 3), and household or apartment occupancy may arguably be relevant, too. Nevertheless, the three factors mentioned are those discussed most widely.

lower cost through increased energy efficiency. Hence, reasonable costs for energy services depend to no small extent on energy efficiency. Improving energy efficiency is therefore a major political aim in the fight against energy poverty. This aim gains further weight still through the fight against global warming which places restrictions on adequate energy consumption as long as it remains linked to greenhouse gas emissions. Energy efficiency is thus a key to the mitigation of global warming.

Against this background, energy prices are not always considered as important for energy poverty as is energy efficiency. This leads to a conventional criticism of the UK's official energy poverty indicator in the period 2001–2013 (discussed in Section 2). The criticism alleges that the indicator is overly sensitive to fuel price changes. Since the role of price changes bears on questions of energy poverty in general – and drives German interest in the notion of energy poverty – it seems sensible to discuss this criticism before turning to specific indicators. At first glance, there seem to be some strong political reasons to focus on energy efficiency instead of prices. After all, governments can influence the energy efficiency of buildings or technologies, but cannot manipulate world market prices for fuels or the production costs of energy. However, energy and fuel prices are regulated, subsidized and often heavily taxed Hence, energy prices for consumers are, in principle, no less subject to political decisions than the energy efficiency of buildings, and it is by no means implausible to investigate the impact of politically motivated price changes on energy poverty.

In any case, energy prices are at least *conceptually* as important for quantitative, expenditure-based indicators of energy poverty as is energy efficiency. All these indicators represent energy poverty as a problem of excess expenditure on energy. Expenditure is the product of a consumed quantity (influenced by energy efficiency) multiplied with price. Prima facie, there is hence nothing wrong with an energy poverty indicator that is sensitive to energy prices. In fact, it is plausible to assume that rising energy prices will ceteris paribus cause more energy poverty. It cannot even be excluded that rising energy prices could cause an over-proportional increase in energy poverty in a given country. This is a warning to not methodologically discriminate against price-sensitive indicators of energy poverty for political reasons.

However, there is a problem with price sensitivity in the UK's long-standing indicator in comparison with sensitivity to income (see below). This problem should not be misunderstood as a problem of price sensitivity as such. It arises because increases in income do not compensate for increases in price of the same absolute amount.[12] In effect, this means

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[12]See Moore (2012: 22)

that an indicator's price sensitivity may be a problem in middle or high income ranges. It is not immediately clear, however, whether this is a generally disabling problem for the indicator or for its indiscriminate application at all income levels. The significance of this aspect will become clear in the paper. *Ex ante*, at least, the sensitivity of energy poverty indicators to energy prices and energy efficiency should be treated as an open question, provided that both play a significant role.

2. The Ten-Percent-Rule

2.1 Persons are energy poor according to the Ten-Percent-Rule (TPR) if they (have to) spend more than ten percent of their net income on adequate energy services. The TPR became prominent through Brenda Boardman's work on energy poverty and was the UK's official indicator of energy poverty from 2001 to 2013.[13] One of the great advantages of the TPR is its simplicity, public communicability, and apparent pragmatic versatility. However, appearances can be deceptive.[14] Data sets on income and household spending often contain easily extractable information on actual spending for energy services. Equally often, it is neither easily possible to determine the precise nature of the services nor the adequacy of energy use with the data in question. It is therefore tempting to apply the TPR with respect to actual energy spending (TPR_{act}) instead of looking at adequate energy services.[15] Empirical studies show that this modification leads to the assumption of very high levels of energy poverty in Germany. The share of the energy poor households in 2011 in Germany would be above 25 percent.[16] This figure seems suspiciously high, although one should hesitate to rule it out on a priori grounds. Comparisons with other energy poverty indicators confirm TPR_{act} as an outlier for Germany.[17] We arrive at the same result when we apply plausibility checks using subjective indicators of energy poverty. Of the households at risk of poverty in Germany, 17

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[13]See Boardman (1991: 227, 2009: xv) for the definition of fuel poverty as "not having adequate energy services for (less than) 10 percent of income". As mentioned, the official criterion refers to adequate warmth instead of adequate energy services. I will not elaborate here on this difference, although it would lead to a higher threshold for more inclusively defined energy poverty. The reasons for assuming a particular threshold need to be reconsidered, anyway.

[14]A point emphasized by Hills (2011: 102).

[15]Waddams Price et al. (2012) have done this, and E-Control (2013: 14) suggests it for pragmatic reasons, but see the detailed counterarguments of Liddell et al. (2011: pp. 67).

[16]Heindl (2013: 20).

[17]Heindl (2013: 20).

percent feel that they are unable to adequately heat their rooms.[18] Such a percentage of (almost) poor households suggests that much fewer than a quarter of all households will be energy poor in total. On the other hand, household energy consultants confirm that many German households at the median income level spend around ten percent of their net income on energy and are thus at risk of becoming energy poor.[19] It is easily conceivable that half of these (or poorer) households could in fact be energy poor. It is also possible, however, that energy consultants base their risk assessment of becoming energy poor on TPR_{act}. In this case, the validation of TPR_{act} would rely on a circular argument.

In light of these problems, we should take a closer look at the initial justifications for the TPR. In 1988, the year of reference for Boardman (1991), the TPR represented the actual average share of energy spending among the 30 percent poorest households in Great Britain as well as roughly twice the median share of actual energy spending for all households.[20] There is, of course, not necessarily a nexus between these two sources of the TPR. In fact, British researchers widely accept the double median share as a guiding consideration, whereas proximity to poor households' actual average spending is regarded as mere coincidence.[21] (This interpretation substantiates criticism of the UK's official decision in 2001 to peg the criterion of energy poverty at an outdated 10 percent value.) It is one of the main claims of the present paper that this orthodoxy of understanding the TPR is wrong. The justification for the TPR should rely on energy expenditure at the lowest income strata and not on the overall double median share of an entire country's energy expenditure. Serious methodological problems with double median indicators, as outlined in Section 3, confirm this claim. Presently, I will proceed with a normative justification of the TPR (or similar fixed percentage rules). Average spending at low incomes has, of course, no immediate normative import, but normative considerations are necessary because poverty thresholds specify which households require support.

2.2 In the UK, normative considerations enter the debate on energy poverty via the notion of expenditure to achieve adequate energy services. Adequacy is a normative concept. The calculation in the UK is based on 'modelled bills' rather than on actual spending. A modelled bill is an idealized and homogenized instrument for comparing the energy needs of diverse

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[18]Kopatz (2013: 64).
[19]Kopatz (2013: 74).
[20]Boardman (1991).
[21]See Hills (2012: 30), Moore et al. (2011: pp. 19), Moore (2012: 21), Liddell et al (2012: 27) for a 2M measure instead of a fixed percentage-rule. Liddell et al. (2011: pp. 81) indicate that Boardman has accepted the double median as a guiding principle. The EU has also moved in the direction of 2M measures, see European Commission (2010: 10).

households. Expenditure modeling and the assessment of adequacy are rife with value judgments and open to moral disagreement. It is common practice to achieve political action despite normative disagreements (in particular, disagreements that cannot be settled by open discussion) through political decision procedures. Insofar, the official adoption of a methodology by the UK government to determine adequate energy services conveyed normative legitimacy to the methodology in question. Note that this legitimacy is not merely political, but to some extent also morally legitimate, because it is a moral desideratum to fight energy poverty (and poverty in general), despite reasonable normative disagreements about its precise nature.[22] However, such assurances do not preclude criticism of a methodology which in particular has implications for future legislation or official standards. It is therefore noteworthy that adequacy in the British understanding mainly refers to adequate room warmth. It is reasonable to postulate respective standards (e.g., 21° C) for all households, regardless of income, because they relate to health. The same is not true for adequacy standards for electricity consumption or home size. Such factors may vary considerably with income, and it is reasonable to assume that higher electricity consumption and more space are adequate for higher income households. Standards of adequacy for all levels of income and all types of energy services are thus highly contentious (and remind some observers of sumptuary laws). On the other hand, the mitigation of global warming may require standards for adequate energy services to be defined for all. How the arising normative tensions between pluralism, individual freedom, and ecological responsibility ought to be handled, and presumably also be mitigated, cannot be discussed here.[23] They do, however, tell us that normative justifications of the TPR for low and high incomes are distinct issues.

For lower incomes, an energy cost allowance within the scope of a welfare program provides a possible normative basis for the TPR (or, in any case, a regularly updated fixed percentage rule) as an approximate and pragmatic standard for energy poverty. This is particularly the case if such allowances are based on a minimum consumption basket for the households in question, as in the MIS approach in the UK. In Germany, the energy cost allowance for *ALG II/Sozialhilfe* (welfare assistance) recipients is difficult to determine in this respect. Its formulation repeatedly refers to the adequacy of allowances and payments, but its calibration mainly relies on empirically measured averages. Presently, there is a lack of data

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[22]Among philosophers, much more ought to be said about normative problems when dealing with reasonable disagreements and about the different perspectives of involved normative legitimacy. However, I will spare the reader these ramifications.

[23]Such a discussion should include the doctrine of eco-sufficiency. Eco-sufficientarians argue for lifestyles that require low levels of energy consumption, assuming that the survival of the human species will otherwise be in jeopardy. An attempt to specify adequate energy consumption for all income levels might suit this view.

on a nationwide assessment of the cleft between acknowledged adequacy and actual expenditure, above all for heating. Whether the TPR is a good proxy for a normative TPR_{adeq} or not (with regard to adequate energy services) for German welfare recipients cannot be said. In any case, *if* the TPR is used as a pragmatic indicator of energy poverty, e.g, to establish a baseline for assessing changes in energy poverty, presumed or methodically constructed adequacy for low income households should be the underlying reason. The TPR will then roughly reflect an acceptable government specification of a reasonable share of income spent on energy at the welfare level, which means that it does *not* have to coincide with an overall double median share.

Of course, judgments of adequacy may change and it seems reasonable to adapt welfare allowances to altered circumstances or conditions in different regions or countries. It would therefore be wrong to assume that the value of 10 percent is written in stone. The TPR may give way to other percentage rules, and perhaps it was indeed unwise to adopt a rule in 2001 based on data for 1988. However, it makes sense to retain the TPR as a baseline for OECD countries if the share of energy allowances at welfare level in different countries and over time varies around the 10 percent threshold.[24]

2.3 The calculation of allowances is fraught with difficulties and it may thus appear tempting to use a population's double median share of energy expenditure as a standard for adequate energy expenditure at the welfare level. However, Section 3 will show that this is not a good idea. The practice of assessing households' basic energy needs in detail and how to determine adequate warmth is methodologically far better and more in line with normative entitlements to basic goods or capabilities.[25] Of course, the suggested justification of the TPR has its price. As already indicated, anchoring the TPR at the level of welfare assistance creates problems for its application at higher income levels. This can also be demonstrated by some straightforward considerations. Clearly, households with much higher incomes will not fall into poverty if they spend more than 10 percent of their income on energy. This insight has led Hills (2012) to resort more directly to a cost-push indicator for energy poverty.[26] It is instructive to show how quickly TPR_{act} loses relevance with this alternative approach if incomes increase. Let us look at the amount of disposable income after deducting the costs for

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[24]The value of 10 percent does not have to be the modus, median, or mean of the distribution of such data. It suffices if it is the closest round and salient number, a consideration that is buttressed by the requirement of having a publicly communicable threshold of energy poverty.

[25]For these normative entitlements, see Alkire (2002), Comim et al. (2008), and with respect to energy poverty, Schweiger (2013).

[26]As mentioned, LIHC and MIS measures will be discussed in a separate paper.

adequate energy services of a welfare recipient who collects EUR 900 (including for rent, heating, and electricity). If 10 percent of the welfare recipient's total disposable income covers the costs of adequate energy services, he or she should be left with EUR 810. A EUR 950 household would be left with the same amount of disposable income if it spent approximately 15 percent of its income on energy costs, and a EUR 1,000 household would have to spend more than 19 percent of its income. Both incomes are still well below the German median household income of around EUR 1,400 for 2012.

This provides further indication that a normative justification of TPR for higher incomes will be difficult to come by. Yet these difficulties do not impugn the TPR as such. It suggests applying the TPR to lower income ranges only and to presume that energy poverty for higher incomes is only a reality for particularly vulnerable households. Hills (2012) opts for a low-income presumption, which can be introduced in a different way in the TPR by weighing the rule inversely with income, assuming an income cut-off point[27] or some other suitable refinement. I will return to these suggestions in Section 5. Hence, the TPR could (empirical studies pending) be applied as a simple and suitable indicator of energy poverty. Without a refinement, the TPR is probably too unreliable.

3. M and 2M Indicators

3.1 The TPR initially represented double the median share of household energy spending relative to income. This raises the question whether double median indicators can serve as indicators of energy poverty in their own right. Actually, the question should be understood as including further indicators as discussed by Heindl (2013):

- Double the median household expenditure on energy
- Double the mean household expenditure on energy
- Double the median share of household expenditure on energy
- Double the mean share of household expenditure on energy.

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[27]Hill repeatedly mentions the idea of a cut-off point for the TPR (Hills 2011: 106, Hills 2012: 40), but apparently, no in-depth investigations have followed.

This set of indicators results from the fact that median (or mean) expenditure and the median (or mean) share of expenditure are not always sufficiently differentiated in the research on energy poverty. Only the double median share relates to the TPR, but arguably, the other indicators might bear some significance with respect to energy poverty, too. Hence, Heindl includes them in his analysis and shows that they lead to significantly different results for a German data set. I will call this family '2M-indicators' to denote their dependency on statistical medians or means.

Furthermore, Hills (2012) uses a median indicator as a threshold in his two-tiered criterion for energy poverty. Spending more (for a modelled bill) on energy services than the population's overall median is a precondition for being energy poor according to Hills. Hills' preference for median expenditure is already an implicit criticism of 2M's view of energy poverty, because he uses the median expenditure and not the double median expenditure share as a threshold for unreasonable energy expenditure. Nevertheless, I will first discuss the rationale behind a median expenditure threshold before proceeding to a critique of 2M indicators.

Hills justifies his threshold with the argument that "it is unreasonable for low-income households to have to pay more to keep warm than typical households on much higher incomes".[28] This consideration seems plausible, indeed. Yet it does not follow that expenditure up to the median should therefore be considered reasonable for low-income households. The insight that eating more than five steaks in a row would be unreasonable does not imply that eating four is reasonable. Hence, treating the median of (modelled) expenditure as a threshold has to be justified on additional grounds, and other researchers object that requiring poor households to spend up to the median already overburdens them. This objection needs empirical validation, but so does Hills' threshold, and it is noteworthy that several British experts on energy poverty endorse the objection and that the Scottish government has repudiated Hills' approach for this very reason.[29]

3.2 It is quite difficult to invest the median of energy expenditure with normative meaning, and the task is not facilitated by moving to twice the median. Why should we accept the double median share of energy expenditure as a *normative* threshold of energy poverty (on problems of its use as an empirical proxy, see below)?[30] There is apparently nothing in the

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[28]See Hills (2012: 53).
[29]See the criticism of Moore et al (2011: 17) and the Scottish Fuel Poverty Forum (2012).
[30]Several authors have remarked on the arbitrariness of a double median share threshold, see E-Control (2013: 10), Hills (2012: 30).

double median that singles it out for this role. Imagine a wealthy household that spends more than the overall double median share on energy. Why should we consider that household energy poor? The household might be spending a lot on lighting a park-like garden at night. Of course, a 2M indicator gains in plausibility if it is linked to adequate energy services. It may seem that households which need to spend more than twice the median share of all other households on adequate energy services are, in all likelihood, overburdened. However, this only applies if "adequate" means adequate for poor or average citizens (see the considerations in Section 2). The Queen may, in fact, spend more than twice the British median share for energy services, but she probably spends it on energy services that are *adequate for a Queen* and hence is not energy poor.[31] This raises the question whether the standard for adequacy ought to be modified at higher income levels, which, prima facie, seems plausible. The higher a household's income, the higher (and more expensive), prima facie, are adequate energy services.

Even without such considerations, 2M indicators are subject to the same objection as Hill's median criterion. Higher income shares may plausibly be too much of a burden for average citizens, but it does not follow that shares up to 2M are therefore in order. Independent reasons are necessary for this assumption, and it is interesting that apparently no sustained conceptual argument exists in the literature on energy poverty for the double median share, including by the proponents of a 2M interpretation of the TPR. They emphasize that the TPR was intended as a 2M rule, but do not provide good arguments why the double median is an appropriate threshold. Reference to the double median share apparently goes all the way back to an early discussion paper of Isherwood and Hancock (1979), which is difficult to come by. In any case, it is difficult to find a critical assessment of the reasons that led Isherwood, Hancock and subsequent researchers to favor the double median share – except for its link to the TPR. This renders considering the double median share as an underlying threshold for energy poverty problematic.

Of course, coincidence with the TPR ensures that the double median share is empirically equivalent as a threshold for energy poverty. Hence, despite their lacking normative justification, 2M indicators may serve as proxies for a fixed percentage threshold if a sufficiently high empirical correlation exists between both indicators. Diverging empirical results for the TPR and 2M indicators, nevertheless, suggest that such a proxy relationship

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[31]On the Queen and energy poverty, see the article "Soaring prices push Queen close to 'fuel poverty'" in the Financial Times 20. 10. 2011.

does not exist,[32] and there are further methodological reasons to reject 2M indicators of energy poverty, to which I will now turn.

First, most researchers agree that a double median indicator is better than a double mean indicator for energy poverty. One reason is that the mean is more sensitive to outliers or habit changes in the upper or lower ranges of a distribution. The mean share of energy spending increases if wealthy consumers begin driving more SUVs. Hence, the share of energy poor in a society will decrease without any change in the consumption habits or spending of the poor. A median-based indicator can circumvent this effect.

Another reason for preferring the median is a moral one. Empirical distributions of energy expenditure or the income share spent on energy services are usually right-skewed (like a log-normal distribution). In most right-skewed distributions, the median precedes the mean. Using the median as an indicator is thus favorable to households that might be energy poor. If we wonder whether the median or the mean is the more appropriate indicator, the median gives low income, high cost consumers the benefit of the doubt. Theories of justice suggest that this is in order. Rawls' difference principle and more generally principles of prioritarian concern for people who are worse off, demand an allocation of burdens and benefits in favor of persons who are relatively worse off.[33] Median indicators of energy poverty fit this demand, while mean-based indicators do not.

3.3 This is not to say that the double median is an appropriate indicator, because it remains unclear why it should be an indicator of energy poverty at all. In fact, double median indicators of energy poverty have some awkward properties. Adding a constant to an otherwise unchanged distribution will reduce the number of households above the double median in right-skewed distributions.[34] This means that adding a fixed cost to the energy expenditure of all households could ceteris paribus reduce the number of energy poor – an utterly counter-intuitive result. It seems wrong to use an indicator of energy poverty, which implies that it is possible to reduce the number energy poor households by making everybody pay an additional fixed sum for energy services. This effect signals a violation of Sen's monotonicity requirement for poverty measures. According to this widely accepted

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[32]See Heindl (2013), Liddell (2012: 28).

[33]See Clayton/Williams (2004), Gosepath (2007) for theories on social or distributive justice. Walker/Day (2012), Schweiger (2013) have offered a first interpretation of energy poverty.

[34]Without normalization, the respective distributions provide different information under a transformation of scale. Normalization has the undesired effect of re-introducing the mean as a key measure.

requirement, poverty rises when a poor person's income drops.[35] With double median expenditure indicators it is the other way round.

Unfortunately, this is also a problem for the double median expenditure *share* indicator. For uniform income (all earn the same), adding a constant to energy expenditure is tantamount to adding this constant divided by income to the expenditure share. Hence, the distribution of expenditure shares moves by a constant to the right, but double the constant has to be added to the old double median. The number of households (or cases) above the new double median will therefore decrease. This means that Sen's monotonicity requirement is violated in such cases as well.

Now, let all have the same energy costs at varying incomes and add a constant to energy costs. All have higher energy expenditure under these premises, but the number of households above the double median in the distribution of energy expenditure shares remains constant.[36] Again, the monotonicity requirement is violated.

These are, of course, simple thought experiments. They are only immediately significant for research on energy poverty if one accepts that indicators of energy poverty should not violate conditions commonly accepted for poverty measurement, and which are above all commonsensical. Under this methodological premise, an indicator for *x* (say, an increase of poverty or temperature) that signals the opposite (a decrease in poverty or temperature) in a plausible thought experiment in which *x* should rise is already, for this reason, inacceptable. Some hard-nosed empiricists might nevertheless want to ignore such problems as long as an indicator functions reasonably well under observed conditions. Hence, a counter-intuitive result under counter-factual conditions remains irrelevant because none of these assumptions fits social reality or can be expected to fit social reality in the near future. I do not think, however, that this escape route works. The fixed-increment thought experiment suggests that general increases in expenditure can lead to less energy poverty according to the double median share indicator even in practice. This effect depends on the median income and the share of energy expenditure at the median income level, the depth of energy poverty, the variance of expenditure shares, and other variables. Models can be built to demonstrate this.[37] Usually, we will not know enough about social reality to ensure that the double median share indicator does not backfire. Precisely for this reason, we cannot trust the indicator. It might

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[35]See Sen (1976), Zheng (1997: 131).

[36]In this scenario, the distribution of expenditure shares is stretched along the x-axis through a multiplication with $1+c/K$. (c = increment; K = basic expenditure). Let a^* be the original median share. Hence, for the new double median share, we use: $(2a^*)(1+c/K) = 2 [a^*(1+c/K)]$. The transformed old double median is twice the transformed new median.

[37]A publication with simulations of cost variations for German social panel data is presently being prepared. Preliminary calculations show which variables influence the level of energy poverty for 2M indicators.

signal a decrease of energy poverty although the burdens of energy expenditure have increased for all citizens, so that energy poverty in any reasonable understanding of the concept cannot possibly have decreased.

4. Conclusion and Refinements of the Ten-Percent-Rule

4.1 Section 3 contains what I consider strong arguments against 2M indicators of energy poverty. Double median standards appear arbitrary, but that is not the worst that can be said about them. The added-fixed-cost problem and the non-monotonicity of their relationship with energy poverty (plausibly conceived) should suffice to disqualify double median standards from consideration as indicators of energy poverty. The flexibility of median-based concepts in comparison with fixed percentage rules, which have to be monitored and re-researched from time to time, offers no compensation for these shortcomings.

In general, the construction and application of energy poverty indicators has to confront two familiar types of errors: false positives and false negatives. False positives are cases in which households are considered energy poor, although they are not. This type of error presumably occurs most at the upper ranges of the income scale. Moreover, empirical studies suggest that this type of error increases rather rapidly with income, particularly in OECD countries. In these countries, spending too much on energy does not lead to poverty in any intuitive sense for middle to high income households. False negatives are cases in which households are not considered energy poor although they are. This error prevails at the lower income ranges. Theories of justice call for an avoidance of false negatives over false positives. Hence, thresholds for energy poverty should not risk excluding energy poor households even at the cost of including some households that are not energy poor. Many suggested median standards violate this requirement. They peg a threshold at a point where all observers readily agree that energy poverty applies. However, setting a threshold at a point where universal agreement is reached discriminates against those households that are only probably, but not definitely, energy poor.

Giving theories of justice their due may, of course, be costly and politically difficult. Yet this does not imply that median indicators need to be reinstated. It is also possible to fight false positives by excluding higher income households from consideration (unless they are particularly vulnerable). I suggest applying this strategy to the TPR (or a related fixed

percentage rule) based on an adequate energy allowance at the level of welfare assistance. It needs to be taken into account that a 10 percent share of income for adequate energy services apparently becomes ceteris paribus rapidly misleading as incomes rise (see the considerations in Section 2). However, it is an empirical question how rapidly this effect sets in, which in any case might be tempered by an increased need for energy above the welfare level. It is thus impossible to validate an appropriate cut-off point for such considerations without empirical research, but it may be reasonable to look for one.

4.2 A cut-off point is not the only possibility to refine the application of the TPR. Following the methodological principle that complexity should increase only sparingly and not more than necessary (a corollary of Ockham's razor), empirical studies should examine whether they can achieve satisfactory results with the following simple refinements of the TPR:

    (a) Capped TPR

    (b) Weighted TPR

    (c) Capped and weighted TPR.

Capped TPR embodies the desideratum of avoiding false positive results. Ideally, the cap should be set so that it can, prima facie, reasonably be assumed that wealthier households are not energy poor. This requires calibration. Statistical correlations, subjective indicators of energy poverty, or the judgments of social workers may help place a suitable cap on the TPR. The cap should be placed generously. Theories of justice recommend leaning toward overestimation of energy poverty under uncertainty rather than toward underestimation. Accordingly, it should be fairly obvious which households lie above the cut-off point and are not really energy poor unless they are particularly vulnerable[38] or unless specific reasons for an assumption of energy poverty exist.

      Weighted TPR asserts that the number of false positives will increase gradually with income. Hence, it might be helpful to multiply the cases that exceed the TPR threshold with a weighting factor a_{TPR}. The factor has the value $a_{TPR} = 1$ at the level of welfare assistance, and then falls monotonously following a plausible function. One problem with this suggestion is

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[38]Elderly people that live in houses that are too big come to mind as vulnerable, or single parents. It is indeed a normative problem whether senior citizens should be asked to leave apartments or houses that are too spacious, considering that these were their homes for decades. If senior citizens are entitled to stay in their homes, adequate energy services for them ought to include heating, lighting and warm water. Even senior citizens who are relatively well-off could become energy poor if they can no longer bear the costs of adequate energy services for their homes without inadequate restrictions.

that the weighting function appears arbitrary unless it is guided by some further considerations of energy poverty. A remedy might consist in (c) which combines (a) and (b). The cap for the TPR represents an income cut-off point above which energy poverty is very unlikely. If we find reasons for such a cap, it becomes a natural end-point for a weight reduction. Hence, a_{TPR} may assume the value of 1 at the level of welfare assistance and monotonously fall to 0 (or a positive value < 1) at the cut-off point. Whether these simple modifications of the TPR bring reasonable results needs to be empirically validated.

Last but not least, my plea for a refined TPR (or fixed percentage rule) should not be understood as a plea against (modified) LIHC and MIS indicators or against subjective considerations. All these approaches may be informative with respect to energy poverty in OECD countries and in Germany in particular. Nevertheless, retaining the TPR might prove helpful because the rule is simple and suited for political communication. Capping it does not add much complexity, but will improve its message.

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