Tracking the Energy Poor – Empirical Insights on Energy Poverty Measurement Approaches

By Gunther Bensch*

Energy Poverty Metrics as Part of a Modern Energy Access Framework

The Sustainable Energy for All (SE4All) initiative is currently set up to channel activities for achieving universal access to modern energy by 2030. The initiative is the first to be jointly chaired by the UN Secretary-General and the president of the World Bank Group, underscoring the emphasis placed on energy access. The current challenge for the scientific community is to support operationalizing this universal access goal. A milestone in this endeavour is the multi-tier framework promoted in the recently published Global Tracking Framework (World Bank, ESMAP and IEA 2013).

This multi-tier framework is intended to go beyond binary measures of energy access to capture aspects like the quantity and quality of electricity supplied, the efficiency, safety and convenience of household cookstoves and access to energy services in local enterprises and social infrastructure. This framework is the fruit of lively debates that helped to deepen understanding of energy access as a complex multidimensional construct. It is widely recognized that energy access is a process that undergoes different phases and levels, conceptually organized into various 'tiers' of access to and use of electricity and modern cooking.

Hence, much effort has been put into capturing the intricacies and complexities of the path that stretches from people's deprivation of their basic energy needs to a state of "vibrant and sustainable social and economic growth" (Bazilian and Pielke 2013) empowered by modern energy access. Without trying to thwart the ambition of globally achieving a truly modern access to energy for everyone, it is debatable whether we do not also need a single, easy-to-understand index of energy poverty. Similar to the international poverty line of USD 1.25, which condenses the challenges behind individual economic development, it seems reasonable to also establish a critical threshold for energy poverty. To date, though, there is no clear consensus about the key characteristics of such a metric of energy poverty, which is crucial in effectively identifying the energy-deprived population as well as measures to overcome their deprivation.

An Empirical Analysis of Existing Energy Poverty Metrics

The literature proposes a range of candidates. Eight types of metrics can be distinguished that are typically discussed in the context of energy poverty measurement (see, for example Pachauri 2011 and Khandker, Barnes and Samad 2012). Four of them actually reflect an (absolute) energy poverty concept that – as desired in this context – seeks to identify the people not able to fulfil their basic energy needs: first, a minimum energy consumption threshold approach proposed by Modi et al. (2005) and the UN Secretary-General Advisory Group on Energy and Climate Change (UN-AGECC 2010), second, an income-invariant energy demand approach introduced in Barnes, Khandker & Samad (2011), third the Multidimensional Energy Poverty Index (MEPI) by Nussbaumer, Bazilian & Modi (2012) and fourth the Total Energy Access (TEA) standard presented in Practical Action (2012).[1]

Apart from the MEPI, to date however none of them has ever been applied to real-world data with the aim of determining energy poverty levels. Therefore, I recently analysed all four indices empirically using a rich unique household dataset that accommodates the data requirements imposed by all metrics (Bensch 2013). The data comes from 13 different surveys conducted in both rural and peri-urban areas of five countries in Western and Eastern sub-Saharan Africa: Benin, Burkina Faso, Senegal, Mozambique and Rwanda. The focus on sub-Saharan Africa reflects the energy access situation in the region, which can be considered as particularly demanding. The focus on sub-Saharan Africa furthermore implies a high homogeneity among the analysed countries. While certain energy services, such as space heating, are basically not demanded, the remaining services are indispensable for all households. As a consequence, low consumption levels in these energy services are likely to reflect suppressed demand and, hence, to represent symptoms of energy poverty. Therefore, the used data set allows identifying and expanding the most promising avenues for effective energy poverty measurement data based on a systematic analysis of the same type of empirical data.

In the course of the analysis, the income-invariant energy demand approach has shown a couple of drawbacks which put into question the suitability of the approach. Not least, the reality in the field suggests that – counter to the assump-

* Gunther Bensch is with the Rheinisch-Westfälisches Institut für Wirtschaftsforschung, Essen, Germany. He may be reached at gunther.bensch@rwi-essen.de
See footnote at end of text.

tions inherent in this approach – energy consumption is elastic even among the poorest of the poor. In the following, I will, therefore, discuss main issues that came up in the course of the analysis of the remaining three indices.

Degree of Energy Poverty Differs Widely Across Metrics

While all metrics generally identify a high share of the population as energy poor in the assessed sub-Saharan countries, the index values of the analysed metrics differ up to a range from 0.35 to 0.98 for individual surveys. It is worth noting that the surveys were either baseline surveys for upcoming projects or part of evaluation studies on energy access interventions ranging from improved cookstoves to central grid extension. They do not claim to be in any way representative on a national level. Instead, it seems plausible that the assessed households are slightly better-off in terms of energy poverty than the national (rural or otherwise urban) average. First, for being eligible for energy and particularly electrification interventions, rural communities typically need to have a reasonable level of purchasing power such that households are more likely to afford electricity payments. Second, part of the surveyed households have previously undergone interventions such that their energy situation has already been improved. A comparison with Demographic and Health Survey (DHS) data from the various countries supports this interpretation.

The Minimum Energy Consumption Threshold Approach and the Relevance of Improved Cookstoves

Rates of electrification and household use of non-solid (i.e., liquid or gaseous) cooking fuels are typically relied upon to give a snapshot of energy access in developing countries. There are, however, some handicaps to these two indicators, most notably that connection to the grid can be intermittent and, hence, unserviceable and a range of improved appliances exist to use solid fuels in a healthier and more sustainable way even in the absence of modern non-solid cooking fuels.

The minimum energy consumption threshold approach (also called 'UN-AGECC metric' in the following) can be seen as an extension of these two indicators. Here, two energy poverty thresholds are normatively determined as the sets of energy needs that are deemed indispensable: First, a minimum amount of final energy used in the form of modern fuels and technologies (including improved biomass cookstoves) for cooking and, second, a minimum amount of electricity for all other services, excluding heating and mobility. Concretely, cut-offs are proposed in terms of consumption per year and capita: 40 kilogrammes of oil equivalent (kgoe) for cooking, which is equivalent to 37 litres of liquefied petroleum gas (LPG) or 105 kg of firewood, as well as 50 kilowatt hours (kWh, equivalent to 4 kgoe) for rural households and 100 kWh for urban households.

According to this double threshold metric, energy poverty is virtually universal among the surveyed households. As many as 97 percent turn out to be energy poor, among which around 86 pecent do not consume the amount of modern cooking fuels deemed as sufficient. The cooking component, hence, seems particularly binding, which also becomes clear when taking the example of the subsample from urban Senegal with its high rates of LPG usage (see Schlag and Zuzarte 2008). Here, two thirds of households using exclusively the clean cooking fuel Liquefied Petroleum Gas (LPG) are still considered as deprived in cooking energy, since the threshold is set higher than their per capita consumption levels. At the same time, a large share of those other 14 percent that are not considered as deprived use firewood or charcoal with improved cookstoves. This finding underpins the importance of improved cookstoves (ICS). First, due to the generally overwhelming percentage of the poor who still rely on traditional biomass energy and, second, since the energy poverty metrics legitimately depend crucially on the concept of clean versus traditional cookstoves. The stoves considered as improved in the context of this study have mainly been simple low-cost biomass stoves that are adapted to the needs and habits of the population and locally produced based on metal and/or clay. While they definitely have an effect on woodfuel demand and may in certain circumstances have sizable impacts on human development (Bensch and Peters 2012, 2013), it is still unclear whether they will be universally accepted as ICS by main actors in the field like the 'Global Alliance for Clean Cookstoves' and, hence, which role they are attributed to in alleviating energy poverty. In this regard, a clear and universal catalogue of which types of stoves can be considered as improved is of high relevance.

Figure 1 depicts the energy poverty rates when changing the minimum energy consumption threshold by 25, 50, 75 or even 100 percent. This graph now allows comparing the energy poverty cut-offs imposed by the UN-AGECC metric (values on the right side of the figure) to the electrification and clean cooking access rates, which correspond to the 100 percent reduction in the threshold level. It becomes clear that for electricity, there are larger differences between the pure access-based indicator and the proposed energy poverty index that also accounts for usage intensities, e.g., in urban areas the difference is 26 percent compared to 53 percent, respectively.

Composite Indices as an Alternative

The UN-AGECC metric is basically a unidimensional metric, as it aggregates the different energy services to a single, physical unit (the kilogrammes of oil equivalent). As highlighted more recently in the energy policy literature, there are good conceptual reasons to also consider energy poverty as multidimensional. Dimensions that have been attributed to energy include energy for lighting, cooking, heating, cooling, information, communication, productive purposes, mobility and in social infrastructure institutions. Some of these dimensions can only be expressed in terms of ordinal sub-indicators (e.g., usage of improved cooking stoves (cooking), ownership of a fridge (cooling) and, therefore, not aggregated to a single unit. Composite indices are constructed instead that apply cut-offs and weights for each of the individual dimensions and furthermore have a poverty cut-off that determines in how many of these weighted dimensions an individual has to be deprived in order to be classified as poor.

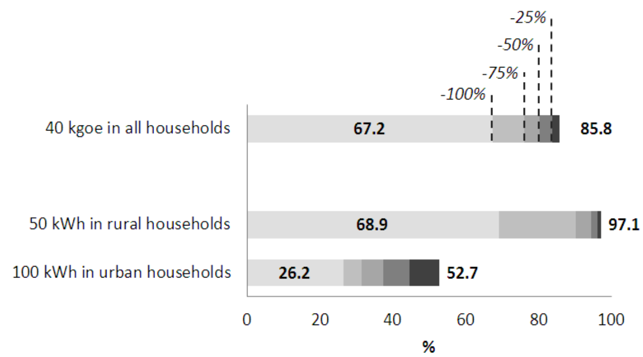

Figure 1: Proportion of Energy Poor According to the Components of the Minimum Energy Consumption Threshold Approach, by Different Threshold Levels.

The MEPI and TEA are two such composite indices, which deliver quite distinct results mainly depending on the normative judgments inherent in the two indices. While the MEPI allows for a certain degree of deprivation (e.g., a household may be considered energy non-poor even though it has neither a fridge nor a radio or a television set), the TEA is far more restrictive in that everybody is considered energy poor who is deprived in any of the six sub-dimensions. With only slight adaptation of the originally proposed sub-indicators, one may come up with a common multidimensional indicator set. In doing so the two metrics can be considered as one metric with the option of context-specifically adapting poverty cut-offs and dimensional weights as illustrated in Figure 2.

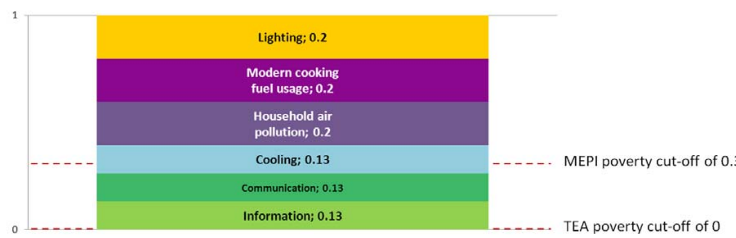

Figure 2: Dimensions, Dimensional Weights and Poverty Cut-offs According to the MEPI and TEA

Note: The dimensional weights refer to those proposed by Nussbaumer, Bazilian & Modi (2012).

The Choice of Metrics and Sub-indicators

In terms of index construction the UN-AGECC metric and the MEPI/ TEA performed well in the given setting, not least owing to the additional information provided through their subcomponents along which all can be decomposed. Deciding on the poverty cut-offs (and dimensional weights, if necessary) is ultimately a process that needs further discussion backed by empirical data, which is supposed to reveal the actual implications of these decisions. The same seems to hold for a definite decision on one of the metrics. If the necessary data are available, it seems recommendable for the time being to continue testing and applying both of them.

The concrete application of the poverty metrics to real-world data revealed that data requirements, however, are high for all metrics. Even having this tailored household energy dataset available, the analysis still had to rely on certain assumptions and conventions, such as energy efficiency factors and improved cooking stove definitions. In addition, even carefully collected data is not immune to measurement error, which can be expected to be particularly pronounced for the consumption of non-market goods as it is the case for collected firewood. The recommendation emanating from this analysis is to restrict a basic energy threshold level to a basket of energy services that can easily and reliably be identified as is basically the case with MEPI/ TEA and to a lesser extent for the UN-AGECC metric.

In order not to miss relevant new developments, it is further recommended to closely follow the technological transformations and coping strategies that come up in energy poor regions of developing countries. The upcoming low-cost lighting devices mentioned in this paper are only one example among many in the dynamic field of energy provision. With this data at hand, it could better be decided on the level of ambition; for example, it seems debatable to reach universal ownership of fridges in the near term, whereas modern cooking can be considered as unanimously indispensable.

Finally, all decisions on sub-indicator choice and modifications need to be harmonized with the multi-tier framework of the Global Tracking Framework. The goal here is to make the energy poverty metrics an integral part of this indispensable instrument for guiding investment flows in the energy sector to where they are needed and to where they can actually make a difference.

Footnote

[1] The arguably most popular metric, the Energy Development Index (EDI) from the International Energy Agency (IEA), is also among the other four metrics. By looking at per-capita commercial energy consumption, the share of the commercial sector in total final energy use, and the share of population with access to electricity, the EDI rather measures a country's degree of transition towards a modern energy infrastructure.

References

Barnes, Douglas F., Shahidur R. Khandker and Hussain A. Samad. 2011. Energy Poverty in Rural Bangladesh. Energy Policy 39 (2): 894-904.

Bazilian, Morgan and Roger Pielke Jr. R. 2013. Making Energy Access Meaningful. Issues in Science and Technology, Summer, p. 74-79.

Bensch, Gunther. 2013. Inside the Metrics – An Empirical Comparison of Energy Poverty Indices for Sub-Saharan African Countries. Mimeo.

Bensch, Gunther and Jörg Peters. 2013. Alleviating Deforestation Pressures? – Impacts of Improved Stove Dissemination on Charcoal Consumption in Urban Senegal. Land Economics, 89 (4): 676-698.

Bensch, Gunther and Jörg Peters. 2012. A Recipe for Success? Impact Evidence from a Field Experiment of Improved Stoves in Senegal. Ruhr Economic Papers No. 325. Essen: RWI.

Khandker, Shahidur R., Douglas F. Barnes and Hussain A. Samad. 2012. Are the Energy Poor also Income Poor? Evidence from India. Energy Policy 47: 1-12.

Modi, Vijay, Susan McDade, Dominique Lallement and Jamal Saghir. 2005. Energy Services for the Millennium Development Goals. Washington DC/ New York: International Bank for Reconstruction and Development/ The World Bank and the United Nations Development Programme.

Nussbaumer, Patrick, Morgan Bazilian and Vijay Modi. 2012. Measuring Energy Poverty: Focusing on What Matters. Renewable and Sustainable Energy Reviews 16 (1): 231-243.

Pachauri, Shonali. 2011. Reaching an International Consensus on Defining Modern Energy Access. Current Opinion in Environmental Sustainability 3 (4): 235-240.

Practical Action. 2012. Poor People's Energy Outlook 2012. Rugby: Practical Action Publishing Ltd.

Schlag, Nicolai and Fiona Zuzarte. 2008. Market Barriers to Clean Cooking Fuels in Sub-Saharan Africa: A Review of Literature. Stockholm Environment Institute Working Paper 8. Stockholm: Stockholm Environment Institute.

UN Secretary-General Advisory Group on Energy and Climate Change (UN-AGECC). 2010. Energy for a Sustainable Future: Summary Report and Recommendations. New York: United Nations.

World Bank, Energy Sector Management Assistance Program (ESMAP) and International Energy Agency. 2013. Global Tracking Framework – Sustainable Energy for All. Working Paper 77889. Washington, DC: World Bank.