CHAPTER 23

Crique of Energy Poverty Measurement and Metrics: The Way Forward

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Introduction

...ergy poverty and fuel poverty are sometimes used interchangeably by ...me authors, some scholars consider energy poverty as an idea ...ighlighting energy problems in developing countries, while fuel poverty is ...een to be prevalent in the Organization for Economic Cooperation and ...evelopment (OECD) countries (Schuessler, 2014). British definition of ...uel poverty from 2000/2001 is expressed as "adequate standard warmth" ...r not being able "to keep a home warm at reasonable cost" (Schuessler, 2014). Boardman (2009) offered a broader definition according to which a household is energy poor if it cannot attain adequate energy services for less than 10 percent of its net income. Simply said, energy poverty is a term used to describe poverty that exists as a result of lack of access and consumption of energy services

Access to energy is germane to the overall development of a nation. Energy access is at the core of many global development challenges, including education, food security, climate change, health, inequality and poverty (Nussbaumer et al., 2011). Najam et al., (2003) pointed out that for one to enjoy qualitative living standard, healthcare service, adequate shelter, employment, education and water access, energy is essential. Although energy itself is not a basic requirement of man, it is a requisite tool for the achievement of man's basic needs. The nexus between energy poverty and the millennium development goals have been emphasised and discussed exhaustively in literatures (Modi et al., 2005 and Nussbaumer et al., 2011). Existing actions developed in respect to energy poverty eradication is not all encompassing both in scale, pace and indicators, it is in view of this trend that (IEA, UNDP and UNIDO 2010) posited that if the current trend continues, more people will fall into the energy poverty cadre (without ...energy). Redirecting the energy poverty pathway requires ... commitment that goes beyond mere

2010). In the last two decades, the international community has put forth a goal of providing universal access to modern energy services, but this effort may be hampered due to current lack of quality data.

In view of the burgeoning arguments on the importance of energy access to various aspect of social, economic and environmental development, there is need for the development of effective methodologies and indicators for the monitoring and reporting of progress towards energy poverty eradication especially in the developing countries. This study therefore reviews specific metrics and analysed the strength and weakness of some methodological models of energy poverty developed by scholars and international organizations.

Energy Poverty Measurement

A fundamental question that must be answered when it comes to energy poverty measurement is "What are we to measure?" It is important to know that scholars have agreed that measuring energy poverty should reflect the level of energy services enjoyed by households, business (Laura, 2017) and other public community institution such as schools, health centres and civic centres. This agreement is reflected in the goal of UN secretary general Advisory Group on Energy and Climate Change (AGECC) "a basic minimum threshold of modern energy services for both consumption and productive uses". AGECC (2010) further suggested that the modern energy services must be reliable affordable, sustainable and free from green house gases.

The fact that energy poverty can be seen through the lens of energy services such as lighting, cooking, space heating, cooling, refrigerating, processing, mechanical power and communication is an indication that people do not consume energy directly, but needs energy in virtually every aspect of human endeavour to alleviate poverty and economic development (Laura, 2017). The agreement of scholars in principle that energy poverty is lack of energy services, does not translate to easy measurement of energy poverty. This is because energy poverty cannot be measured in one unit.

Measuring energy poverty is a difficult task. It is a private condition, being confined to the home, it varies over time and by place, and it is a multi-dimensional concept that is culturally sensitive (Thomson et al., 2016). The choice of measurement approach is also contingent on whether energy poverty incidence is to be measured at the pan- European, national or regional level for monitoring and benchmarking purposes, or whether a finer grained dataset is needed to identify energy poor households at the local scale for policy delivery. It is further shaped by the availability of data and resources to undertake additional empirical research, and prevailing policy priorities in terms of social groups considered most in need/ deserving of support.

Energy Poverty Metrics

Over the years, quite a number of metrics and methodologies have been developed both within and outside the energy sector (Nussbaumer et al., 2011) from which ample knowledge on energy poverty measurement can be drawn when developing a new metric to measure energy poverty. Energy poverty metrics are either *uni or multidimensional;* that is single indicator base metric or multiple indicator base metric.

The single indicator based metric of energy poverty metric provides an unbiased, powerful message that is easy to interpret in relation to one specific dimension or variable of study. Single indicators are straightforward to handle (Nussbaumer et al., 2011). However, studies have shown that single indicator only provide a narrow picture of the subject matter (energy poverty). Modi et al (2005) argued that single indicators are usually not suitable for less tangible issues such as poverty and sustainable development; it is perhaps appropriate in some cases e.g measurement of economic activities with GDP. Energy poverty like general poverty is a complex issue that is multi-dimensional in its true nature. To get a better understanding of energy poverty, there is need for a holistic framework that can capture various elements. However, using large number of indicators to evaluate changes has not proven to be an easy task.

Composite indices are single value derived from number of variables; on the premise of an existing model that seeks to present an aggregated value of a concept (Bazillian et al., 2010). Composite indices are widely used as an alternative to uni-dimensional (single indicator). The need for aggregated information for easy and convenient analysis underscores the use of composite indices. Composite indices are easier to interpret than trends in a number of separate variables. Composite indices have proven to more convenient and easy in monitoring and reporting performance especially between countries. If evaluated with the same methodology at regular time intervals, they provide information on changes across different units and time, thereby allowing trends to be identified (Bazillian et al., 2010). The composite indices is not without weakness or drawback; which include reduction of variables to a single measure by combining variables. When the analysis is simplistic or poorly constructed, composite indices can be misleading in terms of policy. Saisana and Tarantola, (2002) provide a detail analysis of merit and demerit of composite indices in t measurement of phenomenon.

Several studies have highlighted the lack of theoretical underpinning of number of composite indices (OECD, 2003; Munda and Nardo, 2005 focusing on issues related to the aggregation model and/or the weighting in particular. However, many believe that composite indices provide useful statistical summary of particular issues. Sharpe (2004) analysis of the non aggregators and aggregators suggested that the former claims tha aggregation and weighting is arbitrary, while the latter point to the potentia to attract media and policy makers. Example of the common composit indices metric of energy poverty is the Multi-dimensional energy povert index (MEPI), The Total Energy Access (TEA) and Multi-tier Energy Poverty Measurement approach.

Energy Poverty Measurement Approach

Several methodologies (MEPI, EDI, TEA) have been developed for the measurement of energy poverty in developed and developing countries. Eight types of metrics can be distinguished that are typically discussed in the context of energy poverty measurement (Pachauri and Spreng 2011 and Khandker, Barnes and Samad 2010). Five of the metrics actually reflect an (absolute) energy poverty concept that is desired in the context of this study. The minimum energy consumption threshold approach as 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), fourth the Total Energy Access (TEA) standard presented in Practical Action (2012) and fifth the multi-tier energy poverty measurement approach by Nicolina Angelou (2014) for Energy Sector Management Assistance Programme (ESMAP). Therefore, this study undertakes a review of the strength and weakness of the five highlighted methodologies below;

I. Energy poverty line approach,
II. Estimate of minimum energy require to satisfy basic human needs
III. Multi-dimensional Energy Poverty Index (MEPI)
IV. Total Access Standard (TEA)
V. Multi-Tier Energy Poverty Metrics (MTEP)

The Energy Poverty Line

This measurement approach is deduced from the conventional income or expenditure poverty measure. Energy poverty is determined by estimatin energy use as a function of income or expenditure and by estimating the average level of energy use that correspond to the amount of expenditure or income specified by the official income or expenditure poverty line (Pachauri, and Spreng, 2003). Although this approach to energy poverty measurement is easy to compute and useful in determining headcount of energy poverty, it is often criticized on the grounds that it only provides a single energy or fuel poverty line and does not provide an insight by way of suggesting the factors responsible for the low spend or low consumption by households (Jain, *et al.*, 2015). The energy poverty line approach does not consider the efficiency of the energy consumed by the households or enterprise; hence, the approach is considered too narrow to present the multiple dimensions of energy poverty.

Minimum Energy Require to Satisfy Basic Needs

The minimum energy requirement approach was developed by Modi et al., 2005 in collaboration with AGECC. This approach to energy poverty measurement uses estimate to determine the amount of energy required to satisfy basic need (Pachauri & Spreng, 2003; Practical Action, 2010). Unlike the energy poverty line approach, two (2) energy poverty line must be exceeded; the first is the minimum amount of final energy used in form of modern fuel and second is the minimum amount of electricity for all other services excluding heating and mobility (Jain, *et al.*, 2015). This is in response to the criticism of the energy poverty line approach, which is silent on the efficiency of the energy use.

The energy poverty line and minimum energy required estimate approach are uni-dimensional and normative in nature. Ascertaining the minimum level of energy required for basic needs is the problem with setting the normative threshold, which is usually due to the significant inter-country and regional differences in cooking practices and heating requirement (Jain, *et al.*, 2015). Khandker, *et al.*, (2010) argued that energy requirement and consumption is location specific which is due to difference in climatic condition and cultural practices. The minimum needs for physical quantities of energy (for specific tasks) are chosen somewhat arbitrarily. In the opinion of Nussbaumer *et.al*, (2011), modern energy services have a higher service quality, hence it reduce household expenditure and increase resource efficiency simultaneously. It therefore implies that as technology improves in energy wise, these metrics (and thresholds) require to be updated constantly and often lose their utility over time.

In the bid to overcome the drawback of these two approaches, Khandker, *et al*, (2010) empirically determine an energy poverty threshold based on estimation of final and end-use energy consumption. The threshold is defined as the income decile where energy consumption is significantly different from the consumption in the first decile. In this approach, the threshold represents the point at which energy demand becomes insensitive to income changes as threshold below the point can only consume a bare minimum of energy (Jain, *et al.*, 2015). This metric provides the basic understanding of the difference that exist between income and energy poverty. Nonetheless, it is often criticized for not providing insight into the factors that keep households from meeting the threshold energy consumption. Furthermore, the approach fails to highlight that energy consumption is elastic even among the poor (Bensch, 2013).

Multi-Dimensional Energy Poverty Index

The availability of datasets that provide necessary data for both the developed and developing countries coincided with the notion of poverty as a multidimensional phenomenon (Deaton, 2010). Multi-dimensional Energy Poverty Index (MEPI) is a child of the Multi-dimensional Poverty Index (MPI) and it was presented by Nussbaumer, (2012). This approach proposes dual cut-off instead of a single poverty cut-off to define threshold in two steps; weight is attached to each sub-dimensions so that the final headcount of energy poverty that is defined incorporates the importance that is attached to all each dimension. The authors were of the opinion that attainment in all the six sub-dimensions are important and are expressed as dummy equalling one (Jain, *et al.*, 2015).

MEPI has been criticized on the basis that the proxies used in defining energy access quality in this approach are not robust enough. Jain, *et al.*, (2015) argued that possession or mere consumption of a quantum of these assets does not translate to energy access for households. Just like It was noted by KandehYumkella, the then Director-General of the UN Industrial Development Organization, and UN Secretary-General Ban Ki-moon's that "*the provision of one light to poor people does nothing more than shine a light on poverty*". Therefore, it can be said that energy access transcends mere possession of modern energy assets and consumption of small quantum of energy. Fuel stacking which is a common phenomenon especially in developing countries is not fully accounted for or penalized.

Total Energy Access Standard (TEA)

In the light of the criticism of MEPI, an alternative multi-dimensional approach was developed by the Practical Action (PA, 2012) in United Kingdom (UK). This approach was developed in cooperation with the International Energy Agency (IEA), World Bank, The Global Alliance for clean cooking stoves and the National Development Cooperation Agencies. This approach is called the Total Energy Access Standard (TEA). The TEA correspond to the headcount ratio of energy poverty, the major point of departure from MEPI is in intensity as it considers the intensity of deprivation as irrelevant. Even with the numerous dimensions captured in the TEA, some areas exist with intractable field data and some areas exist where the definition is just to define the absolute bare minimum threshold of energy consumption.

Jain, et al., 2015 argued that even though TEA is dimensionally extensive, it has a binary view of energy access. Identifying the intensity of energy provided by a device can be difficult, as it involves on field measurement and mapping, however, TEA provides an avenue for classifying energy users on spectrum of energy access beyond defining who is in the lowest tier of energy access. Jain et al., (2015) also pointed out that TEA provides a binary view of energy access, even though it provides an extensive dimension of energy access. This implies that TEA measures energy access in terms of "having access" or "not having access" even though it captures several dimensions of energy poverty.

Multi-Tier Energy Poverty Index

The recent attempt at understanding the subtle difference in energy poverty is that of the Global Tracking Framework (GTF). The aim is to develop a multidimensional approach for measurement of energy poverty. They combined multi-dimensionality of energy poverty with multi- tiers. This implies that all the facet of the community is captured in terms of the households or community energy access, productive energy access for agricultural processing and enterprises for economic activities. The multi-tier energy poverty measurement approach was developed by Nicolina Angelou who is an Energy economist for Energy Sector management Assistance Programme (ESMAP) in 2014. This method of energy poverty measures energy poverty based on energy access as a continuum of improvement, based on the performance of the energy supply which includes; Capacity, Duration/Availability, Reliability, Quality, Affordability, Legality, Convenience, and Health & Safety. It is a composite energy poverty approach and it is expressed mathematically as $\Sigma(Pi \times K)$. The multi-tier energy captures all the dimensions of energy poverty from different tiers of the community. Multi-tier framework does not only measure the consumption of energy services, but also measures the quality, reliability, affordability, safety and adequacy of energy access. The method has been applied by ESMAP in five countries namely; DRC, Uganda, India, Ethiopia, and Malawi and has since been completed. The multi-dimensionality and the composite measurement approach of the multi-tier energy poverty measurement approach is a good improvement to the existing multidimensional energy poverty measurement approach.

In the submission of Bensch (2014), he argued that MEPI and TEA are two composite indices which deliver quite distinct results mainly depending on normative judgment inherent in the two indices. MEPI allows for a certain degree of deprivation (e.g. a household maybe energy non-poor even without having neither a fridge nor a television set), while the TEA is far more restrictive in that everybody is considered energy poor who is deprived in any of the six sub-dimensions of the TEA. The multi-tier framework underlying *Beyond Connections* will prove to be a tool for measuring and goal setting, investment prioritization, and tracking progress. It will help us capture the multiple modes of delivering energy access from grid to off-grid and to the range of cooking methods and fuels. It will also help reflect the contributions of various programs, agencies, and national governments toward achieving the sustainable energy for all (SE4All) goals.

Summary

Going by the foregoing analysis, it can be observed that a giant stride has been made towards the development and application of energy poverty metrics for better and efficient estimation of energy poverty in both developed and developing countries, especially in the last two decades. However, energy poverty measurement metrics and methodologies have been criticized on several grounds. Some of the critical criticisms of the metrics are: inability of the methods to capture the efficiency of the energy options (cleanliness), climatic variation, over-reliance on indicators of energy poverty that preclude energy access, the binary nature of energy access measurement, intractable field data and lack of absolute bare minimum energy threshold for energy consumption. The metrics have also failed to capture the quality and efficiency of energy access which is an important indicator of energy access.

Conclusion and Recommendation

Having critically analysed the strength and weakness of the five identified energy poverty metrics, the study concluded that energy poverty metrics are defective on several grounds depending on the conceptualization. Therefore, in order to develop a more effective and generally acceptable metric for energy poverty measurement, the critical criticisms of the metrics must be addressed. Attention must be paid to the efficiency of the type of energy consumed, the socio-economic and climatic determinant of energy poverty are accounted for. energy access must be seen as a continuum and not binary access, and data required must not be unavailable. Even more important is the fact that attention must not be focused on issues that preclude energy access alone. Issues on the quality, duration, affordability and and efficiency of access must also be incorporated into the energy poverty metrics. This will help to account for the multi-dimensionality of energy poverty from all tiers of the community fabric.

To make sure that tomorrow's cities provide opportunities and better living conditions for all, it is essential to understand that the concept of inclusive cities involves a complex web of multiple spatial, social and economic factors. Inclusive cities requires the provision of necessities such as housing, water, sanitation and energy at affordable prices for all and sundry. Therefore, effective estimation of energy poverty is germane to the eradication of energy poverty and consequently to the attainment of the inclusive city goals. The study therefore recommends that consistent measurement frameworks and regular data collection systems on energy poverty should be developed. Metrics used for designing and evaluating energy access programmes should be widened. Indicators that adequately assess needs and describe living conditions of targeted beneficiaries are required.

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