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What are we measuring? An empirical analysis of household electricity access metrics in rural Bangladesh

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ABSTRACT

Measuring energy access through binary indicators is insufficient, and in some cases even misleading. In this work, we critically evaluate the World Bank's multi-tier framework (MTF) to measure household electricity access using a household survey in rural Bangladesh. We argue that the MTF addresses multiple objectives, thereby offering less value as a single composite index than as a set of dimensions along which to evaluate different aspects of electricity access. We test the robustness of the framework to alternative specifications as regards the choice of attributes and tier thresholds. The study shows that access measurement is highly sensitive to changes in parameter values, the application of different algorithms, and data availability. We also discuss the wider implications of applying the framework to current electricity access intervention programs in Bangladesh, provide feedback on the MTF's design, as well as suggest potential improvements for its application in the future.

Introduction

Recently, there has been growing interest in support of the sustainable energy for all (SE4ALL) goal of achieving "universal access to modern energy services by 2030" (Ki-moon, 2011). This has culminated in the recent uptake of universal access to affordable and clean energy as part of the *Global Goals For Sustainable Development* (Global Goals, 2015). These developments necessitate a robust set of measurement tools to track progress toward achievement of this goal. However, at least three issues still remain largely unclear — what we mean by access, what is useful to measure to track access, and how to design the right metrics to measure it. What is increasingly clear and widely agreed is that simply having an electricity connection or a modern cook stove is insufficient and incomplete measures of energy access (AGECC, 2010; Practical Action, 2013; IEA/WB, 2014). That is, any measure of energy access should contain multiple dimensions to reflect its multi-faceted nature.

The World Bank's Energy Sector Management Assistance Program (ESMAP) has been mandated to develop a new framework for measuring energy access. Their newly developed measurement approach is referred to as the multi-tier framework (Banerjee et al., 2015). It has been heralded as a new "milestone" in energy measurement (Bensch, 2013). The multi-tier framework (MTF) assesses energy access for households, productive entities, and communities along several dimensions of access, referred to as attributes (see Fig. 1). Tier assignments along these individual attributes are aggregated by different decision rules to determine the overall tier assignment, which defines the level of access enjoyed by the household.

In this paper, we critique the proposed MTF for electricity access using a case study of 230 households in Bangladesh to illustrate our arguments.[1] We use the MTF as a vehicle to explore effective ways to measure household electricity access, because the MTF seems to be the most advanced framework available. Our main premise is that conceptual clarity and communication about what is being measured are critical to the evaluation of an appropriate metric. With this view, we argue that the MTF addresses multiple objectives, thereby offering less value as a single composite index than as a set of dimensions along which to evaluate different aspects of electricity access. In particular, a subset of attributes characterizes electricity supply, while others, related to consumption, characterize aspects of household energy poverty. The latter depend on the former, but are also influenced by a number of other household attributes. We argue that while both concepts – electricity supply and household electricity poverty – are multi-faceted and require the type of approach embodied in the MTF, they require separate metrics. We also discuss the pros and cons of the

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[1] For the sake of clarity and focus, the present paper only deals with one dimension of energy poverty, namely electricity access for households, despite acknowledging an important demand for cooking and heating energy, and equally important productive and community needs.

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Multi-tier Matrix for Access to Household Electricity Supply

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Capacity	Power[1]		Very Low Power Min 3 W	Low Power Min 50 W	Medium Power Min 200 W	High Power Min 800 W	Very High Power Min 2 kW
	AND Daily Capacity		Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR Services		Lighting of 1,000 lmhrs per day and phone charging	Electrical lighting, air circulation, television, and phone charging are possible			
2. Duration	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hrs	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration < 2 hours
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of a standard consumption package of 365 kWh per annum is less than 5% of household income		
6. Legality						Bill is paid to the utility, prepaid card seller, or authorized representative	
7. Health and Safety						Absence of past accidents and perception of high risk in the future	

[1] The minimum power capacity ratings in watts are indicative, particularly for Tier 1 and Tier 2, as the efficiency of end-user appliances is critical to determining the real level of capacity, and thus the type of electricity services that can be performed.

TABLE ES.2

Multi-tier Matrix for Access to Household Electricity Services

	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Tier criteria	Not applicable	Task lighting Phone charging	General lighting Television Fan (if needed)	Tier 2 AND Any medium-power appliances	Tier 3 AND Any high-power appliances	Tier 4 AND Any very high-power appliances

TABLE ES.3

Multi-tier Matrix for Electricity Consumption

	TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Annual consumption levels, in kilowatt-hours (kWh)	<4.5	≥4.5	≥73	≥365	≥1,250	≥3,000
Daily consumption levels, in watt-hours (Wh)	<12	≥12	≥200	≥1,000	≥3,425	≥8,219

Source: Bhatia & Angelou, 2015

Fig. 1. Multi-tier matrices for household electricity access (2015 version).

definitions of individual dimensions and their method of aggregation, and suggest alternatives, where relevant. Using the example of our case study from Bangladesh, we test the robustness of the framework to alternative specifications of the choice of attributes and tier thresholds. We also discuss the wider implications of applying the framework to current electricity access intervention programs in Bangladesh. We finally conclude with our learnings from the application of the framework in Bangladesh, and provide feedback on the MTF's design, as well as suggest potential improvements for its application in the future. In particular, we argue for moving toward a framework focused more on measuring the actual service level a household with electricity enjoys rather than the current supply and consumption focus of the MTF that undermines efficiency considerations and rapidly innovating decentralized solutions.

The paper is organized as follows. The Measuring electricity access section provides a brief description of a few key approaches to measuring energy access and presents the essence of the MTF as well as a generic critique. The Applying the MTF in rural Bangladesh section briefly presents a country overview of Bangladesh and a descriptive analysis of the households surveyed in Bangladesh. It further applies the MTF to the case of Bangladesh followed by a qualitative and