Guiding Action: A User Centric Approach to Define, Measure, and Manage Electricity Access

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ABSTRACT

The role of electricity in human development is well established as being key to improved quality of life, safer environments, greater communication and connectivity, better educational services, and increased economic opportunities. Despite it having such a fundamental role, nearly one billion people across the world are deprived of electricity access, and many more suffer with poor and limited access. Limited definitions of electricity access have led to improper measurement and monitoring and inadequate management, resulting in poor targeting of efforts by governments, enterprises, and investors. This in turn has adversely affected the pace of improvement. Based on a survey of the literature and policy discourse on the subject in recent years, the authors argue that multidimensional, multi-tier, multi-locale energy access can help not just to better define, but also to better monitor and manage electricity-access provision. While the multidimensional approach to energy access has been featured in the literature lately, no attention has been paid to the integration of this approach into planning and action. In this regard, we are proposing that an end-user-centric approach helps guide planning, execution, course correction, and operations, to achieve universal energy access while keeping the objective of overall human development at its core.

Keywords: Electricity access, Multidimensional energy access, Defining electricity access, Measuring electricity access, Data for electricity access, Achieving electricity access

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1. INTRODUCTION

Access to modern energy, particularly electricity is a pre-requisite to achieve basic human well-being. It improves food and water security, supports delivery of healthcare and education, and increases opportunities of income generation (Pachauri and Brew-Hammond 2012; Practical Action and One 2010; World Bank 2017). Poverty and inaccessibility of affordable energy are viciously related—where lower income does lead to poor, unreliable, expensive and unsafe access to energy while those who lack access to modern energy are often trapped in perpetual cycle of economic and social deprivation (Karekezi et al. 2012). Energy access has conventionally been considered as an input to achieve human development goals. While energy access was not considered as a Millennium Development Goal (MDG) in early 2000,

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the close and strong linkage of energy with sustainable development led to its inclusion among one of the sustainable development goals (Nakicenovic et al. 2012, UNSG 2016). Access to modern energy—particularly electricity—is a prerequisite to achieving basic human well-being. It improves food and water security, supports delivery of healthcare and education, and increases opportunities for income generation (Pachauri and Brew-Hammond 2012; Practical Action and One 2010; World Bank 2017). Poverty and lack of accessibility to affordable energy are viciously related: lower income leads to poor, unreliable, expensive, and unsafe access to energy, while those who lack access to modern energy are often trapped in a perpetual cycle of economic and social deprivation (Karekezi et al. 2012). Energy access has conventionally been considered as an input to achieving human development goals. While energy access was not considered to be a Millennium Development Goal (MDG) in early 2000, the close and strong linkage of energy with sustainable development has now led to its inclusion as one of the Sustainable Development Goals (Nakicenovic et al. 2012; UNSG, 2016).

While the importance of energy in fulfilling basic human needs cannot be overemphasized, the inequity of energy access—the lack of access to modern sources as well as the wide variation in consumption—remains one of the most pressing global problems of today. As of 2015, about one billion people still did not have access to electricity, while about three billion relied on solid fuel and kerosene for cooking and heating (World Bank 2017). In Sub-Saharan Africa, 609 million people (six out of ten people) did not have access to electricity, while the number was 343 million for South Asia, where 20 percent of the population was electricity deprived. In India alone, 164 million people living in rural areas did not have access to household electricity.[1]

Often the problem of energy access is mentioned within the boundaries of a household, which limits the scope of the issue. Lack of energy access also imperils other community services such as health and education, and income-generating activities (also referred in the literature as "productive uses"). In Sub-Saharan Africa, 255 million people are served through unelectrified health centers, with 30 percent of facilities lack electricity (Practical Action 2013). About 90 percent of Sub-Saharan African primary schools are unelectrified, and close to 27 percent of village schools in India lack electricity. Collectively, about 188 million children go to schools not connected to any kind of electricity supply (UNDESA 2014). The dearth of energy, especially in energy-deficit regions, penetrates other domains as well. For instance, almost 53 percent of the net sown area in India remains unirrigated because of lack of water and energy provision for irrigation. Access to energy for irrigation is much worse in Sub-Saharan Africa.

2. DEFINING ENERGY ACCESS

If acknowledgement of the problem is the first step towards rectification, its robust articulation should follow. The articulation, or definition, of the problem of energy access has evolved over time for two main reasons: 1) to accurately capture the realities of the problem; and 2) to guide action aimed at solving it.

1. As of January 2018, number of rural households without electricity was 33.5 million (http://saubhagya.gov.in/); Average size of rural households was 4.9 (Census 2011).

2.1 Energy Poverty and Income Poverty

The definition of energy access, in a sense, has evolved with the definition of poverty. In the same way that having a definition of income poverty (earning $1 per day per person) does help us define a threshold and direct efforts at a global level, looking at energy in terms of "haves and have nots" draws attention to the severity of the problem. Just as a higher income does not necessarily translate into satisfying other important human development needs such as education, health, and social security, the mere access to modern energy sources does not ensure reliability, quality, affordability; the sustained use of those energy sources; or lead to desired socio-economic impacts.

2.2 Evolving Definitions of Energy Access

Conventionally, there have been three major approaches to defining energy access. The first is defining an "energy poverty line" or "fuel poverty line" by looking at energy as a function of income or expenditure. Energy use is then calculated as a proportion of income (expenditure), as specified by the income poverty line (Pachauri and Spreng 2003). This approach is computationally straightforward, but on its own does not add any new insight: it helps estimate the number of energy poor as per the definition. Using the energy poverty line has limited utility as the poverty line is often defined in terms of general economic and social policies rather than national energy-specific policies. This assumes that the income poor are necessarily energy poor, but fails to include the energy poor who are income non-poor. Chances of exclusion could be high under such a metric.

The second approach is an engineering-based approach, determining basic needs in term of useful energy at the consumer level, and access to modern energy services such as more efficient fuels and equipment (Pachauri et al. 2013; Practical Action 2010). This causes difficulty in pinning down the exact minimum level of energy required for basic needs, owing to inter-country and regional differences in cooking practices and heating requirements.

The third approach tries to understand the interrelation between energy poverty and income poverty, and proposes a threshold at which energy consumption begins to rise with an increase in income (Khandker et al. 2010). This approach controls for a variety of household characteristics. It is difficult to gauge the reasons for the state of energy poverty and the factors which would increase the levels of energy consumption within those energy-poor households.

2.3 From Unidimensional to Multidimensional Electricity Access

Unidimensional analyses of energy access make for easy interpretation and are straightforward to handle but, as with human development, the problem of energy access is complex. Restricting its definition to one specific dimension does not capture the entire picture. The mere presence of electricity at a household does not tell one about the comprehensive experience of the end user, which is determined and influenced by factors such as duration of electricity supply, its quality, reliability, etc. Even worse, in India for instance, a village is deemed electrified with the mere provision of village-level infrastructure. The major challenge with such methods is that they fail to capture: 1) spatial granularity at the state, district, village, hamlet, and end-user level; 2) multidimensionality (the capacity, duration, reliability, quality, affordability, legality, and safety aspects of energy access); and 3) multi-locales—going beyond a focus on households (energy services across lighting, cooking, water heating, space heating, cooling, information and communication technology (ICT)), to energy needs for community services (education, health, street lighting, public institutions, and infrastructure services), and for productive use (energy across agricultural value chains and other enterprises).

Based on the above conceptual understanding, more holistic definitions of energy access have emerged in recent years. The Multidimensional Energy Poverty Index (MEPI) is an adaptation of the general Multidimensional Poverty Index (MPI) (Nussbaumer et al. 2011). It lists dimensions and variables (including cooking, lighting, appliances, education/entertainment, and communication) with cut-offs and their relative weights, to capture an indexed value of energy poverty for a typical household. While it delves into the idea of capturing the multidimensionality of the problem, it merely focuses on the possession of assets as proxies, and restricts itself to energy services such lighting, entertainment, and cooling/heating, and overlooks fundamental dimensions of electricity service such as reliability, affordability, quality, etc. Moreover, the MEPI approach does not look beyond households to community spaces and productive uses for enterprise.

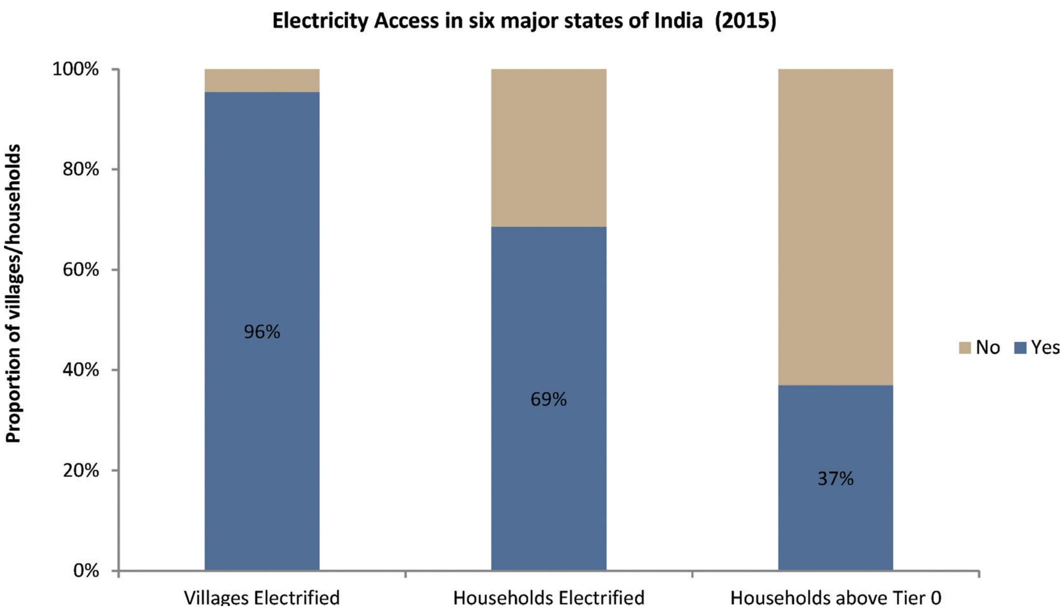


FIGURE 1

Using multi-dimensional vis-à-vis uni-dimensional definition of energy access.

Notes: As one looks at the issue of energy access through different definitions, viz. village electrification, household electrification, and a multi-tier framework, different outcomes emerge. For instance, six energy-deprived states in India were almost fully electrified in 2015 if one looks at village-level electrification, and a majority was electrified at the household level but, based on a multidimensional assessment, only 37 per cent of the households were above Tier 0.

Source: Own illustration.

The UK-based organization, Practical Action, has developed an alternative multidimensional energy-access approach, the Total Energy Access (TEA) Standards, in cooperation with International Energy Agency (IEA), the World Bank, the Global Alliance for Clean Cookstoves, and national development cooperation agencies (Practical Action 2012). TEA is multi-locale and defines a multidimensional energy-access approach for households, community services, and enterprises. This approach has been further developed into a multi-tier framework by the World Bank's Energy Sector Management (Bhatia and Angelou 2015). The Council on Energy, Environment and Water in India developed a similar multi-tier, multidimensional framework referred to as Access to Clean Cooking Energy and Electricity Survey of States, or ACCESS (Jain et. al. 2015). These approaches include six to seven dimensions of electricity provision which, at a conceptual level, could be understood as: (i) capacity of electricity supply, which refers to the level of services to the end user that the electricity supply can support; (ii) duration of electricity supply, pertaining to the typical number of hours for which the electricity supply is available in a day; (iii) quality of electricity supply, mainly referring to the voltage situation associated with electricity provision (i.e., more voltage-related issues would mean poorer quality of supply); (iv) reliability, which pertains to the predictability of the electricity-supply situation (the more predictable the supply, the higher the reliability); (v) affordability of electricity consumption, which pertains to end users' economic ability to consume a basic level of electricity services without significantly compromising their other needs and expenditures; (vi) the legal status of electricity connection, referring to the lawful provision of electricity to the end user (an end user such as a household, community space, or enterprise, may be enjoying good quality electricity supply on all other dimensions, but may be illegally hooking into the electricity supply line, adversely impacting the network and thus the electricity provision for the overall consumer base of the region); and (vii) health and safety, which pertains mainly to the provision of safe electricity to the end user. It is worth noting that the multi-tier approach defines the characteristics of electricity provision but is agnostic in terms of technology and energy source.

TABLE 1

World Bank's MTF Framework for Household Electricity Access.

Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Power		Very low power Min 3 W	Low power Min 50 W	Medium power Min 200 W	High power Min 800 W	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 1000 lm-hrs per day and phone charging	Electrical lighting, air circulation, television, and phone charging are possible			
Duration	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration < 2 hrs
Quality						Voltage problems do not affect the use of desired appliances	
Affordability					Cost of std. consumption package of 365 kWh < 5% of household income		
Legality						Bill is paid to the utility, prepaid card, or authorized representative	
Health & Safety						Absence of past accidents and perception of high risk in the future	

Source: Bhatia and Angelou (2015).

Under the multidimensional approach, the situation of end users is assessed across each of these dimensions on a graded scale instead of a binary classification of haves or have-nots. The overall tier assigned to a household is the minimum tier achieved across all attributes (Bhatia and Angelou 2014). End users may progress or regress on these scales, depending upon the changes in their electricity provision and consumption. Table 2 shows a multi-tier, multidimensional framework for households, as proposed by Bhatia and Angelou (2015). Each row of the framework represents a dimension, and tiers are defined across columns for each dimension.

Inclusion of these multiple dimensions in defining access to energy helps not just to better understand the various aspects of energy access at the conceptual level, but also helps in better monitoring it and managing for it, as discussed in the following sections.

3. MEASUNG ENERGY ACCESS

While a universal conceptual-level definition of energy access in a multidimensional, multi-tier, multi-locale form is essential for actors such as state, policymakers, enterprises and even consumers to understand the problem and act accordingly, operationalizing such a definition for measurement in each country or region needs a consideration of local context. There are two main reasons why contextualization is necessary:

For certain dimensions of energy access, defining and categorizing the end-user situation on a dimension is normative in nature. For example, the preferred duration of supply and choice of hours of supply corresponding to different tiers may vary from country to country.

The data availability and context may limit the use of a particular definition and tier classification. For example, a country with an efficient electricity-monitoring infrastructure in place may measure quality using an objective indicator such as number of days in a month when low voltage or voltage fluctuations were experienced, whereas another country may define it on a qualitative indicator that necessitates a response from the end user, for example, to understand their satisfaction with voltage stability.

ACCESS tries to address the above two concerns in the Indian context. This framework was empirically tested through a large-scale survey study of approximately 8,600 respondents, which captured the electricity and cooking energy situations in households. In the World Bank's MTF, capacity and duration drive the need for the total number of tiers. The capacity dimension as suggested in MTF does not correspond to existing commercial offerings in India. A grid-connected household would automatically be placed in Tier 4 or 5, while the actual tier allocation would depend on the services enabled by the provided capacity, including microgrids or off-grid sources. The normative aspects associated with the defining indicators of measurement under each dimension—and their cut-offs for each tier—is further illustrated in Table 2, through a comparison of MTF and ACCESS frameworks.

In a typical multi-dimensional approach, two aspects are central to the measurement issue: 1) Using appropriate measurable indicator(s) against each dimension, such that the indicator is observable, feasible, and detectable (Glennerster and Takavarasha 2013); and 2) gathering data through multiple channels that are relevant, time bound, and cost-effective.

Groh et al. (2016) conducted an empirical analysis of household electricity access in rural Bangladesh using the MTF framework. The paper allots the sample households to a tier based on six different frameworks (apart from MTF) and established that the tier assignment is sensitive to the respective framework and classification of tiers, as defined by each framework. Further,

TABLE 2
Comparison of MTF Framework with ACCESS framework.

	MTF framework for household (electricity access)—Global	ACCESS framework (electricity access)—India
	Lists seven dimensions: capacity, duration, reliability, quality, affordability, legality, and health & safety	Uses only six dimensions: capacity, duration, reliability, quality, affordability, and legality. Excluded health & safety due to lack of comprehensive data availability
	Uses 6-tier categorization: Tier 0–Tier 5	Uses 4-tier categorization: Tier 0–Tier 3
Capacity	Power rating (kW)/daily capacity (kWh)/ services (lighting/television/phone charging)	Services (No electricity/lighting + basic entertainment/lighting + air circulation + entertainment/Heavy loads)
Duration	Uses hrs/daytime or evening (1/2/ 4/ 8/ 16/ 23)	Overall hrs (<4/ 4-8/ 8-20/ >20)
Reliability	Max. disruptions per week (14/3 disruptions with total<2 hours)	No. of blackout days/month (>5/ 2-4/ 1/ 0)
Quality	Voltage problem not affecting appliances	Voltage surge causing appliance damage and low voltage causing limited use
Affordability	Cost of std. consumption of 365 kWh<5% of household income	Cost of std. consumption (1kWh/day) <4% of monthly household expenditure
Legality	Bill is paid to the utility/ authorized representative	Pays bill to utility/authorized rep.
Health & Safety	Absence of past incidents and perception of risk in future	N/A

Source: Own illustration.

it establishes that under the MTF, the influence of capacity and duration attributes in the overall tier assignment for households is more than the other attributes (ibid.). The dimensions should be defined and classified across tiers in a manner that helps guide the service providers and administrators in their efforts to improve the electricity-access situation (as discussed in the next section).

3.1 Data for Measurement

Although the multidimensional approach to defining electricity access is far more comprehensive and action-oriented than past methods, the availability of data to assess the access situation under such an approach is the biggest challenge in developing countries. Unlike developed parts of the world, information on development indicators is fairly limited in developing countries (Serajuddin et al. 2015; Data for African Development Working Group 2014). Electricity utilities or governmental entities often do not collect or declare information beyond connection or village-level infrastructure.[2] A significant part of the population in these regions is still not connected with any form of electricity supply and thus the availability of

2. Indian government website showcasing real time data on household connections (http://saubhagya.gov.in/).

electricity-related information for such end users is very limited. Even for users connected to the grid, the availability of administrative data (i.e. data available from service providers and utilities about their operation and customer management) is very limited, incomplete, and unreliable. Most of the power utilities in developing countries struggle with challenges such as poor metering rates, a high proportion of defunct meters, limited manpower to read meters on a regular basis, poor monitoring of infrastructure, and a supply situation at the local level where significant manual dependency leads to substantial gaps in data, if at all available (Tallapragada et al. 2009; Mcrae 2013; Besant-Jones 2006). Whereas even in efficiently managed systems such as microgrids in Sub-Saharan Africa and South Asia (where data is available from system operators), integration of data from thousands of such microgrids is still missing.

3.2 Survey-based Data

In the absence of administrative data, end-user surveys are the most common Method of gathering such data. Researchers across several countries have conducted independent data collection to help measure multi-dimensional energy access (Jain et al. 2015; Tait 2017; Groh et al. 2016). Surveys provide flexibility in gathering information beyond the usually recorded administrative data, particularly on subjective aspects such as user experience, customer satisfaction, etc. Despite the many benefits of gathering electricity-access-related data through surveys, the typical challenges pertaining to such data-collection methodologies persist. These include recall biases, acquiescence biases, and extreme responding. However, these can be addressed to a certain extent through robustly designed survey instruments. The quality of survey data can be further improved through comprehensively established survey protocols, rigorous training, and adequate data quality monitoring, including checks for observing enumerator bias. Moreover, the traditional survey approaches are also very time consuming and resource intensive, limiting their scale and frequency.

3.3 Leverage Technology for Data

Survey approaches are also evolving with the evolution of technology, graduating from paper-based surveys to smartphone/tablet-based surveys. While they do not eliminate the need for enumerators to go into the field and physically interact with respondents, digital surveys are easier to administer and monitor, thus helping improve the quality of the data. In addition, with the coverage of mobile phones steadily increasing among the population deprived of energy access across the Global South, telephonic surveys are also emerging as a nimble, efficient, and resource-efficient alternative to physical surveys (Dillon 2010; Tomlinson et al. 2009). Jain et al. (2016) used a telephonic approach to surveying about 1,200 households across three states in India.

Another interesting example of employing technology in gathering data on electricity access is the Electricity Supply Monitoring Initiative (ESMI), an open-data project by Prayas Energy Group in India and Kenya (Odarno et al. 2018). Under ESMI, the data is collected using electricity-monitoring sensors deployed at the household level and transmitted to online cloud platforms. Such a technology-assisted approach addresses the issue of obsolescence of survey data monitoring the rapidly evolving situation on the ground. Sensors can objectively monitor and log electricity-supply attributes such as duration, quality, and reliability of supply. Such an approach is useful as it increases the data-gathering frequency to as high as milliseconds, and provides visibility of the electricity-access situation on a few dimensions almost in real time (EED Advisory et al. 2017). However, these approaches need to be complemented with conventional or telephonic surveys in order to gather additional data on aspects related to affordability, legal status, and capacity of the electricity supply.

In addition, unconventional data sources such as satellite maps and mobile-app-based data-gathering information further help in the assessment of some dimensions of electricity access (ESMAP 2017). For instance, researchers have used nightlight data from satellite imagery to estimate rural electrification in different parts of the world (Dugoua et al. 2018; Min et al. 2017). However, so far, these emerging techniques and technologies have been used as singular approaches by most researchers, who also use data from other approaches (typically surveys) to calibrate predictive models and validate the findings. Going forward, it would be highly valuable to use these approaches simultaneously, by design, to leverage their complementary strengths to improve information on energy-access dimensions for deprived populations.

4. MANAGING ENERGY ACCESS

The utility of developing such a comprehensive measurement framework and collecting extensive data collection remain limited, unless exploited to inform decisions and actions of policymakers, administrators, service provides, and investors towards improving electricity access. Conventional data on electrification rates at the village or household level can only guide up to the level of providing electricity connections. Here again, aggregated data is useful for understanding the situation at a state, regional, or national level, but ultimately only disaggregated, granular-level data can help guide action on the ground.

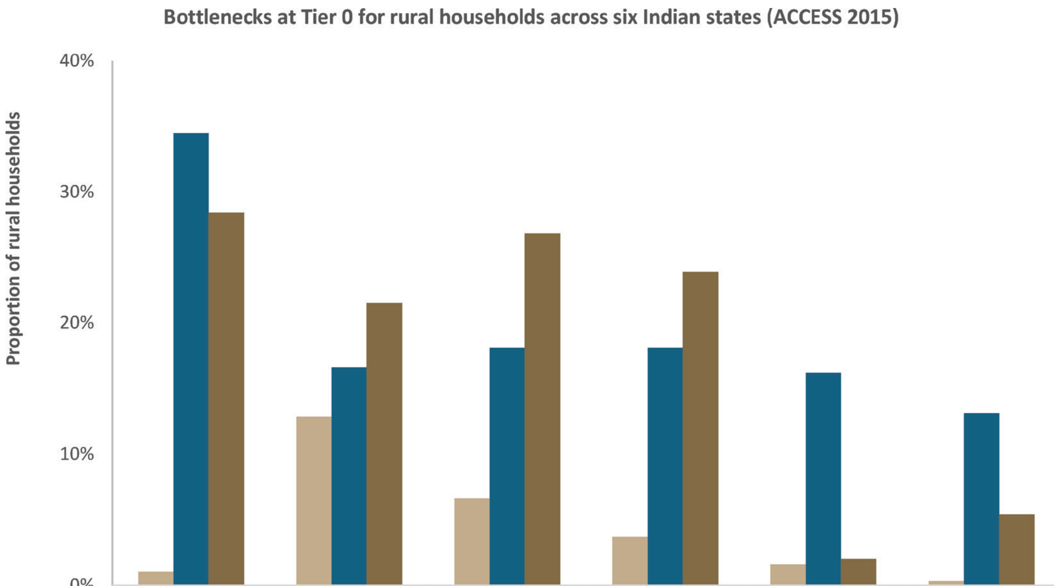
4.1 Multi-dimensionality Guiding Action

The multi-tier framework estimates the overall tier for a household, community space, or enterprise by considering the lowest tier achieved across all the dimensions of electricity access.

The framework considers the use of various dimensions to assess energy access situations, making it more comprehensive. Such an approach, in fact, reveals the reality of the situations and guides specific action to address the gaps. For instance, Figure 2 highlights the reasons for the lack of energy access in different states of India among electrified households. Quality of electricity supply is the biggest bottleneck in Madhya Pradesh, West Bengal, and Odisha, whereas reliability is the major hurdle for such households in Jharkhand.

This approach helps to understand the limiting dimensions which prevent end users from graduating to higher tiers, in other words, from realizing better energy access. For instance, we assessed the electricity-access situation in two districts, Bareilly and Banda, in Uttar Pradesh (the most populous state of India), using the freely available ACCESS survey data (See Table 2). We found that in both Bareilly and Banda, more than 85 percent of households are in Tier 0 for electricity access, but that the limiting dimensions are very different in the two districts. The majority of households in Banda are in Tier 0 because of a complete lack of electricity provision, whereas in Bareilly, almost half of the households in Tier 0 have an electricity connection but suffer limited duration, poor quality, and poor reliability of supply. Thus, the state administration and utility company should focus on providing electricity to more households in Banda, while in Bareilly they should focus on improving the duration, quality, and reliability of supply, as well as providing electricity to the remaining households.

Another example from the same data illustrates how policymakers and electricity regulators could benefit from such a multidimensional analysis. We assessed households in Tier 1 for the states of Madhya Pradesh and Bihar. In Madhya Pradesh, almost 80 percent of households



	Madhya Pradesh	Bihar	Jharkhand	Uttar Pradesh	West Bengal	Odisha
Duration	1%	13%	7%	4%	2%	0%
Quality	34%	17%	18%	18%	16%	13%
Reliability	28%	22%	27%	24%	2%	5%

FIGURE 2

Different factors limiting households at Tier 0 across different states—ACCESS 2015.

Source: Own illustration.

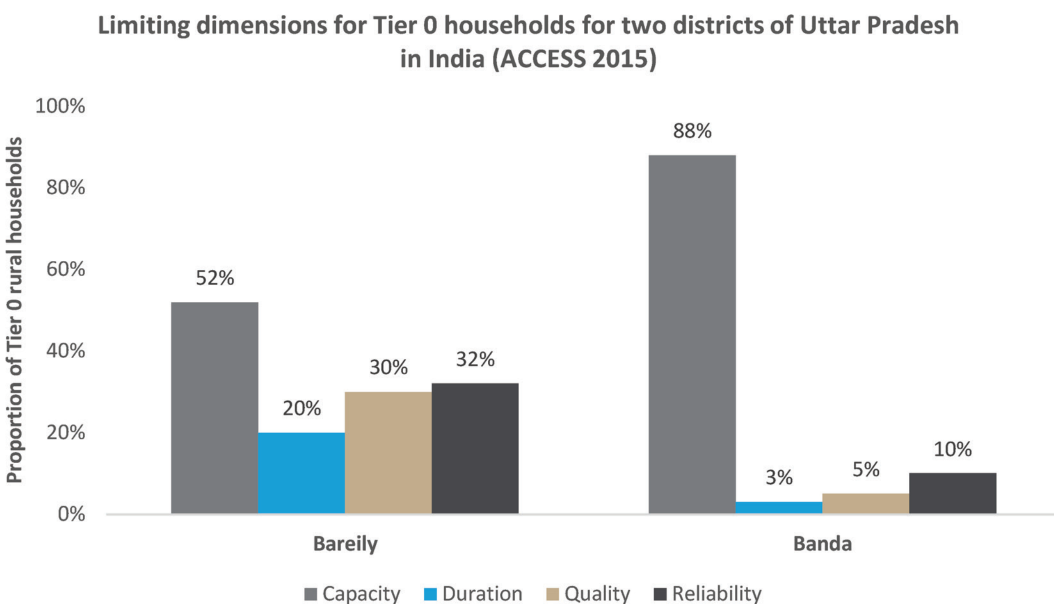


FIGURE 3

Dimensions limiting Tier-0 households in Bareilly and Banda, two districts of Uttar Pradesh.

Source: Own illustration.

that have illegal connections would not be able to afford electricity for basic consumption if they had to pay for a legal connection (Figure 3). Thus, the pricing of electricity could be a big driver for illegal connections in Madhya Pradesh, and electricity regulators should consider this fact while setting state consumer tariffs. In the state of Bihar, however, only eight percent of households that have illegal connections would find a legal connection unaffordable. Thus, the measures required to reduce illegal connections in Bihar may differ from what is necessary in Madhya Pradesh.

Such a framework could help inform the actions of the respective stakeholders, which is the biggest reason why governments and donors should consider investing resources in multi-dimensional assessment of energy access.

4.2 Multi-locale Guiding Planning

Apart from multidimensionality, the multi-locale approach to energy access also contributes to better planning, design, and management of electricity infrastructure. For instance, if network planners consider households to be the primary consumers of electricity in an area, and do not consider community spaces or productive uses, significant under-sizing of the network will result, leading to frequent transformer failures, low voltage incidents, and congestion in the network.

5. ACHIEVING ELECTRICITY ACCESS TO SUPPORT HUMAN DEVELOPMENT

Finally, defining, measuring, and managing energy access for universal coverage would be only useful if it could effectively contribute towards human development. The multidimensional, multi-tier, multi-locale approach considers the enabling role of electricity for various aspects of overall human development. The role of electricity in improved health and educational services, growth of income, increase in leisure time, and women's empowerment, has been well established (Practical Action 2016; Karekezi et al. 2012; Kanagawa and Nakata 2008; UNDESA 2014). Electricity access may not be sufficient to improve final development outcomes (such as learning outcomes in children or mortality rates among newborns) as they need inputs and support beyond electricity. But it certainly improves intermediary indicators such as the availability of light for reading, or adequacy of labor room and neonatal care facilities in primary health centers (Bernard 2012; Khandker et al. 2014).

Definition itself can play a critical role in shaping policy objectives and policy targets, and thus shape the direction of policy action. The evolution of electricity-access policies and targets in India stand testimony to this fact. For more than a decade, rural electrification in India was limited to village-level electrification, necessitating electricity infrastructure at the village level, an electric connection to public infrastructure, and connections to at least 10 percent of households, which meant that household-level electrification was never in focus. Recently, however, the policy targets in India on electricity access have moved from village electrification to household electrification, and the policy itself is now moving towards 24x7 affordable power for all (GOI 2018a, 2018b). However, given that policies and targets were originally chasing village-level electrification, the system locked itself into time- and resource-intensive expansions of centralized grid infrastructure. It may seem economically rational for the Indian government to capitalize on the sunk cost of infrastructure and provide households with grid connections in areas with a grid network, but had the original targets themselves been more considerate of the multidimensional nature of energy access, they may have led to a different approach to achieving universal electricity access, possibly exploiting decentralized energy generation and distribution technologies, achieving universal electricity access much faster and at a much lower economic and social cost.

The measurement and monitoring of electrification programs in India have also evolved with policy targets, moving from the village to the household level. While this is a step forward, eventually enterprises and community spaces should also be included, as well as monitoring of dimensions beyond just connection, in order to provide multidimensional electricity access supporting overall development of deprived populations.

Management of electrification in a multidimensional manner improves socio-economic outcomes. For instance, in the state of Chhattisgarh in India (keeping the multidimensional view in mind), the state government realized that while electric connections are provided to all primary health centers (PHCs) in the country, a significant proportion were suffering from poor quality of supply (voltage fluctuations), and limited duration of supply. Voltage fluctuations were causing frequent damage to PHC equipment, including cold storage for vaccines. To improve the electricity provision in the health centers, the state government deployed a 2kWp solar rooftop system across all state PHCs. An independent assessment by Ramji et al. (2017) shows that PHCs with sufficient electricity availability (either through rooftop solar or because of a general improvement in grid supply) perform much better on various objective indicators assessing health service delivery. The number of deliveries, the number of patients consulted in outpatient departments, retention of medical staff etc., were all significantly higher for PHCs with improved electricity situations.

The technology-agnostic multidimensional electricity-access approach, with socio-economic development as the goal, leads to more pragmatic decision-making at the planning, execution, and operations levels. Such an approach brings end users and service delivery to the center of planning and action.

6. CONCLUSION

Electricity remains a critical input to supporting human development and well-being. Deprivation of modern forms of energy holds back individuals, households, communities, and enterprises from achieving their potential, and limits their opportunities. The policy action on electricity access in the Global South has been limited to connecting households to grids, with limited consideration of the overall experience of the end user. Frameworks such as MTF and ACCESS argue for the use of a more comprehensive approach to defining, measuring, managing, and ultimately delivering energy access for all. To operationalize such approaches, data and monitoring are essential. Leveraging technology towards monitoring and data gathering could significantly help in operationalizing such an approach. Assisted through technology, the multidimensional, multi-tier, multi-locale approach to electricity access provides a way for governments, service providers, administrators, and investors to achieve universal energy access faster and under optimized costs, while keeping socio-economic impact and human development at its core.

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