Powering Communities

Clara Mewes, Master of International Affairs Candidate, Hertie School, Berlin
c.mewes@mia.hertie-school.org
+49 162 8378610
Föhrer Str. 6, 13353 Berlin
Sangeeth Raja Selvaraju, Master of Public Policy Candidate, Hertie School, Berlin
Harish Vikram, Master of Public Policy Candidate, Hertie School, Berlin
Tilman Leicht, Master of International Affairs Candidate, Hertie School, Berlin
Eleanor Batilliet, Master of International Affairs Candidate, Hertie School, Berlin

Abstract

Energy is at the core of nearly every major global challenge. 860 million people worldwide lack affordable, reliable, and sustainable energy. This exacerbates social and economic inequality. Energy is pivotal for food production, increasing incomes, security, or climate change. In other words, it is a precondition for all other SDGs. According to official data, only 1,417 of India's villages have 100% household connectivity, and 31 million households remain in the dark. Electrification is a three-step process, extending the infrastructure to the village, the second is to connect the household and the third is to ensure a reliable and affordable supply on a sustained basis. In India, grid-powered electricity is perceived as unaffordable and unreliable. Electricity providers have no incentive to develop off-grid solutions due to potential profit loss. Three factors are hindering grid electricity adoption in India: irregular bill collection, expensive meters, and intermittent sources of energy. Customers in rural communities have over numerous occasions expressed their dissatisfaction with the grid electricity services provided, due to it being inadequate and unreliable. From multiple surveys, the consensus has been that these communities are willing to spend more money on high quality and reliable electricity. Our proposal is to put more emphasis on the role of communities in electrification efforts in rural India to provide reliable and affordable energy. A sustainable renewable energy project will bridge blackouts of the main grid whilst enabling communities to profit from electricity generation and consumption. This will support government efforts in India aiming at universal electrification. Community inclusive initiatives can provide an effective, decentralized democratic and socially responsible alternative for rural electrification in developing and emerging countries such as India, especially if financial and educational support facilities are in place, leading to increased local participation and empowerment of local people.

Introduction

A subset of the United Nations Sustainable Development Goals (SDGs) relates to improving living standards on a local level. These include the provision of access to affordable, clean and reliable electricity and clean cooking energy. These amenities play a crucial role in minimizing deprivations known to constitute multidimensional poverty. The world is not on track to achieve the energy-related components of the SDGs. 860 million people worldwide lack affordable, reliable, and sustainable energy. Without substantial changes to the paradigm of electrification, one billion people are expected to remain in the dark by 2030. 80% of those projected to remain in deprivation will live in rural areas (IEA 2017).

India stands to be one of the fastest growing economies, it is expected to have an annual GDP growth rate of 7.6 percent and it also accounts for 18% of the world's population, yet it contributes a mere six percent of global energy demand. India's energy consumption doubled between the years of 2000 and 2015, its per capita energy demand continues to remain around one third of the global average (UNDESA 2017). The International Energy Agency produced a report, India's Energy Outlook (IEA 2015) that predicts by 2040, India's energy demand will experience a staggering growth, putting it on track to become one of the highest energy consumption growth countries.

India has achieved a remarkable transformation of its energy systems in the past ten years. In 2018, the central government of India announced that the country had a power surplus, and all villages had been electrified. Nonetheless, a multitude of issues in the power sector persist. Proposed policy solutions by the Indian government rarely address these issues. India continues to face both energy deficit and peak deficit, at a relatively marginal level. The deficit is exacerbated in financially poorer states, particularly in the North East. The quality of electricity services is often poor. "One in two households with grid-electricity faces a power cut of at least eight hours per day" (Agrawal, Bali, and Urpelainen 2019, 41).

The trajectory of the Indian economy has brought on a rapid modernization and expansion of the energy sector in both the generation and grid extension. This fast-changing landscape of the Indian energy sector has made leaps in most infrastructure areas but overlooked certain key stakeholders and characteristics in wanting to effect universal and convenient use of electricity by households. This paper attempts to highlight one such key missing stakeholder, the rural communities that use the electricity. The paper is structured as follows; the first section links energy access with development and highlights why literature has failed to consider community as a key stakeholder, it then provides some background on the structure of the power market in India. The paper then digs into some of the shortfalls in the current literature on energy access and the role of the community inclusive initiatives in expanding the access to reliable, affordable and sustainable energy to all. Finally, the paper will discuss attempted policy solutions by the Indian government and the challenges they have been facing and ends with the section discussing the key role of the community in the energy access discourse.

Energy access and development

Energy access as its own SDG (7) represents significant progress in the recognition of energy for sustainable development.[1] Nevertheless, 860 million people worldwide still lack affordable, reliable and sustainable energy (IEA 2019). The overwhelming majority resides in rural areas of the Global South. This imbalance exacerbates social and economic inequality. Energy is pivotal for the reduction of inequalities, but also poverty alleviation, successful climate action

[1] In deficiency of a universal definition of the term energy access, we use energy access to mean access to modern and clean, affordable and reliable energy services by the population of a country.

and life on land. Succinctly, it is a precondition for all of the UN's Sustainable Development Goals (Bhattacharyya 2012). The literature on the determinants of energy access has considerably grown over the past decade. Scholars have focused on identifying the causes of electricity poverty (Sovacool 2012), the interconnection with climate change (Alstone, Gershenson, and Kammen 2015) and the effects on democratic values (Thombs 2019).

Energy access is predominantly a rural problem. In the absence of reliable energy, a vast majority of households' resort to at least one additional source of electricity, e.g. kerosene, diesel, or biomass such as firewood (Agrawal, Bali, and Urpelainen 2019, 41). These secondary energy sources can create serious health issues and impose higher costs on households. Consequently, a key barrier to electricity adoption is the perceived non-affordability of energy. Despite many subsidies and policy schemes, rural households and enterprises perceive grid-electricity as unaffordable. Contrarily, various studies have shown that "with the exception of a few households with limited resources, grid-electricity appears to be well within the purchasing capacity of a majority of non-users" (Agrawal, Bali, and Urpelainen 2019, 37).

Innovative approaches are required to address the needs of the 860 million people lacking electricity, while at the same time proceeding with a transition to a decarbonized energy system. Off-grid technologies appear to meet these challenges, yet come with challenges themselves (Lemaire 2018; Jhunjhunwala and Kaur 2018; Joshi et al. 2019; Alstone, Gershenson, and Kammen 2015; Mahajan, Harish, and Urpelainen 2020) Sovacool (2012) identifies five ideal conditions for overcoming barriers in the deployment of off-grid technology: (1) Prioritize High-Impact Actions, (2) Enable Sufficient Financial Incentives, (3) Distribute Reliable Information, (4) Encourage Nested Institutional Arrangements, (5) Build Human Capacity (Sovacool 2012, 47). On the basis of these conditions lies the recognition of rural energy users as active participants in energy projects and more than sheer passive consumers. This fundamental assumption is shared by a majority of scholars advocating for a move away from the donor-driven approach towards a more market-driven approach to take on the Global South's electrification (Baldwin et al. 2015; Chaurey et al. 2012; Harper 2013). Especially "[r]ural energy users must be viewed not as passive consumers but as active participants in energy projects" (Sovacool 2012, 48). Mahajan and his colleagues use traditional consumer choice theory to underline the end-user's pivotal role in global electrification efforts (Mahajan, Harish, and Urpelainen 2020).

The focus in operating and managing energy access needs to shift towards the community involvement. Unfortunately, a majority of "programmes promoting energy access are neither sustainable nor adequately contributing to development" (Bhattacharyya 2012, 260). Most "impact studies tend to focus on the technology and forget to describe operations on the ground and to take into consideration the social interactions between end users of solar systems and installers (and also with nonusers)" (Lemaire 2018, 13). The lack of community involvement in the operations and management of energy access projects is one of their major limitations (Chaurey et al. 2012; Joshi et al. 2019). Generally, little to no research has been conducted on the developmental impacts that different level and types of access to electricity have on rural end-users. Aklin and Urpelainen (2020) investigate the drivers of deteriorating energy access. They identify problems with infrastructure and financial hardship as the two primary reasons why households lose energy access. However, while the literature identified the challenges to energy access, the possible solutions to address the lack thereof have not yet been adequately studied, understood and deployed.

The structure of the power market in India

The power sector in India can be roughly divided into three parts: generation, transmission, and distribution. Power generation is constituted of three main sectors: central generating utilities (24% of overall generation), state utilities (30%) and private utilities (46%). Transmission is carried out by central and state organizations and remains primarily a government-controlled activity. The transmission sector was removed from the central generation agency in 1989 and the Power Grid Corporation was established. Electricity losses from transmission and distribution for India are nearly 20% of what it generates, which is higher than the global average of 8.251% of the total generation. The distribution side of the power sector involves the maintenance of distribution network and retail supply of electricity to the public. The distribution aspect of the power sector is mainly carried out by the state-owned distribution companies otherwise known as DISCOMs.

The goal of expanding the main grid to India's villages has overshadowed the need to provide good quality access and service to the consumers in rural communities, which is demonstrated by the extensive use of supplemental energy sources other than the grid. Half a billion people in India gained access to electricity between 2000 and 2016, increasing the share of grid-electrified households in the country from 43% to 82%. Key findings from multiple studies have shown that grid-electrification coverage and implementation is relatively high in rural communities. The key usage of electricity in rural households is lighting and majority of it sourced from the main grid. Other sources of electricity such as solar home systems, rechargeable batteries, mini-grids, and diesel generators are also an integral part of the electricity systems in rural areas. Reasons as to why the main grid isn't the only source of electricity and must be supplemented by other sources is the crux of the energy access challenge in India. Facilitating full access to electricity in the country has been a critical landmark in the modernization of developing and emerging countries.

The dire financial situation of India's DISCOMs has had a significant impact on the power sector. Their poor financial structure and health indicate a remaining inability to buy power and invest in the transmission and distribution infrastructure. This impact is felt by both the power producers and the retail consumer purchasing this power. Consumers receive low quality of power. Producers are unable to sell power in the market, hence face losses and therefore, default on the loans accrued. The accumulated losses of state DISCOMs has increased from 1.56 billion USD in 2004-05 to 9.51 billion USD in 2013-14. As of March 2015, the state DISCOMS had accumulated losses of approximately 50 billion USD and an outstanding debt of approximately 57 billion USD. In the last two decades significant measures have been taken to improve the financial health of DISCOMS In November 2015, the government introduced the UDAY scheme to bailout distressed state DISCOMs. The scheme was optional for states but nearly all signed up for it. Under the UDAY scheme the states had to take over 75% of the DISCOMs' debt over two years. However, the scheme also held states responsible for fulfilling certain operational efficiency improvements like smart metering and upgradation of transformers. While the UDAY policy intends to improve the financial state of DISCOMs in the short term and help them clear their books, it remains unclear whether this would alleviate entrenched problems in the long run. Post the bailouts, DISCOMs tend to accumulate these losses again, and the cycle repeats all over again.

In April 2018, the central government of India announced the landmark achievement of all villages in India electrified, i.e. the entire country has access to the main grid. This was made possible under the Saubhagya scheme, 18,374 households remain to be electrified as of March 31, 2019. However, even with strides the country has taken to make access to electricity a reality for many, fundamental issues remain to be addressed. The continuous supply of electricity is a major challenge. Data shows that nearly 53% of the villages in the

country continue to receive electricity for less than 12 hours in a day for domestic purposes. As a result, the challenges faced by the suppliers, the DISCOMs, are passed down to the rural communities who depend on good quality, uninterrupted electricity.

These efforts to reform, improve and extend the grid have all been critical steppingstones to establishing better energy access. However, these programs have continued to fail to treat and sufficiently consider the user experience of electricity, in other words the rural communities who are the intended beneficiaries of the expanding energy access programs.

Attempts to Provide Energy Access

Energy access is defined as the degree of access that rural communities have to energy end-use services accessible through modern energy carriers like electricity, petroleum products and bioenergy (Sagar 2005; Kanagawa and Nakata 2008). Basic energy needs such as cooking, and lighting are typical energy end-use services that determine energy access levels in rural households. Energy access means these energy services are available with acceptable quality, affordable (low capital costs) and abundant (Bhattacharyya 2006). Yet there are multiple factors hindering energy access, which this section will highlight.

- Lack of physical access: entire villages are unelectrified, the individual building or house is not connected to the main grid in an electrified village or the individual building or house is unfit for an electricity connection.
- Lack of physical availability: lack of local energy resources to produce the required energy carriers; as well as the generation capacity resulting in blackouts or repeated power cuts; the unavailability of skilled human resources to maintain, operate and repair the respective carriers.
- Lack of acceptability: low quality of supplied electricity which is frequently interrupted and has voltage fluctuations; technological complexities and the extra effort to procure the energy carrier, reluctance influenced by behavioural/social/informational factors like lack of awareness, misinformation and indifference.
- Lack of affordability: high initial cost of establishing a connection and the prevalence of income poverty in the region resulting in the inability to pay for energy or for the connection.
- Lack of adequacy: energy resource limitations and inefficient production resulting in energy shortages; constraints with regards to financial resources preventing the construction of new facilities for production, transmission and distribution systems as well as, transport infrastructure.

Universal access to electricity has been preserved in almost all energy policy pronouncements. The draft National Energy Policy (NEP) of June 2017 targets complete electrification of all the Census villages by 2018 and universal electrification with uninterrupted electricity by 2022 (NITI Aayog 2018). But mere fund allocation is insufficient, structural problems in the energy sector must be addressed while drafting policies.

“Energy for All” has been enshrined in several recent energy pronouncements in India, such as the Deen Dayal Upadhyay Gram Jyoti Yojana (DDUGJY) launched in July 2015, which focuses on rural electrification. The Saubhagya scheme announced in September 2017, emphasizes energy access to rural and urban households (Mehra and Bhattacharya 2019). It aims to provide funding to around 40 million households for last mile connectivity to help achieve the objective of a hundred percent electrification across the country. It relies strongly on solar energy for off-grid connectivity and aims to power remote hamlets with solar power packs of 200-330 watts. The Pradhan Mantri Ujjwala Yojana, another energy welfare scheme

launched by India's Ministry of Petroleum and Natural Gas in May 2016 to provide free LPG or cooking gas to women from below poverty line families.

While a free electricity connection from the Saubhagya scheme could reduce the financial burden of upfront costs on households, it will do little to ease the recurring burden of electricity bills. In rural and remote areas people remain victims of faulty metering and other malpractices as this conflates the electricity bills these communities receive. Metered connections remain unpopular and it is unlikely to make headway unless rural communities are adequately educated and made aware of its benefits. The rapid progress the Ujjwala scheme has resulted in substantial policy conflicts. Recent statistics show India's imports of LPG in 2017-18 exceeding eleven million tons, making it the second largest importer of LPG (Duttal 2018). Any "Energy for All" policy will have to settle these critical trade-offs between the switch to a cleaner and efficient fuel source and the rising dependence on energy imports.

Non-grid electricity sources gained popularity among practitioners, scholars and end-consumers to solve the last-mile issue. To achieve the goal of reliable, affordable and sustainable energy for all, especially distributed renewable energy sources such as solar mini-grids, bear great potential (Lemaire 2018; Jhunjhunwala and Kaur 2018; Joshi et al. 2019; Alstone, Gershenson, and Kammen 2015; Mahajan, Harish, and Urpelainen 2020; Agrawal, Bali, and Urpelainen 2019). Distributed generation projects vary in type and scale along a wide spectrum – from grid-connected systems to so-called pico applications such as solar lanterns (Baldwin et al. 2015). Generally, the productive "use of small off-grid solar nevertheless seems limited and till now is still poorly studied" (Lemaire 2018, 1).

Even the smartest technology will prove ineffective if the incentives for its right usage are too weak (Fowlie et al. 2018). Although India has made progress in electrifying its people, rural communities in states such as Uttar Pradesh and Bihar continue to face long periods of time without electricity and large electricity bills. Modern fuels like kerosene and liquefied petroleum gas (LPG) are the major sources of cooking energy in urban India. However, a large proportion of rural households still use biomass such as firewood, dung, crop residue, and charcoal. Strategies to encourage the use of improved cooking stoves or induction stoves, and ventilated cooking spaces are short-term options that can quickly improve the quality of life with better health and more leisure time. Results from the Indian Human Development Survey 2005 show that educational attainment, socio-demographic factors, and access to electricity and water supplies are important determinants of fuel choice. Moreover, new energy technologies are not apolitical, but rather processes embedded in larger socio-ecological systems (Thombs 2019). The "introduction of solar can destabilize "traditional" communities: by being a vector of the consumer society, solar can create an ecosystem of technologies perpetually initiating new needs that can lead to high level of debts" (Lemaire 2018, 14).

Some studies (IEA 2006) have focused primarily on providing deeper insights into current status of access to modern energy carriers and services in developing countries. Yet the issues regarding energy access in India are only treated superficially in national and international development plans (UNDP 2006). This is because energy governance caters more towards the "supply-end". The energy sector has so far focused on the expansion of electricity generation and efficiency, transmission and distribution, and to maintenance a steady stream of various fossil fuels, domestic or imported. Solutions discussed tend to revolve around "hardware" updates or improvements. The "demand-end" aspect of energy in India has been neglected.

"A better understanding of rural customers is instrumental in identifying diverse needs and constraints in electricity access" (Agrawal, Bali, and Urpelainen 2019, 13). Understanding their acceptance, usage and maintenance decisions is a first step. Energy services, just as any other service, need to apply a "customer-first approach" (Agrawal, Bali, and Urpelainen 2019,

4). The view must shift from the supply side to the demand side. Moreover, as energy access projects are generally designed as technology driven, the focus must shift to the social and economic aspects of energy initiatives. How can electrification efforts create a sustainable and democratic local energy ecosystem?

Community inclusive initiatives

Electrification efforts must be tailored to communities' needs and capacities. The impact of community engagement on energy projects, in India and globally, deserves more investigation. The historic discourse on energy access has classically been that "one involving 'givers' and 'takers': the utility giving electricity or donors giving technology, and the consumers taking it. This completely places the energy services provider and consumer into a false dichotomy" (Sovacool 2012, 47). This legacy of viewing energy access as a dichotomous choice dominates the way energy access reform is carried out today including in India. A key stakeholder that is sometimes mentioned but rarely given its due course in the energy access ambitions is the community. This section explores some theories potential frameworks to include community in the energy access debate.

Physical access to electricity alone is insufficient to accomplish the desired economic and social development. It needs innovative approaches to ensure that gains in household electrification and quality of electricity service are preserved over time. Out of the four potential energy futures identified by Thombs (2019) - (1) the libertarian energy decentralism, (2) technocratic energy centralism, (3) democratic energy centralism, and (4) democratic energy decentralism - only the two democratic scenarios will reproduce democratic and just social relations and thus ensure the sustainability of energy access programs. Unfortunately, these democratic futures "are more hypothetical in nature given the lack of examples that have been successfully implemented at a sufficient scale" (Thombs 2019, 162). How will these democratic futures look like and how will we get there?

We argue that community-inclusive initiatives should be the channel through which a democratic energy future and long-term sustainable development is attained. Community involvement is the necessary means to ensure and expand gains in rural electrification. Community inclusivity as a partnership and business model can vary in type and scale. While decentralized energy networks are rapidly spreading, community engagement can also be situated within centralised energy systems. As a "complete centralization or decentralization will have both social and ecological limitations, so a just and sustainable future will likely be an amalgam of the two that creates interconnected communities, resources, technologies, and governance structures" (Thombs 2019, 166).

The future of energy systems must be based on collaborative, multilevel governance (Baldwin et al. 2015). The "pro-poor public-private partnership" model ("5 P") is such a model of collaborative governance. It is an advanced version of public-private partnerships, explicitly targeting poor communities. The approach considers "the poor not only as consumers that receive benefits, but also as partners in business ventures" (Chaurey et al. 2012)

Profit motivations are harmonized with social needs and the empowerment of the targeted communities. Another model, proposed by Moroni and Tricarico (2018), is the polycentric energy system which is composed of decentralised energy production units that are under numerous, different and autonomous forms of self-governance.

The invaluable role of local partnerships in achieving environmental, economic and social impacts has been emphasized by an overwhelming majority of the literature. Joshi and her colleagues (2019) demonstrated that local involvement is key in the dissemination of solar technologies. In most studies, the inclusion of the community promotes "the sustainability of

the project as the members of the community set the tariffs, manage the project, ensure O&M [operation & maintenance], and also undertake other development work in the village from the funds created under the project" (Chaurey et al. 2012, 49). Active communities can bridge the demand-side gap between availability and access by offsetting the deficiencies arising from a lack of education and financial hardship.

Energy access projects in rural India have already demonstrated that education within community settings has an impact on both the energy system and the consumer. Education of the end-user can "greatly improve user satisfaction: without an understanding of why energy and power must be limited, users will complain and may ignore or bypass restrictions" (Harper 2013, 8). The Lighting a Billion Lives (LaBL) initiative, for example, provided every partner with exhaustive and advanced training on the vision of its program, the use of the technology, the implementation model and the partner's role in sustaining the LaBL initiative (Chaurey et al. 2012). The training of selected members of the community in technical topics and methods of facilitation, governance, and communication, can greatly improve the overall operation of the energy system. Vaghela (2010) discovered in her work on mini grids in India that an effective method of training communities is to have experienced members from neighbouring communities as mentors.

The affordability of improved energy services in rural India is, as described in the above, a major challenge. Thus, a key condition for successful energy intervention is the provision of sufficient financial incentives. Financial assistance to overcome the first cost hurdle related to energy technology that not only encompasses the fees to access the energy network but also the acquisition of first appliances substantially enlarge the sustainable development. While financing can come from different sources, community financing has been proven very effective in other sectors. Hence, "[c]ommunity financing of renewable energy projects is significant in ensuring the economic sustainability of these endeavors" (Joshi et al. 2019, 274).

Conclusion

The previous sections established why community inclusive initiatives in electrification efforts are the necessary means to achieve long term sustainable development. But, until these have been implemented on a large scale, the impact of communities on sustainable development in the energy sector remains hypothetical. Future research should aim to gather survey data from different contexts to test for the here hypothesized impact of community inclusive initiatives on energy systems and their end-users. **The shift from a supply-side view to a demand-side view is pivotal to achieve sustainable development. It is crucial to create an ecosystem of innovation that goes beyond physical access but includes social concerns and the empowerment of local communities to sustain energy access projects.**

Two crucial variables in the interplay of energy and sustainable development are businesses and enterprises, whose perspectives and needs have received less attention in this paper due to a lack of space. Nevertheless, the use of electricity for productive purposes is essential to the improvement of livelihoods in the Global South. No matter how promising advances in technology and energy science may be, its effects on eradicating energy poverty will be extremely limited unless initiatives and policymakers take the importance of community involvement into consideration. **This paper hopes to encourage, stimulate and catalyze attention to the community in the energy access debate. While literature in the past has without doubt mentioned the community, it has failed to take a critical and sufficient look at the role they play.**

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