Analytics on Pricing Signals in Peer-to-Peer Solar Microgrids in Bangladesh

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1. Motivations underlying the research

To be able to provide growing populations with access to affordable, reliable and clean energy in a manner that satisfies requirements based on all three dimensions, economic, environmental, and socially equitable, current business models need to be overhauled and be in synch with government policy and operations. In order to reach universal energy access by 2030, as defined in the Sustainable Development Goal (SDG) 7, we need integrated electrification pathways, where grid extension and distributed energy can work hand-in-hand. Grid expansion must not act as a counterweight to the wider adoption of clean distributed electrification solutions. Moreover, in the race toward achieving SDG 7, the world needs to build approximately 50 new microgrids per day. This stands in stark contrast to the present average rate of only one microgrid per day.

Bangladesh is home to the world's largest Solar Home System (SHS) market. Since 2003 local partner organizations have deployed over 4.3 million SHSs through a soft-financing program provided by the government's Infrastructure Development Company Limited (IDCOL). People living in energy poverty can be trapped in an (energy) poverty penalty that implies adverse effects for their development opportunities. This research's implementation partner, SOLshare, is a Bangladesh-based social enterprise that is leveraging existing distributed energy infrastructure to allow households and small firms to trade their surplus energy with SHS owners and non-owners through a local smart microgrid. The peer-to-peer trading network combined with mobile money-enabled pay-as-you-go billing provides customers with more reliable energy and allows them to generate a direct income from electricity sales. Solar microgrids enabling peer-to-peer energy exchange among off-grid households are poised to contribute to electrifying rural areas in the Global South.

The trading price currently does not vary dynamically, and the company takes a fee on each transaction by establishing a sell price that is relatively lower than the buy price. These local trading platforms offer a unique opportunity to study the gains from trade for both consumers and "prosumers" (i.e. customers with SHSs that consume and sell the electricity they generate). Measuring willingness to pay will facilitate the estimation of demand elasticities and consumer surplus, which can thereby inform pricing and guide the design of subsidies, as well as improved business models, a necessary requirement for a much larger uptake of microgrid deployment across the globe.

2. A short account of the research performed

To ensure these microgrids can be run sustainably, this paper seeks to provide some initial answers on how to improve on the prevailing static pricing approach. We are piloting variations in the buy and sell prices for electricity in several solar microgrids in rural Bangladesh to elicit price sensitivities. We analyze villagers' trading behavior in presence of varied prices by comparing absolute amounts of electricity bought and sold in the testing months in 2021 to data from the same time in the year in 2020.

3. Main conclusions and policy implications of the work

Understanding how reliable electricity can impact household and firm incomes in this setting can help inform policies that seek to maximize the returns to electrification. We find that making electric-

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ity much cheaper did not lead to observable shifts in customer behavior. Rendering feeding into the microgrid much more lucrative for prosumers, customers who sell electricity to as well as purchase it from the microgrid, produced inconclusive results. Anecdotal evidence of consumption smoothing in a microgrid with decreased buy-prices and of increased pick-up by customers with many appliances points to potential benefits from adjusting buy prices to daily and seasonal supply peaks and troughs. Failure of increased sell-prices to induce more prosumer energy feed-in may furthermore motivate new thinking on current passive trading regimes, which give preference to matching geographically close supply and demand and thus disadvantage individual prosumers. That a one-month buy-price reduction in two separate grids led to no clear changes in electricity purchase behavior among microgrid customers may cautiously be interpreted as an indication of microgrids meeting current village-level energy needs at prevailing prices, albeit with caveats. Those caveats, in turn, inform future research for better intervention design. Policymakers, especially in the Global South, might therefore want to consider (continuing) support for decentralized solar microgrids to boost rural electrification, despite relatively higher electricity tariffs for households. Moreover, microgrids, once established, can continue to play an important role for their participants even after national grids have reached their villages, as indicated by one of the microgrids in our sample. Given microgrids' cost-effectiveness, compared to national grid extensions, as well as their high reliability in providing energy throughout the year and the Covid-19 pandemic, they ought to play a bigger role in energy provision to remote and socially disadvantaged areas. In this context, well-designed subsidy schemes such as energy credits can help combat energy poverty and ensure citizens' energy needs are met. These positive indications notwithstanding, it is evident that for these local solutions to contribute to electrification meaningfully and sustainably in the mid to long term, a departure is required from setting microgrids' electricity buy and sell prices statically. Dynamic pricing must, however, be implemented so as to optimize trading to better reflect demand and supply shifts throughout the day and seasons. Peer-to-peer solar microgrids further empower prosumers while paying heed to both environmental and developmental concerns. The lessons from this experiment in Bangladesh also bear relevance for energy regulators in the Global South and can inform their design of incentive regulation of energy networks.