


POLICY BRIEF

Community energy and development: the potential of mini-grids

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Energy access is a core pillar of the 2030 Agenda for Sustainable Development yet, globally, around 750 million people still lack access to electricity and more than two billion lack access to clean cooking fuels. Future energy systems must be renewable, inclusive, and resilient, which is why decentralised energy systems—where generation and governance occur closer to the point of use—have an important role to play in achieving Sustainable Development Goal 7 (universal access to clean and affordable energy). ‘Community energy’ is one form of decentralised energy system that is getting renewed attention from policy makers and funders alike. Community-led projects have the potential to accelerate the deployment of renewables while generating socio-economic benefits. However, the expansion of community energy still faces significant barriers.

In this note, we explore the potential of community-led energy systems through the lens of micro-grids. We draw on experiences from a number of different contexts, highlighting lessons learned to help inform future programmes.

First, it’s important to note that:

Not all decentralised energy provision is currently clean. In low-income countries many mini-grids are powered by fossil fuels, with diesel generators providing an estimated 350–500 GW of energy across 20-30 million individual sites, producing the equivalent power of 700-1,000 coal fired power stations and resulting in significant emissions and pollution. They also deliver some of the most expensive electricity in the world, with up to USD \$100 billion spent on fuel each year¹. That said, the Mini-grids Partnership reports that there was a significant decline in the share of diesel capacity in mini-grids between 2018 and 2024, with diesel’s share falling from 42% to 29% while solar PV systems’ share rose from 14% to 59% during the same period².

Not all decentralised renewable energy provision is ‘communal’ – some of the biggest strides made in energy access in recent years have been through households purchasing solar lanterns or solar home systems³ through Pay As You Go (PAYG) arrangements. By 2016 the sector



had gone from a near-standing start a decade earlier to over 100 active companies and cumulative sales of 30 million lanterns and solar home systems globally^{4,5}. However, since 2016, sales volumes have plateaued with estimated sales levelling-off to around 30 million products per year⁶. Growth in the off-grid solar sector was initially largely driven by East African markets, in particular Kenya, Tanzania, and Uganda although only Kenya has continued to see market growth since 2016.

Not all 'community' energy systems are community-led.

There are other decentralised energy systems (renewable or fossil fuel powered) that could be described as 'communal', in that they supply multiple households and possibly other communal services from a local generation source through some sort of micro or mini-grid, but are not necessarily community-owned or community-managed.

What is a mini-grid?

Mini-grids (or micro-grids or isolated grids) connect a small-scale generation source to a limited number of nearby consumers using a distribution grid that can include an energy storage system (e.g. batteries). It typically operates separately from the main electricity grid (i.e. off-grid) but can be interconnected (i.e. grid tied) to supplement an unreliable main supply.

In general, (off-grid) mini grids make most sense where they are more cost-effective to install than expanding transmission lines to remote areas currently unserved by the main grid. That said what constitutes 'remote' is changing as mini grid costs decline. In 2019 the upfront capital cost per connection for mini-grids (around USD 500-2,100) was already in line with an unsubsidised main grid connection, and since then technology costs have fallen further⁷. The World Bank expects that the levelized cost of energy for mini-grids will reach USD 0.20/kWh by 2030⁸. Mini-grids may also offer a more resilient supply of electricity to communities, for example, grid-tied mini-grids that are fitted with energy storage can continue to operate even if the main grid fails due to climate hazard or other factors⁹

There are at least four mini-grid models -

- a. Private sector model - where companies entirely finance and develop mini grids – typically only found in areas of high demand such as commercial or industrial developments.
- b. Utility model – where the state-owned utility designs, finances and operates mini-grids in places where it is uneconomic to develop grid connections.

- c. Community model – mini-grids owned and operated by communities through some form of local government, association or cooperative.
- d. Public-private model – where there is some sort of collaboration across the two sectors to finance, build and operate mini grids.

The specific benefits, risks and shortcomings of mini-grid supplied electricity in a development context differs depending on the model used to install and manage the system.

Mini-grid models: pros and cons

It is becoming widely accepted that reaching the world's poorest and most remote communities will require subsidisation, given these consumers' ability to pay. It will be important to consider not just community ownership (model (c) above) but also utility- and public-private models (models (b) and (d) above) in finding the right mix to ensure energy access and promote development.

Communal management and ownership should mean that community members have a greater vested interest in their system and ensuring it remains well maintained and the electricity is affordable to the largest number of people. However, communities may lack the technical capacity to operate and maintain what can be quite complex systems and governance issues such as setting tariffs, managing disputes, dealing with default bill payers and so on. Also, of the three models, the community-managed one faces the greatest challenge in accessing debt, equity or other forms of finance when additional capital is needed for major repairs or further extensions to an existing system.

In recent years, those arguing for the **utility-based model** (model (b) above) have become more prominent. Sometimes known as Utilities 2.0, the approach focuses on utilities' ability to lead integrated planning across grid and off-grid approaches to deliver the least cost access solution for an entire country, as opposed to treating grid and off-grid separately. It opens up the potential for cross subsidisation for rural poor consumers, leverages the ability of utilities to access cheaper capital and install and manage mini-grids at scale, and also makes use of digital technologies now available such as smart metering and remote monitoring of supplies. An early example of this approach was a 40kWp mini-grid in Kiwumu, Mukono district in Uganda¹⁰.



Public-private models probably remain the most common form of mini-grid development with the private sector developers raising commercial funding and then additional government or donor funding is (ideally¹¹) used to make up the difference between what is affordable for the consumer and what is commercially viable for the private operator. Private investment in mini-grids has risen six-fold from less than \$100m in 2015 to nearly \$600m in 2022¹². Subsidies are generally focussed on part of the capital expenditure in order to get the commercial finance requirement to a level that, together with the operating and maintenance costs, can be recovered as an affordable tariff from the users. This aims to get the best outcome for public funding while ensuring private capital is deployed in a way that meets social goals of affordability and access¹³.

Beyond access: ensuring development outcomes

Across all the mini-grids models, there are certain conditions that need to be met to ensure access to electricity can lead to social and economic benefits. Our 'Energy and Economic Growth' Applied Research Programme, funded by the UK Foreign, Commonwealth and Development Office (FCDO) included seven research projects looking at this issue across Ethiopia, India, Nepal and Sierra Leone. This research found a number of potential factors affecting social and economic impact of such projects¹⁴:

1. **Cost** – unsurprisingly, tariff levels seem to correlate with levels of use of electricity (and consequently the level of social or economic benefit derived). In Sierra Leone tariffs for mini-grids are two to three times those for grid-connected households in urban areas, with consumption significantly lower for the former compared to the latter. Comparisons between grid-connected urban households in India and Ethiopia painted a similar picture with high levels of consumption (approaching European levels) and very low tariffs in Ethiopia compared to relatively high tariffs and very low expressed demand in India.
2. **Supply constraints** – the Sierra Leone mini grids reviewed were designed primarily to serve local health clinics and only secondarily to serve surrounding communities. As a result, they were undersized and could only provide sufficient power for lighting for the wider community. Households reported favourably on the resulting access to clean modern energy for lighting (which may have important social benefits in terms of enabling greater social interaction after dark, the ability

to charge phones and have better access to information and improved perceptions of security, for example). But the research found very little indication of significant health, education or economic impact on beneficiary communities compared to similar communities without electricity connections, most likely because of the very low levels of use.

3. **Access to appliances** – along with access to a supply of sufficient size, at an affordable tariff, the affordability, reliability and accessibility of appliances to convert electricity into productive use applications appears also to be a critical factor in ensuring provision of electricity leads to any form of economic impact.
4. **Access to market** – our research found some evidence that economic impacts of energy access are not automatic but dependent on 'complementary inputs', such as access to appliances as mentioned above, but also access to finance and to markets (for trade), with some evidence from Nepal that distance to the nearest road had an impact on how much economic activity was stimulated by the arrival of electricity. There is also some evidence that where economic impacts do occur, they can take time to materialise, which cautions against trying to measure impacts too quickly after electrification happens.

Challenges to overcome

Drawing on experiences from the Energy and Economic Growth Programme, three major barriers need to be overcome to ensure mini-grid systems fulfil their purpose:

1. **Ensure systems are designed to provide sufficient power to allow for productive use to support economic activity.** The mini-grids in Sierra Leone referenced above are an example of under-designed systems providing sufficient power for just a few lights and phone charging in each house and are highly unlikely to lead to economic benefits. The Rockefeller Foundation¹⁵ argues that global energy ambitions should be raised and has proposed a 1000kWh per capita per annum Modern Energy Minimum Standard. Whilst still significantly lower than the median annual consumption of 6720kWh per capita for high-income countries, it allows for 300kWh per capita per year at home, plus 700kWh per capita per year in the wider economy to enable industry, commerce, transport, agriculture, and public services needed to underpin the economic activity needed to deliver higher incomes and growth in household consumption.



- 2. Consider ways to boost energy consumption as part of a mini-grid design.** When mini-grids fail it is often because they have been unable to achieve financial sustainability in the form of sufficient revenue to cover their operation and maintenance costs. As noted above, without complementary inputs household energy consumption can remain low even after access to electricity is provided. Therefore, alongside construction of mini-grids it is important to facilitate access to appliances and the finance / credit necessary to make them affordable. Attracting commercial anchor loads at the outset, to provide initial substantial revenue while domestic loads are still growing can be effective. Approaches often involve trying to attract local agricultural business such as mills and presses or providing credit to allow local shops to purchase fridges and freezers. But innovative approaches have extended to build in the power requirements of mobile phone masts as anchor loads¹⁶ or even, more recently, bitcoin manufacturing¹⁷.
- 3. Ensure affordable tariffs.** There is a ‘chicken and egg’ relationship with (2) above here. Without affordable tariffs domestic demand will not increase and social and economic benefits will be limited. But without raising consumption affordable tariffs cannot be achieved. Ensuring commercial anchor loads and the potential of domestic productive use is critical to achieving affordable tariffs.

- The multi-funder Energy and Environment Partnership Fund (EEP) provides early-stage grant and catalytic financing to innovative clean energy projects in 17 African countries.²² Since 2010, it has disbursed more than €60 million to over 270 projects.
- A recent initiative by the African Guarantee Fund (AGF) aims to mobilise \$5 billion worth of local currency for SMEs in decentralized renewable energy.²³
- The 2022 AfDB’s Leveraging Electricity Access Finance (LEAF) Framework, in collaborating with the Green Climate Fund, launched a \$800 million programme that will distribute commercial and local currency investments across Africa.²⁴

Impact investors are also providing low-cost capital to private companies in the mini-grid sector. For example, Acumen’s \$250 million “Hardest-to-Reach” initiative, targeting energy access in sixteen of Africa’s underserved geographies.²⁵

Development funders also provide technical assistance to governments to establish the policy, regulatory and wider enabling environment to promote a mini grids market. For example, the UK FCDO funded the ACE-TAF programme from 2019 to 2023. This was active in 14 countries in Africa focused on improving policies and regulations, such as taxation, as well as increasing knowledge and evidence of the off-grid market.²⁶

There have been important efforts by development funders to coordinate support. In addition to GEAPP and Mission 300, other initiatives include the Energy Sector Management Assistance Program (ESMAP), a partnership between the World Bank and 18 partners providing advisory and financing solutions for clean energy; the Transforming Energy Access programme, an international partnership led by FCDO (2016-2027) for research and innovation on new technologies and business models, and a Technical Assistance Facility to improve the capacity and potential of local players²⁷; and the Mini Grids Partnership, a voluntary association to coordinate efforts of development and finance institutions²⁸.

Funding mini-grid development: the story so far

Development and other finance institutions have been engaging with the potential of community energy under Sustainable Development Goal 7 to “ensure access to affordable, reliable, sustainable and modern energy for all. The most notable include the IFC’s Lighting Global programme, which was the major market building initiative on decentralized solar up to around 2022 focused on the PAYGO market for solar home systems and lanterns¹⁸. The Global Energy Alliance for People and Planet (GEAPP) was launched in 2021, an alliance of more than 50 international governments, investors and development institutions to accelerate the transition to renewable energy¹⁹ The most recent initiative, with support from the World Bank, African Development Bank, GEAPP and others, is “Mission 300”. which aims to electrify 300 million people by 2030²⁰.

Grants, results-based financing and a combination of grants and credits represent 52%, 12% and 10% of public funds to mini grids in 2024²¹ , respectively. For example:

List of references

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- 2 [Global Market Report 2024 | Mini-Grids Partnership](#)
- 3 Solar home systems are individual household systems with a solar panel, typically with sufficient power to run a few lights and possibly some small appliances such as a radio or TV, as well as provide charging facilities for a phone.
- 4 Lighting Global (2016) "Off-Grid Solar Market Trends Report 2016", [Link](#)
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- 6 Lighting Global (2022) "Off-Grid Solar Market Trends Report 2022", [Link](#)
- 7 Power for All (2019) "Power for All Factsheet", [Link](#)
- 8 ESMAP (2023) "Expanding Mini Grids for Economic Growth", [Link](#)
- 9 IEA (2022) "Climate Resilience for Energy Security", [Link](#)
- 10 [New integrated energy model to reduce electrification cost in Uganda](#)
- 11 We say 'ideally' because the subsidy is not always allocated in such an efficient manner. When subsidies allocated by programmes are in excess of what is actually needed to bridge the gap between consumer affordability and private operator commercial viability then market distortions can result which discourage further private investment in the wider market.
- 12 [Global Market Report 2024 | Mini-Grids Partnership](#)
- 13 [Understanding the Different Types of Mini-Grids: Utility, Private, Community, and Public-Private Models – HavenHill Synergy Ltd.](#)
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