UK PACT

Community-focused decentralised energy systems

Trends driving adoption

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Community-focused decentralised energy systems - trends driving adoption

While climate change mitigation has been prominently on the global political agenda, what is new is the global consensus that an energy transition grounded in renewable technologies is the only way to limit the global average temperature increase to 1.5°C. Decentralised renewable energy systems play an essential part in realising this.

UK Partnering for Accelerated Climate Transitions (UK PACT) supports emerging economies in their energy transition through eight Country Programmes. In our partner countries, we see that the energy sector - normally known for its slow pace of change - is currently undergoing a dynamic transition. Technologies are rapidly developing, and new business and financing models are emerging to bring these technologies online. In particular, decentralised energy systems are seen as a key component in the energy transition, specifically decarbonising heavy industries through innovative technologies such as hydrogen.

Alongside climate change, a lack of improved energy access for over 900 million people globally is driving the widespread adoption of decentralised renewables. While many of our UK PACT partner countries have high electrification rates, deep rural areas and new settlements in these countries are still often unconnected. For areas connected to the grid, ageing grid infrastructure and shortages in energy supply lead to frequent power outages. Diesel-powered generators help households and businesses to bridge these blackouts but come at a high financial and environmental cost. In this context, decentralised renewable energy systems are increasingly becoming a cleaner and cheaper alternative.

In the last two decades, many private sector players, governments and non-governmental organisations (NGOs) have entered the off-grid energy market across the globe, providing energy to often remote rural areas with no to deficient access to energy. With complexities and costs around last-mile distribution, limited local power demand and unfavourable regulations, it has been difficult for companies to develop financially sustainable business models. However, technology and business model evolution, an increased enabling environment and more innovative financing mechanisms are driving maturity in the sector. Below we highlight the trends we see across our UK PACT Country Programmes countries in each of these domains and show how these drive adoption of community-focused decentralised energy systems.

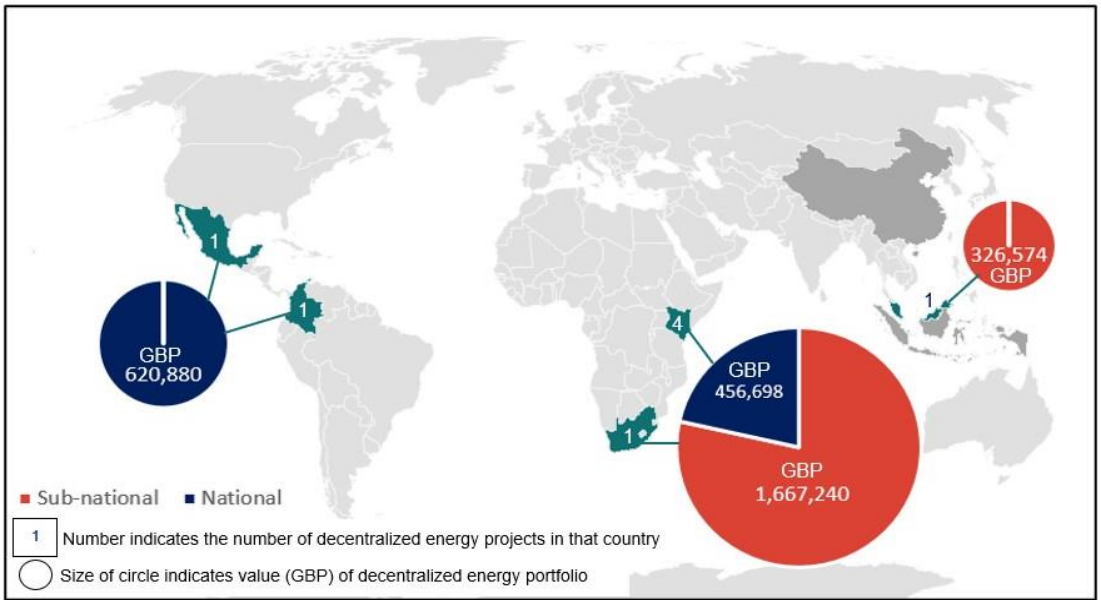

Image: Location, value and beneficiary type for UK PACT Country Programmes portfolio of decentralised community energy projects

Technology and business model evolution

Advancements in renewable energy technologies and business models have led to more flexible decentralised systems that can grow organically and provide a more 'development orientated' solution to rural electrification.

The most common community-focused decentralised energy systems are solar-powered mini-grids and standalone systems, including solar lanterns, multi-light systems and solar home systems (SHS). While the total energy provision of standalone systems is modest on a global scale - adding around 60 MW newly installed capacity annually - its development impact in terms of providing energy access and improvement of livelihoods is large. Off-grid lighting products provide improved energy access to 105 million people. Furthermore, USD 6.3 billion of additional income is generated due to off-grid system ownership over the expected lifetime of all off-grid solar lighting products sold since July 2010 (GOGLA, 2021).

Currently, over 5,500 mini-grids are installed globally, mainly in Sub-Saharan Africa, Asia and small island nations (with some in Latin America),

> **"The key goal of the Forever Sabah project is to work with the Malaysian government to upscale mini-grid solutions that have been pioneered in our rural communities in the past 20 years to address rural electrification in a systemic way"**
>
> *- Gabriel Winn, Asia Regional Advisor, Green Empowerment*

according to the state of the global mini-grid market report (Mini-grid Partnership, 2020). Most of these mini-grids are solar-powered (50 per cent), followed by hydro (21 per cent). Biomass and wind are also used as renewable energy sources for mini-grids, but form very small market segments (over three per cent).

Business models for mini-grids for rural electrification vary, with different approaches to ownership and operation, customers, service delivery and billing, depending on the local context. The most common models are the utility operator model, the hybrid model and the community-owned model. In the utility operator model, the national utility owns and operates a mini-grid. In most hybrid models, the government finances and owns the mini-grid with the private sector player contracted to operate the system.

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Lastly, in the community operator model, a community owns and operates the mini-grid. In our partner country Malaysia, we see the community-owned model as dominant in rural areas such as in the state of Sabah. These off-grid renewable energy systems have also proven to be maintained well. Research conducted by one of our implementing partners in Malaysia found that 80 per cent of systems installed as far back as 2003 are still operational. Comparatively, in our partner country Kenya, the hybrid model is quite common, with the Kenyan government's Rural Electrification and Renewable Energy Corporation (REREC) owning 19 mini-grids that are operated by a retail utility, Kenya Power.

Until now, adequate sizing of mini-grids has been a typical challenge for creating financially sustainable business models. Initial energy demand in rural communities is often low due to the limited ability to pay for energy services. Mini-grid developers address this by targeting small businesses and industrial users alongside residential consumers to increase revenues, while others finance appliances to boost demand or even become off-takers. However, up to now, electricity costs of mini-grids have remained high - between USD 0.50 and USD 0.70 per kWh to make systems financially viable, which is significantly higher than the average kWh electricity price for households globally (USD 0.15 according to the International Energy Agency).

A sharp decline in costs in photovoltaic (PV) and battery energy storage, combined with remote connectivity, control and data analysis, is changing this. Smart metering supports the implementation of various pricing schemes, such as time of use tariffs, i.e. charging different prices to encourage consumers to use electricity when more is available cheaply. This scheme benefits end consumers and project developers alike; consumers benefit from lower tariffs by shifting their electricity loads, while project developers can - with a more evenly spread out energy demand during the day - design more (cost) efficient systems.

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Also, the development of more hybrid solutions connecting mini-grids and SHS within one system using Internet of Things (IoT) technology - allowing systems to expand gradually while the demand for power increases - are bringing down the cost of energy for end-users. These hybrid solar systems currently only form 13 per cent of all mini-grids installed but are the fastest-growing segment of the mini-grid market.

Alongside technology innovations, the inclusion of Productive Use of Energy (PuE) promotion in mini-grid business models increases the financial sustainability of these systems. Project developers are increasingly working together with NGOs, government and suppliers to introduce PuE (solar pumps/milling etc.) or promote PuE by investing in

Box 1. **Anchor based community models in Colombia**

In Colombia, UK PACT works with the Global Green Growth Institute (GGGI) to support the Ministry of Mines and Energy and the Institute for Planning and Promotion of Energy Solutions for Non-Interconnected Zones in developing financially viable business models for rural electrification.

This project will assist in advancing Colombia's energy transition and help provide sustainable and affordable energy solutions to vulnerable and isolated rural communities and households.

GGGI is working with local developer Innova Solar Colombia and local mobile network operators to power 300 telecom towers bringing digital connectivity to 450,000 new users and power surrounding rural communities. GGGI is also engaging (Roundtable on Sustainable Palm Oil certified) palm oil companies to generate electricity by capturing methane emissions from lagoons for palm oil mill effluents and supplying this at a nominal cost to surrounding households to meet their energy needs.

These interventions can be scaled up to other regions in the country, increasing energy access while reducing greenhouse gas emissions.

Image: © Rocky Mountain Institute, Nigeria

energy-consuming infrastructure themselves (i.e. industrial parks).

This nascent market for PuE has a huge potential to scale. For instance, in Sub-Saharan Africa alone, the current serviceable market for solar water pumps represents 700,000 households and is worth USD 500 million, but is expected to value USD 1.6B by 2030 (Efficiency for Access Coalition, 2019). Initiatives developing quality standards for PuE equipment, such as the Collaborative Labelling and Appliance Standards Program (CLASP) are helping to grow this market.

Promoting productive use also provides many opportunities for Gender Equality and Social Inclusion (GESI), specifically regarding income generation and job creation for rural women and youth, as illustrated in Box 3 and UK PACT's GESI thematic brief.

Enabling environment

Governments are making notable shifts in their approach to energy planning, switching to least-cost electrification modelling and utilising planning approaches that help guarantee energy services meet community needs and aspirations.

In many more remote areas, decentralised energy systems are increasingly the lowest cost option for electrification. Governments are making their energy planning processes increasingly sophisticated to accurately determine what type of energy solution is the least-cost option, considering the costs, benefits and risks of different energy sources (see Box 2).

Box 2. **Supporting least-cost energy planning in South East Asia**

In Malaysia, UK PACT supports the state government of Sabah (East Malaysia, Island of Borneo) to conduct least-cost modelling using a bottom-up approach. A consortium of four NGOs, Forever Sabah, TONIBUNG - Centre for Renewable Energy & Appropriate Technology, Green Empowerment and the PACOS trust, are implementing partners.

The project will help ensure access to affordable, reliable and sustainable energy for the state of Sabah, accounting for 70 per cent of Malaysia's rural electrification needs.

The project is studying 200 rural villages to understand people's aspirations and how communities are growing to develop an energy demand analysis. In this exercise the project considers potential future policy interventions such as introducing renewable energy feed-in tariffs to assess how this affects the model. More specifically, since consortium members have considerable in-house expertise in mini-hydro, the energy modelling is identifying where this renewable energy technology has the highest potential, taking into account a facilitative policy framework for this technology. This project could provide the template for similar communities in Malaysia.

"Our work will help embed an innovative energy delivery model and nexus approach in Kitui county to tailor solutions that use green energy to improve lives and livelihoods in rural areas. This project will act as a beacon for other counties across Kenya to meet the challenges of a just energy transition and build back better."

– Ben Garside, Head of Energy, IIED

As a result, many countries – such as UK PACT partner country Kenya – are increasing the role of decentralised renewable energy systems within their national electrification plans. For instance, the Kenyan National Electrification Strategy (2018) identified the potential for 100,000 connections through intensification of existing mini-grids, 35,000 connections through 121 new mini-grids, and 1.96 million connections through standalone solar home systems to realise their ambition of universal access to electricity by 2022.

Alongside utilising least-cost electrification modelling, using methods where the development of communities are at the core ensures the maximum value of improved energy access. In such approaches, development needs are adequately understood first before looking into energy and non-energy related solutions to ensure these needs are met. Non-energy related solutions could, for instance, be market linkages, sector-specific skills upgrades or introducing energy-powered efficient livelihoods equipment. In one of our projects in Kenya, 'Energy Enabling Green Development and Recovery in Kitui County Kenya', we are supporting the county government in implementing such a development-focused bottom-up energy planning process (see Box 3).

Policy reform raising caps for decentralised energy generation, easing licencing and Independent Power Producer (IPP) contracting processes further promote the uptake of decentralised energy generation systems.

For instance, in Kenya, the Energy and Petroleum Regulatory Authority (EPRA) has developed the Energy Regulations (2021) framework to spur investment in mini-grid solutions and accelerate universal access to electricity. These regulations are (when enacted), amongst others, harmonising the mini-grid approval requirements by the national government, county governments, and relevant regulatory bodies. These efforts provide mini-grid tariff approvals; and offer a clear and competitive process for mini-grid licensing and interconnection to the main grid.

Box 3. **Putting development needs and aspirations of communities at the heart of energy planning – a new approach in Kitui County, Kenya**

In 2019, Kenya introduced a new framework for energy planning in the Energy Act 2019. All counties must develop County Energy Plans every three years to inform national energy planning. This new framework offers an opportunity to put local development needs at the centre of national energy planning.

The International Institute of Environment and Development (IIED), Loughborough University, and the Catholic Diocese of Kitui- Caritas Kitui recently worked with the Kitui County Government to develop their County Energy Plan. Under UK PACT, the partners will build on the plan and use the Energy Delivery Model (EDM) approach to design green energy initiatives for jobs in underserved areas. EDM's participatory process identifies the priority needs of men and women with different livelihoods and public services.

The project will apply the EDM process in partnership with the Kitui County Government and local stakeholders to design productive use of energy initiatives such as solar-powered irrigation for agriculture and solar-powered incubators for poultry. The communities themselves have prioritised these initiatives under previous EDM processes. For example, women's groups are interested in expanding into poultry as they see a financial opportunity in that market. The project will also train government and civil society organisations to apply EDM in their work.

The initiatives designed using EDM will mitigate emissions and provide resilience against climate impacts, combined with financial and social sustainability. The work in Kitui will feed in to a separate national initiative to strengthen capacity on energy design and delivery for all of Kenya's counties.

Some governments also have started to mitigate the risks for mini-grid developers, including the build-out of the central grid to areas where they operate systems, as this poses an existential risk to the financial health of mini-grids. Mitigation measures that are already used are offering compensation, providing mini-grid developers permission to continue running their operations alongside the grid or ensuring appropriate disclosure of information on planned grid extensions so mini-grid developers can design their sites in areas that are falling outside the grid extension plan.

Finance

There is an increasing recognition within the financial sector that decentralised energy systems are solid investment cases when taking a blended finance approach.

Investors, governments and international donors agree that decentralised energy systems – like grid infrastructure - should be cross-subsidised to reach remote non-electrified areas. This can be realised by utilising financing mechanisms that mix public and private capital (i.e., a blended finance approach) including result based financing funds, crowdlending platforms and impact funds.

Until now, two types of government subsidies have largely driven mini-grid development: subsidies covering (part of) the infrastructure development costs (i.e., Capital Expenditure or 'CAPEX'), and results-based financing initiatives, providing payment for electricity connections established by mini-grids. The latter only provides funding after it has been verified that functional electricity connections are indeed established.

> **"238 million households will need to gain electricity access in Sub-Saharan Africa, Asia and island nations by 2030 to achieve universal electricity access. Mini-grids can serve almost half of this total – an estimated 111 million households. This will require capital investment of USD 128 billion, 78 percent higher than the estimated capital investment in a business-as-usual scenario"**
>
> - *Mini-grids Partnership, 2020*

While significant funding for the mini-grid sector has been approved - a total of USD 2.07 billion by March 2020 by 14 funders according to the Mini-Grids Funders Group - only 13 per cent of this funding has been disbursed. This indicates significant delays in getting funding, and therefore in projects moving forward. Funding should also look at a more diversified pipeline, as committed funding is heavily concentrated in certain regions, countries and technologies. On top of that, there is a lack of pure commercial financing as the mini-grid market lacks scale, project developers' track records are often limited, and their balance sheets are small.

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> **"At the global level, the investment opportunity in standalone systems is huge. To sustain current levels of growth, it is estimated there is need for around 4 billion USD of additional funding. The size of the total available market has been estimated at 104 million households in latent markets and an additional 22 million households in established ones"**
>
> - *GoGLA, the global association for the off-grid solar industry, on the investment demand of the sector*

Bundling individual decentralised energy systems into one single transaction - a so-called portfolio approach – brings transaction costs down, making investing in mini-grids more attractive for commercial investors. Utilising a portfolio approach at the project development stage by applying similar system designs for different locations and purchasing equipment in bulk can create further economies of scale.

Consolidation in the sector is also helping to make mini-grid projects more easily investable as project developers are becoming increasingly mature and are often larger companies with stronger balance sheets. Until recently, the sector was dominated by small scale start-ups and early-stage companies. Now, many large players have entered the market by acquiring companies that offer battery storage systems, uninterrupted power supply (UPS) and control software technologies, or by partnering and investing in mini-grid project developers directly. Examples include major utilities and oil companies such as EDF, Enel, ENGIE, Iberdrola, Shell and Tokyo Electric. The COVID-19 pandemic has further fast-tracked consolidation in the sector, with more financially sound and agile companies weathering this external crisis much better than some of their weaker counterparts.

Conclusion

The community-focused decentralised energy sector has arrived at an interesting point in time, where technologies and business models have matured, and governments are increasingly taking an integrated approach to rural electrification. Lastly, energy services are increasingly seen as an enabler of community development when rolled out in conjunction with other essential non-energy related solutions such as market linkages, sector-specific skills upgrades and an introduction to energy powered efficient livelihood equipment. With these building blocks for the successful implementation of community-focused decentralised energy systems in place, it is now time to scale the implementation of these solutions to bridge the energy access gap. Below we provide recommendations of what governments can do to support this scaling.

Recommendations

Recommendation 1: Increase quality infrastructure (QI) of decentralised RE systems - Quality infrastructure includes comprehensive standards, testing, certification and accreditation, inspection and monitoring, and metrology. QI can be used to ensure that installed decentralised energy systems are in line with the best available technologies, and guidelines reflecting best practices in operating and maintaining these systems are set and monitored.

Effective QI can improve the financial conditions of decentralised energy systems, limit legal, regulatory and performance uncertainty and further reduce the levelised cost of electricity (LCOE), which together enhances the scalability of decentralised energy markets.

Recommendation 2: Integrate a gradual approach to QI in policy frameworks - Policies should consider the constant evolution of decentralised energy systems, refer to different levels of QI at different times and at market development to ensure QI is realistic and practical to implement. The experience from the solar PV market uptake shows that mini-grids also need a certain level of national and international QI for a sustainable market.

Recommendation 3: Build market awareness on productive use of energy technologies - PuE is still a very nascent but also a critical market in meeting local community development needs and aspirations. Governments can spur this market by addressing the considerable lack of consumer knowledge on product efficiency and lifecycle costs of most efficient technologies.

Recommendation 4: Increase public finance for decentralised energy systems through developing supportive regulatory frameworks and incentives - For instance, by setting up guarantee funds for decentralised energy projects with innovative business models/technologies; by introducing or scaling existing subsidies providing capital development and/or pricing support; or by working with commercial investors to co-finance decentralised energy system portfolios.

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