ESG Economist

Microgrids, an overlooked solution

Moutaz Altaghlibi – Economist, Energy Markets and Energy Transition moutaz.altaghlibi@nl.abnamro.com

- **Microgrids have many advantages that set the scene for them to be appropriate solutions for different sustainability and development challenges**
- **Microgrids could play a role in ameliorating energy access, alleviating energy poverty, promoting sustainable energy, and boosting the energy transition**
- **Despite the advantages of microgrids, there are some limitations and challenges that make their deployment more challenging, complex, and expensive**
- **Access to finance represents one of major obstacle for microgrids in developing countries**
- **The use of grants, subsidies, public-private partnerships, or guarantees by governments and international development agencies helps to reduce uncertainty and boost the roll out of microgrids**

Introduction

Microgrids is an independent small network that can be defined as: the aggregation of loads and one or more energy sources operating as one system to generate and consume electricity or heat within limited geographical or community-based limits. Microgrids could involve renewable or fossil-based power sources, along with storage capacity that helps smoothing out the supply and bringing more stability. Microgrids could be operated as part of a wider grid network or as a stand-alone system where they can be operated in isolation (Islandic microgrids). Moreover, microgrids can be scaled up by adding new supply capacity to meet growing demand without compromising the stability of the system. Thus, microgrids are most appropriate for rural areas where grid access is concentrated and inconsistent. There are multiple generations of microgrids. Third generation microgrids are those relying on renewable energy sources for the main supply, while second generation microgrids depend on hydro and diesel.

In this note, we dive into the various advantages of microgrids and their role in alleviating energy poverty, ameliorate energy accessibility, and securing sustainable energy supply in developing and less developed countries. Furthermore, we zoom into the role they can have in boosting the transition in developed countries. Finally, we list the challenges facing the development of microgrids, along with potential solutions.

Microgrids' advantages

Microgrids have many advantages that stage set the scene for them as to be appropriate solutions for different sustainable sustainability and development challenges. Microgrids could be used for effective main grid extensions especially when the expansion of the main grid is expensive or when long leading times are needed for the expansion to materialize. In that regard microgrids could provide a quick and relatively cheaper alternative as they save on transmission and distribution cost besides the high initial cost for the expansion[1].

[1] The cost for traditional grid expansion ranges between 19 and 22 thousands USD per km for transmission and around 9 thousands per km for distribution (see more here).

Microgrids provide the option to isolate the load and generation from the main grid in the event of system wide disturbances, which increase the resiliency and limit the impacts of such events, which is very crucial in areas disposed to natural disasters such as hurricanes, floods, or earthquakes. Furthermore, microgrids could perform as a backup supply system that support disaster relief and recovery efforts after natural disasters, especially when damage to the main grid entails prolonged power outages.

Additionally, microgrids can be tailored to the needs, limitations and resources of local communities at different scales (building, neighbourhoods, villages), which increases the overall resilience of the energy system. Also, the relatively smaller scale of microgrids and the proximity to loads makes them less complex and easier to manage. This helps in improving energy efficiency though the optimization of the generation, transmission, and consumption.

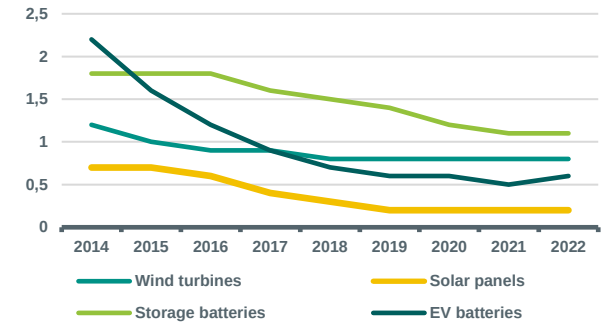
Accordingly, microgrids deliver an attractive alternative to main grids that is cheaper, easier to manage and better positioned to integrate renewable resources. Finally, when operating in a connected mode, microgrids can act as a support system by supplementing the main grid during demand peaks.

Opportunities brought by microgrids

Microgrids could economically benefit local communities by allowing for new business models and community ownership structures, which could provide employment opportunities for the local residents. Furthermore, as microgrids increase energy access and security, they could provide a base for economic development within or outside involved communities. Additionally, digitalization and other emerging IT technologies, such as block chain and artificial intelligence could be used to optimize the operation of microgrids by facilitating real time financial and power transactions between participants.
The recent cost reduction in solar and wind technologies have given a momentum to modern power systems. According to the International Renewable Energy Agency (IRENA), solar PV module prices have seen a decrease of 90% since 2009, along with lowering costs of batteries as shown in the left hand side chart below. This have boosted the deployment of solar PV as seen in the right hand panel in the figure below.

Average prices for selected clean technologies

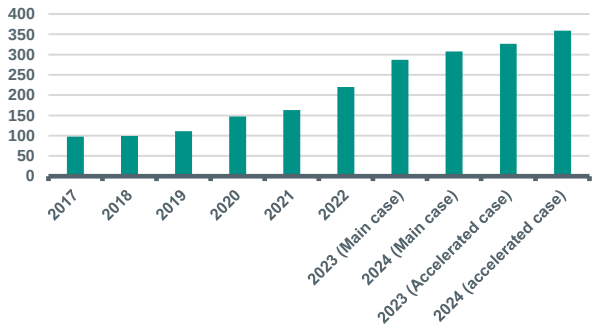
Million USD/MW (nominal prices)



Source: IEA, ABN AMRO Group Economics

Net solar global capacity addition 2017-2024

GW



Source: IEA, ABN AMRO Group Economics

Ameliorating energy access

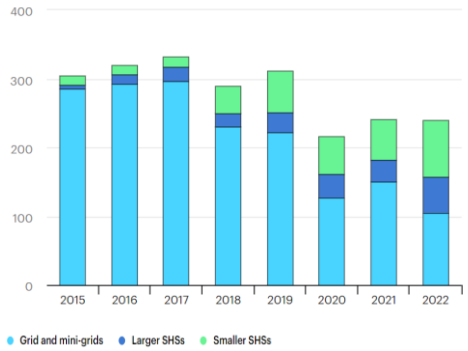
Access to electricity in developing countries is vulnerable to fuel supply disruptions and fluctuations in fuel prices, excessive demand, and limited/inefficient grid infrastructure. Third generation microgrids that depend on renewable sources combined with storage can ameliorate energy access and reduce vulnerability to international energy markets. Accessibility to electricity is not only necessary for energy poverty alleviation, rather it is a prerequisite to sustainable economic development and growth especially as electrification is positioned to play a crucial role in the energy transition.

According to an IEA estimate, Solar Home Systems (SHS) provide electricity access to 4% of African households. Microgrids in sub-Saharan African give access to around 2% of the population, while main grids provide access to more than 40%. The remaining 54% are left with no electricity access as seen in the figure below (see more **here**). Microgrids also play

a role in mitigating energy poverty by delivering an affordable and reliable power to people with lower income levels. This is especially the case given that SHS have a limited impact on inclusivity while failing to enhance socioeconomic development.

Annual increase in electricity access by source in Sub Saharan Africa

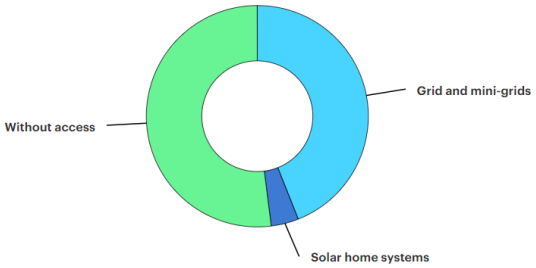
Million person



Source: IEA

Population with power access in Sub-Saharan Africa by technology in 2022

Percentage



Source: IEA

The role of microgrids in the energy transition

In most European countries, limited grid capacity is one of the main bottlenecks hindering the energy transition. The inability to connect to the main grid halts the deployment of needed renewable capacity and delays the electrification process in other sectors. That is, the extension of the grid is lagging behind, which jeopardizes the reaching of climate goals in time. This is because of many factors such as long lead times for permitting and the lack of coordination between multiple stakeholders.

Microgrids are appropriate to use as a permanent or temporary solutions where connecting to the main grid is expensive, inconsistent, concentrated or needs prolonged time to be extended due to permitting and other administrative procedures, lack of supporting infrastructure, or in the absence of urban planning.

Microgrids can help to integrate solar and other renewables within the main grid and boost the transition by reducing the waiting time needed for renewable projects to be connected as grid expansions take place. Additionally, microgrids could play a crucial role in boosting the energy transition by facilitating the creation of supporting infrastructure for the adoption of EV and the transition in the transportation sector. Especially in remote areas where the cost of grid extensions are quite high.

Microgrids are being used in many developed countries within communities and cultures using a combination of solar panels, storage and backup generators to provide an affordable and reliable electricity to residents or local grids such as the community-based Brooklyn project in New York (see more **here**), and the Alamosa project in Colorado (see more **here**).

Challenges facing the development of microgrids

Despite the advantages of microgrids, there are some limitations and challenges that make microgrid deployment more challenging, complex, and expensive. For example, synchronization problems may appear when there is a switch between islanded and grid connected modes (see more **here**).

Moreover, for a well-functioning third generation microgrid system, a sufficient storage capacity is necessary to smooth out the intermittency in renewable output. However, the system is still vulnerable to weather conditions, such as a prolonged periods of extreme cold, heatwaves, slower wind, or cloudy sky. Moreover, even with a recent decrease in cost, storage cost still comprises a substantial additional upfront cost and the use of chemical batteries involve environmental concerns regarding the scarcity and extraction of critical minerals.

One of the operational challenges facing microgrids is grid management (control and protection) when providing multiple energy services such as heating, cooling, and power.

The lack of appropriate regulation that takes into account the particularities of microgrids in term of scale, cost, and type of participants is also a limiting factor to the development of microgrids (see more **here**)

In the use of online services to integrate and operate microgrids safely, cyber security becomes an important part of the well-functioning microgrid systems. There is also a concern related to the impacts of microgrids on social inequalities as they can enforce existing inequalities if microgrid accessibility is exclusive to classes with the financial means. That is microgrids should involve equality and inclusivity in their design.

Also, the upfront costs and limited access to finance, especially in developing and least developed countries, represent a challenge to microgrid development. Accessibility to finance is one of the major limiting factors especially in developing and least developed countries with weak institutions. In these countries, microgrid development by private investors is halted by many uncertainties making these project unprofitable or too risky. This is originated from many factors such as, the absence of appropriate regulation and financial incentives (subsidies, for example), the lack of long term track record, the lack of technical expertise, the underdevelopment of a reliable financial system, challenges in determining current and future cash flows, and political instability. Furthermore, microgrids could be customable to the needs of communities and thus costlier making access to finance more challenging (see more **here**).

Potential solutions and recommendations

Some potential solutions for the financing challenge is the use of grants, subsidies, and guarantees by governments or international development agencies. Also, the use of public-private partnerships and the adoption of certain flexible models, such as pay-as-go models[2], would help make microgrids more accessible to lower income families. Furthermore, microgrid projects with renewable capacity could be financed through carbon credits[3]. The development of supporting regulation for pricing, permitting, designs, and cost recovery that would reduce uncertainty and help boosting investments in microgrids. Also, the sharing of information along with factors governing the success or failure of microgrid projects would enhance the resilience and adoption of microgrids. Providing trainings and tailored courses, along with the sharing best practices to build capacity in needed skills would also be a step forward (see more **here**).

[2] In a pay-as-you-go (PAYG) pricing model users are charged based in their real consumption.

[3] Carbon credits can be generated in microgrid projects that use renewable resources. These credits can be used by multinational companies aiming to offset carbon emissions from their operations.

DISCLAIMER