THREE GENERATIONS OF MINI GRIDS

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5th Mini Grid Action Learning Event and Summit
Global Technical Conference on Mini Grids

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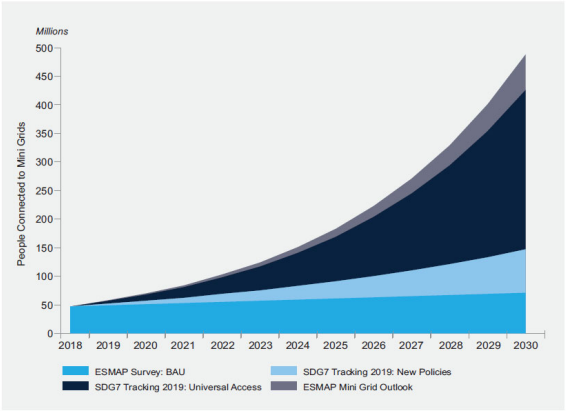
Scale of the Challenge

Number of People Connected to Mini Grids Under BAU and Universal Access Scenarios



840 MILLION PEOPLE WITHOUT ACCESS TO ELECTRICITY → 490 MILLION PEOPLE BEST SERVED WITH MINI GRIDS → 220,000 NEW MINI GRIDS REQUIRED BY 2030 → $230 BILLION INVESTMENTS FOR NEW MINI GRIDS

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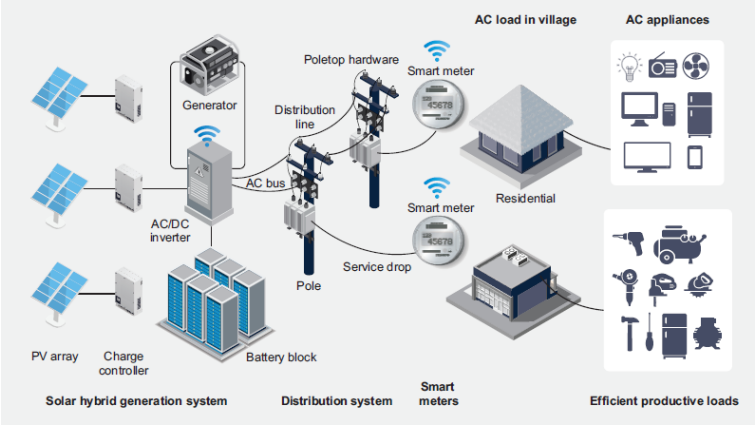
As we know from the findings of the most recent Tracking SDG7 report, which came out about a month ago, the current global electrification rate is approximately 89%, and, if current global trends and policies continue, the world is only likely to reach a 94% rate by 2030. These numbers translate into roughly 840 million people living without energy access today, and 1.2 billion people that will need to be electrified between now and 2030.

As you heard from the presentation made by James, our team at ESMAP estimates that, out of these 1.2 billion, over 490 million people will be most cost-effectively connected through mini grids.

What is a Mini Grid?



A **mini grid**, sometimes called a micro grid, is an electricity generation and distribution network that supplies electricity to a localized group of customers. Mini grids can be isolated from and/or connected to the main grid.

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But what is a mini grid? And why are they the best solution for such a large portion of the remaining unelectrified groups?

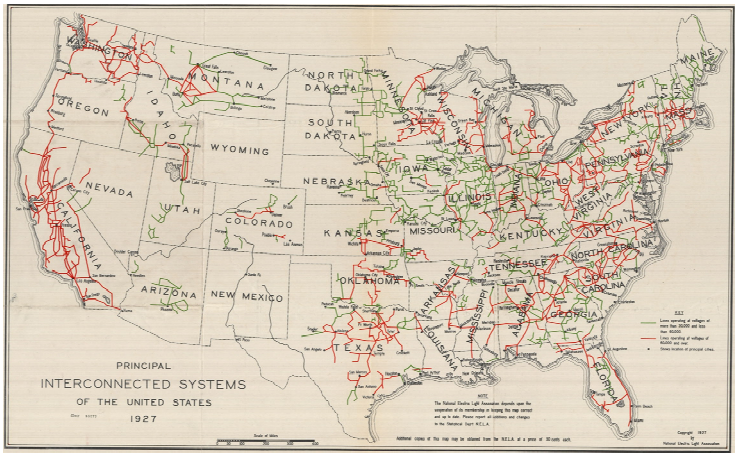
We at the ESMAP Global Facility on Mini Grids define them as electric power generation and distribution systems that supply electricity to a localized group of customers, and exist as a single controllable entity within clearly defined electrical boundaries. We intentionally do not define mini grids in terms of size – in our interpretation, they can provide electricity to just a few customers in a remote settlement, or bring power to tens or hundreds of thousands of customers in a town or a city. Nonetheless, in our detailed analysis of mini grid costs and in our global database of more than 26,000 mini grid projects – both of which are discussed in our Executive Summary report, and presented in detail in the main report - the vast majority (more than 99 percent) ranged from a few kW to several MW in installed capacity.

Mini grids can be fully isolated from the main grid, or connected to it. If they are grid-interconnected, mini grids must be able to intentionally isolate (or 'island') themselves from the main grid.

Mini Grids supply power to households, businesses, public institutions, as well as anchor clients, such as telecom towers and large agricultural processing facilities.

We at the ESMAP GFMG categorize them across three generations of systems.

1st Generation of Mini Grids



U.S. power system network in 1927

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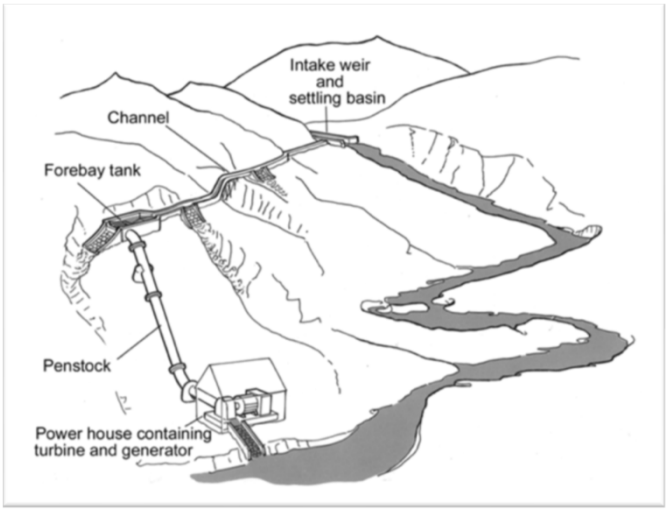
Mini grids are not a new phenomenon: all current centralized power grid systems started will small isolated power systems and mini grids.

These systems were the initiating "spark" of electricity uptake some 130 years ago, and were pivotal to the early development and industrialization of most modern economies, such as the United States, United Kingdom, Sweden, Spain, Ireland, China, etc. While these systems were initially few and scattered, their development was coupled with, and amplified by, the co-evolution of supply, demand, disruptive technology, and policy. As technologies improved, demand increased, and the policy and regulatory regimes stabilized, larger generators could be built, and electricity could be transmitted over longer distances. These factors resulted in the emergence of centralized utilities (either privately or publicly owned). Mini grids either became integrated with one another, forming the nucleus of a larger centralized system, or were absorbed by a larger grid system as it expanded. We describe these historical systems as the **first generation of mini grids**, which faced many of the same policy, regulatory and operational challenges experienced by mini grids in developing countries in Sub-Saharan Africa and Asia today.

One key note about these systems – which was already exemplified so eloquently during his Monday presentation by Mr. Jakab of the Steinbeis Consulting Centre: Private power companies would not or could not serve all of the population and provide power at large scales. The unelectrified areas were filled with small municipal public systems,

rural cooperatives, and large federally owned power generation corporations—and supported through public and nonprofit entities, such as Rural Electrification Agencies and, in the United States, the National Rural Electric Cooperative Association (which was referred to by Mr. Jakab as the American AMDA).

2nd Generation of Mini Grids



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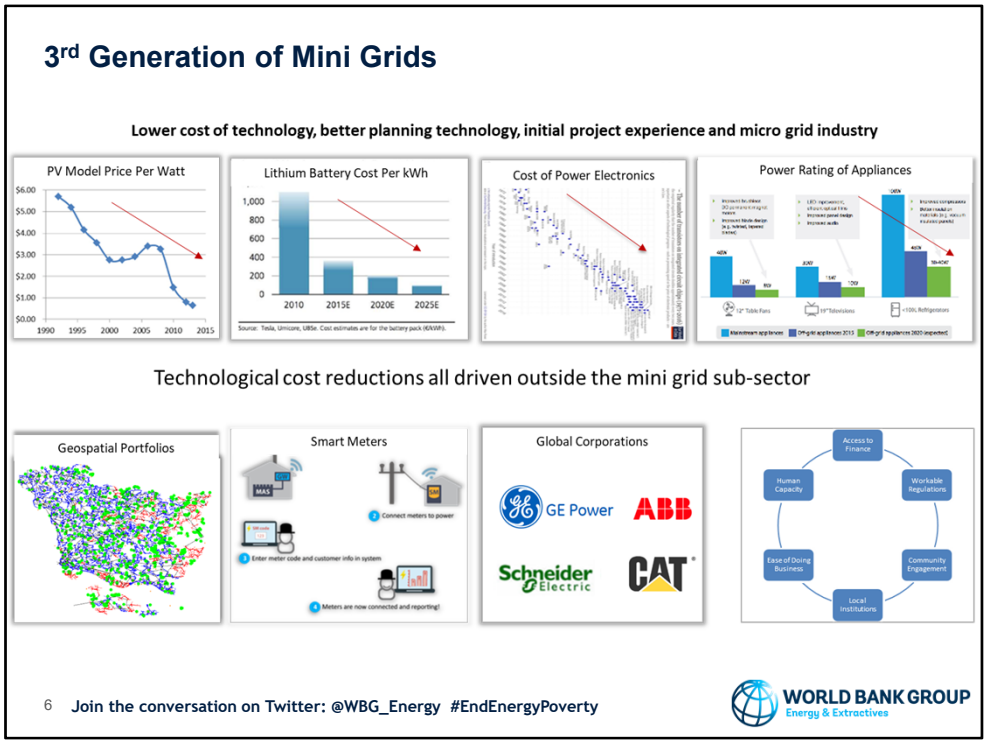
The **second generation of mini grids** can be found in modern developing countries. These systems are typically small and isolated, and generally built by local communities or local entrepreneurs to provide access to electricity in zones with low population densities and low demand, primarily in rural areas that have not yet been reached by the main grid or where it would be too prohibitively expensive to extend it.

Typically, such second-generation systems are built to supply electricity to single villages. The developers, whether public or private, are motivated by the overriding need to supply rural communities with a higher level of electricity service as soon as possible. When these mini grids are developed, little thought is given to the possibility of later interconnecting with the main grid, and many of them are simply abandoned when the main grid arrives. If they do not go out of existence, these mini grids often choose to become small power producers (particularly if using a more affordable renewable energy generation source rather than diesel); or small power distributors, converting to buying all of their electricity supply wholesale from the main grid and selling it to the local customers at retail prices.

Developers of such second generation mini grids almost always rely on standard existing technologies – such as diesel or mini hydro generation – as well as basic meters, on-site meter reading, and in-person bill collection. They also generally charge flat monthly tariffs or postpaid fees calculated and collected at the end of each month

based on the customers' power consumption for that month.

As you have heard from James' presentation, our (ESMAP's) data indicates that the almost all of the 19,000 mini grids that we've identified across the world are 2nd generation systems.



In the recent years, a new, **third generation** of mini grid technologies and business models has emerged. These third-generation mini grids differ from the earlier generations in several important ways:

New technologies

Breakthrough technology advances and innovations seen within and outside the mini grid subsector are changing the landscape of the industry. The costs of technical components, such as solar PV panels, electronics, and batteries, are falling rapidly.

Other technology advances include the increasing energy efficiency of appliances and devices that can be used in the home and for productive (agricultural and other income-generating) uses with the electricity supplied by mini grids. As they provide AC power, mini grids can support a significantly wider array of productive uses than stand-alone solar home systems. The list of energy-efficient AC-powered appliances is growing by the day, and includes machines for welding, milling, rice hulling, ice making, and egg incubating.

New players

National and international private companies have joined the space previously only

occupied by local entrepreneurs and community organizations, and are building or proposing to build these third-generation projects. They seem to be motivated by the possibility of using the modular (often proprietary) technologies that can be scaled up quickly to serve different sized villages and towns, providing opportunities for cost-reducing economies of scale that were not available to second-generation developers. Companies such as Caterpillar, Tesla, Siemens, General Electric, and ABB, have publicly announced that they intend to enter the mini grid market. These new third-generation companies have ready access to national and international financial markets.

Public–private partnerships

(As already presented on Monday by these countries) in Sierra Leone, Kenya, and elsewhere, governments have proposed public–private partnerships to build and operate mini grids. This is an alternative to pure publicly owned or pure privately-owned mini grid systems that have been used in second-generation mini grids. These new partnerships appear to be motivated, in part, by the reality that it is politically easier to channel a subsidy through a government entity in a joint venture than to simply give the same or even a smaller subsidy to a private company.

Not necessarily isolated

Mini grids are no longer being built only in isolated rural villages. For example, in the Indian state of Uttar Pradesh, one private mini grid operator (OMC Power) has built many mini grids in villages that are already served by a government-owned distribution utility, because the distribution utility has not been able to provide reliable service, especially during peak evening hours. A similar arrangement has been stipulated by the Nigerian mini grid regulation.

Access to new geospatial tools

In the last three years, low-cost geospatial planning tools have become more widely available to those planning to develop mini grids. These new tools use satellite imagery data that allows potential developers to obtain important market intelligence on the physical characteristics, likely initial customer base, and probable daily electricity demand profiles of individual villages. The cost of acquiring the data is rapidly coming down.

Targeted regulatory systems

Until recently, developers were “flying blind” on government policies and regulations that would apply to mini grid projects. This, too, is changing. Mini grid regulatory systems have been developed by governments in Nigeria, Rwanda, Sierra Leone, Myanmar, India, Kenya and Tanzania. These systems reduce regulatory uncertainty for mini grid developers, though there is always the remaining uncertainty as to whether the regulatory rules will be implemented as written.

The innovations that we’re seeing emerging in these third-generation MGs, in order for them to take root and scale, there has to be a business environment that is conducive to new ways to doing business, and conducive to scale.

Thank you for your attention. Please use the following link to download the Executive Summary of our upcoming report: **Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers**.