SABAHRE²roadmap

What Are Mini-Grids?
How Are they Relevant to Sabah?

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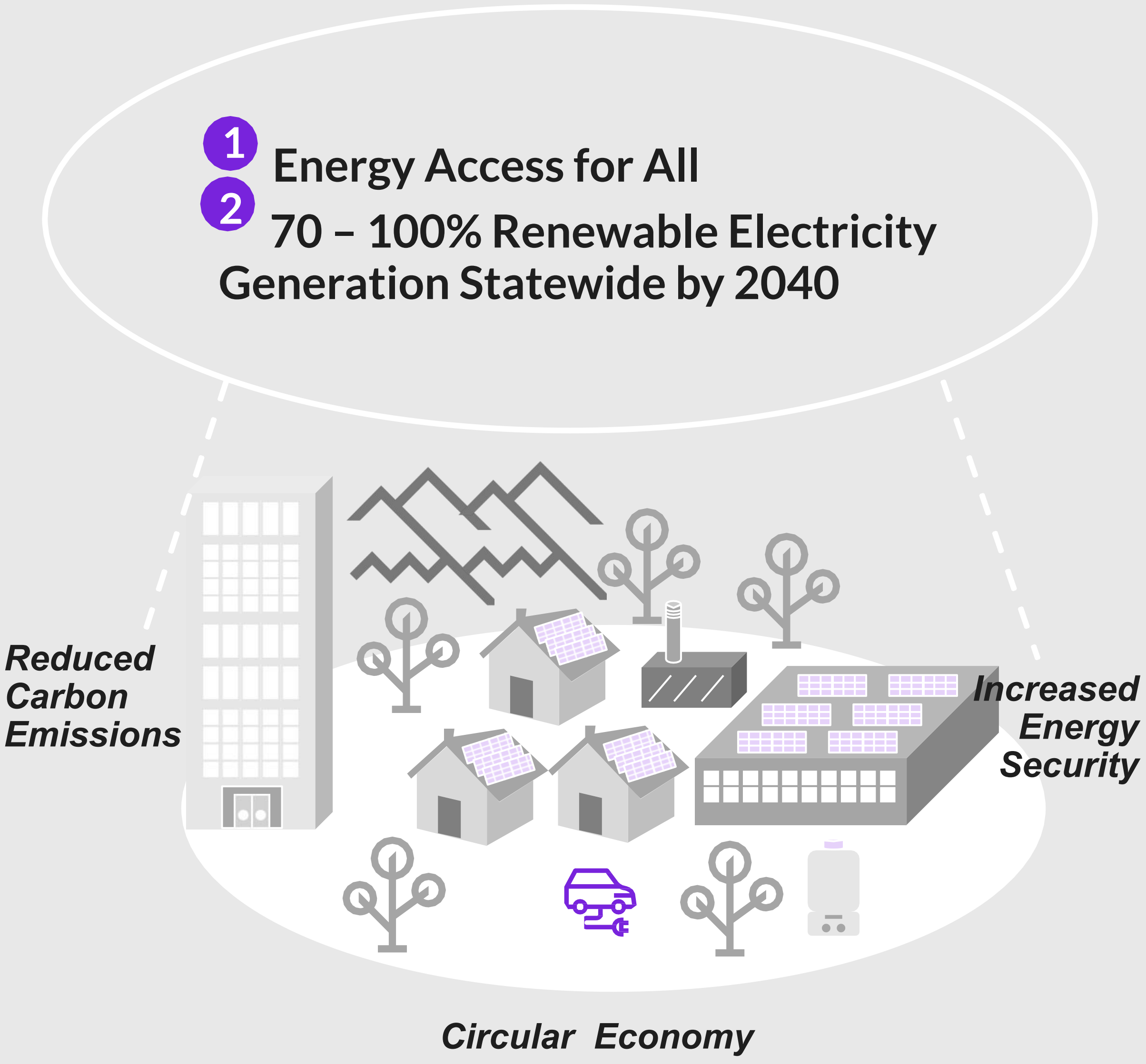
Sabah is faced with a unique opportunity to deploy renewable energy approaches in line with SDG 7's goal to ensure access to affordable, reliable, sustainable and modern energy for all



Milestones

1 Energy Access for All

- Identify communities seeking electrification and establish buy-in
- Identify financial investment pathways
- Build technical and institutional network and capacities
- Integrate electrification into village development plans

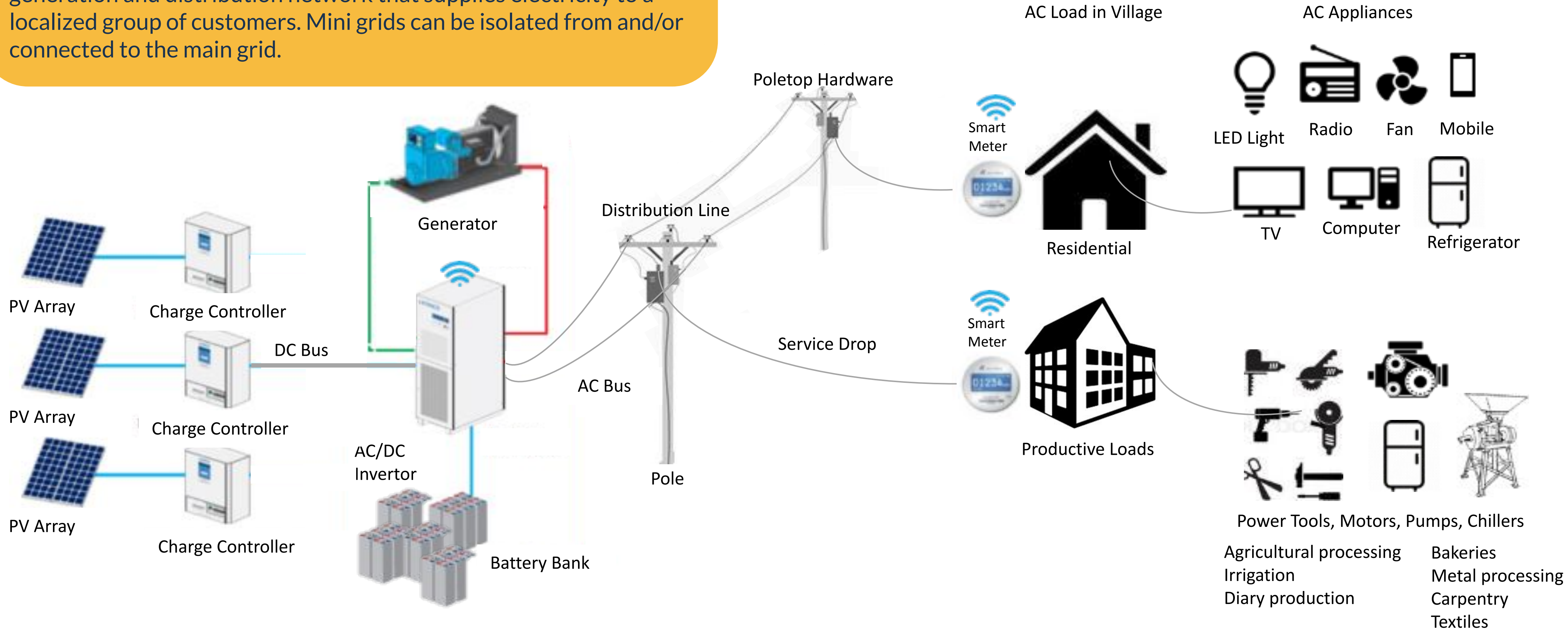
2 70 – 100% Renewable

- Alliance with government & NGOs for policy support and advocacy
- Transfer utility to state-owned enterprise
- Pass legislation to encourage renewable energy development
- Support the labor transition as fossil fuel subsidies are phased out

What is a Mini Grid?

example 1

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.



Solar Hybrid Generation System | Distribution System | Smart Meters | Efficient Productive Loads

What is a Mini Grid?

example 2

An integrated energy system consisting of interconnected loads and distributed energy resources—including generators and energy storage devices—which, as an integrated system, can operate in parallel with the utility grid or in an intentional islanding mode.

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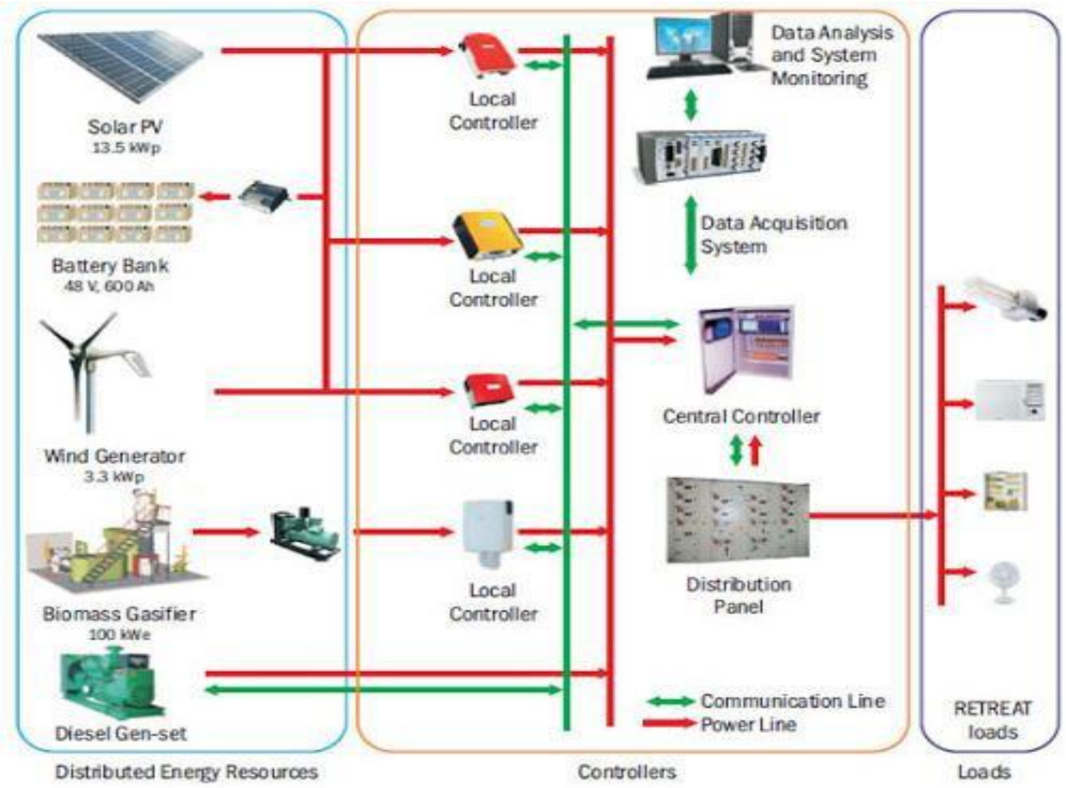


- A modern mini-grid can include renewable and fossil-fuel based generation, energy storage facilities, and load control.
- A modern mini-grid is scalable, so that additional generation capacity can be added to meet growing loads without compromising the stable operation of the existing mini-grid.

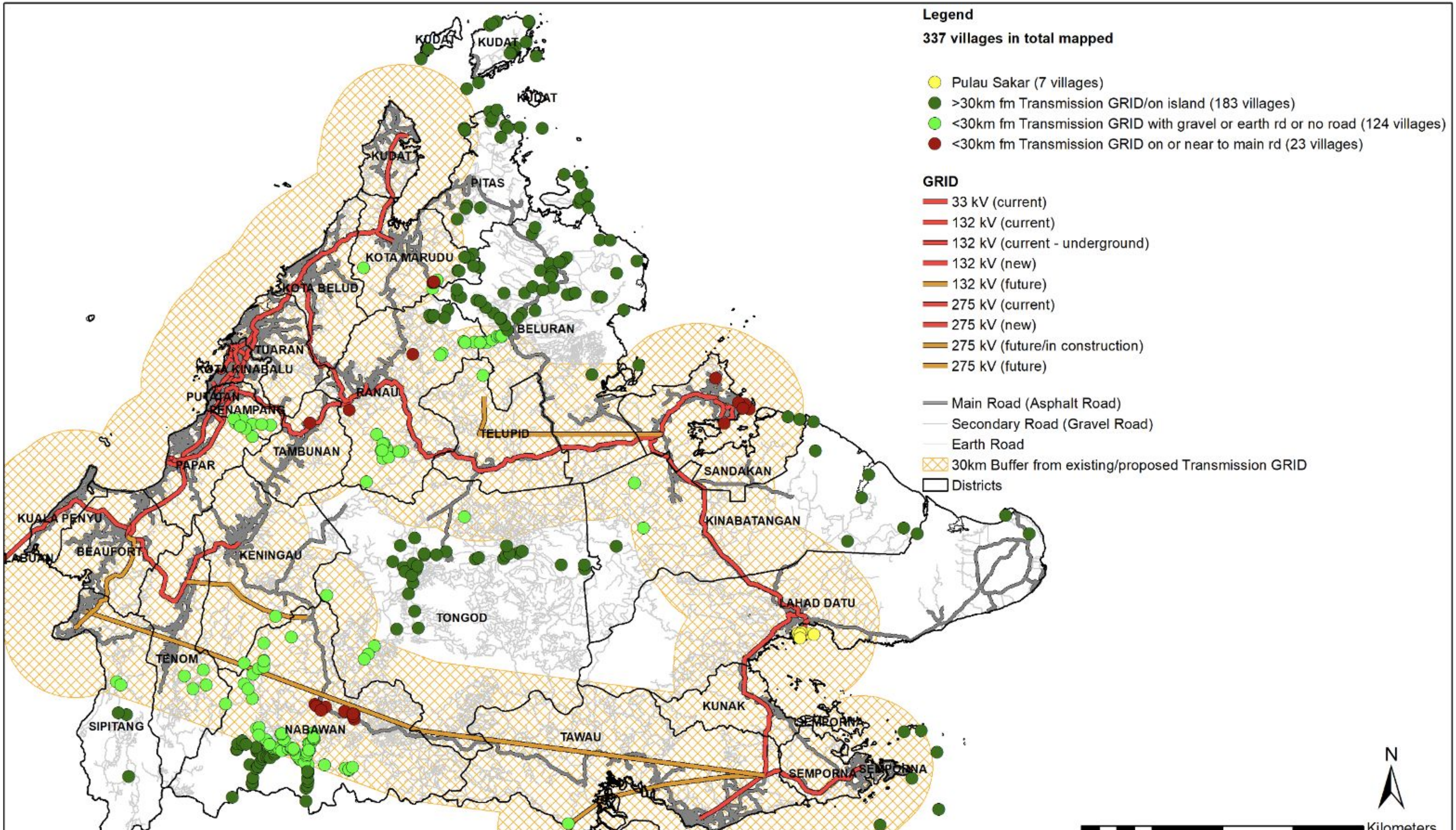
Source: "Smart Mini-Grid, A TERI Initiative." (Undated). TERI The Energy and Resources Institute. Accessed February 26, 2013: http://www.teriin.org/events/SmartMini_G rid_Brochure.pdf

Why Mini Grids?

Renewable energy mini-grids offer possibilities for improved energy generation and access

- Displace expensive diesel-based generation.
- Utilize local renewable energy resources in the system design.
- Graduate from household solar systems and off-grid lighting devices.
- Provide power for commercial and agricultural applications (not just for residential use).
- Create local jobs.
- Provide environmental benefits.
- Able to “leapfrog” traditional development pathways in combination with advances in cellular technology.

Source: Lawrence Berkeley National Laboratory, Schatz Energy Research Center at Humboldt University

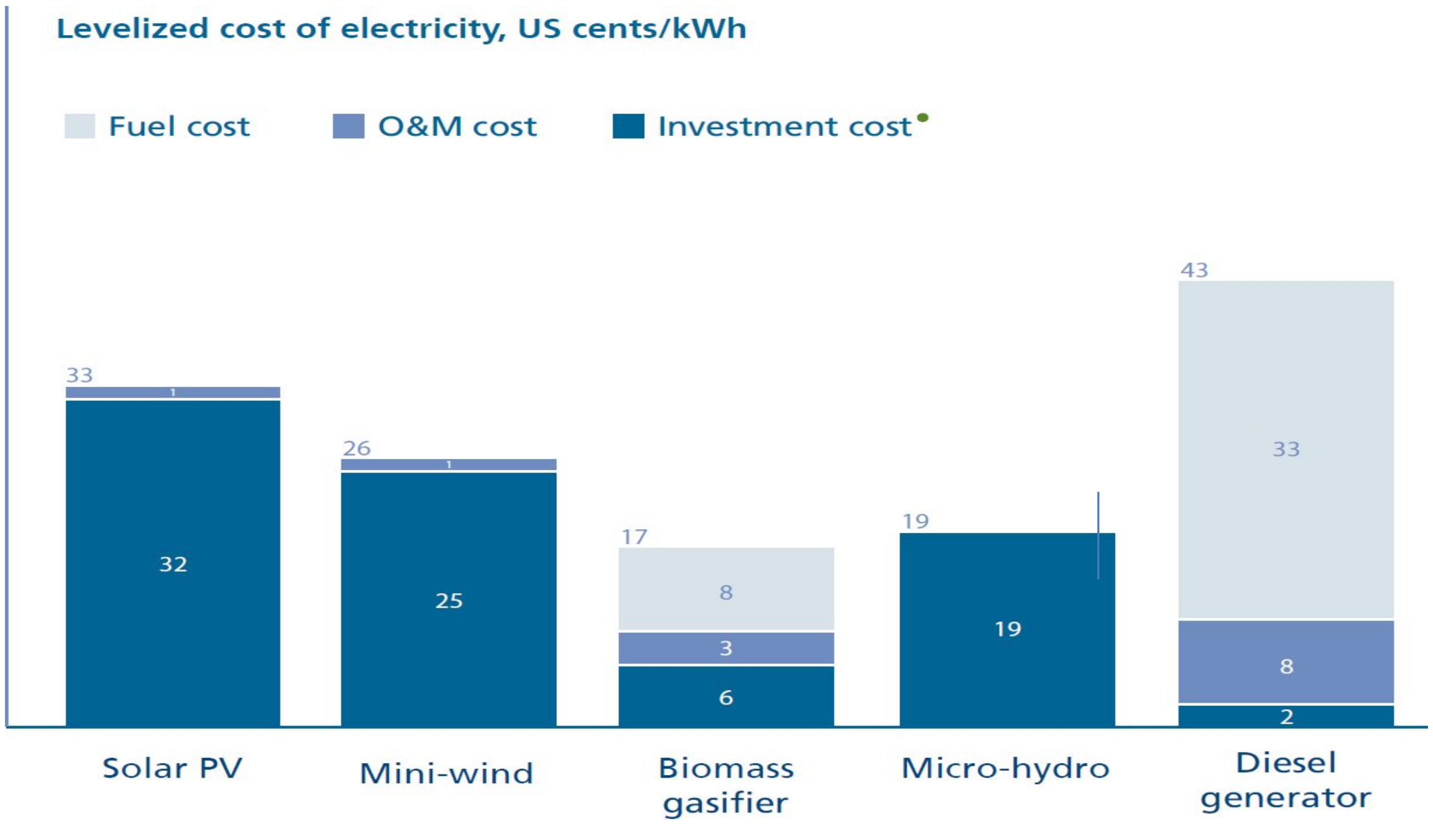

Legend
337 villages in total mapped
Pulau Sakar (7 villages)
>30km fm Transmission GRID/on island (183 villages)
<30km fm Transmission GRID with gravel or earth rd or no road (124 villages)
<30km fm Transmission GRID on or near to main rd (23 villages)
GRID
33 kV (current)
132 kV (current)
132 kV (current - underground)
132 kV (new)
132 kV (future)
275 kV (current)
275 kV (new)
275 kV (future/in construction)
275 kV (future)
Main Road (Asphalt Road)
Secondary Road (Gravel Road)
Earth Road
30km Buffer from existing/proposed Transmission GRID
Districts
N
Kilometers
KUDAT
PITAS
KOTA MARUDU
KOTA BELUD
BELURAN
TUARAN
KOTA KINABALU
RANAU
PUTATAN
PENAMPANG
TELUPID
TAMBUNAN
PAPAR
SANDAKAN
KINABATANGAN
KUALA PENYU
BEAUFORT
LABUAN
KENINGAU
LAHAD DATU
TONGOD
TENOM
KUNAK
SIPITANG
NABAWAN
TAWAU
SEMPORNA

Current Status of Mini-Grids Globally

- There is need for more data on the number and type of current mini-grid installations at the regional, country, and global levels.
- Mini-grids are becoming more efficient and growing in size as demand rises with falling generation costs and cheaper, easier system maintenance.
- As integration of automatic control technology in micro-grid systems improves, known as “smart-grids”, many governments are investing in them at various scales as clear alternatives to grid extension.
- Mini-grids have grown to provide power for small industry uses in addition to households and small businesses, thereby stimulating economic development in rural areas.
- While mini-grids typically provide about 100 kW of maximum power, in 2012 several supported up to 500 kW and even 1,000 kW.
- Combined with the importance and growth of cellular technology, these trends can allow developing countries to “leapfrog” traditional modes of development.

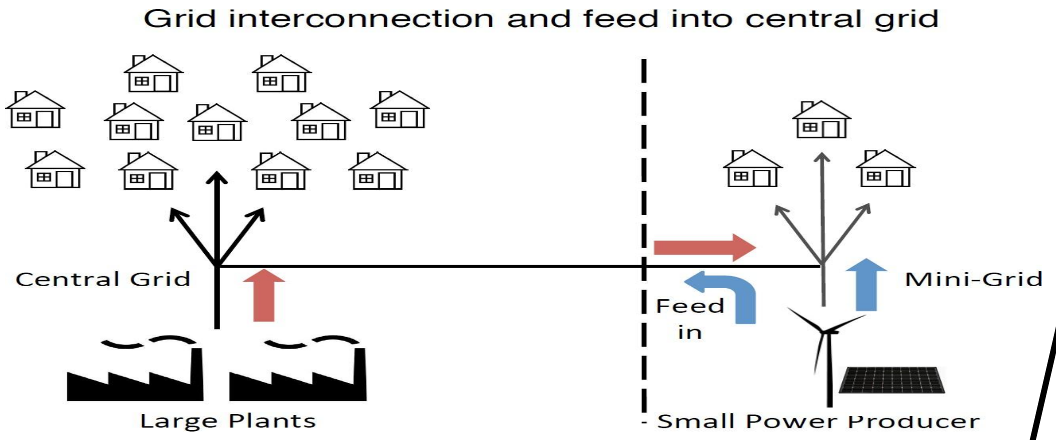
Global Levelized Cost for Mini-Grid Systems

- Capacity factors, fuel costs, and access to credit influence overall cost.
- Depending upon the price of diesel



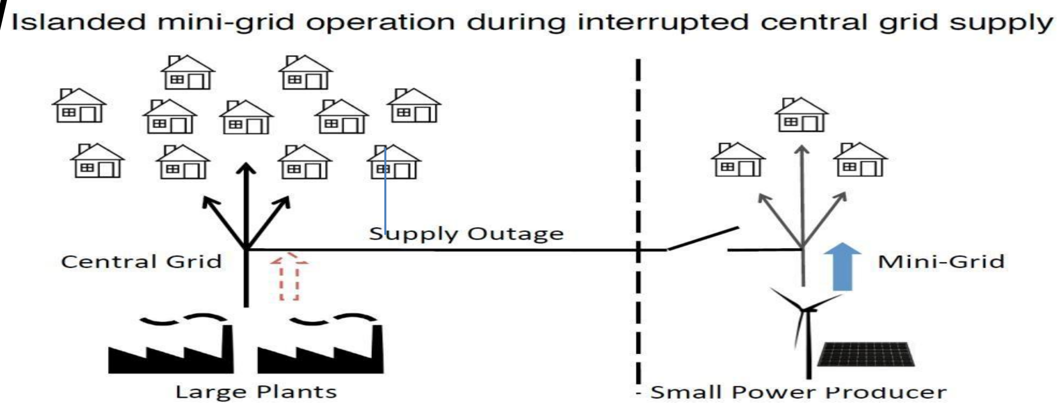
Source: ESMAP –World Bank, McKinsey analysis. 2011.

Scaling Up A Mini-Grid



Mini-grid and central grid both supply power to the local community. Excess power from the mini-grid is fed back into the central grid.

Mini-grid supply is uninterrupted during central grid supply outages



Source: Lawrence Berkeley National Laboratory, Schatz Energy Research Center at Humboldt University

Barriers to Mini-Grid Implementation

- Technical
- Financial
- Policy
- Regulatory

Technical Barriers

Technical Factors	Impact on Mini-Grid
• Significant fuel costs, lack of fuel availability, and variable renewable energy production all reduce the reliability of power generation.	• Technical expertise often is difficult to find at the rural local level. This poses a challenge in maintaining the mini-grid and ensuring its reliability.
• The use of intermittent renewable energy— such as wind and solar—requires energy storage	• Energy storage technology—such as batteries—is expensive and can increase the cost of mini-grid projects.
• Diesel engines are the primary power source for many rural communities due to a lack of technical expertise in other technology opportunities.	• Renewable energy and other power resources are often ignored for traditional, familiar diesel systems.
• Operation and Maintenance (O&M), poses a challenge and can threaten the continuity of the operation and the reliability of power supply.	• Hybrid mini-grids are utilized to improve the reliability of power generation, but add complexity and cost to the system.
• Mini-grids are custom made for each rural location.	• Resource assessments and accurate load analysis of the hybrid mini-grid require upfront analysis and site-specific designed systems that can be technically challenging, costly, and not easily replicable, and also can prevent scaling-up.

Policy Barriers

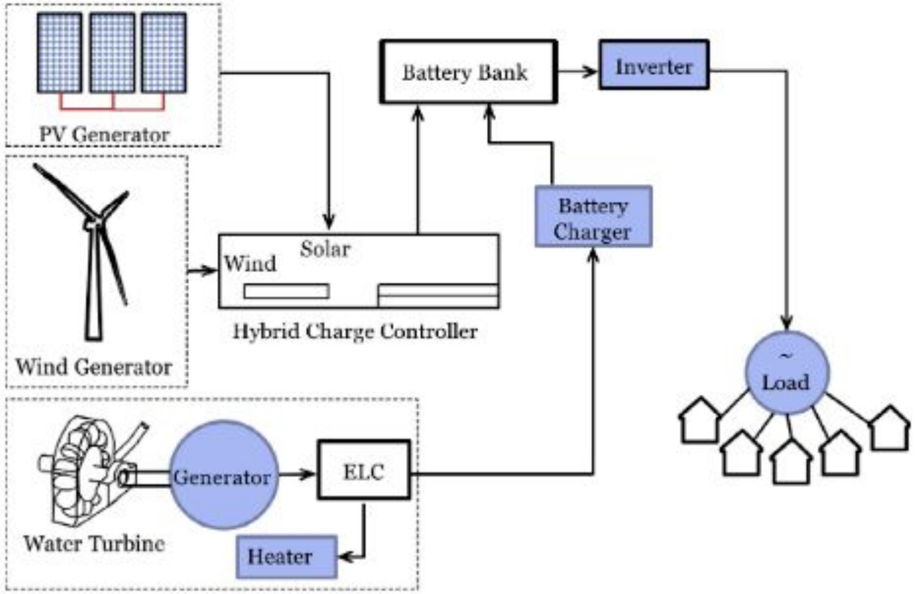
Policy Factors	Impact on Mini-Grid
Existing policies do not address the multiple methods for achieving rural and remote electrification.	Electrification is achieved primarily through central grid extensions, even when this is not cost effective. Current policies encourage this approach and deter mini-grids.
There is a shortage of information in the public domain on process issues, and a lack of consumer awareness and access to information.	Information is needed for both large global corporations and very small local players to evaluate entering the market.
Subsidy policies, such as capital subsidies, are aimed at short-term performance.	Short-term subsidies are not effective or efficient in promoting long-term performance.
There is a lack of government support for rural electrification institutions or programs.	Countries lack institutions that fully understand the electricity needs of rural and remote populations. Many state-level governments lack the capacity to properly address rural electrification needs.
Subsidy policies follow a "bigger is better" approach.	Subsidies for renewable energy often encourage large projects, such as hydro or multiple-megawatt wind facilities. This subsidy framework does not encourage small mini-grid renewable energy projects.

Regulatory Barriers

Regulatory Factors	Impact on Mini-Grid
• Lack of understanding of the culture and capacities of rural and remote regions makes it difficult to estimate electricity demands, establish appropriate payment infrastructure, and select suitable technologies. • No standard operating procedures, quality standards, or health and safety standards exist for setting up mini-grids. • Existing regulations act as an umbrella for all regions and technologies. • Lack of protection for developers when mini-grid served areas become grid connected.	• Regulations make mini-grid options unaffordable and do not address the unique needs of rural and remote regions, such as operation and maintenance challenges. • The lack of standards results in a high-risk perception that discourages private investment, which limits funding opportunities. Demand for electrification through mini-grids decreases due to uncertainty about the quality of service, accurate billing, and safety. • Mini-grids differ based on the region, customers, and the available resources. Umbrella regulations can discriminate against certain technologies, system management, or tariffs. It is not cost-effective for mini-grids to provide electricity at the same price for all grids and customers. • Developers and investors are unlikely to support mini-grids if the region is likely to be connected to the grid in the future.

Technical Solution: Hybrid Smart Mini-Grid

- **Hybrid smart mini-grids** can overcome many of the barriers challenging 100% diesel systems, which are created by high diesel prices and low fuel availability.
- **The combination of renewable energy technology with a genset** makes the hybrid power system less dependent on fuel availability and affordability and allows the system to provide 24-hour power. Solar and wind power can be substituted for diesel power and reduce diesel fuel use.
- **Local involvement and training** is essential for a successful reliable power system. Training and scheduled O&M services can increase the life and reliability of the system.
- **Adding batteries** to hybrid power systems that have variable renewable energy ensures that electric power is available and can provide frequency and voltage stability.
- **Resource assessments and accurate sizing** of the hybrid mini-grid is key to providing quality power and meeting future load requirements.



Technical Solutions: Smart Mini-Grids

Load Management

Many **load management** technologies exist—including GridShare—that enable grid managers to limit power demand during peak hours and to encourage conservation

Smart Grid

Smart grid advances could enable us to leapfrog elements of traditional power systems in terms of both technology and regulation.

Improved Power Consumption of Household Appliances

Improved power consumption of household appliances, such as energy efficient light bulbs, televisions, and refrigerators, can allow a small amount of low-cost power supplied commercially to go a long way to improving the access picture.

Technical Solutions: Mobile Towers

Machine-to-Machine (M2M) Module Design

New **machine to machine (M2M) module design**—technologies that allow both wireless and wired systems to communicate with other devices of the same ability—could unlock high-volume growth.

Remote Monitoring & Asset Management

Combining mini-grids and information and communication technology (ICT) allows **remote monitoring and asset management.**

Feasible Metering & Billing

ICT may provide **feasible metering and billing** solutions.

Control

ICT may provide **control** of generation resources and interruptible loads.

Reliable Power

Mini-grids provide **reliable power** for phones, towers, links, and data centers.

Mini-Grid Policy and Regulatory Solutions

Institutional	Technical	Financial
• Defined Roles: Ownership, Deployment, Operations, and Maintenance • Regulations and Licensing • Community Involvement and Capacity Building • Monitoring and Verification	• Standards: Quality of Equipment, Construction, and Service • Grid Interconnection and Islanding: Mini-Grids as part of the Larger System • Resource Surveys and Potential Site Studies	• Public Support: Capital and Ongoing Subsidies and Incentives • Financing: Loans, Banking, Channeling Aid and Grants • Revenue streams: Retail and Wholesale Tariffs

Load Management Technologies

Load management technologies can significantly improve the level of energy access through off-grid mini-grids

Simple and smart load limiters better manage supply and demand.

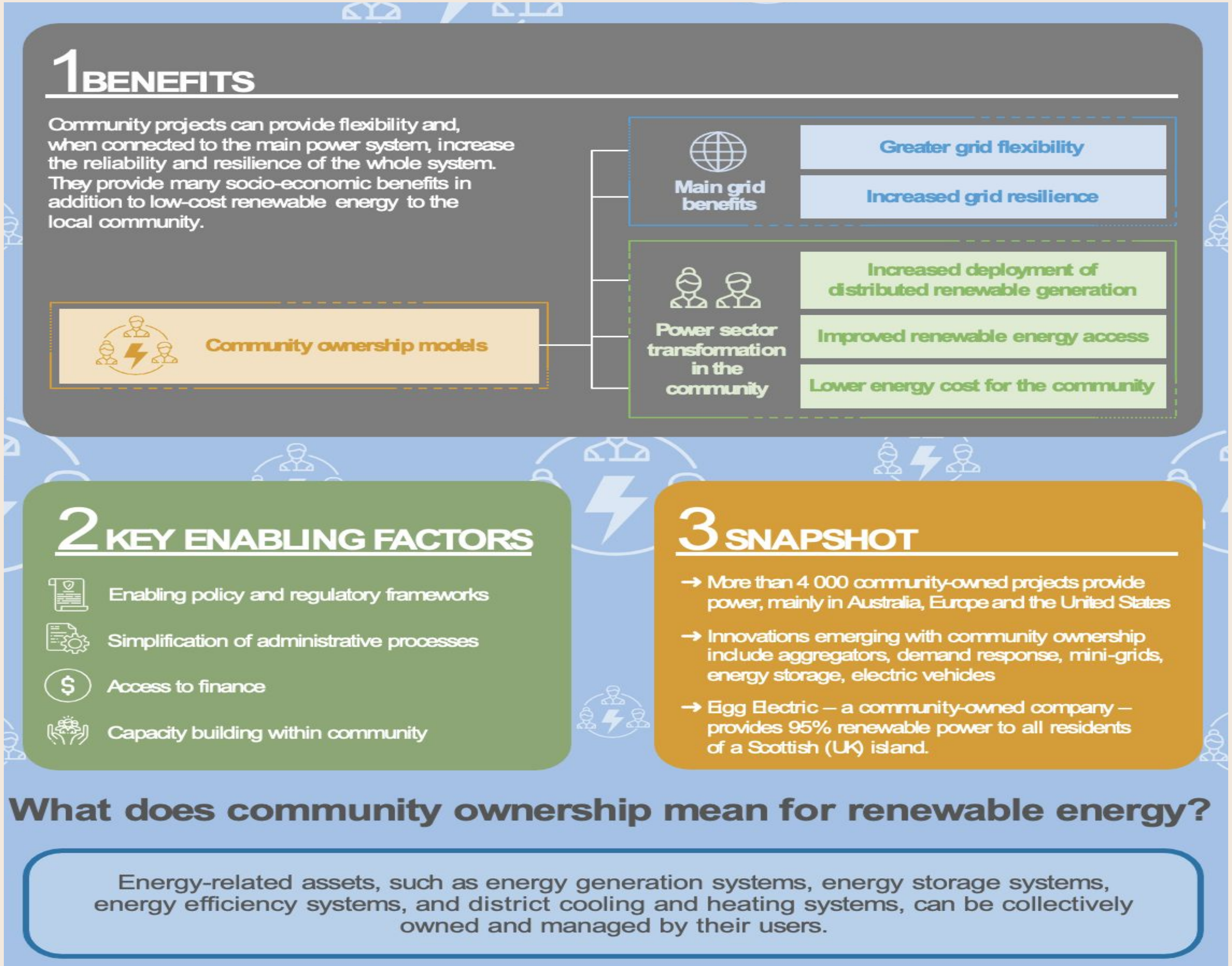
- Metering encourages conservation.
- Prepaid metering enables payment in small increments.

Bushlight India
http://catprojects.squarespace.com/bushlight-india

Centralized communication facilitates monitoring and management.

Source: Lawrence Berkeley National Laboratory, Schatz Energy Research Center at Humboldt University

Community-Based Mini-Grids



Source: IRENA Energy Innovation Landscape Brief

Characteristics: Community Ownership Models

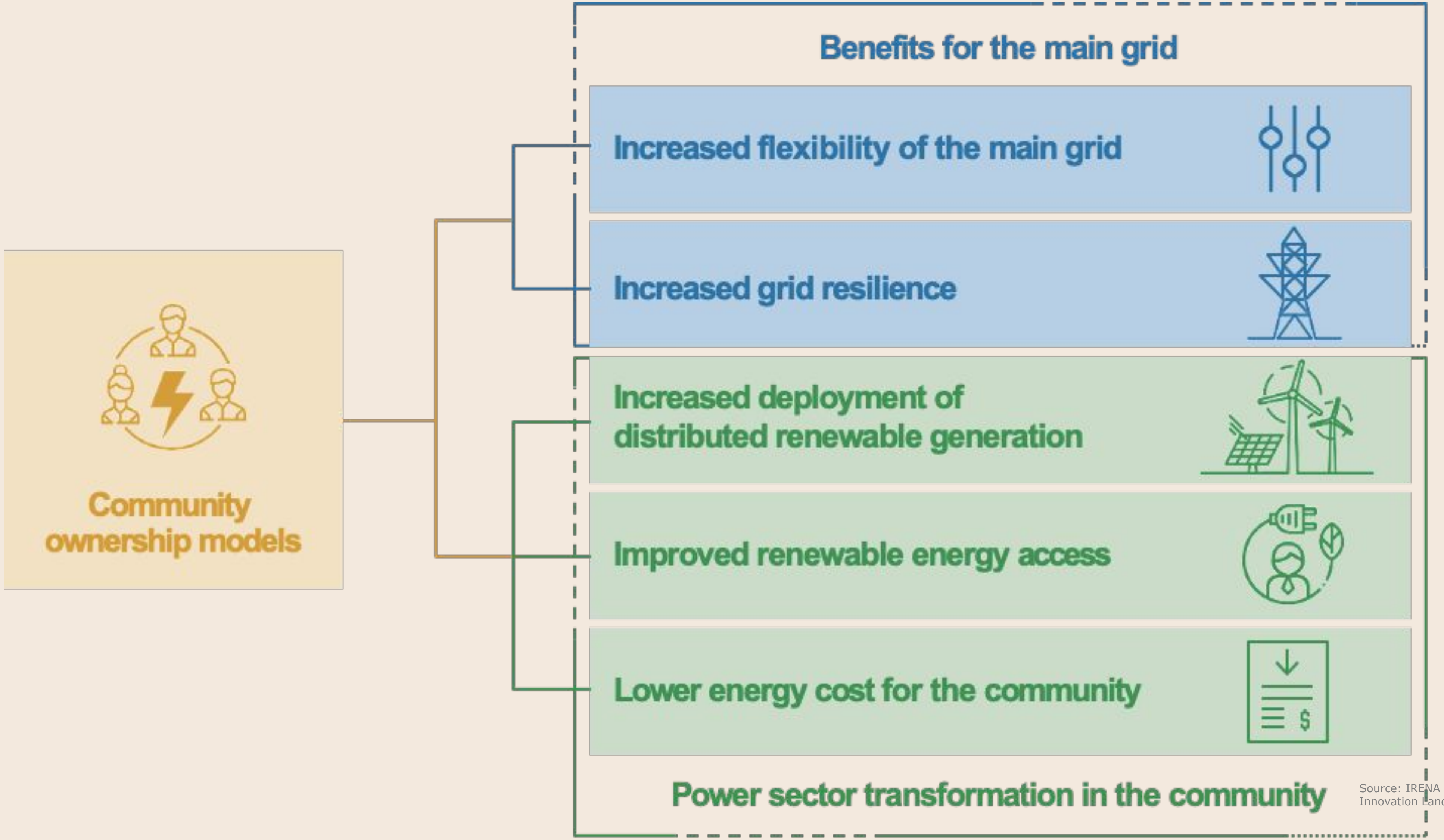
Source: IRENA Energy Innovation Landscape Brief

Legal Forms of Community Ownership

Community Ownership Model	Description
Co-operatives	Co-operatives are jointly owned by their members to achieve common economic, social or cultural goals based on the democratic principle of "one member, one vote". Co-operatives rely largely on volunteers but can have paid staff.
Partnerships	In partnerships, individual partners own shares in the community-ownership model. The key objective of a partnership is to generate profits for the shareholders, in addition to any other benefits of the project. Unlike co-operatives, partnerships may not operate on the basis of "one member, one vote". Nor do partnership firms rely largely on volunteers, as co-operatives do. They may employ full-time staff to provide expertise needed for specific projects.
Non-profit organisations	A non-profit organisation is formed by investments from its members, who are responsible for financing the organisation but do not take back any profits. Profits are re-invested in projects focused on community development.
Community trusts	Trusts use the returns from investments in community projects for specific local purposes. These benefits are also shared with people who are not able to invest directly in projects.
Housing associations	A form of non-profit, such associations offer housing to low-income families and individuals.

Source: IRENA Energy Innovation Landscape Brief

C.O. Models can Lead to Positive Power Sector Transformation



Source: IRENA Energy Innovation Landscape Brief

Lessons Learned In Real World Mini-Grid Implementation

- Investing in anchor loads are key
- Need to invest in technologies that facilitate load management.
- State engagement and capacity can provide energy to the poorest customers.
- Training and education of the local population creates local ownership and opportunities for scaling-up.
- Quality power increases customer willingness to pay.

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Thank You!

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