ICLEI Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

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IKI INTERNATIONAL CLIMATE INITIATIVE

solutionsgateway Climate, Energy, and Finance Solutions

100% RENEWABLES SOLUTIONS PACKAGE

Renewables-based mini-grids

This solution is part of a package of solutions meant to guide local and regional governments in implementing a local renewable energy transition by providing guidance on mechanisms, applications or technologies that can help accelerate their climate and energy action.

It was produced as part of the 100% Renewables Cities and Regions Roadmap project, which supports nine cities and regions across Argentina, Indonesia and Kenya to develop bankable renewable energy projects and in-depth local strategy and action plans to achieve one hundred percent renewable energy. The 100% Renewables Cities and Regions Roadmap project is implemented by ICLEI – Local Governments for Sustainability and funded through the International Climate Initiative (IKI), which is implemented by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA).

DISCLAIMER

All cities are unique. The Solutions Gateway has been developed as an advanced knowledge catalogue to provide an overview of possible Low Emissions Development Solutions. The Solutions and Packages it contains provide guidance on general conditions, which may not correspond to the existing conditions in your city or jurisdiction. The consultation and use of the Solutions Gateway does not waive the need for the Local Government to assess the feasibility of a Solution or Package in the local context in its city or jurisdiction, prior to implementation. Please note that the impacts, benefits and co-benefits indicated are generally valid but may not materialize in particular circumstances.

ABOUT SOLUTIONS GATEWAY

Solutions Gateway is an online resource platform for Local Governments where they will be able to find possible Low Emissions Development (LED) Solutions for their cities.

In the context of the Solutions Gateway, Solutions are processes, or groups of actions, which Local Governments can implement to deliver climate change mitigation results and enhance local sustainable development. Taking an integrated approach, and focusing on Local Governments usual responsibilities and roles, Solutions include core actions as well as enabling and multiplying actions essential to maximize their effectiveness and efficiency. These include policy, regulatory, governance, capacity building, awareness raising, stakeholder engagement, etc.

ABOUT ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI – Local Governments for Sustainability is a global network working with more than 2,500 local and regional governments committed to sustainable urban development. Active in 125+ countries, ICLEI influences sustainability policy and drives local action for low emission, nature-based, equitable, resilient and circular development. ICLEI's Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

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1. INTRODUCTION

Mini Grids involve small-scale electricity generation (10 kW to 10 MW) which serves a limited number of consumers via a distribution grid that can operate independently of the national power transmission grid. They can be powered by energy sources based on different technologies such as solar, wind, micro hydro, or coupled with energy storage systems such as batteries or diesel (bio-diesel) or hybrid. Hence, they can constitute different types such as:

- **Solar mini-grids:** A solar mini-grid is a decentralized and localized electricity generation and distribution system that primarily relies on solar energy to generate electricity. Solar mini-grids are gaining popularity due to the falling cost of solar photovoltaic (PV) modules worldwide. Since they can generate electricity only in the daytime, battery storage is required to meet the peak demand at night.
- **Micro hydro power (MHP):** In micro-hydro power generation, water flows from a higher elevation down a penstock to turbines at a lower elevation, which then turn the turbines to generate electricity. The generation of electricity is dependent on the flow of water and also requires a certain altitude. This makes MHP geographically limited. They are mostly run-of-river and therefore have very little environmental impact. MHP also has the lowest levelized cost of generation.
- **Hybrid mini-grids:** Mini-grids with renewable sources, when coupled with other clean energy sources such as bio-diesel systems or with other renewable sources, are called hybrid mini-grids. These mini grids are flexible as they can generate power on demand. An example of a hybrid system is a solar-diesel mini-grid.

RE-based mini-grid is one of the cost-effective solutions for electrification as the costs of mini-grid deployment are considered lower than national grid expansion and cleaner, modern and resilient in terms of electricity supply compared to other on-grid and off-grid systems running on fossil fuels.

1.1 RELEVANCE

Access to reliable and affordable electricity is a critical issue for many developing countries, as around 1.1 billion people still lack access to electricity globally. RE based mini-grids can play a significant role in addressing this issue by providing a cost-effective, flexible, and quick solution to provide access to electricity in remote and underserved communities. Besides access to electricity, the following are other motivations for developing RE based mini-grids as an electrification solution for cities, towns and regions in developing countries:

- **Energy independence:** Cities, towns and regions in developing countries can reduce their dependence on imported fossil fuels, which are often subject to price fluctuations and supply disruptions. Renewable energy sources are abundant locally and can provide energy security.
- **Cost-effectiveness:** mini-grids can be a cost-effective solution for electrifying remote communities, as they are often less expensive to build and operate than traditional grid extension projects.
- **Flexibility:** mini-grids can be designed and sized to meet the specific energy needs of a particular community, and can be easily expanded or modified as needed.
- **Speed of deployment:** mini-grids can be deployed relatively quickly, which can help to meet the urgent need for electricity in many communities in developing countries.
- **Local ownership and control:** mini-grids can be owned and operated by local communities or entities, which can promote local ownership and control of the energy system, and can help to ensure that the system is responsive to local needs and priorities.
- **Renewable energy integration:** mini-grids can be powered by RE sources such as solar, wind, or hydro, which can reduce greenhouse gas emissions and improve energy security.
- **Rural economic development:** mini-grids can provide a reliable source of electricity for small businesses, which can help to spur economic development in rural areas and create jobs.

1.2 SDGs ADDRESSED

Developing RE based mini-grids in rural areas can help to address several Sustainable Development Goals (SDGs) outlined by the United Nations. Some of the SDG targets that are addressed by developing RE based mini-grids include:

SDG 4 | Quality Education: Mini-grids that provide access to electricity can enhance educational opportunities by enabling schools to utilize electronic tools, lighting and computers that improve learning environments.

SDG 5 | Gender Equality: Mini-grids can help to promote gender equality by easing the workload for women and girls who frequently spend substantial time on domestic tasks such as gathering fuel for conventional energy sources.

SDG 7 | Affordable and Clean Energy: Mini-grids powered by RE sources can provide reliable and affordable energy to remote communities, helping to achieve the goal of universal access to modern energy services.

SDG 8 | Decent Work and Economic Growth: Mini-grids have the potential to boost economic growth by providing power to business, aiding small-scale industries, and generating job opportunities for mini-grid operation and maintenance.

SDG 9 | Industry, Innovation and Infrastructure: Mini-grids can support economic development and create jobs in rural areas through the development of local industry and infrastructure.

SDG 11 | Sustainable Cities and Communities: Mini-grids can improve the quality of life for residents of remote communities by providing access to electricity for lighting, heating, and other essential services.

SDG 13 | Climate Action: Mini-grids powered by RE sources can help to reduce greenhouse gas emissions and support the transition to a low-carbon economy.

SDG 17 | Partnerships for the Goals: Developing mini-grids requires partnership between the public and private sectors, and between different levels of government, and also with communities, which can help to promote sustainable development and achieve the SDGs.

1.3 MAIN IMPACTS

- Reduced dependency on fossil fuels for energy generation.
- Reducing GHG emissions – carbon footprints which leads to the Improvement of air quality and the reduction of pollutants in the served areas.
- Reducing operational cost compared to the business-as-usual power generation, e.g., diesel power plants (with transported diesel oil to rural areas), which also means cost-saving to the community and/or government.
- Providing electricity to unelectrified or underserved rural areas that are not covered by the national electricity distribution grid/network
- Increasing service quality and quantity of electricity (reliability of supply) in the rural areas, which later facilitates the social-economic growth of the communities.
- Increasing awareness and practices of the productive use of energy in the rural areas, as well as public knowledge and understanding on renewable energy.
- Attracting private sector investment to the RE-based mini-grid business model, supported by several policy/ regulation and incentive measures.
- Increasing sustainable, renewable energy generation in the areas while enhancing resilience to climate change.

1.4 BENEFITS

BENEFITS TO THE LOCAL GOVERNMENT AUTHORITIES AND LOCAL COMMUNITIES

- **Access to electricity:** Renewable energy-based mini-grids can provide reliable and affordable electricity to remote and underserved communities, ultimately enhancing both the standard of living and stimulating economic growth.
- **Climate change mitigation:** Renewable energy-based mini-grids have the capacity to lessen greenhouse gas emissions and enable mitigation of climate change.
- **Governance and local control:** Renewable energy based mini-grids enhance management and control at a local level. Local authorities can exert a direct impact on the functioning and administration of small scale renewable energy mini-grids within their remit. This degree of management allows for flexibility in decision making to cater to the requirements and choices of the local populace. Local regulations can be formulated to encourage energy availability, durability and financial expansion in the area.
- **Security and Resilience:** Renewable energy mini-grids improve energy security by diversifying energy sources, decreasing dependance on centralized power generation, and reducing susceptibility to external disturbances. Local governments can rely on these robust mini-grids to provide reliable electricity during challenging situations, increasing community resilience.
- **Efficient resource management:** Local authorities can regulate and monitor the use of renewable energy resources within their jurisdiction, ensuring efficient management of energy sources such as solar, wind or hydro. Effective resource management practices result in reduced energy costs, improved energy sustainability and optimized energy production for the community.

- **Tax benefits:** Revenue generated from mini-grid operations can contribute to local tax revenue, supporting essential public services and infrastructure development. Efficient distribution of subsidies can be directed towards optimizing energy access, benefitting marginalized communities and driving inclusive development.
- **Land/Area Management:** For deploying renewable energy based mini-grids, local authorities can aid in defining suitable land or areas for renewable energy infrastructure, guaranteeing their correct usage without invading vulnerable ecosystems or communal areas. Prudent land management can promote sustainable development, reduce environmental impacts, and improve the overall quality of life for residents.
- **Cost-effectiveness:** RE based Mini grids can be a cost-effective solution for electrifying remote communities, as they are typically less costly to build and operate than traditional grid extension projects. They can provide reliable electricity supply for citizens and communities.
- **Local ownership and control:** Mini-grids can be owned and operated by local communities or entities, which can promote local ownership and control of the energy system helping to ensure that the system is responsive to local needs and priorities.
- **Rural economic development:** Mini-grids can provide a reliable source of electricity for small businesses, helping to spur economic development in rural areas and create jobs. Mini-grids can also provide a stable supply of electricity to power schools, contributing to improved education in underserved areas.
- **Improved educational opportunities and outcomes:** Access to electricity is essential for improved educational opportunities, providing adequate lighting and power for studying, computer and internet access, ultimately advancing education.
- **Improved health:** Consistent access to electricity is crucial for improving and maintaining a good quality of life. Access to electricity also improves health by providing better lighting, refrigeration of medicines and vaccines and access to essential services at health facilities; mini-grids can enhance overall living conditions.

BENEFITS TO THE PRIVATE SECTOR

- **Economic investment opportunity:** Robust business models supported by attractive policies, regulations, and incentives can encourage the private sectors to enter the rural electrification market through RE-based minigrid, providing technological advancement to the local communities. Such technology is not only in terms of electricity supply, but also through the application of payment mechanisms, such as the Pay-as-You-Go / electricity token.

1.5 SUGGESTED INDICATORS FOR MONITORING RESULTS

There are several indicators that can be used to monitor the results of renewable energy-based mini-grid projects. These indicators can be used to track the performance of the mini-grid over time and to compare the performance of different mini-grids. Some examples include:

- **Electrification rate:** This indicator measures the percentage of households or businesses that have access to electricity from the mini-grid.
- **Maintenance downtime:** Monitoring frequency and duration of maintenance and downtime events to access system reliability and responsibility
- **Renewable energy penetration:** This indicator measures the percentage of total energy generated by the mini-grid that comes from renewable sources.
- **Capacity factor:** This indicator measures the average percentage of time that the mini-grid generating capacity is actually used to produce electricity.
- **Energy generation:** This indicator measures the total amount of electricity generated by the mini-grid, usually measured in kilowatt-hours (kWh).

- **Revenue collection rate:** Measuring the percentage of electricity bill payment collected by mini-grid operators, which ensure financial stability.
- **Energy consumption:** This indicator measures the total amount of electricity consumed by the customers connected to the mini-grid, usually measured in kilowatt-hours (kWh).
- **Availability:** This indicator measures the percentage of time that the mini-grid is available to provide electricity to customers.
- **Consumer satisfaction:** This indicator measures the level of satisfaction of the customers connected to the mini-grid, through surveys or focus groups.
- **Employment and income generation:** This indicator measures the number of jobs created and the income generated by the mini-grid.
- **Reductions in greenhouse gas emissions:** This indicator measures the reduction in greenhouse gas emissions resulting from the use of renewable energy sources in the mini-grid.

1.5 TYPICAL LOCAL GOVERNMENT ROLES

- Regulatory and policy support, including
    - Incentives, subsidy, and tariff scheme to attract private sector investment into the Mini Grid business.
    - Data access and availability of the electricity needs in rural areas.
    - System standardization of RE-based Mini Grid.
    - Renewable energy resources mapping and planning in the mini grid served areas.

- Especially to the donors and government-built Mini Grid systems, ideally, it is important to consider:
    - Capacity building and stakeholder engagement to ensure adequate know-how for the local operators, including access to spare parts.
    - Business models, including payment mechanisms from the customers to ensure sustainable operation of the plants (covering operational expenditures and possible re-investment requirements ahead).
    - Increasing local peoples' awareness on the productive use of energy

2. INTEGRATED SOLUTION OVERVIEW

	Enabler Actions	Required Actions	Multiplier Actions
Policy	• Evaluate and map regulatory frameworks, energy legal framework and success case studies including from other countries especially on how to involve private sectors into the RE-based mini grid business model. • Evaluate the current practices of RE-based mini grid projects, including government and donor-driven projects, thus the lesson-learnt can be mapped for further policy improvement. • Analyze the electricity supply and business planning of the Utility to identify the size and which areas the RE-based mini grid is needed. • Developing clear planning of electricity supply provision in rural areas, identify the cost-benefit of grid extension or mini grid implementation. • Set out the clear tariff and subsidy policy mechanism for RE-based mini grids, especially when aiming at attracting private sector investment in mini grids and rural electrification. • Developing the business model and guarantee mechanism with regards to involvement of private investment into mini grid business.	• Developing clear planning of electricity supply provision in rural areas, identify the cost-benefit of grid extension or mini grid implementation. • Developing clear tariff and subsidy policy mechanism for RE-based mini grids. • Developing new sets of key performance indicators that incorporate the measures on quality and quantity of electricity supply and services for rural areas.	• Developing clear and robust regulatory frameworks and roadmap on electrification, including RE-based mini grids for identified rural areas.
Stakeholders and Awareness	• Engage the community and all involved stakeholders spreading awareness, informative and educational campaigns on renewable energy.	• Mapping the socio-environmental dimensions including engagement with the local stakeholders of the targeted areas for rural electrification based mini grid.	• Energy crowdfunding can provide a new source of financing for mini-grid projects, particularly in developing countries where access to finance is limited.

	Enabler Actions	Required Actions	Multiplier Actions
Stakeholders and Awareness	• Engage the local leaders in targeted areas for rural electrification based mini grid. • Involve and inform other levels of government	• Involving local communities / beneficiaries of the RE-based mini grids in terms of project planning and community involvement. • Improving intergovernmental coordination between central, local, and utility companies.	• Energy crowdfunding can help to build community ownership and engagement in mini-grid projects by allowing local residents to invest in and support the development of the project.
Governance	• Set up collaborative committees on mini grid program planning, involving central & local government, utility, donors, international organizations. • Assess laws and regulations of the RE-based mini grid especially that involves private sector investment.	• Assess laws and regulations of the RE-based mini grid especially that involves private sector investment. • Improving coordination among stakeholders regarding the mini grid program planning by involving central & local government, utility, donors, international organizations.	• Set up collaborative committees across stakeholders involving inter ministries/agencies (including Energy, Rural Development, and Public Works, etc) and the Utility.
Capacity Building	• Capacity building regarding the management issue and sustainable operation of mini grid. Such cases in Indonesia for example are as follows: ◦ The IMIDAP Project, GIZ EnDev, and GIZ MHPP that provided capacity building on know-how of mini grid applications and productive use of energy. ◦ IBEKA supports local community empowerment through micro-hydro. • Capacity building on technical aspects of mini grid for local government, stakeholders, and local communities (as beneficiaries). • Capacity building and training to ensure the sustainability of the grid, operation and maintenance	• Evaluate the implementation of the current program on RE-based mini grids, identify the weakness and constraints, and develop various measures to improve the program under capacity building activities. • Conducting needs assessment of stakeholders regarding the multi-aspects of RE-based mini grids. • Developing cooperation with international organizations/ donors on technical assistance for RE-based mini grids.	• Develop well-structured programs and curriculums regarding renewable energy including mini grids in vocational schools. • Establishing and implementing cooperation with donors and international organizations regarding mini grids operation and maintenance (best-practice) for stakeholders.

	Enabler Actions	Required Actions	Multiplier Actions
Technical	• Identify the size of RE-based mini grid projects that are required **in a country**, including the energy audits. For example, in Nigeria, such data is available in the form of a geospatial database. • Identify the local available renewable energy resources for the RE-based mini grid development. • Identify the technology availability and cost of development, including technical specification and availability of spare parts to ensure sustainable operation of the project.	• Understand and adhere to relevant national and sub-national regulations and required standards for developing and operating RE-based mini grid projects Identify and calculate the renewable energy potential in the served areas. • Identify the technology availability and cost of development, including technical specification and availability of spare parts to ensure sustainable operation of the project. • Ensure fulfillment of technical standards during the procurement and construction of the RE-based minigrid. • Develop technical assistance program for RE-based mini grid planning and operation.	• Demonstrate how RE-based mini grids can support local communities to get clean, affordable, and cost-efficient (compared to the BAU of diesel genset) energy and electricity supply. • integration with other socio economic development plans such as healthcare, agriculture, transport, etc. For e.g. deploying solar for remote healthcare facilities and their needs; or for agriculture cold chains • Increase local awareness and knowledge on the benefits of operating RE-based mini grids.
Finance	• Identify blended and alternative financing supports for RE-based minigrid, including government funding, donors, international grants, Islamic finance (including Zakat fund), CSR, etc. to ensure the availability of capital required to build RE-based mini grid projects (especially for social programs). • Developing robust business models including Public Private Partnership (PPP) schemes in which the local government can act as the government contracting agency and private sector conduct the off-grid renewable energy investment. • Developing and formulating subsidy and tariff structure for RE-based mini grid for rural electrification purpose.	• Review different project financing options available and whether there are any restrictions on access to those options. • Identify blended finance options and develop cooperations between local governments and the potential funder (including CSR, islamic finance, donors, international organizations). • Creating robust PPP structure and business model for RE-based mini grid, including planning, business case studies, and tender documents. • Developing government guarantee schemes under the PPP structure for RE-based mini grids in order to attract private sector investment and increase the project bankability. • Legal and institutional study to develop tender documents, financing strategies and contract models depending on the type of investments.	• Attract investments to improve the system and the program in general.

3. WORKFLOW /PROCESS PHASES

3.1 PREPARATION

- Develop clear regulatory frameworks for RE-based mini grids for rural electrification.
- Develop RE-based mini grid program planning.
- Improving coordination between central and local governments and the utility company.
- Conduct energy audits of served RE-based mini grid areas.
- Map renewable energy potential in the served areas.
- Engage local communities / beneficiaries of the RE-based mini grid in terms of project planning and community involvement.

3.2 APPROVAL

The typical approvals needed for the development of renewable energy-based mini-grid projects can vary depending on the specific country and project. However, some common approvals that are typically required include:

- Environmental impact assessment (EIA) or any Environmental and social clearance and approvals.
- Environmental and Health and Safety (EHS) permit
- Permissions from LRGs on use of land, water bodies and other assets and resources.
- Cultural Heritage and Archaeological Assessments: In areas with historical or cultural significance, assessments and permits related to cultural heritage and archaeological preservation may be necessary.
- Grid Interconnection Agreement: Permission from the local utility or grid operator to connect the mini-grid to the existing electrical grid (if applicable).
- compliance with benchmarks and standards including building and construction permits to ensure that the project complies with safety and building codes.
- electrical safety and inspection approvals are typically required to ensure that the project complies with electrical safety regulations and codes.
- Zoning approvals, where applicable
- Approval for projects based on EPC from authorized mini-grid implementer and operators.
- Permits from relevant ministries/authorities in forestry, agriculture, horticulture and other related fields.

3.3 PROCUREMENT

- Develop technical specifications of RE-based mini grid projects in the areas (i.e., type of technology, capacity, standardization) including the monitoring system.
- Develop procurement method following the determined technical specification.

3.4 IMPLEMENTATION

- Identify the implementation method and ensure sustainable operation and maintenance of the mini grid project.

3.5 MONITORING

- Implement monitoring systems in the project, for example online site remote monitoring for solar PV projects (e.g., SMA, Huawei, etc.).
- Consistently monitor the routine cleaning and maintenance tasks
- Keep monitoring the sustainable operation of the project by providing and developing one-stop-shop apps for operators to access information of mini grid operation and spare parts.
- Evaluate the program implementation periodically.

4. REALITY-CHECK

This solution is applicable:

- In rural areas which remain not electrified or have not enjoyed reliable and stable electricity supply however they have sufficient local renewable energy resources.
- In a situation that expanding the national electricity grid to such areas mentioned above is less efficient and less economically effective when compared to the mini grid development.

4.1 REQUIRED PRE-CONDITIONS

- Availability of local renewable energy resources for the mini grid utilization.
- Technology of RE-based mini grids (e.g., solar, hydro, etc.) depends on the resource's availability.
- Financing capacity, either through donors, government funding, communities, or private sector involvement.

4.2 SUCCESS FACTORS

- **Strong government support:** Government support is crucial for creating a favorable policy and regulatory environment for the development of mini-grids. This includes providing clear and stable regulations, as well as providing financial and technical assistance to support project development.
- **Community engagement:** Engaging with local communities and building their capacity to participate in the planning, development, and operation of the mini-grid is essential to ensure that the mini-grid meets the needs and priorities of the community.
- **Financial viability:** Mini-grids must be financially viable in order to be sustainable in the long-term. This includes ensuring that tariffs are set at levels that are affordable for customers, and that there are mechanisms in place to provide subsidies for low-income households.
- **Technical feasibility:** Mini-grids must be technically feasible and able to meet the energy needs of the community. This includes selecting appropriate renewable energy technologies and ensuring that the mini-grid is designed and sized to meet the specific energy needs of the community.
- **Long-term maintenance:** Mini-grids must be designed and operated in a way that ensures long-term maintenance and sustainability. This includes regular maintenance, training of local technicians, and the use of appropriate technologies that are easy to repair and maintain.
- **Quality of energy services:** The quality of energy services provided by the mini-grid, such as reliability and continuity of supply, must be continuously monitored and improved to meet the needs of customers.

4.3 FOLLOW-UP NEEDED AND/OR RECOMMENDED

- Consider the eventual increase of demand once the transition to renewable sources is completed (e.g., more use of electric cars and smart devices.)
- Consider the rebound effect, once there can be a behavioral change in the consumption after the installation, increasing the demand
- Eventually audit the project in order to find opportunities
- Involve the community in the decision-making process
- Provide training to the actors involved in the project
- Prioritize local suppliers and workforce
- Monitoring if utilities are billing and crediting energy correctly to the RE-based mini grid, in case of on-grid systems.

4.4 BARRIERS

- The availability of high-quality data of resources and renewable energy potentials for RE-based mini grids.
- Access to spare-parts of RE-based mini grids, including inverter, solar charge controller, and/or energy storage (Solar PV), mechanical equipment for micro-hydro, etc.
- Private sector involvement on rural electrification including RE-based mini grid business would help the achievement of the SDG-7, however unclear and uncertain regulatory frameworks including tariff and subsidy policies are barriers for private sector involvement.

4.5 RISKS

- General and common risks of mini grids, especially government or donor-funded projects, are regarding sustainable operation. Many of the projects cannot work sustainably in the long-run due to the lack of operational cash and payment to cover operational cost, inadequate access to spare parts, lack of maintenance, and weak organization structures in the community that makes the project abandoned.
- Lack of maintenance or the use of poor quality or untested technology. This could be as a result of lack of sufficient funding to sustain the project over its lifetime or the shortage of local skills for maintenance of the mini grid.

5. CLIMATE CHANGE MITIGATION POTENTIAL

Deploying renewable energy-based mini-grids in developing countries as an electrification solution can have significant potential for climate change mitigation. Some ways in which mini-grids can help to reduce greenhouse gas emissions include:

- **Reducing dependence on fossil fuels:** Mini-grids powered by renewable energy sources such as solar, wind, or hydro can reduce or eliminate the need for fossil fuels such as coal, oil or natural gas, which are a major source of greenhouse gas emissions.
- **Reducing emissions from power generation:** Renewable energy sources do not produce greenhouse gas emissions when generating electricity, whereas fossil fuels do. By increasing the share of renewable energy in the power mix, mini-grids can help to reduce emissions from power generation.
- **Reducing emissions from transportation:** Mini-grids can help to reduce emissions from transportation by providing electricity for electric vehicles, instead of relying on fossil fuels.
- **Reducing emissions from cooking and heating:** Mini-grids can help to reduce emissions from cooking and heating by providing electricity for electric cook stoves and heaters, instead of relying on biomass, which is a major source of emissions.
- **Increased energy efficiency:** Mini-grids can also increase energy efficiency by providing reliable power, which can reduce the need for backup generators and other inefficient energy sources.

6. NATIONAL – SUBNATIONAL INTEGRATION IN THE CONTEXT OF THIS SOLUTION

6.1 BENEFITS TO LOCAL GOVERNMENT

- RE-based mini grids can reduce the local government dependency and spending on fossil fuel import and transportation to the rural areas.
- Reliable electricity supply for its citizens / communities provided by RE-based mini grid.
- RE-based mini grids can be a promising solution to the high cost of extending the electricity network to rural areas.

6.2 BENEFITS TO OTHER LEVELS OF GOVERNMENT

- Achieving the targets of renewable energy development and electrification rate.
- Contributing to the achievement of the GHG emission reduction target under the NDC.

7. RESOURCES/SUPPORT

7.1 CASE STUDIES

EXPANDING RENEWABLE ENERGY ACCESS WITH PRO-POOR PUBLIC PRIVATE PARTNERSHIPS IN THE DEVELOPING WORLD [4]

Abstract: The provision of energy services through renewable energy is capital intensive and requires significant upfront costs compared to conventional energy technology. In most cases, government investments and public budgets have proved insufficient to expand access to electricity and modern energy in rural areas in a sustainable manner. There is a great need for mobilizing financial resources to expand local energy services delivery in the developing world. Pro-poor public-private partnerships are one of the best mechanisms to supplement and overcome government budgetary constraints for widening access to energy services, especially to the poor, as they can allocate project-risks between the public and private sector. This article explores eight case studies throughout the world of where pro-poor public private partnerships for renewable energy have expanded access to energy services for those most in need of them.

- **Cinta Mekar Micro Hydro Project, Indonesia**

  One of the cases shown above is the Cinta Mekar micro hydro project in Indonesia (the "Project"). The Project is a showcase of the cooperative model utilizing the 5P approach. The 120 kW micro hydroelectric facility was built through a partnership between public, private, and community organizations. At first the Project was built only to serve communities that remain un-electrified in a small district in Subang, West Java, managed under a community cooperative. However, when the Utility grid extension arrived, the energy was used to electrify village homes and produce revenue through exports to the national grid resulting in income for the cooperative and sustainable operation of the mini grid.

Name	Cinta Mekar Micro Hydro Power Project
Installed Capacity	120 kW
Location	Cinta Mekar Village, Subang, West Java, Indonesia
Investment	• USD 75,000 (IBEKA, donors funds) • USD 75,000 (Grants from UNESCAP) • USD 75,000 (HIBS Corporation)
Ownership	Joint venture between Cinta Mekar Cooperation (local community, 50% profit) and HIBS Corp (private company, 50% profit)
Beneficiaries	122 households
Discharge Flow, Head	1500 L/s with head 18.6 meters
Annual Generation	864,000 kWh
Monthly exports to PLN	around 72,000 kWh
Power Purchasing Price by PLN	IDR 432, -/kWh
Sustainability	Profits achieved are invested on village development: MHPP maintenance, education, health, seed capital, and village infrastructure

THE ROLE FOR LOW CARBON ELECTRIFICATION TECHNOLOGIES IN POVERTY REDUCTION AND CLIMATE CHANGE STRATEGIES: A FOCUS ON RENEWABLE ENERGY MINI GRIDS WITH CASE STUDIES IN NEPAL, PERU AND KENYA [5]

Abstract: As a potential poverty reduction and climate change strategy, this paper considers the advantages and disadvantages of using renewable energy technologies for rural electrification in developing countries. Although each case must be considered independently, given a reliable fuel source, renewable energy mini grids powered by biomass gasifiers or micro-hydro plants appear to be the favoured option due to their lower levelised costs, provision of AC power, potential to provide a 24 h service and ability to host larger capacity systems that can power a wide range of electricity uses. Sustainability indicators are applied to three case studies in order to explore the extent to which sustainable welfare benefits can be created by renewable energy mini grids. Policy work should focus on raising awareness about renewable energy mini grids, improving institutional, technical, and regulatory frameworks and developing innovative financing mechanisms to encourage private sector investments. Establishing joint technology and community engagement training centres should also be encouraged.

- **Pokhari Chauri, Nepal**

  Pokhari Chauri is a rural settlement of 239 households in Kavre district, central Nepal. The area had had no access to electricity and households relied on candles and kerosene lamps for their basic lighting needs. However, in July 2000 a 22 kW run-of-river hydro plant was installed by the United Nations Development Programme (UNDP)-led Rural Energy Development Programme (REDP). Households were fitted with a 100 W mini-circuit breaker and those with larger machinery (for example carpentry tools or mills) had meters installed. Electricity is supplied every day between 4 a.m. and 4 p.m. and again from 6 p.m. until 11 p.m. Approximately 2% of the households are provided electricity for free due to their lower economic status. The community has greatly benefited from the arrival of affordable electricity. School children now study for an average of 1–2 h more per day and teachers believe them to be better informed from increased radio and television access at home.

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