PARLIAMENTARIANS' TOOLKIT FOR BUILDING POLITICAL SUPPORT FOR ENERGY ACCESS THROUGH MINI GRIDS

Introduction

This toolkit has been prepared to provide information and encourage legislators to lobby for the adoption of **mini-grids** as one of the options for providing modern energy and meeting the challenges of rural electrification.

Access to modern energy (renewable energy and cleaner fossil fuels such as LPG & LNG)[1] is vital to fighting poverty and improving the living standards of the poor in many ACP countries. This has been demonstrated by countries such as Tunisia and Morocco, where modern energy and rural electrification in particular has greatly improved living standards of populations living in rural areas, with positive contribution to the general economy.

There are two main options of providing modern energy, electricity in particular; the centralized and the decentralized option. (Figure 1 below gives a guide on how to choose the most appropriate option for rural electrification). The centralized option refers to provision of energy through extension of a centralized grid. For many ACP countries, extension of the centralized grid has been the dominant approach for rural electrification. However, despite massive investments in extending the centralized grid, barely 10% of the rural population in many ACP countries is connected to the grid. The slow pace of grid extension reflects the inefficiency of this electrification model when it is applied inappropriately (Refer to background policy paper: Appendix 1).

[1] Modern Energy refers to relatively cleaner energy types needed now and in the future, particularly clean energy technologies such as solar, wind, wave, hydro, biomass and geothermal.

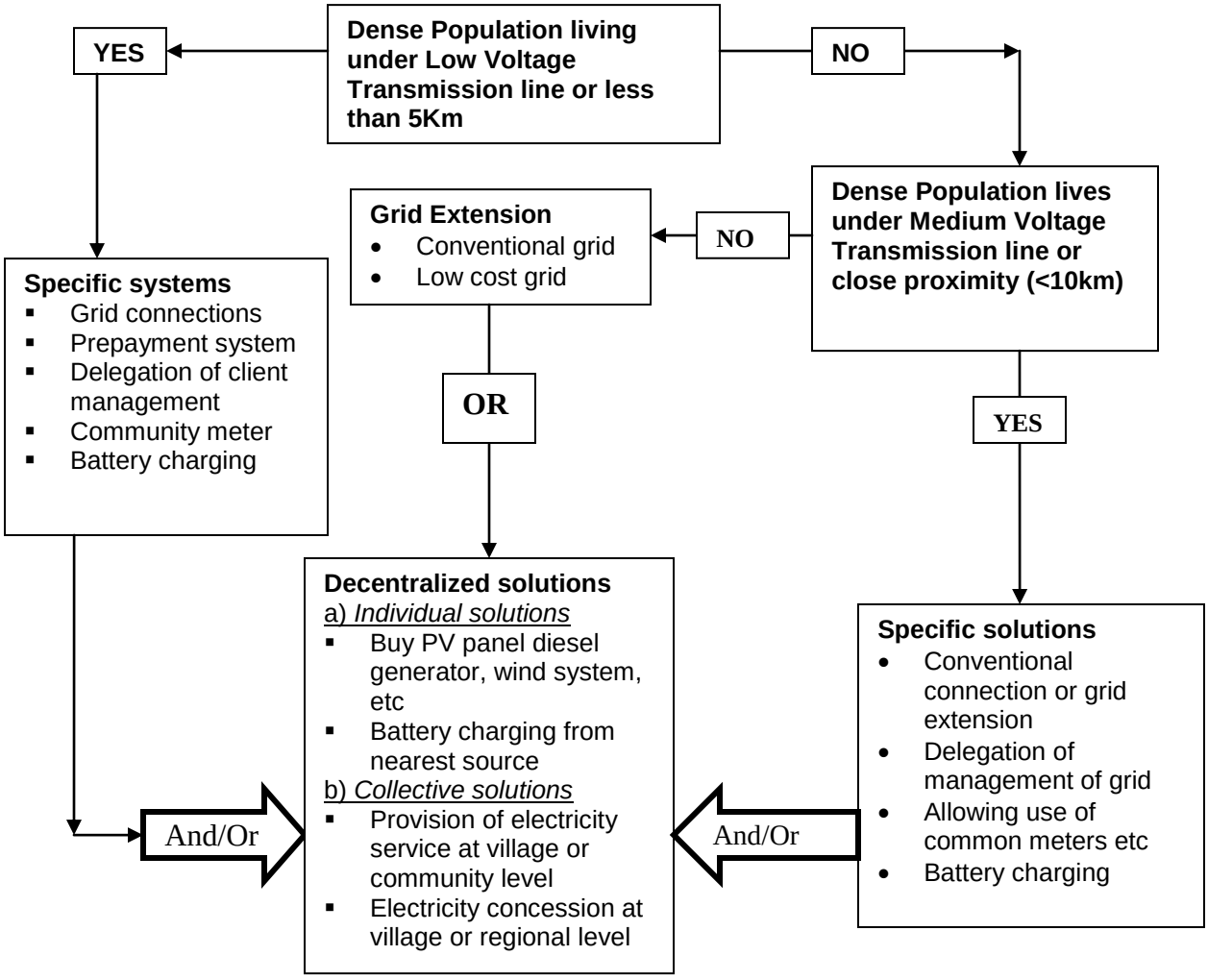

Figure 1

In view of the numerous constraints slowing down rapid extension of the centralized grid, many energy researchers and institutions such as the World Bank and UNDP, have been advocating for reforms and innovative interventions for scaling-up access to modern energy including electricity in developing countries. Decentralized electrification has become the focus of such reforms and efforts as it is considered the cutting-edge. Decentralized solutions can be grouped into two: **stand alone systems** and **mini-grids. (Figure 2 shows a guide on how to choose an appropriate decentralized solution)**

A **stand alone system** operates independently of an electric transmission and distribution network. In this model, the end-user acquires energy equipment such as solar panels, wind generators or diesel generators and makes the necessary arrangement for maintenance and repairs of the equipment. The energy equipment may be acquired through several financial models such as cash, credit or leasing.

What is a mini-grid?

A mini-grid is an isolated distribution network, usually operating only at a low voltage[2] and providing electricity supply to a target community, village or town. It is supplied by a single source or a combination of different sources of power (such as, a micro-hydropower plant, wind generator, or a cogeneration plant from a local factory or a diesel generator) feeding into the network. This may involve private companies, cooperatives or membership groups which supply electricity or electric services at the village or regional level. In this arrangement, the private investor or group of investors invest and own the mini-grid system. Depending on the terms of the business transaction or group membership, the owner or manager of the mini-grid invoices the customer either on the basis of the *volume* of the power consumed (e.g. kWh) or through a *lump-sum payment* calculated according to the estimated load of the service provided (e.g., the number of lamps or outlets). Contrary to the standalone model, the customer (e.g. a household) in a mini-grid system does not perform maintenance or manage the equipment. Instead, system maintenance and management is the responsibility of the private investor or the management committee elected by the members in a group or cooperative.

Providing modern energy through **mini-grids** has been common in Asia and the rate of adoption is on the rise in the Caribbean and Africa.

[*A community-owned mini-grid in Kipini, Kenya*]

[2] In Kenya, for example, the distribution voltage in mini-grids varies widely from 415V to 11kV depending on the financial and technical resources available to the particular community.

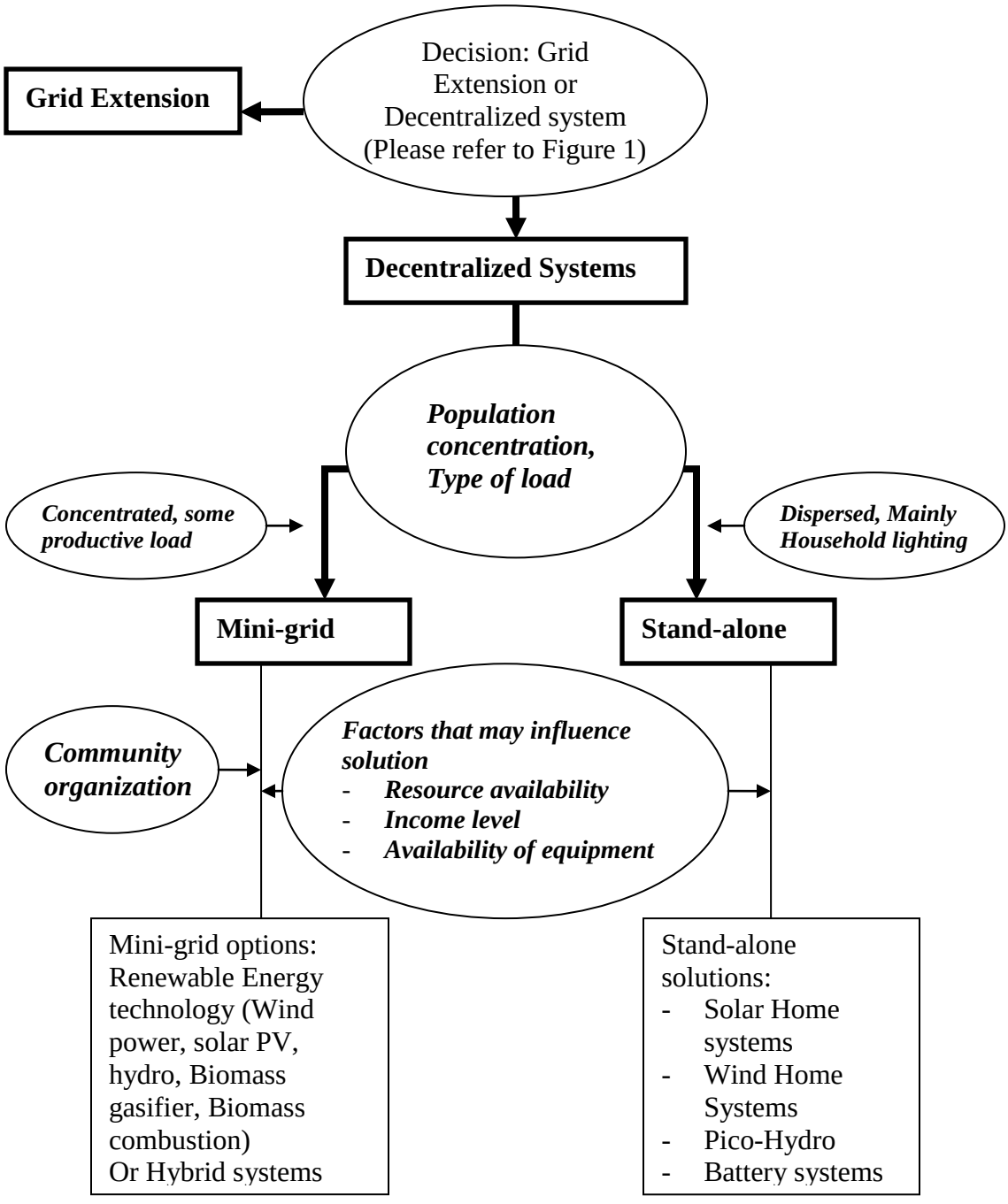
Decision: Grid Extension or Decentralized system (Please refer to Figure 1)
Grid Extension
Decentralized Systems
Population concentration, Type of load
Concentrated, some productive load
Dispersed, Mainly Household lighting
Mini-grid
Stand-alone
Community organization
Factors that may influence solution
- Resource availability
- Income level
- Availability of equipment
Mini-grid options: Renewable Energy technology (Wind power, solar PV, hydro, Biomass gasifier, Biomass combustion) Or Hybrid systems
Stand-alone solutions:
- Solar Home systems
- Wind Home Systems
- Pico-Hydro
- Battery systems

Figure 2

Benefits of mini-grids

The mini-grid option presents a myriad of benefits especially to the rural population. The following are but a few illustrative examples:-

- Mini-grids provide an opportunity for a relatively low-cost, community and/or private-sector driven approach to rural electrification.
- Mini-grids allow a combination of different sources of electricity –such as wind, solar PV, mini-hydro and biomass electricity) to feed into the same network, hence it is possible to achieve high security of energy supply. (See Box 2[3])
- Most ACP countries are endowed with vast resources of renewable energy. Mini-grids can easily tap into these resources and significantly benefit the environment, and local community besides reducing the total cost of providing energy.
- Since the energy is generated and used locally, this minimises losses associated with transmission over long distances, and makes mini-grid a more efficient option. (See Box 1)
- Mini-grids can easily address operation, maintenance and administrative challenges that usually hinder the extension of the central grid
- Renewable energy based mini-grid projects often keep money in the local area boosting the local economy. They help bring community regeneration by providing social-economic benefits such as jobs for the local population and opportunities for productive uses of energy in local microenterprises (e.g. agro-processing, carpentry, welding, tailoring, etc) thus supporting income generating activities.
- By supplying electricity to local institutions such as health centres and schools, mini-grids enable rural communities located far away from the national grid access improved health and education services.
- Mini-grids make rural communities less vulnerable to economic and political fluctuations at the national level. This is because mini-grid option are managed locally often without interference by national politicians, and provide social economic benefits such as opportunities for productive uses of energy in local micro-enterprises and opportunities for local employment and income generation as shown above

[3] For more information on technology please refer to: Technical and Economic Assessment of Off-Grid, Mini-Grid and Grid Electrification Technologies and the mini-grid design manual.

Box 1: Renewable Energy Minigrids in Dominican Republic

Under the Electricity Law of 2001 companies in the Dominican Republic that generate electricity using renewable sources, are given preference in the sale and dispatch of electricity.The Dominican Republic has one of the broadest experiences with harnessing solar photovoltaic (PV) power and making efficient use of the small amount of low-voltage (12 V) direct current energy generated by such systems. It also makes use of the small stream flows found in its numerous streams, by transporting water long distances in PVC pipes for irrigation and electricity generation. Pico-hydro mini-grids have been found to be more cost effective compared to solar home systems which have higher capital and recurring cost. The country is planning to articulate its national energy policy and roadmap. The policy will address among others issues: self generation, independent power production, net metering, development of indigenous sources of renewable energy, service standards, tariffs energy efficiency, environmental aspects and universal access to electricity. This is likely to boost renewable energy generation and adoption of mini-grids. http://www.undp.org/sgp; http://www.enersol.org; http://www.cne.gov.do

Box 2.
Solar Photovoltaic Technology (PV)
Solar PV systems convert energy from the sun into electricity using semiconductor-based materials (also kwon as solar cells). Solar cells are assembled together to produce solar modules, and a group of solar modules are connected together to produced the desired power is called a solar array. A solar PV system typically consists of a solar array, power conditioning and/or controlling device such as a charge regulator or inverter, and electricity storage device (battery), supporting structure and cabling to connect power system to the load or mini-grid.

Solar PV systems can be classified either as stand-alone systems or small to large centralized solar power plants. Stand-alone systems are designed to provide electricity for a single user while centralize systems can provide power to a small village. Solar energy has an advantage over the other renewable options in that this resource is more evenly distributed through out the world. In addition, data to assess solar energy resource before opting for a solar system is easily available; because the amount of solar energy reaching a specific point on the earth over the year is know with great certainty than for wind and hydro. The drawback for solar PV systems for mini-grid application is high cost linked to the hardware necessary to harness solar energy and make it usable. However, some ACP countries have taken the solar PV option for mini-grids, despite the drawbacks of this technology. These projects include PV-mini-grids for Yap state in Micronesia and PV mini-grid in Akane village northern Morocco

Wind Electric power systems
A wind electric power system uses wind turbines which convert the kinetic energy of the wind into electricity. The mechanism to capture the energy and then transmit and convert into electricity involves several stages, components and controls. Wind turbines can be broadly classified into two types according to capacity-Small turbines (up to 100kW) and large wind turbines. Small wind turbines are used for stand-alone systems (single user), mini-grid applications or grid, while large wind turbines are used almost exclusively for interconnected grid power supply. When small wind turbines are used together with suitable DC-AC inverters and a battery bank, the turbines can deliver reliable power to a mini-grid. A particularly attractive configuration in small wind turbines is the 5kW turbines, generating AC power that can supply village-scale mini-grids. Wind turbines must be located where the resource is found, this could be on hilltops, ridges and along coastal lines. It is necessary to ensure that the wind regime is adequate, both in terms of wind speed and availability over the day and thought out the year, before such an option is adopted.

Small – Hydro systems
Small hydro systems (Mini/Micro/Pico- hydro) are systems that convert kinetic energy from flowing streams or rivers into electricity. Small hydro electric projects are usually “run of the river” schemes which operate by diverting part or all of the available water flow by constructing civil works e.g. an intake weir, fore bay, and penstock. Water flows through the civil works into a turbine which drives a generator producing electricity. The water flows back to the river through additional civil works. These projects do not require catchments or dams, and thus have minimal environmental impacts.

The biggest advantage of this system is their simplicity and that they can be built locally at low cost. The draw back of these systems is the seasonal variation in flow, which makes it difficult to balance load and power output on an annual basis. Small hydro power generation is more popular in many community owned mini-grids and has also found favour with private investors. Several ACP countries (such as Kenya, Zambia, Solomon Islands, Dominican Republic etc.) have had an experience with small hydro system. Examples of some small hydro projects include: Thima, Kathamba and Tungu kabiri all in Kenya, micro-hydro electrification in Iriri village of Solomon Islands.

Biomass Power generation systems
Biomass based power generation technologies can be classified as direct firing, gasification and pyrolysis. These technologies utilize biomass fuel to produce electricity. In addition, it is also possible to generate electricity using biogas; however, these technologies are still unpopular in many countries. Biomass based electricity generation projects are considered to be Green House Gas (GHG) neutral, as there is sequestration of GHGs due to the growth of biomass feedstock- provide that the biomass used id harvested in a sustainable way.

Hybrid systems
This is another promising configuration that can meet rural electricity need. It involves a combination of different technologies feeding into the same mini-grid. These can be: a combination of wind systems and solar PV system, small hydro system and solar PV system, or a combination of all three systems. However, this is dependent on the availability of the resources (i.e. wind, adequate sunshine, and running stream/river) in the same location. This configuration allows each recourse to supplement the other, thus increasing the overall capacity and security of supply. South Africa has experience in hybrid systems, and examples of projects include the wind/solar PV hybrid in Hluleka Nature Reserve and Lucingweni villages.

How MPs can initiate and support the development of mini-grids?
The main advantage of mini-grids is that they can be initiated by an individual investor, a community, a Non-Governmental Organization (NGO), Community Based Organization (CBO), businesses or government. As local and national leaders, MPs can play a considerable role in influencing the initiation and development of mini-grids. For an MP to be effective in supporting the process of initiating and management of mini-grids, attention to the following set of issues is crucial.

- Financing
- Technical support
- Legal and regulatory frame work

The following are suggested policy measures that MPs can focus on in order to significantly increase rural electrification through mini grid:

Addressing financial challenges: Like most other rural electrification options, the initial investment cost for mini grid is relatively high. There is therefore need to identify financial resources. The World Bank (http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTENERGY2/0,,contentMDK:21456395~pagePK:210058~piPK:210062~theSitePK:4114200,00.html) and its subsidiary the IFC (http://www.ifc.org/ifcext/about.nsf/Content/WhatWeDo) have soft loans for renewables, Multilateral organization such as GEF (http://www.gefweb.org),, regional banks such as Africa Development Bank (http://www.afdb.org/en/) are also potential sources of financing. In addition, MPs can mobilize financial resources from regional, rural or constituency development funds, community contributions and bilateral organizations such as Danida, SIDA and JICA and local banks to cater for or augment the initial capital,

In Kenya, the Rural Electrification Authority (REA) has initiated a facility through which Members of Parliament contribute towards the implementation of small rural electrification projects in their areas. The facility, referred to as "matching funds", is meant to assist in the construction of projects that require the installation of transformers and short power lines (mini-grids). To access the facility the MP remits to REA a certain amount towards the cost of the proposed project (contributions can be from the constituency development fund, personal or community contribution). In return, the REA provides funds equivalent to the local contribution but subject to a maximum of Ksh 1.5 million (USD 20, 000.00) per constituency**.**

With 22 projects already approved, statistics from the REA indicate that they are currently considering funding 127 rural electrification projects,. Out of these projects, REA has adopted 8 mini-grids to supply power to 8 remote districts. Besides the rural electrification projects by REA, there are many other mini-grid projects being initiated and run by communities in various parts of the country (http://www.rea.co.ke)

To overcome financial challenges, the Mozambique government created an energy fund (FUNAE) and a National Directorate of New and Renewable Energy in 2005 (The Electricity Law of 1997 Law number 21/97). Through the creation of FUNAE (a public funded institution that provides finance to rural energy projects) has recorded tremendous success in the development of stand alone and promotion of mini-grids in rural areas of Maputo, Sofala and Inhambane provinces. By September 2009, FUNAE had successfully succeeded in implementing 30 mini grids through generator sets with a total capacity of 3000 KVA (about 3MW); 13 mini-hydros with a capacity of 1.2 MW and installed 1.9MW of Photovoltaic (PV) systems for families and small businesses across the provinces. *(*http://www.funae.co.mz/funae.php?__lang__=en*).* Given that total electrical energy in Mozambique is 2468 MW and less than 2% of rural areas is electrified, FUNAE's projects contribution of about 6.1 MW in the rural areas in the last five year can be said to be significant. (http://www.reeep.org/index.php?id=9353&text=policy&special=viewitem&cid=47)

In order to be able to reach large sections of rural communities, Zambia's government established a Rural Electrification Authority (REA) through an Act of Parliament in 2003 and was mandated to provide electricity infrastructure to all remote rural areas in order to contribute to improved productivity and quality of life for all Zambians. To ensure successful project implementation and sustainability, the Government of Zambia signed a multi-million project financing agreement with the World Bank in 2008. The funds to be channelled through REA are aimed at increasing access to electricity services through among others renewable energy mini-grid system. (http://www.rea.org.zm)

MPs can influence policies that reduce the initial investment cost for mini grids through provision of financial subsidy and/or reducing or removing applicable duties and taxation on the equipment. This can greatly improve the affordability of capital intensive renewable energy mini grids and attract private or community investment. Subsidizing the cost of equipment and partial financing of mini grids are some of the measures that can be used to reduce capital cost. Under such a model, the community or private sector will be required to cover the remaining investment cost and full cost of operation and maintenance. For instance, in Sri Lanka, communities borrowed from banks to supplement a subsidy of about 15–20 percent of the capital cost, to set up community-owned and -managed, micro-hydro grids.

Besides addressing the initial capital costs, other incentives that could favour electricity generation by renewable energy are necessary. One such incentive is favorable **feed-in-tariffs**. A feed-in tariff is a renewable energy law that obliges energy suppliers to buy electricity produced from renewable resources at a fixed price, usually over a fixed period - even from householders. These legal guarantees ensure investment security, and the support of all viable renewable energy technologies[4] By guaranteeing access to the supply network (in this case the mini-grid) and setting a favorable price per unit of power, FITs ensure that renewable energy is a sound long-term investment - for

[4] *Accelerating the Deployment of Renewable EnergyBy Miguel Mendonca*

companies, for industry, and for individuals - thereby creating a strong economic incentive for investing in renewable energy. **Feed-In Tariff** (FIT) laws have proved the best approach for accelerating the deployment of renewable energy in the electricity sector and are a crucial element of the policy framework for promoting renewable energy (*www.Onlinepact.org*). Currently only a few ACP countries including Algeria, Kenya, Mauritius and South Africa have FITs. However, most FIT laws are designed to benefit the grid, a locally-adapted variation of the FIT is therefore necessary to encourage development of renewable energy mini-grids. (Further read: the Renewable energy Regulated Purchase Tariff JRC European Commission)

Addressing technological challenges: Access to technical assistance especially during the development phase of projects is crucial whether the mini grid is being developed by a private investor or a community. Technical assistance can be in the form of feasibility studies, site surveys, capacity building, technical assistance in designing and social organization of communities, for example, into users associations. (Ref: Mini-grid design manual by 2000 by Allen R. Inversin, on the technical aspect). Maximizing the awareness and involvement of the beneficiary community early in the assessment phase is vital to the success of mini-grid projects. Key activities include promotional programs, capacity building of local technical people, and regular meetings with community leaders and focus-group meetings. (See Box 3)

Box 3:
A pilot village based micro-hydro electrification system in Iriri village, Solomon island, has been in existence since 1983, on a model of local identification of need, community partnership in design and construction, followed by local ownership, operation and local (village) financial return. It was upgraded (without external assistance or finances) to provide increased output and service new neighbouring communities. The Iriri experience prompted the Village First Electrification Program (VFEP) and led to similar projects in neighbouring villages of Vavanga and Ghatere. In the absence of government support structures that can effectively work at the village level, the VFEP has been providing for the unprecedented demand for the model's diffusion as an appropriate technology and as a Melanesian-style-socially-conducive project management method. As a result, indigenous, registered national Councils have been formed in Solomon Islands and Papua New Guinea (Solomon Island Village Electrification Council and Papua New Guinea Village Electrification Council) with similar structures being nurtured in Vanuatu and Bougainville and interest being shown from East Timor and several other pacific nations. The Village First Electrification Model has been developed over many years to meet the particular contest of rural, village based society with little to no prospect for government support. (Ref: Village First Electrification Program (VFEP) contact: Mrs. Barbara Hardy, APFED, bhardy@picwine.com.au)

For renewable energy based mini-grids to be economical and sustainable, there is need to brake away from the stringent technical standards place on the grid system. The

principles behind the design of mini-grid should be safety, adequacy of power, expandability, local maintenance and efficiency. Therefore to avoid the complexity and high costs that can quickly place the mini-grids beyond the reach of the typical village, standards that take into account the local circumstance, resources and low cost technologies that depend on rural skills should be encouraged. General guidelines on how to provide the desired local technical assistance include training of energy service providers in equipment management, production of training manuals for end-users and training manuals of local technicians/installers.

MPs can help by ensuring the building of local technical capacity which will go towards facilitating the mini grid option, into national and rural development policies. This means that access to modern energy via mini grids will be given the same seriousness just as access to education and health services, and therefore it will be easier to build technical capacity. This link http://practicalaction.org/energy/micro_hydro gives an example of an existing mini hydro initially funded by UNDP. It has a video that narrates the history and the operations and challenges facing Tungu Kabiri mini-hydros.

(*Genset and Transformer in Inhambane Mozambique*)

Addressing the legal and regulatory framework: Despite the energy reforms being carried out in various ACP countries, power transmission and distribution still remain in the hands of government. Many governments still rely on policies that were developed for centralized grid supply networks which are not appropriate for mini grids or other decentralized electrification options. Decentralized electrification requires a different approach in terms of operation, maintenance, customer service, and billing.

MPs can help create appropriate, workable legal and regulatory frameworks for mini-grids. A regulatory framework can take either of the following options:

- A light handed approach to the regulation, for mini-grids. This means that rules are not so stringent for mini-grids

- Devolved regulation – this is a situation where regions or constituencies are allowed to set their own regulations for mini-grids and energy in general.
- Flexibility in regulation – this is where, an energy regulator is allowed to apply and vary methods of regulation depending on prevailing factors such as region, and stakeholders involved.

The current Kenya Energy Act (2006) explicitly encourages private electricity distribution by communities and other interested players. This is in contrast to the previous legislation (Electricity Act, 1997) which, though it allowed private generation, it did not permit distribution of electricity by private investors.[5] Aside from simplifying and expediting the permitting process for investments below 3MW, the current Energy Act provides yet another key incentive: permission to charge tariffs that cover operating costs and yield a fair return on investment. The ability to charge tariffs that enable investors to recoup their investments has important implications for attracting private capital, thereby creating incentives and opportunities for scaling-up and replication of mini-grid systems.[6]

Tools to facilitate MPs to build political support for mini-grids

There are various ways MPs can use to build political support for mini-grids and renewable energy in general. Some of these include:

- Through appropriate parliamentary committees on energy, environment or natural resources
- Working with relevant government ministries to influence them directly
- Through Renewable energy associations and community based organizations
- Political networks such as the Parliamentary Network on Renewable Energy and Climate Change (an example of a parliamentary network in Kenya) (http://www.panerecc.or.ke)
- Through civil societies such as Non-Governmental Organizations (NGOs), Community Based Organizations (CBOs) and other local development groups
- Through the media, both print and electronic
- Ensure national or state budget has funding for REAs or matching funds or seed funding
- Amend current or draft laws to encourage mini-grids
- Approach policy, researchers, energy experts, consultants, etc to assist with background research on appropriate mini grids[7]

[5] Energy Act 2006 part III section 27
[6] Energy act 2006 part III section 45 (the energy act is available for download at www.energy.go.ke)
[7] For more information on what MPs can do visit the links below:
http://www.undp.org/governance/sl-parliaments.htm
http://www.e-parl.net/eparliament/welcome.do
http://www.pnowb.org/

Roadmap of the steps that must be taken to develop a government plan for mini grids

1. Identify energy needs of a community or group of people
2. Carry out survey of existing renewable energy resources within the vicinity of the community
3. Carry out a feasibility study to include the technical as well as cost benefit analysis of developing available resources taking into account the positive environmental aspects of renewables
4. Discuss the report with community leaders, local NGOs and local government to obtain their buy in, support and ownership.
5. Approach the relevant government ministry for technical as well as policy support
6. Mobilize local and external financing as appropriate
7. Launch and develop the project.