PV Mini Grids in Uganda – Best Practices

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Dr. Al-Mas Sendegeya has attended and given presentations in a number of fora on Sustainable and/or Renewable Energy. He has experience of more than 20 years lecturing and curriculum development in Tertiary institutions and supervising students' research projects at both undergraduate and Master's levels. He has engaged in energy and power systems research addressing extending power to rural communities. His main research interest is in the field of sustainable energy, energy for rural development and social engineering aspects. His research interest is to cover the gap between social related problems and engineering. His research publications are mainly in capacity building in sustainable energy. He has provided various consultancy services in the field of Solar Energy and rural energy development with GIZ Uganda. He served on the board of an NGO in Uganda promoting Renewable Energy technologies in Uganda. Under this Organisation he worked on a number of rural energy projects, and served as the technical advisor in Renewable Energy issues and Energy for Rural transformation. He was involved in the EU funded project, the Sothern African Sustainable Energy (SASEI) project coordinated by Namibia University Science and Technology (NUST). The project has been focusing on capacity building in sustainable energy in which three regional partner institutions were involved (Namibia, Botswana and Lesotho) and one Germany University. He has engaged in a number energy consultancy with different private sectors. Technical Consultant with the Electricity Control Board in Namibia. Solar thermal Training expert under the SOLTRAIN project managed by the Namibia Energy Institute (NEI), under the Namibia University of Science and Technology. Considering isolated mini-grids and embedded generation. Currently, engaged in a number of research activities related to sustainable energy issues. A visiting lecturer with the National University of Lesotho, giving lectures on Sustainable Energy. Full time employment at Kyambogo University in the Faculty of Engineering, Department of Electrical and Electronics Engineering. A national coordinator for the joint project "Resilient and Sustainable Energy Networks for Developing Countries" done with other universities (University of Southampton, Jomo Kenyatta University of Agriculture and Technology).

Current Research

Background

The demand for modern energy services is increasing in most part of the world especially in the developing nations. Rural electrification is among the issues addressed on the agenda of most governments in the developing nations. Energy for Rural Transformation is becoming a slogan among developing nations to capture the understanding of the need to increase modern energy services in rural communities. The demand for affordable, reliable and sustainable energy services is increasing in most parts of the developing nations. The success of such energy supply should consider promoting and developing locally available resources e.g. renewable energy sources. To increase reliability of supply the

optimal design and hybrid operation of these systems should be given special consideration. In this regard, planners and designers of isolate rural power systems are increasingly considering hybrid power supply systems. Mini-grids in power networks can be considered isolated though may have various power supply options.

Mini-grids at Kanyegaramire and Kyamugarura

Kyamugarura and Kanyegaramire villages are located in Western part of Uganda, Kitega Parish, Bufunjo Subcounty Mwenge county, Kyenjojo District almost at the same latitude (0.657958^0N), longitude (30.864482^0E) and altitude. The two villages operate solar PV power mini-grids. The two mini-grids are close to each other at a distance of about 1km. The infrastructure in the area in terms of roads and other systems like mobile communication facilities are available. The two sites have power plants of the same capacity. Solar PV Plant with installed capacity for panels of 13.5kW, 54 modules each at 250Wp. The inverter size in each site is 10,000VA, 2 inverters @ 5,000VA, 48V and storage capacity 24 Batteries @ 800Ah, 2V. The grid networks in both areas are standard single-phase AC 240 Volts power network for low voltage consumers. The installation was designed following standard grid codes of the country. The developer is the same and the support locally is from the main stakeholder (Rural Electrification Agency, REA). REA is working on the upgrading of the systems to coup up with the increasing demand.

Solar PV modules on top of two containers (one container is accomodating battery bank and other BOS components, the second container is the administrative office)

Battery bank

Overhead distribution lines (single phase 240 V)

Road in the community showing poles and households.

Demand: The customer size is averagely the same in the two villages. In Kanyegaramire there are approximately 78 customers, 32% commercial and 68% households, while in Kyamugarura there are currently 65 customers, 30% commercial and 70% households. The households predominantly have “Life-Line” needs of about 2-3 kWh per month for 3 LED lights, a radio and mobile phone charging. The two communities are committed to the connection of public loads (schools, health centres and street lighting), commercial loads (shops, local restaurants, entertainments places, tailors, barbers etc.). Though

the current system does not support large commercial consumers, there is potential for the mid-day period, mechanical tasks (milling, welding, oil-pressing etc.). The culture of people in the two communities is the same and they have almost the same economic activities.

Metering and Tariff: In both areas a connection fee of UGX 140,000 (Approx. USD 39) is charged from each customer and is inclusive of house wiring, bulbs, meters and sockets. The customer only pays for the energy used. Tariff of 1000 UGX/kWh (Approx. 28US cent /kWh), paid cash and offered a token on a smart card for the prepaid meters. The system employed avoids billing costs and prevent arrears. Revenue collection is accomplished by a permanent staff employed by the village cooperative.

The power mini-grid systems to be clustered must meet the following:

- **Existence and operational of systems:** The systems to be clustered must be operational and generating power to the local communities.
- **Same power characteristics:** The power generated from the system must have the same power characteristics AC two-phase or three-phase. The technology for the grid networks must be the same to avoid mismatch during interconnection and operation.
- **Closeness of the systems:** The distance between the mini0grids to be connected must in a reasonable proximity to reduce the cost of building an interconnection links. Also this can be supported if the areas between the existing networks have a potential demand for electricity.
- **Sufficient generation and flexibility for expansion:** At least most of the existing mini-grids must have sufficient power generation which can be expanded and delivered to other areas with deficit in demand. The design of the existing systems must be flexible in terms of expansion and/or the cost of expansion must be reasonably affordable by the local communities/developer/operator.
- **The clustered systems support use of local resources:** The mini-grids to be clustered are expected to promote the use of local resources both energy sources and human resource.

The mini-grid systems at the two sites mentioned above can easily be adopted for clustering and eventually for interconnection to the national grid. However, for interconnection it might require to upgrade the system to three-phase to higher voltage (possibly 11 kV) for distribution network in Uganda. The systems make use of the local resources and the systems are managed locally. This has demonstrated the ability to build local capacity.

It is envisaged that after clustering there will be a need to employ one or two staff within each village to provide customer support and monitor the equipment. The Cluster will be supported by a Regional office with technical, marketing and finance staff. Pre-payment for bundles will be by mobile phones or coupons can be sold from the Energy Kiosk Large SME, public loads will also be considered to pre-payment. Research on this issues is ongoing.

NB: *This article is not an official publication from the research team but presented to inform colleagues reading the PPRE Newsletter about the progress of my research.*