Session 6: Offgrid Technology and Lighting Africa

Wednesday, June 10, 2009

Currently, 500 million people in Sub-Saharan Africa (SSA) are estimated to live without electricity. Although grid electricity is gradually being extended, its reach is still primarily limited to urban and peri-urban areas. Electrification rates in rural areas, where the majority of the SSA population lives, are below 10%.

Off-grid solutions can effectively complement grid electrification efforts. For remote and dispersed populations, in particular, the only way to access modern, clean and affordable electricity is through off-grid technology. Major advances in off-grid energy technologies provide new opportunities for cost effective service provision models.

Lighting is often the most expensive energy item for African households. Lighting is typically provided by inefficient fossil fuels, such as kerosene. One person in three obtains lighting from fuel-based sources – this represents 17% of global lighting costs, but only 0.2% of the actual lighting output received. Fuel-based lighting is not only expensive, but is also polluting (and indoor pollution often leads to serious health problems) and potentially hazardous (safety/fire issues). Its poor quality also limits its impact in education and other productive activities.

Technological advancements are resulting in rapidly increasing efficiency and falling prices of modern off-grid electricity products, like solar home systems and LED lamps. Therefore, for the first time in history it may be possible to offer energy services that are clean, efficient and reliable, and at price points that are comparable to typical expenditures for kerosene.

Even the lowest-cost products, however, represent significant investment expenditures for poor households. The quality and durability of these products, therefore, is of the utmost importance. Unfortunately, rapid innovations result in constant modifications and upgrades of these products and a wide spectrum of products offered as well. While this is generally beneficial for the customer, it also makes quality monitoring and enforcement very difficult.

The session provided an overview of new technologies and trends in off-grid electrification, both for mini-grids and stand-alone systems, and discussed the current efforts in determining

and promoting quality standards, particularly for low-cost solutions, such as solar or rechargeable lanterns.

The **hybrid mini-grids** are a promising solution for remote villages, but their potential in rural electrification is often not fully recognized. Hybrid mini-grids rely on a combination of different but complementary energy generation systems based on renewable energies or a mixture of renewable and conventional energy sources (e.g. renewable energy and a diesel genset). Hybrid mini-grids providing steady community-level electricity service, such as village electrification, also offer the possibility of being upgraded through grid connections in the future.

The session provided insights into the mini-grid powered by solar PV technology. The session presented examples of PV mini-grids from **Senegal, Morocco and Ecuador**. The session showed that hybrid mini-grids are a cost-effective solution for remote communities and are superior to grid-extension and fossil fuel alternatives. The falling prices of PV panels and the availability of better tools for load management and improved efficiency make this alternative even more attractive.

Pros and cons in comparison to stand-alone PV systems were discussed. One of the key benefits is the provision of AC electricity. In terms of usage, PV mini-grids can provide the same services as stand-alone solar home systems, but they are better suited for productive uses and some community applications, such as village water pumping and public lighting.

On the other hand, they require the sharing of available energy among community members, which may be a challenge. Good social organization and load management are essential. Other challenges include relatively high investment costs, more sophisticated maintenance requirements, and the collection and management of funds for maintenance and spare parts. Experience recommends a fixed tariff and an operator for long-term security.

In **Mozambique,** new and old technologies meet in a GTZ-sponsored project which takes advantage of the existing **maize hydro-mills** and retrofits them with new, repaired and/or upgraded equipment for power generation.

Maize mill owners produce and sell power to households via mini-grid or battery charging, collect the connection fee and the tariff, and are responsible for improvement and maintenance of the turbines, water system and power houses. They are required to repay their loan for mill upgrading within two years into a community revolving fund. The mill owners form part of the community committee for the management of the fund and are trained in business management. Households pay 50% of the in-house installation (or battery) through monthly payments for up to two years, contribute with poles and labor for the establishment of the mini-grids, and select young people to be trained as electricians for maintaining the grid and in-house installations.

As a result of these activities, demand for more micro-hydro projects is generated in the region. Productive use of electricity is now starting and the number of local shops is increasing. There is now good potential for the local manufacture of runners and turbines, although the market is still very limited and services are rather expensive. The market is, however, expected to grow as others are now copying this approach, lots of publicity is given to the existing projects.

The session also discussed the latest trends in the **solar PV industry**, with a particularly focus on **solar home systems** and its implications for Sub-Saharan Africa. The session on "wireless power" asked two provocative questions: "Why doesn't PV grow faster in the rural areas while, other technologies like cell phones have conquered a large market in a shorter time?", and "Is PV second-class electrification?". The session showed that even in developed countries, PV is becoming a part of the energy supply, fueled by falling costs and environmental concerns. The presentation draws the parallel with cell phone technologies which have overcome the need for a hard wire network (often available only in densely populated areas) and has rapidly become the technology of choice in Europe, Africa, and elsewhere.

Similarly, power grids in Africa are available only in big cities and high density areas. At the moment, kerosene and candles are used for lighting in rural areas, while dry cell batteries are used for radio. Both are expensive (1 liter of kerosene cost at least US$1 and lasts for one week or about 20 hours. A radio costs about US$0.05 for one hour of use). PV systems can offer superior solutions. Since PV systems can be sized to demand, they are well suited to be a technology of choice in rural Africa. For example, a solar home system may be sized to power a larger house with a refrigerator and TV (costing US$$1,000) or a large TV and 3 lamps (for US$250) or a small TV, 3 lamps and a radio (for US$100) or a lamp, radio and cell phone charger (for as low as $50 – about the same cost as a cell phone!). Factors to reduce cost include efficient loads, innovative batteries, and lower module cost.

Lighting is typically the most expensive energy item of an African household. In total, $17 billion is spent annually in Africa for fuel-based lighting, which offers a huge market for modern lighting products. Although the market has low profit margin, its strength is in the high number of clients (if the right product for the right price can be offered). The GTZ-sponsored pico-PV program and World Bank Group's Lighting Africa are examples of two initiatives that aim to transform the lighting market from fuel-based products to clean, safe and efficient modern lighting appliances.

The **Lighting Africa** initiative, an innovation of the World Bank and IFC, works with the private sector, governments and NGOs in Sub-Saharan Africa to develop and disseminate low-cost, clean and efficient modern lighting solutions for the 500 million Africans who currently rely on kerosene or other forms of inefficient and polluting fuel-based lighting. The activity exploits new technical innovations, such as the latest LED, fluorescent and solar technologies. Lighting Africa's goal is to accelerate the market transformation and to ensure that affordable quality products reach Africa.

Lighting Africa is therefore addressing a number of barriers currently constraining a higher penetration of good quality products on the continent, including market information, quality assurance, innovation, policy and regulatory issues, market aggregation, information and networking and finance facilitation. The long-term goal is a rapid scale-up of access to clean, reliable and affordable modern off-grid lighting services for 250 million people across Africa by 2030.

Quality of off-grid lighting products remains one of the key challenges. Rapid technological advancements and innovations, as well as a multitude of products available at the market, make quality control a difficult task. In this respect, **GTZ-sponsored quality and performance tests of pico-PV** systems provide valuable information and illustrate the challenges ahead. The consequences of bad quality products are (i) a reputation loss for a whole product range — endangering market development; (ii) waste of scarce resources; and (iii) environmental hazards.

The pico-PV program focuses on systems under 30Wp. These may be classic solar lanterns (for lighting) or multifunctional systems, offering lighting and additional appliances like radio use or cell phone charging. The objectives of the test were to (i) contribute to transparency in the dynamic pico-PV market, (ii) support development of a testing methodology, and (iii) start identifying pico-PV systems with good quality and affordability that are suitable for large-scale dissemination.

Fifteen systems from China, Laos, Great Britain, Germany and India were tested in a two-level procedure. Seven tests passed the level 1 test, and five of those passed the level 2 tests. The main problems at the first level were: insufficient luminance; broken components; bad mechanical design; and the poor quality of electric and electronic parts. The main problems at the second level were poor electrical and electronic design; solar panels and batteries not showing their nominal values; light degradation of the LED; and bad quality of the battery and solar panels.

The test confirmed that the quality of solar lanterns on the market is mixed, and that only a few products of acceptable quality are affordable for the target market. However, market growth is expected due to price reductions and additional technological developments. The products are therefore expected to keep evolving. In this process, continued monitoring of lantern quality and dissemination of information to potential customers is needed to ensure transparency.

The session concluded with two presentations demonstrating both the potential and the implementation challenges for pico-PV and other low-cost lighting products. A project in Liberia (a Lighting Africa Development Market Place winner) aims at supplying improved lighting products for at least 500 low-income households and 300 street vendors in rural Liberia. The project uses a two-fold business model to remove the affordability barrier, including (i) cash sales for social institutions, small businesses and other more affluent customers; and (ii) a microfinance credit facility for low income and poor consumers — for example, 500 Glowstar solar lamps are offered for a US$12 monthly fee.

The project's key challenges were a delay in the project's kick-off date; the long procurement process due to a lack of suppliers on the local market; the lengthy legal processes involving in getting a micro-finance and loan guarantee agreement signed with the local bank; and limited awareness on improved lighting products amongst rural residents.

The path towards sustainability consists of identifying, selecting and training potential community based distributors and sales agents (solar entrepreneurs); developing effective supply chains locally; working with the local bank to include solar PV in its loan portfolio; and partnering with institutions such as E+Co to ensure financial viability through energy enterprise development.

Similarly, in **Burkina Faso**, solar charging stations have emerged as a response to rural demand. 80% of the rural population in Burkina Faso has no electricity and about 10% have a cell phone (with 15% annual increase in penetration rates). Cell phone holders face difficulties like long journeys and high costs in recharging their phones. Therefore, the NAFORE project has started offering solar charging stations. One station, operated by a micro-entrepreneur, has the capacity to charge about 780 cell phones per month at a price of 0,22€ FCFA. Currently 24 stations in 22 localities are in operation. The key challenges include growing demand (surpassing the capacity of the charging stations), difficulties in pre-financing the stations, and the difficulty of obtaining a bank loan despite the business' high profitability. In the future, NAFORE plans to increase the capacity of the charging stations, including that for portable lanterns, LED lamps and battery charging. NAFORE is a winner of 2009 UN SEED Award.

Presentations::

Prof. Peter Adelmann, University for Applied Science, Ulm, Germany – Future Small PV Technologies for Africa.

Anil Cabraal, Lighting Africa Program Manager, World Bank Group.

Kilian Reiche, AEI Lead Adviser, Pico PV (GTZ LET & ESMAP) .

Gus Goanue, Private Entrepreneur – Lighting Africa and pico-PV: Challenges on the ground, Lighting Africa Development Market place.

Antoine Graillot, Trama Technoambiental (TTA), Spain – Smart PV and Hybrid Mini-grids for Africa.

Klaus Homberger, GTZ Mozambique – Mozambique Micro Hydro Mill Retrofits.