Case Study From

NEW ERA IN OIL, GAS & POWER VALUE CREATION

Hospital-Sponsored Power Generation in Democratic Republic of the Congo[1]

In August 1996, the managers of a non-profit hospital and nursery school in Kizaba Village – a four hours drive from Bakavu in Kivu Province, Democratic Republic of the Congo – began powering the facility with a hydropower generator on the Luzinzi River. The new 150 kW power plant, run on a 40-year old turbine purchased from Norway, replaced the hospital's three diesel units with a total capacity of 50 kVA.

- *How did the institutional framework for the project develop?*
- *What issues arose during project implementation?*
- *What are the implications for community development?*

Background

The Christian missionaries of Communauté des Eglises Libres de Pentecôte en Afrique (CELPA) have been providing education, community development and humanitarian aid to the Democratic Republic of the Congo (DRC, formerly Zaire) since 1922. Even before regional hostilities resumed in the mid 1990s, CELPA's Humanitarian Aid Project (HAP) began not only addressing the immediate needs of affected people, but also supporting community rebuilding efforts, including small business loans to almost 300 women. Despite a 2002 power-sharing agreement between the Kinshasa government and Ugandan-backed rebels, a peace treaty with Rwanda, and a military pull out by neighboring countries, internal hostilities continue to simmer.

CELPA's focus, unlike that of the United Nations and other international relief agencies, has been remote or insecure areas. As early as the 1960s, CELPA began developing a hospital to serve the rural population in Kizaba, a remote village in Kivu Province. By the early 1970s, the missionaries realized they needed a secure, yet inexpensive, power supply to serve its growing patient load. The rapids of the Luzinzi River nearby made hydropower an option from the beginning, but limited human, as well as financial, capital delayed substantial energy development until the mid 1980s. In 1980, the budget provided for operation of one 6-killowatt (kW) diesel generator three evenings a week, though the hospital owned three diesel units with a total output capacity of 50 kVA. On the remaining evenings, a solar unit supplied only enough electricity for basic lighting.

Located in Kaziba Village, the hospital is four hours drive from Bakavu, the province's largest town, and 40 kilometers from the country's main power grid. In 1986, the hospital considered:

1) continuing to use diesel units – to the extent diesel fuel was available – at a cost of 5 cents per kilowatt hour (kWh);
2) connecting the hospital to the DRC's main grid; or
3) developing a 75 kW hydropower system at an estimated cost of $400,000.

[1] This case study was prepared using publicly available information.

Studies indicated the third alternative was the least expensive, but by 1988, but a new study in 1988 concluded that a 125 kW plant could be constructed at a projected cost of $700,000. By the time of the project's commissioning in August 1996, the cost had risen to $1 million, reflecting substantial war-driven construction delays. This included new wiring and electrical equipment for the hospital and construction equipment that could be put to other uses in the community once the power project was completed.

To run the system, CELPA purchased a fully refurbished, double Francis turbine from a power station in Norway that had used it for 40 years, and a redesigned Hitzinger belt-driven generator with a capacity of 150 kVA, 50 Hz and 1500 rpm. This simple turbine is flexible enough to accommodate water flow variations and utilization swings from 10 percent to 100 percent of full capacity. The generator's reinforced-steel belt purportedly is easily replaceable, yet equally durable, in comparison to gear-driven generators.

To heighten the drop of the spillway – and thus, the power generating capacity of the plant – the developers straightened the river. They had some trouble finding rocks large enough to secure the banks, but compensated by setting stones in concrete along the most vulnerable stretches of the downstream bank and planting waterway grasses with deep roots along the upper bank.

The estimated construction cost for the plant was 9 cents per kWh, covered by a grant from the Norwegian government. The economically viable plant produces about 750,000 kWh of electricity per year, at a maximum capacity of 125 kW. This includes a four-week hiatus for maintenance.

Institutional Development

Local Leadership

The purchase of a turbine from a Norwegian power station was not random. Norwegian churches, the Norwegian Foreign Affairs Ministry, the Pentecostal Churches Mission in Norway, and Norwegian Church Aid, among others, provide collaborative and financial support to CELPA, though all CELPA leaders are Africans.[2] According to CELPA Project Coordinator Sadiki Byombuka, this local, religiously affiliated leadership is a two-edged sword. As an indigenous agency, CELPA has easier access to, not to mention more local knowledge of, the most remote communities. In addition, much of its staff is voluntary and already subject to the personal security risks that work in such war-torn regions entails. On the other hand, CELPA's ties to local churches may make it more susceptible to partisan tendencies and hostilities. Also, CELPA has more difficulty raising funds than more internationally well-known organizations.

Local Training

In addition to procuring a secure, affordable energy supply for the hospital and surrounding environs, the developers wanted a system that could be built, operated and maintained by local residents. In the course of construction, the developers trained members of approximately 150 families in carpentry, concrete mixing and reinforcement, water diversion, tool repair and power plant operations. While CELPA undertook responsibility for business operations – tariffs, budgets, sales and human resources – it employed five technically trained locals to operate the plant:

- two degreed electrical engineers without plant-specific training;
- two primary-school educated employees trained during the project's implementation and testing; and

[2] CELPA also operates in Niger, Rwanda and Tanzania.

- a former school teacher trained as a foreman during construction.

As the plant manager, the former school teacher is responsible for billing, emergency planning, and supervising plant maintenance and operations. The other four work in two teams of two – a degreed and a non-degreed technician – on daily operations and maintenance, with each team alternating standby duty on nights and weekends.

Local Development

In addition to the hospital, the power plant supplies street lighting to the neighboring marketplace and electric power to the local government. It also sells electricity to 50 households in three villages, with plans to expand to another 150 households as circumstances permit. Each village has created an organization that negotiates with CELPA, builds the distribution network from the hospital and wires the homes of those families purchasing electricity. The hospital, as owner of the power plant, supplies distribution planning and wiring expertise, but each village purchases materials, and maintains and operates its own distribution system.

Project Development

Economic

Though not all of the electricity is used, studies by Torodd Jensen and Einar Beheim indicate that plant operations are economically viable. Analysts cite the system's structural integrity and low maintenance costs as significant contributors to this viability. In addition, they point out that the low-tech nature of the turbine, generator and manually operated spillway gate simplifies local operation and maintenance. In addition, the manmade bank reinforcements survived a torrential downpour in December 1995 that overflowed the dam itself.

A comprehensive economic analysis would cover more than just the initial equipment purchase, however. The purchase cost of old, used technology may be low, and the training required for general operation and maintenance of such machinery may be low. This technical training may be difficult to come by and may take a long time, however, particularly during periods of armed conflict. On the other end of the spectrum, state-of-the-art technology often is more efficient, and the knowledge required to operate and to maintain the system more widespread. So if local managers have a problem with the equipment, the expertise on how to fix it may be more readily available. However, if older technology takes more people power – as opposed to non-human resources – it still may be more efficient for a low-income community than the high capital cost of newer equipment. Thus, the most cost-effective technical solution may not necessarily be the oldest and cheapest equipment, but rather the most appropriate technology for the quantity and quality of the community's labor supply and energy requirements.

The hospital pays 7 cents per kWh to cover operation and maintenance costs. The 10kW of generation capacity in excess of hospital needs is made available to the local government and sold to private households at 15 cents per kWh. This tariff rate equates a household's use of 3 electric light bulbs for 3 hours per day to burning one kerosene lamp for 3 hours per day. For the Kaziba Project, developers considered reducing household rates below the cost of kerosene to encourage expansion of the electric distribution system. Increasing nighttime consumption by the hospital, and expanding the system to more local households, may actually improve the economics of the project. Analysts assert that, by levelizing the water flow, nighttime consumption reduces sedimentation, thereby slowing the decline of generation capacity available during the day. With more generation capacity, the hospital may be able to generate more income by selling more electricity.

Environmental

Kaziba Village sits at the end of a 4 km-long floodplain. Deforestation, agriculture and gold mining already fill the river with sediment. Expected acceleration of these development activities – spurred on by more accessible energy supplies – should widen the gap between water flow peaks and valleys. Though observational estimates place maximum flows at 30 to 40 cubic meters per second (m^3/s), flows in excess of the 150 m^3/s capacity of the headrace channel could substantially damage the plant, even if the overflow only lasted a few hours. In addition, higher-volume flow peaks reportedly exacerbate already severe erosion of valuable agricultural lands, while slower flows make it easier for the sediment to settle in the channel. Experts believe that more silt in the channel shortens the lifespan of hydropower operations by reducing the catchment capacity and increasing the strain on equipment.

The low-tech nature of the waterworks, however, may make it possible for the operational team to mitigate head loss resulting from the heavy silting. First, they compare the potential cost of head loss to that of wasted electricity production before reducing the flow rate below that necessary to prevent silting. Second, they manually regulate flow velocities – using three tap gates in the headrace channel – when low electricity demand mandates that the turbines operate slowly or not at all. Third, 10-man teams regularly and systematically dig out the headrace channel and flush sediment out of the system at a cost of $20 per cleaning. In addition, project studies indicate that a collateral benefit to straightening the river downstream of the plant was an increase in agricultural acreage.

Social

Plans were in the works for construction of a community workshop that would purchase electricity from the hospital under the same tariffs as those imposed on the villages, but the project was shelved when hostilities resumed in September 1996. Soldiers and bandits raided Kaziba, but the power plant continued to provide secure electricity supplies to the hospital. While CELPA has succeeded in keeping the plant physically operational, despite some trying technical challenges, the most substantial threat to the institution's long-term viability may be continued armed conflict throughout the region.

<u>Sources:</u>

Byombuka, Sadiki, *CELPA: A Local Response to Congo's Conflict* (Dec. 23, 2002), http://www.odihpn.org/report.asp?ReportID=2491 (last visited Mar. 27, 2003).

World Energy Council, *Democratic Congo: The Kaziba Project* (based on studies by Torodd Jensen and Einar Beheim (NVE)), *in* THE CHALLENGE OF RURAL POVERTY IN DEVELOPING COUNTRIES 159-165 (1999).