



Mini-Grid Policy Toolkit- Case Study



Country: NAMIBIA

Project: Tsumkwe Solar PV Hybrid Mini-grid

Utility Operator Model

Project Summary



Tsumkwe Solar Plant under construction 2011 (source: www.tsumkweenergy.org)



Tsumkwe Solar Plant - Completed 2012 (source: David A. Jarrett)

The Tsumkwe solar PV-diesel hybrid power plant was the first off-grid public power supply of its kind in Namibia. Its main purpose is to generate and distribute electric power for the Tsumkwe Settlement Area. Originally the plant was planned as a purely solar PV system, but due to a surge in customer growth and to reduce costs, make the kWh price more affordable, and still allow for an increase in client numbers, it was redesigned as a PV-diesel hybrid system.

Although the regulatory framework relating to Independent Power Producers (IPPs) allows for private sector participation in Namibia, in practice the country's electricity supply is generated primarily by NamPower (the national electricity utility) and distributed by regional electricity distribution companies (REDs) or Municipalities. The Tsumkwe solar PV hybrid mini-grid was therefore the first attempt to spur private involvement in the sector.

Although this was ultimately unsuccessful due to the change in strategy of the plant's configuration, it has allowed the Government to draw lessons for improving the regulatory framework to facilitate independent (whether privately or publicly owned) power production.

Background

In Namibia, only 15.2% of rural households have access to electricity. In 1991, the Namibian Ministry of Mines and Energy (MME) began a rural electrification programme aimed at connecting previously off-grid rural settlements to the national grid. By 2004, MME and NamPower had electrified 80 villages.



During work related to the development of the MME's Off-Grid Energisation Master Plan for Namibia (OGEMP) in 2006, a local NGO called Desert Foundation of Namibia (DFRN) identified the settlement of Tsumkwe as an area undergoing a boom in tourism and other economic development, but also an area that would remain unconnected to the national grid. This made Tsumkwe suitable as a site for an off-grid solar PV plant that would be the largest of its kind in the Southern African region. DFRN and its partners (NamPower and the Otjozondjupa Regional Council) secured financial support for the project from the ACP-EU Energy Facility.

Basic Information

Location	Tsumkwe, Namibia
Project implementer	Desert Foundation of Namibia (DFRN), a local NGO NamPower (14%); Otjozondjupa Regional Council (11%) Ministry of Mines & Energy (MME); Electricity Control Board (ECB)
Project date	Initiated in 2006; commissioned 13 th August 2011
Beneficiaries	The direct beneficiaries of the project include the Tsumkwe community which consists of approximately 1000 permanent residents; 35 local institutions and businesses such as schools, shops, petrol station, regional court, hospital, hotel, and between 2000–3000 San people living in and around the town.
Project cost	NAD 28.8 million (EUR 3.02 million / USD 4.3 million) ¹
Organisations involved	DFRN, with funding from the European Union (ACP-EU Energy Facility), and funding and/or support from the Namibia Ministry of Mines and Energy, Namibia Power Corporation (NamPower), and Otjozondjupa Regional Council (OTRC)

Policy & Regulatory Framework

The Ministry of Mines & Energy (MME) is a government custodian and in the year 2000, mandated by the Electricity Act of 2000, created the Electricity Control Board (ECB) to regulate the electricity industry for generation, transmission, and distribution of electric power. NamPower, the national electricity utility existing as a legacy institution from pre-independence in 1990, has the responsibility for maintaining and improving the electrical infrastructure. The MME and NamPower have collaborated to implement the rural electrification programme established in 1991 with oversight and support of the ECB since its creation.

Namibia's White Paper on Energy Policy of 1998 recognises the importance of renewable energy and its potential in helping the country meet its energy-related objectives. The MME's Off-grid Energy Master Plan of 2007 supports various ways of providing access to modern energy. The 2012/13 Fourth National Development Plan (NDP4) recognises the benefits of public infrastructure and that the "availability of sufficient and affordable energy could become a bottleneck for rapid economic development during the NDP4 period". There is, however, no explicit reference to mini-grids or even

¹ August 2011 exchange rates (http://ec.europa.eu/budget/contracts_grants/info_contracts/infoeuro/infoeuro_en.cfm)



Megawatt (MW) Class renewables as the focus is on demand-side management and energy savings.

As IPP arrangements are still in their early days, their effectiveness as mechanisms for broadening electricity provision in Namibia is not completely established. The Tsumkwe Energy Project was the forerunner and hence a test case for many IPP regulations. However, the signing of two Power Purchase Agreements (PPA's) for grid connected Megawatt (MW) Class PV Plants may help change the playing field.

Amongst other possible barriers, these IPP regulations do not fully address Change of Law, Regulatory, and foreign exchange risks.

Technology

Overview

This is an example of a solar PV hybrid AC-coupled mini-grid. The Tsumkwe plant was originally planned as a 100% PV system with an energy storage capacity of approximately 1.5–2.0 MWh and a peak power capacity of around 150 kW. In order to reduce costs, make the kWh price more affordable, and increase client numbers, the plant was redesigned as a PV-diesel hybrid.

On non-overcast days the solar array provides approximately 50% of the daily energy demand with the gensets powering the remaining 50% of the daily energy demand. It was originally designed to be an automatic system, but due to technical difficulties, the switch over from solar to diesel has to be done manually. The batteries are not allowed to discharge to less than 50% to prevent early battery life failure and therefore the generator is used for additional charging.

The AC-coupled system provides 24 hours of electricity supply. Annual energy consumption is just under 548 MWh.

Technology Approach

This PV-diesel hybrid plant uses a 202kW solar PV array, 1050 kWh (1.05 MWh) battery array, two new 150kVA diesel generators, and an overhauled older 350kVA diesel generator, which has been relocated to a newly constructed powerhouse. The BTF tanks have also been relocated to the new powerhouse. There is a control room containing 36x5 kW inverters and battery cluster controllers, a multi-cluster generation control box, and two distribution boards.



Control room at Tsumkwe Power Plant
(source: www.tsumkweenergy.org)

Operator Model

Ownership and operations

The Tsumkwe mini-grid is a **public utility** owned by the Regional Government (Otjozondjupa Regional Council - OTRC) and operated on their behalf by the Ministry of Public Works.

Tsumkwe was built by the DRFN with a mixture of publicly sourced funds (Government and donor). Originally DRFN intended to privatise the plant. When this did not seem viable, they sought to create a financially and legally independent, publicly owned (i.e. limited) Tsumkwe Energy Supply Company (TESco) to act as an IPP. The possibility of a private operator was discussed until very late in the development, but ultimately discarded.

This independent entity was never created, and the plant instead is managed as a public asset in the same way as other public infrastructure such as roads and water. This arrangement breaks down into the following roles:

- The regional government (OTRC) owns the plant, manages revenue collection, and finances all fuel.
- Plant operation and maintenance (O&M) is managed by the Ministry of Public Works through their local office in the Tsumkwe constituency.
- The Electricity Control Board (ECB) has the mandate to intervene as an arbitrator and regulator on issues of tariff setting and service quality. In practice the ECB has issued the generation licence, but tariffs have been set using the Local Government Act.
- NamPower, whilst having no officially mandated role, occasionally provides technical expertise and experience in critical situations.

A Project Steering Committee, which provided overall guidance to the project and oversaw the activities of the Project Management Unit (PMU), consists of:



- Desert Research Foundation of Namibia (DRFN): Chair
- Otjozondjupa Regional Council (OTRC)
- Namibia Power Corporation (NamPower)
- Ministry of Mines and Energy (MME)
- Electricity Control Board (ECB)
- Tsumkwe Constituency Council.

The community was consulted during the planning stage from 2008-2010, and provided labour as and when required during the construction phase from 2010-2011.

Pricing and Tariffs

The original diesel generator at Tsumkwe provided electricity at a cost of approximately NAD 6/kWh, with tariffs at a highly subsidised NAD 1.20/kWh for households and NAD 2.50/kWh for institutional consumers. The Otjozondjupa Regional Council (OTRC, the Regional Government) operated the diesel generators, collecting subsidised revenue from these sales, but was experiencing a loss of more than USD 75,000 annually (annual electricity revenue of about USD 40,000 less fuel expenses of USD 115,000, without other operating expenses being taken into account).

As originally designed to meet the previously anticipated and growth loads, the 100% solar PV and battery storage system would have generated electricity at an estimated NAD 5/kWh, only slightly lower than baseline costs. The agreed PV-diesel hybrid system made it possible to reduce production costs to NAD 3.50/kWh, which significantly reduced the cost of subsidies by the Regional Council.

Current energy costs are subsidised by OTRC at a cost of approximately NAD 2.00 per kWh, so that the tariffs, which are pre-paid, remain relatively low at NAD 1.50 per kWh for residents and NAD 2.50 for institutional consumers.

Lessons Learned

- ✓ Pure solar PV/battery systems have notable disadvantages when compared to hybrid systems in terms of cost, ability to meet peak demand, and general service levels. In order to maximize cost effectiveness, system stability, and power availability, PV-diesel (or another renewable source such as wind or hydro, if available) systems may be the preferred solutions.
- ✓ If an independent entity for new and complex infrastructure, such as an off-grid power plant is to be created, this needs to be agreed by all partners from the start and supported by policy. In the case of Tsumkwe, although the original plan was for an independent public company to own and operate the plant, such a company was never created. Despite strong recommendations by consultants and even regulations requiring it, no ring-fenced financial and budgetary arrangements were established for the new micro-utility. Instead, the plant and attached micro-utility is managed together with all other public utility assets, which has resulted in unclear divisions of responsibility, weaker ownership and an unclear financial structure. This, however, can be avoided through clear contractual obligations on the institutional set-up from the start of plant financing and construction.



- ✓ For this type of project to be replicable, the institutional and financial framework put in place must be conducive. In particular this means: Requiring a separate legal entity to own and manage the plant in order to ensure a ring-fenced financial structure and professional plant management with clear accountability to performance indicators; Making subsidies explicit to allow them to be codified into policy to make a roll-out of further mini-grid projects across the country economically feasible; Training a number of technicians (possibly 10 or more²) in advanced troubleshooting and maintenance of similar installations in order to ensure sufficient in-country expertise to solve problems; Addressing long-term institutional barriers such as electricity tariff policy to ensure the replicability of mini-grid projects in Namibia, and their contribution to electrification.
- ✓ The dedication of local institutions involved (such as Regional Councils, Local Authorities, MME, NamPower, ECB, DRFN, RED's or Municipalities) is crucial. In this particular instance, their advance commitment to contribute cash and assets to the project was a clear and positive indication.
- ✓ Without donor funding and government subsidies, this project would not have materialized, and indeed it continues to require government subsidy. Had the original tariff scheme and plant configuration been conceived differently, the plant could have been more or completely independent of subsidies.
- ✓ Though the output of this power plant, 202 kW, is small, the project has helped bring the issues and operational requirements of an off-grid mini-grid plant in Namibia to light. Furthermore, it will demonstrate the operational requirements that a smaller-scale decentralised generation plant faces in Namibia's overall electricity generation mix and the possibility of replication of this project to the rest of the country.

² To allow for sick/vacation leave cover and natural attrition