CASE STUDY: Concession for rural electrification with solar home systems in Kwazulu-Natal (South Africa)

Dr. Xavier Lemaire, Centre for Management under Regulation, Warwick Business School. E-mail: Xavier.Lemaire@wbs.ac.uk

I. Introduction

The rural concessions for solar home systems (SHS) in South Africa represent one of the most ambitious projects of rural electrification using solar energy in Africa. This project follows a massive programme of grid connected rural electrification launched by the post-apartheid regime. It aims to provide basic services like lighting and communication to people scattered in the most remote places.

This case study describes briefly the situation in one of the concessions located in Kwazulu-Natal, not far from the border with Swaziland and Mozambique. This concession, managed by the company NuRa, demonstrates how it is possible to solve some of the difficulties linked to the day-to-day maintenance of solar home systems.

I. A. The energy situation in South Africa

South Africa is very different from other African countries in the sense that grid connected electrification has already reached more than 65% of the population compared with an average rate which is still below 30% in sub-Saharan countries. Thanks to the massive electrification led by the national electricity utility since 1994, more than 2.5 million households have been connected to the grid.

The main provider is ESKOM, the national state-owned utility, which produces 95% of electricity generated in South Africa. The remainder is produced by municipal and private generation. Distribution is carried out by the Regional Distribution Companies currently under municipal and Eskom control. Electricity is mainly generated by coal thermal power stations (93%). The price of electricity for households varies from 35,33 cents of Rand per kWh to 45,76 cents of Rand per kWh (beginning of 2006). After a long period of over-capacity, there will probably be a shortage of electricity in the next few years owing to a lack of demand management.

Even with the tremendous electrification effort of the post-apartheid regime, there are currently still more than 1.5 million households located in remote areas, which are unlikely to be connected in the near future. Solar electricity could provide therefore a cost-effective solution in these areas.

---

1 This case study results from a short field survey in the NuRa concession in Kwazulu-Natal. I would like to thank the people from RAPS who answered my questions and the team of technicians from NuRa who enabled me to visit some villages for their help. Documentation and meetings with the researchers from the Energy and Development Research Centre of the University of Cape Town were also useful.
I.B. Energy regulation in South Africa

The regulatory structure for the electricity sector in South Africa is the independent National Energy Regulator of South Africa (NERSA). Under the National Energy Regulator Act (2004), NERSA regulates the electricity, piped gas and petroleum pipeline industries.

Renewable energy is not regulated by NERSA, even though the regulator has been involved in the monitoring of the pilot programme during its two first years (2002-2004), when no other bodies wanted to take responsibility for the agreement with the private companies. After this long process of negotiation, the regulator stepped in to pilot the programme in order to establish some lessons for implementing this kind of project. The pilot programme started in January 2002 and was completed in March 2004. Since then, the concessions have been monitored directly by the Department of Minerals and Energy (DME).

I.C. Rural electrification and social needs in South Africa

As the population in the rural areas of South Africa can be quite dispersed, the choice for electrification in rural areas is between: (1) the extension of the grid with high investments costs for small loads, (2) the use of small diesel generators with high operational and maintenance costs or (3) solar energy.

(1) When people are very poor, connection to the grid does not mean they can afford to pay for a large supply of electricity. Unlike in urban areas, the majority of the households in Kwazulu-Natal cannot afford to buy white appliances. In fact, it appears that after being connected to a prepayment system for a very minimal fee of 100 Rand, a lot of people in the rural areas of South Africa find it difficult to purchase electricity every day.

(2) Diesel generators can be used in remote areas, but this requires a constant supply of diesel and mechanical parts. The cost of the KwH produced is therefore always considerably higher than with connection to the grid. There also tend to be many disruptions, owing to the difficulties that many people experience getting generators repaired promptly.

(3) Solar energy would seem to be an ideal solution to bring electricity quickly to scattered households in rural areas such as KwaZulu-Natal, as Eskom cannot connect all potential customers in the short term and people are not willing to wait for an unlikely extension of the grid.

As the rate of electrification is high, the level of expectation generated by solar electricity could be higher than in other countries: therefore, it should be made clear to potential clients that solar electricity cannot provide energy for cooking and heating. Otherwise, the electricity needs for people in rural areas are currently basic: lighting and communication with the modern world (lighting, TV, radio and charge of cell phones). This can be provided by photovoltaic systems.
11. Concessions: a solution for the large-scale implementation of SHS?

In this section, we will introduce: (A) the principle of concessionaire fee-for-service model for rural electrification with solar home systems and then (B) the case of the NuRa in Kwazulu-Natal. This case shows that well-managed concession schemes appear to be promising for the large-scale implementation of photovoltaic systems in Africa.

11.A. The principle of fee-for-service concessions

Fee-for-service concessions enable to overcome at once the two main barriers to the implementation of photovoltaic systems:

- (1) the initial high investment cost,
- (2) the question of the maintenance of the systems.

(1) The initial investment costs for solar home systems are higher than other stand-alone systems like diesel generators. This is due to the fact that it is actually an investment on systems that are supposed to provide electricity for at least 20 years, with operational costs limited to the one of the replacement of the batteries.

With a fee-for-service concession, the initial investment is not borne by the final users but by the concessionaire (who himself gets a subsidy from the government).

(2) The creation of concession areas for rural electrification with solar home systems relies on the acknowledgement that programmes of solar home systems have been unsuccessful in the past due to the lack of maintenance of the systems. Solar home systems can be very reliable and robust in extreme conditions, but they do need a minimum of maintenance!

With a fee-for-service concession, the maintenance is not borne by the final users but by the concessionaire (whose staff have been trained).

The concessionaire gets a monthly fee from the clients, which covers the maintenance costs and the cost of replacing the batteries. The concessionaire acts like a small local utility that provides a service – electricity – in exchange for remuneration.

This scheme seems simple, but it took a long time and a series of failures in the implementation of projects for the solar energy sector to (re)invent it and dispel the idea that solar energy was free and that people in rural areas could manage relatively complex solar systems by themselves.

2 Manufacturers of solar photovoltaic panels can now guarantee a rating of 80% of electricity delivered after 20 years.
II. B. The history of NuRa

The initial programme, which was launched in 1999 by the government as part of the National Electrification Programme, aimed to install more than 300,000 solar home systems. A call for proposals was issued in February 1999 and seven consortia were identified. When the National Energy Regulator stepped in in 2002, contracts were signed between NERSA and the service providers. Only five concessions have reached the implementation stage. NuRa is one of them.

II. B.a. The company NuRa and its organisation

NuRa is a private company that was initially owned by the Dutch utility Nuon and RAPS - Rural Area Power Solutions. Recently the 20% shares from RAPS have been bought by NuRa and have been transferred to the NuRa staff (under the "black empowerment" initiative).

NuRa has its main headquarters in Mkuze, not far from the border with Swaziland, and employs more than 70 people.

<table>
<thead>
<tr>
<th>Position</th>
<th>Number of staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Management</td>
<td>2</td>
</tr>
<tr>
<td>Middle Management</td>
<td>11</td>
</tr>
<tr>
<td>Technicians</td>
<td>24</td>
</tr>
<tr>
<td>Clerks</td>
<td>18</td>
</tr>
<tr>
<td>Drivers</td>
<td>3</td>
</tr>
<tr>
<td>Labourers</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
</tr>
</tbody>
</table>

Source: NuRa, 2006.

The concession awarded to NuRa covers 10,000 Km². Eight energy stores are located in the concession. They stock parts and sell not only small photovoltaic components but also Liquified Petroleum Gas - LPG. The sale of LPG enables the stores to increase their turnover by supplementing their provision of energy services to rural households (energisation approach).

To ensure a better quality of service, small local shopkeepers (called "tuck shops") will soon also be able to retail photovoltaic components.
II.B.b. Level of subsidies from the government

The business plan approved by the regulator was based on a target of 25,000 installations by the end of 2005, summer 2006 only 11,500 installations have been implemented. This gap would seem to be due mainly to the lack of capital subsidies from the government.

NuRa does get a capital grant from the government. The average capital cost for a solar home system in this concession is around 4,000 Rand (550 US dollars). The subsidy represents the major part of the total cost of the solar home system. The rate of implementation of the systems by NuRa is therefore completely dependent on the funding made available by the government, which is reluctant to commit to a long-term project.

This level of subsidy could be a burden for the government, if this program is to be extended to the 1.5 million people not connected to the grid in South Africa. But, the total cost of the solar systems (4,000 Rand) is far less than the one that the utility would bear to connect households to the grid (between 10,000 and 15,000 Rand). And the governmental subsidy for solar energy (3,500 Rand) is not very far from the one given to the utility ESKOM to connect households to the grid (4,000 Rand).

In rural areas, where people do not use a lot of electricity, solar electricity appears to be competitive, as it provides for basic needs at a limited cost.

<table>
<thead>
<tr>
<th></th>
<th>Solar</th>
<th>Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost per Household</td>
<td>R 4,000</td>
<td>R 10,000 – 15,000</td>
</tr>
<tr>
<td>Subsidy per Household</td>
<td>R 3,500</td>
<td>R 4,000</td>
</tr>
<tr>
<td>Utility Cost per Household</td>
<td>R 500</td>
<td>R 6,000 – 11,000</td>
</tr>
</tbody>
</table>

Source: NuRa, 2006.

The cost of implementing solar home systems in the NuRa concession seems in fact low compared to the cost of installing solar home systems in other African countries\(^3\). This in itself is an interesting result of the large scale concession programme in South Africa: the level of subsidies in South Africa may be high in percentage, but remains low in absolute terms owing the economies of scale generated by the size of the solar home systems programme.

\(^3\) The cost of installation for ESCOs in the Western part of Zambia is around 900 US dollars for comparable 50 Wp systems. This difference may be explained partly by the fact that Zambia is a landlocked country, but also because of the small-size of the ESCOs in Zambia with 200 customers each, which does not allow for economies of scale.
II.B.c. Relations with the customers

To get connected, customers need to pay just a small fee - initially 100 Rand in 1999 (16 US dollars in 1999), today of 500 Rand (68 US dollars) - which represents only a marginal part of the cost of the system. The demand for solar home systems seems to be quite high with more than 1,000 customers waiting to get an installation.

The customers have to pre-pay a monthly fee of 60 Rand, which may (or may not) partially be paid by local municipalities. Some municipalities agree to give the Free Basic Electricity tariff\(^4\) and pay half of the monthly fee, leaving only 20-30 Rand (4 US dollars) for the clients to pay; other municipalities do not, leaving the customers with the 60 Rand (8 US dollars) to pay. This creates considerable distortion between clients.

Owing to the large numbers of customers, contacts with the customers takes place mainly at the energy stores where people make their payment. With small-size ESCOs, the limited number of customer enables them to conduct a monthly visit to each customer at which point they collect the fee and check the functioning of the solar system. In contrast with this, NuRa visits the installations only when there is a problem or during the planned routine visits, which take place every six months.

The contract states that:

"The SOLAR SYSTEM will be able to supply an average of 170 watt-hours of electricity per day, and will be available for at least 90% of the year".

The contract gives NuRa ten days to repair breakdown and thirty days to attend to any other complaints.

The energy stores are central to the process. People come to the energy stores mainly to charge a token which gives them a credit of electricity. The token also contains data on the functioning of the system, which can be transferred to a computer. All the data can be manipulated at the energy store, but are also immediately centralised at the headquarters.

\(^4\) The Free Basic Electricity Tariff was launched in 2003 by the government and derived from government allocations and cross-subsidies. It is used for both for grid and non-grid electrification programme, but is being piloted by municipalities that may prefer to fund other priorities.
Even with this efficient system of reporting, the process of resolving a failure can still take several weeks because: first, the customer needs to signal his problem to the nearest energy stores, and second, the energy store needs to log the failure which is sent electronically to the headquarters. Technicians will have then to be sent from NuRa`s headquarters.

The distance from the headquarters of NuRa to some clients can be quite long (sometimes as far as 150 Km). NuRa uses a quite sophisticated software system, whereby all installations are located by means of GPS. The software groups the installations in reasonable proximity to each other, thereby allowing them to be visited in one day so to avoid unnecessary journeys. The technicians use then their GPS to locate the first installation to be visited, followed by the second... and so on till the end of the day.

Even with the help of GPS, to find the right path to get access to a house can be tricky and time-consuming: in one day, technicians may be able to visit only 4-5 houses. Moreover, it frequently turns out that the cause of failure indicated on the "job card" produced by the reporting system differs from the actual cause discovered by the technicians after visiting a house. As a consequence, technicians may not have the appropriate parts to do the repair. In this case, customers who may have waited several weeks for the visit of a technician may be disappointed to see the technician leave without repairing the system!
III. Important points for replication in Africa

Even though the NuRa concession began only four years ago, some lessons can be drawn from what is probably one of the most ambitious programmes of rural electrification with solar energy in Africa (along with the one in Morocco).

III.a The size of the concession and the level of decentralisation

Large rural concessions seem to be a useful means of implementation of solar home systems. The project nevertheless also faces considerable logistic difficulties when it comes to the daily maintenance of the systems. Large centralised concessions are indeed difficult to manage as the follow-up of photovoltaic systems implies regular visits to the clients not only to replace parts of the systems, but also to train the customers in use of the systems.

When a good system of reporting is in place, it is possible to avoid relying on a complete centralisation of repairs, which always introduces considerable delays for small failures. As the fault is currently reported by the clients themselves at the energy store, this can lead to a wrong diagnosis (even if part of the information on the system is on the token the clients bring with them, there is still a need for data provided by the client himself). As a result the wrong cause of failure is often logged at the headquarters.

It would seem that failures might be more accurately diagnosed if someone from the nearest energy store could inspect the system before the technicians from the headquarters visit the house and discuss with the owner of the system. It may be desirable that energy stores in the future play a more proactive role and serve as a base for technicians who could then come directly from local energy stores when there is a problem (and also do monthly visit).

The idea of using the local shopkeepers as retailers, currently being experimented by NuRa, also seems a way to keep a regular contact with the clients. Local shopkeepers can supply basic elements of a solar system like light bulbs or recharge batteries. They can also earn their living by supplying electricity from their own system for local people who do not have a solar system (like charging mobiles).

But local shopkeepers cannot handle repairs themselves. An advantage of creating many energy stores is that it facilitates the communication process between the headquarters and the clients. The drawback of giving more autonomy to many different energy stores is that it requires more trained staff and more stocks of parts. This can only be justified with a high density of customers near-by. This is why it is so important for the concession to reach a critical mass of customers.
Economies of scale must be supported by economies of density which means that in an area open to rural electrification there should be a sufficient density of clients to enable a network of small shopkeepers to earn their living and to have a sufficient number of energy stores so to canvass the territory and provide a reactive follow-up of the installations.

III.b. The level of service provided

One has to bear in mind that the monthly fee represents a high cost for rural households. The first point is that other priorities like access to clean water or improvement of the roads may be perceived as more immediate. The fact is that solar home systems do not bring any economic development, but this is consistent with the aim of the National Electrification Programme. The question is: does the service provided by solar home systems justify its cost?

The first point of dissatisfaction for some clients is the limit of the system provided: the basic photovoltaic systems currently include a 50 Wp panel with 4 lights and a socket for a radio or a black/white TV only. Each client can choose to upgrade his system to have more lighting or even an inverter and pay a higher fee. This financial cost could be reduced if upgraded systems were more systematically proposed or even considered as the basic system.

Although a shortage of silicone has stopped this trend, the cost of solar systems in itself should continue to decrease. The main cost component of solar home systems will therefore increasingly be the one of maintenance. To maintain a 120 Wp system with an inverter is not a lot more costly than to maintain a 50 Wp system. A general increase of the power of the systems may be therefore an option for the majority in the near future.

The second point of dissatisfaction is the contract, because people are required to pay while the system is not functioning. A rebate for the number of days of failure should be given automatically when the failure is due to a fault or a delay that is the responsibility of the provider. It nevertheless appear that a number of faults are the result of a misappropriate use by the clients - such as the overuse of the batteries. This can sometimes be the result of a lack of information or deliberate tampering. Regular visits by local technicians from the nearest energy stores during the first months of the installations may facilitate the process of understanding of the system by the clients.

---

5 Since the first installations of SHS in Mali in the 80s, it is known that implementing clusters of systems in a defined area is always preferable to deploying systems over large areas: this is the only way to enable a commercial network to emerge and give effective support to clients.

6 "It was understood from the beginning that the primary motivation for the massive electrification of the disadvantaged communities was not to achieve economic benefits". NER, 1998 Lighting up South Africa quoted in ERC, 2006 Energy Policies for Sustainable Development in South Africa, p. 63.
Numerous systems are also stolen. The question of theft is a plague for the solar sector in a lot of African countries – owing to the high value of solar panels. This is often the result of a lack of mutual social control\(^7\). Technical devices provide only a partial solution and increase the cost and the complexity of the systems. There is no easy solution to this question, apart from the identification of panels and batteries which enables a control of their origin. The transfer of ownership could reduce thefts/tampering by the users of the systems.

The third point of dissatisfaction is electricity in itself is only a part of the energy requirement of a household. Solar electricity should be provided among other energy services, notably cooking. This is why allowing sale of LPG by energy stores not only is important for their financial equilibrium, but also provides a very useful service to many customers. This diversification is one of the reasons for the success of NuRa.

**Conclusion**

The concession is one of the ways to deliver a solar energy service and to solve the question of the long-term maintenance of solar home systems that has plagued solar projects for so many years in Africa.

The NuRa concession is considered to be the most successful of all the concessions established by the South African government. This case study remains therefore limited in its scope, as the other concessions have not been surveyed. This case nevertheless demonstrates that the dissemination on a large scale of solar home systems can be done even in a sustainable way in the poorest areas.

An important point will be in the near future the increase of the density of installations. A denser commercial network will ensure then a more continuous service. At this stage of development the issue of the training of a large number of staff, subcontractors and retailers will be critical.

Dr. Xavier Lemaire  
Centre for Management under Regulation, Warwick Business School (UK)

---

\(^7\) In the case of Kwazulu-Natal, people who can afford solar systems have a job outside the area and therefore can have their system stolen during their absence.
References


Websites

www.erc.uct.ac.za, Energy Research Centre, University of Cape Town.


www.dme.gov.za, Department of Minerals and Energy.

www.eskom.co.za, Eskom.