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Fee-for-Service Companies for Rural Electrification with Photovoltaic Systems: the Case of Zambia

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Abstract

In developing countries, photovoltaic systems remain often unaffordable for inhabitants of rural areas. Therefore, special financing mechanisms need to be implemented to support their dissemination. For instance, fee-for-service schemes enable users to spread the up-front costs of photovoltaic systems over a long period, and provide a solution to the problem of their long-term maintenance.

The paper surveys Energy Service Companies (ESCOs) that have been established in the Eastern Province of Zambia. Three small enterprises have been selected in 1999 and manage each 100-150 solar home systems. Regular contacts with technicians facilitate their follow-up and provide feedback from customers. Systems are now running efficiently and customers seem satisfied with the quality of the service provided. However, solar systems tend to be overused and batteries to be constantly discharged as the electricity loads increases.

Furthermore, these small enterprises still faces financial uncertainties due to a high inflation rate in Zambia and the difficulty to increase regularly monthly fees. Even with an initial subsidy from the funding agency, only the wealthiest customers of the area, with regular incomes, can be targeted. And like all rural electrification programs, a long-term involvement of the state is still needed to cover part of the capital costs and expand the scheme to new customers.

However, this case, even with its current limitations, shows that a well-articulated public-private partnership can deliver a cost-effective energy service in rural areas. With a more flexible offer of photovoltaic systems and the adding of other energy services, small energy companies seems to be able to usefully complement the role of conventional utilities.

Keywords: Rural electrification concession, Photovoltaic fee-for-service model (Energy service companies), Solar home systems, Zambia.

1. Introduction

Photovoltaic systems present a number of advantages for rural electrification in developing countries. First, investments in generating energy with solar systems are adjustable precisely to the demand. Second, they can reach end-users directly in remote locations, where electricity can be delivered without waiting for a connection to the grid. Third, the demand for electricity is, for many users in rural areas, quite low.

Combined with the abundance of sunshine in tropical areas - 5-6 kWh/m^2/day in Zambia against for instance 2-3 kWh/m^2/day in a country like Germany - this makes photovoltaic systems an efficient and cost-effective way of delivering energy to meet basic needs, when compared to the poor quality of light provided by "traditional" energies (i.e. candles or paraffin) or to the high operating costs of conventional energies like running a diesel generator in remote areas. Even in areas near the grid, solar systems could, for some categories of users, be better adapted to their low consumption of electricity. Furthermore, the reliability of solar energy systems - once the basic maintenance is done – is far higher than that of a diesel generator due to the lack of dependence on the supply of mechanical parts.

1.1. Small utilities with photovoltaic systems?

Nevertheless, the initial investment cost for these systems remains unaffordable for the majority of end-users living in the rural areas of developing countries. Like grid connection, giving access to solar electricity relies on subsidies. And as with conventional electricity, a commercial and technical network is also needed to keep the systems running.

As conventional utilities do not have the knowledge of solar systems (or, most of the time, any interest in this kind of system), it seems sensible to create specific small utilities specialised in the installation and maintenance of photovoltaic systems. Often, these small companies benefit from a long-term concession and they can obtain a loan from the government to buy the systems.

Energy Service Companies are, in the context of developed countries, concerned with maximising efficient end-use of energy for their customers. In the case of a developing country, Energy Service Companies include small enterprises that provide solar electricity to their customers. Unlike conventional installers, these enterprises are not paid for the installation of a product - the initial fee covers just a small part of the cost of installation - but for the delivery of an energy service for which the ESCOs - acronym that we will use in this paper - are paid, as long as electricity is provided to the customers.

In this scheme, ESCOs are given incentives to ensure the continued operation of the systems, as the customers pay only for the time that the service is provided. ESCOs are in fact not far from conventional utilities that would charge a low cost of connection to the grid and receive a monthly payment from their customers for the delivery of electricity.

1.2. The relevance of the case of Zambia

Several countries in the world have recently implemented or are in the process of implementing off-grid fee-for-service concessions, generally promoting a mix of solar and diesel systems (e.g. South Africa, Namibia, Sénégal and Morocco) [De Gouvello and Maigne, 2002].

Zambia appears to be one of the countries with the longest experience in Africa, as companies have been operating relatively smoothly for several years now. Otherwise, another country with a long experience in rural concessions is Argentina, with solar systems managed by private concessionaires, notably in the remote province of Jujuy since 1999 [Alazraki and Haselip, 2007]. The first place where ESCOs were introduced seems to be in the Pacific region, where small cooperatives were launched in the 1980s [Ross, 2001, p. 6]. This last experience inspired the Zambian scheme.

Many countries have adopted or would like to adopt the fee-for-service scheme in some parts of their rural electrification program [EDRC, 2003; Krause and Nordstrom, 2004]. As it is currently limited in scope with only a few hundred systems installed, the experience of photovoltaic companies in Zambia can be considered as a kind of ideal case of the fee-for-service scheme, as there has been limited political interference or delays in the process, compared to larger projects. It is also well-documented, with several reports and surveys enabling us to retrace all the stages of the project and its impact.

1.3. ESCOs in Zambia

Zambia is a landlocked country. Two thirds of the population lives in rural areas with a rate of rural electrification of 2% (against 35% in urban areas), and grid connection is unlikely to be extended out of the main towns for several decades. Population density is very low with an average of 13.1 persons per square kilometre [Haanyika, 2008]. Therefore, it is a country where the dissemination of stand-alone systems or mini-grids using partly photovoltaic systems seems quite appropriate.

Energy Service Companies were launched in the Eastern Province of Zambia. The project was funded from 1999 until December 2005 by the Swedish International Development Agency (SIDA) with the technical assistance of the Stockholm Environment Institute (SEI) and the University of Zambia. The support was offered at the request of the Zambian government in 1996 [Mbumwae, 1998].

This area was chosen as it includes relatively wealthy communities of farmers. The selection of the enterprises to become ESCOs was made in 1999. One of the criteria of selection was their implementation in the region. They do not benefit from a concession as such, but are the only ones to have access to a loan from the government, which is a barrier of entry to other potential competitors. ESCOs are small structures, typically with a director/project manager, two finance/administrative staff and two or three technicians. Solar service is only a subsidiary activity of these small businesses.

Three autonomous ESCOs have been created in the districts near the border with Mozambique and Malawi: one in Nyimba, operational in 2001 (called NESCO), one in Lundazi, operational in 2001 (called LESCO), and one in Chipata, operational in 2002 (called CHESCO). Initially, a fourth one located at Petauke (called PESCO) was also scheduled, but the company selected went out of business and solar home systems were reallocated to CHESCO and LESCO.

In the ESCO scheme, the Zambian government buys photovoltaic solar systems that are then lent to the Energy Service Companies, which have up to 20 years to reimburse the loan from the government (initially a donation from the Swedish International Development Agency - SIDA). The ESCOs install solar equipment in households and small shops and charge a fee. They then receive a monthly payment for the systems. A Battery Fund is created to replace the batteries regularly.

2. Successes and difficulties of Zambian ESCOs

2.1. The commercial relationship with customers

In 2006, 400 customers were paying a monthly fee to the ESCOs for solar photovoltaic electricity. In Chipata, they are mainly farmers (50%), civil servants who - for the most part - are also involved in farming activities (30%), and business people (20%). In Nyimba, they are mainly civil servants (55%), businesses (23%), farmers (13%) and institutions like schools (9%) [Zhou, 2007, p. 68-69]. In Lundazi, they were civil servants and teachers (24%), small farmers and entrepreneurs (24%) and institutions (48%) [Mr Banda, LESCOs' Managing Director]. Now many of the small farmers and entrepreneurs have withdrawn from the service [Mfune and Boon, 2008, p. 183]. The ESCOs scheme is mainly for government employees with regular income.

Each ESCO has a waiting list of several hundred customers applying for solar installations. Solar systems enable small businesses to extend their hours of work and therefore to improve their income generation. For households, solar systems improve the quality of life, by supplying basic needs like lighting, black and white TV and radio-cassette players. The impact of a basic service like lighting has been evaluated as quite positive, especially for pupils who can study during the night [Gustavsson, 2003; Gustavsson and Ellegard, 2004; Gustavsson, 2007a] or for small businesses (shops, restaurants, bars and mills) who can extend their opening hours.

There seem to be no acts of vandalism and very few solar panels are stolen, which may probably be related to a strong social control (the staff of each ESCO know their customers well) and the absence of a local black market for panels. Each client has to sign an agreement by which they take responsibility for the equipment, and can face severe costs if the system is stolen. In the case of NESCO, 10-15% of the clients are in arrears with paying their fee each month [Gustavsson and Ellegard, 2004]. There is however a good payment record (95% of the clients eventually pay) due to the quality of the service provided by the ESCOs and immediate disconnection in case of non-payment.

Only a limited number of solar systems have been repossessed after a default of payment, [Ellegard et al., 2004, p. 1255]. Once again, this can be explained by the fact that ESCOs with a good knowledge of local applicants have been able to select the ones with regular sources of income.

In Nyimba, because of the connection to the grid of the centre of this town, a small percentage of clients (less than 10%) have surrendered their systems [CEEEZ, 2006, p. 14]. In Lundazi, LESCO has been facing financial problems mainly linked to the non-payment of the monthly service fee by the Zambia National Service Camp, its main client with 64 systems [Swedpower, 2005, p. 16].

Technicians of ESCOs have to go every month to visit the customers and collect the fee (except in the case of prepaid systems). This means therefore that an inspection of the installations is conducted monthly. This also enables ESCOs to have regular feedback from their customers. Furthermore, in the case of malfunction, ESCOs' technicians have two working days to resolve the problem, once notified by the customer.

2.2. The technical problems encountered

The ESCOs' photovoltaic systems originally include a 50 Wp panel with a 90-105 Ah battery. Each ESCO has its own history and faces specific constraints due to its location and the systems chosen.

In Lundazi, LESCO manages 150 systems. During our survey in 2005, 70 only were operating. The other systems were not working mainly due to battery problems and non-payment by the Zambia National Service Camp. In Chipata, CHESCO has 150 systems. 138 systems were working in 2006. CHESCO faced difficulties with the tokens of a SIEMENS prepayment system: every time the charged tokens were not recognised, the customers had to return to CHESCO's office in Chipata from sometimes as far as 40 km and CHESCO had to give them extra days of electricity as compensation. In Nyimba, the first established ESCO seems now to have acquired a good knowledge of the systems: 96 of the 100 systems were working in 2006.

The initial design of the systems and the quality of some batteries were at issue. At the start ESCOs lacked the expertise to maintain the systems. With the change of the batteries, the training of ESCOs' technicians in order to enable them to design the systems, and the dissemination of information to customers who are now aware of the possibilities and limits of their solar system, these initial technical difficulties have been solved. Nevertheless, there is a persistent tendency to overuse the systems, where batteries tend to be constantly discharged as the electricity load increases [Gustavsson and Mtonga, 2005, pp. 554-555; Gustavsson, 2007b; Gustavsson, 2008, pp. 52-63].

2.3. A fragile financial equilibrium

The ESCOs receive a long-term loan that has to be refunded. The ESCOs charge an installation fee that represents less than 15% of the cost of the system (which is in the range of 900-1,200 US dollars). The investment cost was 104,000 US dollars for 100 installed systems in Nyimba, 134,000 US dollars for 150 installed systems in Lundazi and 178,000 US dollars for 150 installed systems in Chipata, for a total cost of around 1 million US dollars [Department of Energy, 2000, p. 5]. The cost of the system can be split approximately as follows: 40% for the panel, 30% for the battery and 30% for installation material and labour [Ellegard and Nordstrom, 2001, p. 18]. The monthly fee was planned to cover the running costs (servicing, maintenance) of the ESCOs, but project developers quickly realised that it could not cover all the capital costs.

Table 1. Fees and monthly service payment

	LESCO	CHESCO	NESCO
Cost of grid connection	800,000 ZMK (244 US$)	N/A	500,000 ZMK (152 US$)
Initial fee for solar ESCOs (without fitting)	500,000 ZMK (152 US$)	400,000 ZMK (122 US$)	350,000 ZMK (106 US$)
Monthly service solar ESCOs	45,000 ZMK (13,7 US$)	45,000 ZMK (13,7 US$)	40,000 ZMK (12 US$)

The local currency is the Kwacha (ZMK). In March 2007, the rate was 1 US dollar = 3,275 Kwacha, which is the rate used in this paper to give an indication of the costs in US dollars.

Source: Swedpower, 2005.

To establish comparisons, the cost of connection to the grid with ZESCO was, during that period, 300,000 ZMK (91 US$) in the capital Lusaka, but slightly higher with a cost of 500,000 ZMK (152 US$) in Nyimba and 800,000 ZMK (244 US$) in Lundazi (see Table 1). This cost of connection was charged to the customer. The cost of grid-extension of a 66 kV line was estimated at 50,000 US$ per km at the beginning of the project [Chandi, 1999]. The low residential consumer monthly tariff of ZESCO was 18,000 ZMK (5 US$) in 2005.

As electricity from the grid is highly subsidised in Zambia, the monthly payment for grid electricity is on average far less than the monthly service charged by ESCOs for solar energy. Therefore, solar electricity remains a quite expensive service. Nevertheless, as grid connection is unlikely to happen due to the remoteness and the low load of rural households, the cost of photovoltaic systems has to be compared mainly with the use of traditional sources of energy (i.e. candles or paraffin for lighting, batteries for radio, kerosene to run refrigerators), with a cost which can be as high as 10 US$ per month for a quite low quality of service [Mbewe, 2004, p. 17]. ESCOs customers have therefore a similar level of expense for electric services and light than they used to have, with now a better quality of service [Gustavsson, 2004; Gustavsson and Ellegard, 2004, pp. 1064-1065]. For instance, light provided by an 8 Watts solar fluorescent lamp can reach 400 lumens, against 10-40 lumens with kerosene lamp [Gustavsson, 2007b, p. 803].

Simply to facilitate ESCOs' access to commercial credit - as it was initially envisaged – would not have been financially viable, notably due to an interest rate in Zambia in the range of 40-65 per cent. So the systems have been subsidised and ESCOs have benefited from a grace period during which they did not have to repay capital costs, but only to cover running costs. In 2005, the formal ownership of the solar systems was transferred from the Department of Energy who made the purchase of the systems to the ESCOs, and it was decided that the capital would have to be reimbursed within 10 years instead of 20 years, but with a 50% capital subsidy for the first installations and 25% for the new installations that the ESCOs would buy from then on [Ellegard, 2005; Swedpower, 2005].

The exemption from taxes can always be reappraised. It has to be noted that the import duty and the Value Added Taxes can raise the price of solar systems by as much as 40-60% [Chandi, 1999]. Moreover, the inflation rate in Zambia is still around 10-20% per year (compared to 400% in the beginning of the 1990s). The exchange rate Kwacha-US dollar can fluctuate sharply. This creates considerable distortion for ESCOs, as all the components of solar systems are paid for in US dollars while ESCOs are being paid in local currency by customers who cannot easily absorb the successive increases of their monthly fee.

The fee charged by ESCOs went up from 20,000/25,000 Kwacha in 2001 to 65,000 Kwacha in 2006. This is a significant increase for customers in rural areas, whose incomes are not indexed to inflation, but the fees remain below what the ESCOs would need. According to a recent survey, the fee covers currently only 80% of the maintenance costs of CHESCO [Zhou, 2007, p. 68]. Inflation is considered as a major problem [Swedpower, 2005, p. 7]. As the money invested in local currency is quickly devalued, some ESCOs have launched a small business (of soft drinks) to make money and keep the capital. The Battery Fund is deposited in US dollars.

3. Conditions of replication

Several lessons can be drawn from this pilot experience in Zambia, which has been going on now for eight years.

3.1. The choice of the location

In the Eastern Province of Zambia, the rural population is wealthier than in other parts of Zambia. The initial survey conducted in 1998 showed that 75% of the respondents in this area were willing to pay 5 US dollars per month for electricity out of an average income of 42 US dollars in 1998) [Ellegard and Nordstrom, 2001, pp. 32-37]. In poorer places, the contribution capacity of households will be even lower. Therefore, until there is a further decrease of the cost of solar systems, the possibility of replication of this scheme seems to be more appropriate in more wealthy places in Africa.

The maintenance scheme implies also that solar systems are not installed into too large an area, so that ESCOs can regularly access all the systems for maintenance and in order to collect the fees. Indeed, only light means of transport (bicycles, small motorcycles) are used by technicians.

Another important point is to take into account any plans for grid extension that can affect the economics of ESCOs. The connection of a town does not necessarily mean that ESCOs have to withdraw from the whole area. Even if the centres of Lundazi, Chipata and now Nyimba are connected to the grid, many customers are situated in the outskirts of the main towns and will not be connected for a while. Some customers in the centre are even keen to keep their solar systems as a back-up to their grid connection due to the lack of reliability of electricity provided by the main utility. Some clients have also bought their own system on top of the one provided by the ESCO [pers. data, 2005]. Nevertheless, connection to the grid, as shown in the example of Nyimba, modifies clients' expectations and is damaging for the ESCOs who have to transfer some installations to unconnected customers and bear the financial cost of this transfer.

The extension of the existing telecom network or TV signal can, by contrast, be positive for ESCOs, as people then want to gain access to electricity to charge their mobile or power their TV: both devices are a considerable incentive to obtain a solar home system [CEEEZ, 2006, p. 14].

3.2. Towards a more flexible commercial scheme

Initially, only one kind of basic system chosen by the Department of Energy was offered: a 50 Wp panel with an 90-105 Ah battery to enable the connection of four bulbs and a power point for a small TV/radio. Now, however, ESCOs could tend to provide a more diversified range to meet the needs of their customers, which should be organised around three standard sets to be proposed to the clients [Andersson 2005, p. 3]:

- the current 50-70 Wp with a 100 Ah battery without inverter,
- a 80-120 Wp and a 150 Ah battery with maybe a small inverter,
- a 120-150 Wp for a system with a refrigerator.

It is also important to take into account the fact that for some groups of customers like farmers, income can vary considerably during the year. Therefore, payment of the debt by ESCOs could be made on a basis other than monthly, - e.g. quarterly or annually. For instance, CHESCO accept payments with interest by farmers after harvest [CEEEZ, 2006, p. 13].

Providing electricity to institutions like schools, health centres and the army may be a priority from a social point of view, but raises the question of the capacity of these public institutions in Africa to pay the ESCOs on a regular basis. As shown with the case of LESCO in Lundazi, it seems that public institutions shall not be the main customers, as small enterprises like ESCOs may be powerless in the case of non-payment from these institutions, unlike with small private clients where systems can be removed more easily.

3.3. Public awareness, training of staff and the choice of equipment

The fact that solar systems need to be sized to the consumption requirement of the users implies a good understanding by the customers of the possibilities and the limits of their solar system. This learning process among people who previously had no experience of solar electricity can be accelerated by interactions with the technicians of ESCOs. The small size of the areas covered seems to enable a good relation between technicians and customers. Awareness campaigns, regular visits of technicians and a system of penalties for overuse can partly mitigate the problem of discharging. The modularity of photovoltaic systems could enable the ESCOs also to follow the users' needs. The Energy Regulation Board in conjunction with the Zambia Bureau of Standards has developed standards of solar systems since 1999 [Mbewe, 2004, p. 40]. The Energy Regulation Board has conducted a quality inspection of all the installations.

Most of the problems with the batteries are not just linked to the product itself. To prepare local stakeholders to take charge of the systems implies creating the conditions for a sustainable business plan and, at the beginning, a constant monitoring and training of local technicians [Department of Energy, 2005; Ellegard and Nordstrom, 2001, pp. 15-16]. Technicians of ESCOs have been intensively trained at the University of Zambia, first in adjusting the regulation of solar systems, and now in the design of systems, thus giving the possibility for ESCOs to buy their systems directly. ESCOs have received training in business development and accounting.

Competitive tender at a governmental level for the purchase of photovoltaic systems, even if it can reduce prices through a bulk purchase, may have to be avoided. It seems better to leave the choice of the system to the companies that can then build direct relations with the suppliers. Direct purchase may also favour the creation of a local network of solar companies, while competitive tender tends to exclude local companies in favour of international companies and create a "stop and go" effect which is detrimental to a sustainable growth of the market. This would be coherent with the choice of existing local companies to operate as ESCOs, thus nurturing the emerging solar market in Zambia [Ellegard and Nordstrom, 2001, pp. 1-3 and pp. 17-18; Ellegard and al., 2004, p. 1256].

The other question is – as solar electricity has its limits – what could be the appropriate mix for an Energy Service Company, between the fees for Solar Home Systems and the sale of other sources of energy for productive use and heating/cooking? Indeed, ESCOs are small businesses with pre-existing activities, and to evolve towards a multi-energy business with other sources of energy could enable them to be less dependent on the subsidies of the government.

3.4. The financial design of the scheme

Although the cost of solar panels has decreased dramatically in the last fifteen years, it remains expensive for households in countries like Zambia: even wealthy farmers and civil servants cannot afford the up-front costs of basic solar systems. Therefore, the expansion of the photovoltaic market in African countries is still dependent on the support of funding agencies. The capital cost for solar electricity, as for conventional electricity, needs to be subsidised because the purchasing power of inhabitants remains low and there are no local financial institutions ready to offer loans to small rural companies.

Furthermore, ESCOs in Zambia face financial uncertainty due to macro-economic conditions out of their control. The situation of inflation and of unstable exchange rates is not specific to Zambia, but is common to many African countries and proves to be quite damaging for small companies. Decoupling the cost of components for ESCOs from the fluctuation of currencies is a priority. Recently, the creation of rural funding agencies has been spreading in many African countries. Once fully operational and correctly managed, these agencies could play the role of buffer organisations and for instance lend money to ESCOs to buy stocks of solar components at the lowest cost or manage the battery funds in US dollars.

The rural authority was created with the Rural Electrification Act of 2003, but has had difficulties in becoming operational [Haanyika, 2008]. This independent rural electrification authority is needed to manage efficiently the former Rural Electrification Fund managed by the government [Government of Zambia, 2003]. Indeed this fund was discredited by the allocation of the 3% electricity levy collected from consumers by the electricity company ZESCO to other uses than electrification projects and also by political interference from the government, which used to select electricity projects [Department of Energy, 2003, pp. 24-25; Mbewe, 2004, p. 9]. Once operational, this rural electrification authority could play the role of the Solar Fund for Zambia, which was initially scheduled at the start of the ESCO project, but was never created, so as to expand the size of current ESCOs and extend the fee-for-service scheme to other areas. Indeed, one role of this new authority would be to support decentralised rural electrification, in contrast to the Rural Electrification Fund which had been narrowly focused on grid extensions [CORE, 2004, Appendix A].

Before the decisions made in 2005, the ESCOs scheme included no subsidies. Therefore, not being able to reach their break-event point, due to their small size, ESCOs could be considered to be unsustainable [CEEEZ, 2006, pp. 25-26]. Now, it should be noted that grid connection in rural areas is also subsidised and that electrification of rural areas is often the result of a political game. It may be more realistic to consider that up-scaling ESCOs by providing a loan for a larger number of systems is necessary and that part of the loan needs to be subsidised. According to a survey undertaken by the Centre for Energy, Environment and Engineering Zambia, the capital subsidy should be in the range of 50-70% [CEEEZ, 2006, p. 29]. Once the capital costs are covered by a subsidy, the fees should enable ESCOs to cover operational costs and to pay back their part of the loan.

3.5. The question of the scale of the company

The small scale of ESCOs operating in Zambia bring some advantages in terms of proximity to the customers. Monthly visits to collect fees appear to be preferable to a scheme where clients themselves have to go to ESCOs' stores to pay, as it gives the opportunity of constant monitoring of each system by technicians during their visits. This is only possible with clients scattered in a small area. In remote rural areas with roads in poor state, proximity to customers is clearly a strength.

Larger-scale ESCOs are more likely to be viable from a financial point of view, but need then to have relays with local shops to maintain links with their customers. In South Africa, similar private businesses with, for some of them, 10,000 solar home systems, rely on a strong logistic organisation to cover the very large size of the concessions: local stores are scattered in the concession and a system of reporting is used by the concessionary company [Banks, 2003].

Their current small size tends to make ESCOs vulnerable to any default of payment from one large client (case of LESCO in Lundazi). Furthermore, small ESCOs need to run other businesses to be viable; they need high levels of subsidies. Zambian ESCOs have benefited from much care from external donors, for ultimately a limited number of installed systems. Bigger companies could amortize more easily the initial investment in terms of training and administrative follow-up from the funding agencies and government. Now, small ESCOs have a potential of growth and could be multiplied. And with the creation of several dozens of similar ESCOs, it could also be possible to create a competitive market for solar home systems.

So, either multiple small ESCOs of several hundred units or larger ESCOs of several thousand units but with decentralised local stores could conciliate close links with customers and the large-scale dissemination of solar systems. The important point is for ESCOs (or local stores) to have a good knowledge of their customers, and that customers can easily reach technicians to get their systems serviced.

4. The advantage of fee-for-service compared to other schemes

Several other schemes exist in the world to enable a large dissemination of solar home systems, notably to overcome the main barrier to market solar home systems, which is the up-front cost of the system [Krause and Nordstrom, 2004, pp. 19-20].

Access to informal or formal micro-credit as in some Asian countries (e.g. Indonesia, Sri Lanka) or the modular cash purchase of the different parts of the systems (e.g. Kenya) both enable customers to overcome this barrier. Nevertheless, it appears that systems in such cases are very small ones (often in the range of 12-20 Watt peak), due to limited personal funding which permits only low consumption.

One benefit of the fee-for-service scheme is to link financial and commercial interests within one organisation. ESCOs can therefore centralise subsidies from public authorities, which otherwise, given individually to each customer, would probably be monitored more loosely by a public administration or a bank. When ESCOs manage the systems, local authorities can trust them to recover the cost of the systems, unlike if the systems were given directly to individuals.

Furthermore, implementing solar home systems in remote areas implies solving the question of long-term maintenance. In the case of photovoltaic projects, up-front costs are indeed a major barrier to the utilisation of solar systems. But traditional funding, even when the initial investment is covered by the donor, does not solve the question of the long-term maintenance of systems, which requires the existence of local organisations with the relevant expertise. The creation of small ESCOs seems to bring a partial solution to this issue: after enabling the establishment of a network of local entrepreneurs, solar systems can be maintained and can deliver a real service.

Compared to other schemes, the main advantage of ESCOs is that maintenance is done by qualified technicians from small companies encouraged to keep the systems running. As private enterprises, ESCOs monitor their customers closely, because they have a direct interest in the collection of fees and the running of the system. This cannot be found in any other schemes, where the organisation choosing the customer and installing the system is not the same as the one doing the maintenance.

Nevertheless, with ESCOs, solar systems are either the property of the government or of ESCOs, not of the final user. In other schemes, the ownership remains with the purchasers of the systems. Therefore, the final user may feel less responsible for the good use of the system. But the case of Zambian ESCOs tends to prove that technical problems are linked to their overuse – mainly discharging of the batteries. However, this happens also when clients own their systems, often because of a lack of understanding of the limits of the system. And once again ESCOs facilitate the learning process through regular visits of technicians.

5. Conclusion

Following some basic rules for a successful implementation, it seems small ESCOs, similar to the ones in Zambia have a strong potential to deliver an energy service throughout remote rural areas while creating jobs. They offer an interesting perspective in terms of improving the living conditions of rural inhabitants of developing countries, and could help in the creation of small networks of sustainable activities in remote rural areas. This public-private scheme seems to provide a cost-efficient way of making progress in rural electrification, especially in areas where individual load is - and will remain in the medium term – very low.

Therefore, as we know that the majority of inhabitants of Africa will never be able to pay for the full cost of solar home systems, in the same way as they are not able to pay for the full cost of grid-connection, the key question is as follows: should inhabitants of off-grid rural areas be entitled to a level of subsidies similar to the inhabitants who can be connected? If the answer is yes, then fee-for-service companies seem to be an appropriate way of delivering a reliable energy service.

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