


Employment-oriented Industry Studies

Resource-based Technology Innovation in South Africa:

Innovations in South Africa's Off-grid Concession Programme

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1. Introduction

This case study deals with South Africa's off-grid concessions programme, an important component of the government's National Integrated Electrification Programme. This programme was aimed at offering access to photovoltaic solar home systems in deep rural areas, pending the supply of grid electricity throughout the country. Like the other case studies in this volume, it is aimed at deepening analysts' and planners' understanding of processes of innovation in the South African energy sector, and identifying key lessons that may be applied elsewhere.

2. Electrification in South Africa

The Reconstruction and Development Programme (RDP) of 1994 stated that:

> *Although energy is a basic need and a vital input into the informal sector, the vast majority of South African households and entrepreneurs depend on inferior and expensive fuels... Although Eskom has excess generating capacity, only 36 per cent of South African households have access to electricity, leaving some three million households un-electrified. Furthermore, some 19 000 black schools (86 per cent) and around 4 000 clinics are currently without electricity. Little attention has been paid to utilising sustainable energy sources such as solar power (RDP 1994:31).*

It further noted that:

> *An accelerated and sustainable electrification programme must provide access to electricity for an additional 2,5 million households by the year 2000, thereby increasing the level of access to electricity to about 72 per cent of all households (double the present number). Both grid and non-grid power sources (such as solar cells and generators) must be employed. All schools and clinics must be electrified as soon as possible. Communities must be involved in the planning and execution of this programme. Micro, small, and medium-sized enterprises must be given support and shown preference in the tendering process.*

Thus began a new era of electrification. Until this time, rural electrification had been largely ignored, except for white-owned commercial farms (RDP, 1994:32). In 1994 the government and the electricity distribution industry, mainly comprised of Eskom, but also local authorities, signed a compact in terms of which 2,5 million households would be electrified in the five-year period from 1994 to 1999. It was felt that access to electricity would significantly benefit previously disadvantaged South Africans. This was seen as a prerequisite for modern development. Importantly, electrification was also seen as an important means of reducing indoor air pollution.

A National Integrated Electrification Programme (NIEP) emerged. It was initially funded by the electricity industry itself, with Eskom cross-subsidising the electrification undertaken by municipalities. The Eskom funds were transferred to the NER, which allocated them to local authorities. Eskom also funded its own electrification programme from internal cash flows.

It was assumed that new customers would consume enough electricity to make the programme financially viable. Very soon, however, it became clear that consumption by rural households was very low (100 kWh a month and less). Typically, poor households cannot afford to use electricity for thermal activities (cooking and heating), and thus tend to use it only for lighting and social communication (including TV and radio). In response, Eskom intensified its technical development

programmes, including pre-payment meter options. It also began to diversify its services, which allowed it to limit electricity supplies to rural households.

Despite these important and valid attempts to contain the real costs of electrification, it quickly became apparent that a large sector of the rural population could not be electrified at 'reasonable' cost. For many communities in sparsely populated rural areas, the on-grid electrification programme (entailing relatively high connection and ongoing costs) would not provide an avenue to changing the quality of their lives.

3. The start of the off-grid concessions programme

In 1996, the government established the Renewable Energy Fund of South Africa (REFSA), tasked with establishing a national programme for installing photovoltaic (PV) solar home systems. In 1997 it announced a subsidy of R1 500 per system; however, it was disbanded soon afterwards without having financed a single deal.

According to the DME, it would have been uneconomical to provide such a service in the deep rural areas (Kotze 1999). Importantly, the two value chains necessary to create a viable rural PV market, namely a network of shops providing access to off-grid solutions, as well as micro financing institutions, were almost non-existent.

The government had to find a new way forward. In the past, public utilities had successfully provided services to low-volume users, and involving them in solar energy as well seemed to be the most logical solution. Nevertheless, Eskom was reluctant to become involved; it argued that it wasn't familiar with the necessary technologies, and that a non-grid programme would probably encroach on its core business.

At that stage the government had not thought about involving the private sector, but did take note of the fact that the private sector was successfully selling PV systems, mainly for telecommunication/transmissions, water pumps and lighting systems.

The DME recognised that if it were to rely on the private sector to deliver PV systems at scale, it would need to offer this sector some special incentives, since it was unlikely to do so on its own. In 1998 the government began to consider a concession-type model in terms of which it would identify franchise areas, grant the franchises to companies, and also provide some financial support.

In December 1998 it released the White paper on energy policy for the Republic of South Africa which stated that:

> *[i]n many cases, grid electrification is simply uneconomical. In such cases an off-grid supply can often provide an adequate electricity service. The government therefore recognises the need to level the playing field between grid and off-grid electrification.*

Annual connection targets and related subsidies will be allocated for off-grid electrification in accordance with the national electrification strategy. Soon after the release of the White Paper, Eskom (Research) and Shell Solar jointly launched an off-grid solar PV programme in the Eastern Cape. Despite the fact that the government had not yet formulated detailed policies in this area, the programme was launched by then president Nelson Mandela, which lent added new momentum to the haphazard development of the off-grid electrification programme.

In 1999, the government invited the private sector to establish technically competent commercial off-grid operators in rural areas. The advertisement described the envisaged off-grid programme in very broad terms, and without specifying technology, business models, and so on in any detail. Importantly, though, it did state that public–private partnerships should be forged, that the programme would not be fully subsidised, that private companies should establish a presence at the local level in their concession areas, and that fee-for-service arrangements should be made between the concessionaires and their customers.[1]

Given that typical rural households use a mix of fuels, and that electricity is rarely used for thermal purposes, the government also asked concessionaires to start providing alternative thermal fuels to wood and coal such as liquid petroleum gas (LPG) and paraffin at the local level.[2]

More than 25 responses were received and evaluated by the National Electrification Coordinating Committee (NECC) Six consortia of local and international partners (see table 1) were short-listed, and added to the Eskom Shell joint venture, called Eskom Shell Solar Home Systems.

Two more years elapsed before implementation began. Indeed, in August 2003 the government stated that the programme was still in a pilot phase. The pre-implementation process was difficult, and involved numerous interested parties and lengthy negotiations. A DME official later acknowledged that the department did not always know where it was headed.

[1] At the time, local and international experience suggested that a fee-for-service arrangement would be the most cost-effective solution. The government did not favour the other major option – direct sales (for cash or credit) – because of concerns about after-sales service and the maintenance of solar home systems. The government was particularly keen for concession companies to provide a service and maintenance function to customers. In order to effect this, concession companies would need to maintain a local presence, hopefully establishing rural outlets for their products and services reasonable walking distance of their customers.

[2] Concessionaires have never been contractually obliged to offer these additional services. All that has been established is a broad agreement that they will work on widening their business scope.

Table 1 – Consortia recommended by the NECC

Consortium	Members
Renewable Energy Africa	Renewable Energy Africa (Pty) Ltd
	Wakowa Development cc
	Kopano Project Managers (Pty) Ltd
	Milani Investment Holdings (Pty) Ltd
BP SA/Emtateni	BP Southern Africa (Pty) Ltd
	Emtateni Investment Holdings (Pty) Ltd
	Eskom
SolarVision	SolarVision (Pty) Ltd
	Khatima Engineering Services cc
	Lebone Engineering (Pty) Ltd
	NVE (North Zealand Energy, Denmark)
Nuon/Raps or NuRa	Nuon (Energy utility, Netherlands)
	Rural Alternative Power Systems (Pty) Ltd
Spescom	Spescom (Pty) Ltd
	Phambili Nombane (Pty) Ltd
	Vantage+
	Net Group
Electricité de France/Total	Electricité de France
	TENESA (Pty) Ltd
	Total
	Phambili Nombane (Pty) Ltd
	The Sirius Foundation

Source: Africon (2004)

4. The off-grid concessions programme today

By June 2004, four of the seven public–private consortia, namely Rural Area Power Solutions (RAPS)/NUON, the SolarVision/Renewable Energy Corporation of Norway, Electricity de France (EDF)/Total, and Eskom/Shell Solar, had reached the implementation phase. A fifth concessionaire, Renewable Energy Africa, was gearing up for implementation, but was struggling to secure adequate finances. The German government (through Kreditanstalt für Wiederaufbau, KfW) was preparing tender documents for a sixth concession.

Selected service providers were allocated exclusive rights to provide off-grid electrification in particular geographic areas (called 'permission areas'). These are situated in broader areas or regions earmarked for off-grid electrification, called 'concession areas'. The rights last for a period of five years; however, the service contracts remain binding for a period of 20 years. Besides solar home systems and mini-grids, service providers are encouraged to distribute alternative thermal fuels such as gas or paraffin. The concessionaires are largely active in former 'homelands' areas, notably two areas in KwaZulu-Natal, two in the Eastern Cape, and one in Limpopo.

Initially, Eskom defined permission areas, but more recently there has been a move towards establishing these areas in negotiations involving local authorities, Eskom and the concessionaries. The rule is that off-grid systems should not be installed within 2 kilometres from a gridline.[3] However, some concessionaires have installed solar home systems as close as 1 kilometre from existing gridlines.[4]

By October 2003, about 16 000 solar home systems had been installed.[5] At that time, the government estimated that there was an electrification backlog of 3 million households in the former 'homelands' areas (Kotze 2003). It was hoped that the off-grid programme would reduce this backlog by 300 000 (and grid connections the balance). This meant that each of the six concessionaires would need to install about

[3] This rule is one of a set of criteria that are used to allocate areas to non-grid service provision.

[4] Areas where households are dispersed owing to low densities or large stands are not likely to become Eskom electrification projects, although if they fall within the 2 kilometre zone they should not, according to this rule, be considered by concession companies. There are two choices here: (a) concession companies can ignore the 2 km restriction and supply a SHS (solar home system) or (b) they can let the customer apply to Eskom as a rural customer on normal commercial terms. This would cost the customer approx R3 000 upfront and it would entail a monthly account of more than R250. This is obviously unaffordable to the poorest of the poor (Van der Merwe 2003).

[5] This figure must not be confused with the one appearing in the National Census of 2001, which states that there are solar home systems in 23 000 households in South Africa. Active accounts as of October 2003 were: NuRa (4 680), SolarVision (3119), KES (2 526) and ESSHS (5 733) (Africon 2004).

50 000 systems during the initial contract periods of five years, and then continue to service them for 20 years. However, it also appeared that the public funds to do so might be lacking: from 1 August 2003, concessionaires were only permitted to install 300 solar home systems a month, and in January 2004 they were informed that subsidies would cease entirely until a comprehensive review of the programme then under way had been completed, prior to the signing of final contracts in March 2004.

5. Customer perceptions of solar home systems

A number of studies have been done to review customer perceptions of the PV solar home systems. These reviews include community submissions to parliament in 2003, as documented by Yaw Afrane-Okese and Jocelyn Muller of the Energy and Development Research Centre, a review by SolarVision in its concession area in Limpopo in October 2002, and by the RAPS Group, which commissioned an independent report on its customer's views (Gothard 2003b). Finally, the DME commissioned a comprehensive national review of the off-grid electrification programme in November 2003 – January 2004, which was conducted by Africon.

The findings have been relatively consistent, and can be summarised as follows:

- Although households would have preferred to be brought into the grid system, the PV solar power systems were very popular in households. They were seen as easy to use and that generally they worked well. However, DME's survey found that many customers did not understand how the solar home system worked.
- While extending energy to rural households, the PV solar systems do not specifically benefit the poorest of the poor, even in the context of subsidies. Household income must be sufficient to pay for the service. Only households that could produce proof of regular incomes tended to be eligible for solar home systems. Beneficiaries of the systems were typically wage earners, pensioners, and civil servants. Unlike grid-electrified households, solar-electrified households were unable to vary their expenditure by varying their electricity consumption. Households objected to paying R58 for only 6 kWhs a month. (This was the full monthly tariff; of this, about R40 was subsidised by the state, leaving households to pay about R18 a month). In some areas, solar system recipients had to travel to pay points to buy monthly credit, while in others monthly fees were collected at their homes. Thus some households were incurring additional transport expenses. The more sophisticated the service delivery mechanisms, the higher the costs to households tended to be. The SolarVision survey found that 41% of users could not pay the monthly user charge of R58.
- Repairs to systems could be slow, as access to rural households could be difficult. Where installation and repair was done locally, these tended to be "men's jobs" – women were not sufficiently drawn into the programme.
- Most households used electricity for lighting and radio/TV, and not for cooking, heating or for income generation. This meant that women still had to collect wood for cooking and heating, and that the systems did not ultimately have the effect of reducing indoor pollution.

6. Innovation in the off-grid concessions programme

As noted earlier, this study is aimed at gaining a better understanding of innovation in the off-grid concessions programme, and to identify key lessons. This section seeks to identify where innovation has occurred. Broadly, it is argued that innovation has occurred in process and products, while experiences in institutional and financing arrangements largely point to barriers inhibiting innovation. However, the concessions programme is still evolving, and no final conclusions can be drawn.

6.1 Institutional and programmatic arrangements

6.1.1 Public–private partnerships

As noted earlier, the South African government was eager to create an off-grid electrification programme involving a partnership between the public and private sectors. Broadly, this has been achieved in the sense that the private sector has expressed a willingness and a commitment to install solar home systems in rural areas, on the understanding that its efforts will be subsidised.[6] The system costs are about 80 per cent subsidised, and the concessionaires contribute the remainder.

Both international and local experience indicates that there is nothing novel about public–private partnerships, in this sphere or others. Furthermore, it is too early to tell whether the partnerships in this sphere will be sustainable. The contracting process preceding implementation has taken several years, and it has been very difficult for the concessionaires to remain 'on board' in such uncertain conditions. Their greatest concern is future certainty.

By early 2004, the concessionaires were still operating in an official pilot phase, and their final contracts with the government had not yet been concluded. Their involvement in this programme also seems tenuous from a financing and risk point of view. Without the capital and consumption subsidies from the government, concessionaires would probably find it impossible to sustain their involvement in this area, and this is proving difficult even with the subsidies at their current level. Typically, these operations will break even (the point where income will exceed expenses) in five to eight years.

[6] Officially, however, the off-grid concessions programme is not a public–private partnership. As set out in the National Treasury's regulations, the core values of a public–private partnership include affordability, risk transfer, and value for money. Transactions that do not possess these values are not classified as public–private partnerships.

Spokespersons for most concessionaires have explained that their participation makes little sense in the short term, but that they see medium- to longer-term potential. A social commitment to improving rural energy provision has kept them in the programme in the short term. Among other things, they have had to live with unstable government funding. Concessionaires have been gearing up to put 50 000 systems in place over a five-year period; however, in August 2003 they were informed that capital subsidies would be limited to 300 installations a month. This ceiling had sharply negative implications for ordering and stocks, staff and training, morale, insurance cover, and so on, not to mention the programme's broader goals.

6.1.2 Contractual process and arrangements

The DME initially presented a time line of 28 November 1998 for private sector applications, 11 December 1998 for a debriefing session, 29 January 1999 for the awarding of contracts, and 1 March 1999 for implementation. It soon became clear that this time frame was completely unrealistic. Indeed, 'interim arrangements' were eventually finalised between March 2002 and July 2003 and were extended up to 31 March 2004, when final agreements were due to be put in place (Van der Merwe 2003).

There were various reasons for these delays, which have been documented in Okese and Thom (2003). For example, major delays developed in the DME's negotiations of pilot contracts with concessionaires. Also, its electrification directorate did not have enough staff to integrate the grid and off-grid programmes; as a result, it was decided that the NER should drive the process until the progress had been brought up to date. While able to administer and oversee the financing of the programme, the NER had neither a legislative mandate nor enough staff to enter into contracts with private sector companies. As a result, Eskom was called in to help administer the off-grid programme. The DME supported this: it did not want Eskom to be excluded from the process for fear that this would give Eskom the space to impose its views on the concessionaires. For some time (nine months or more) Eskom officials were reluctant to play any role in the off-grid programme, as they felt that it competed with their own grid-based electrification programme.

Finally, when Eskom was brought on board, key interim agreements were made with the DME as well as the concessionaires. The government would assume overall responsibility for the programme; Eskom (as a government agent) would enter into and administer contracts with concessionaires, demarcate off-grid areas, monitor performance, and report back to the DME and NER. The NER would be the interim caretaker of off-grid electrification funds; establish and enforce a light-handed framework for regulating the programme, establishing standards, and managing disputes. After these contractual roles had finally been clarified, the programme was further delayed because the concessionaires took some time to agree to the provisions specified in the contracts. Given the high degree of uncertainty and risk, it has been suggested that this delay on the part of the private sector was to be expected.

The contracting process was complicated and slow. As a result, one concessionaire withdrew from the programme, and another fell prey to the march of grid electricity. Also, various concessionaires were forced to diversify in order to remain afloat while the concession areas were being identified, contracting parties identified, and the contracts finalised.

These delays have damaged the programme, and adversely affected its potential beneficiaries. Lengthy periods of uncertainty about whether or not the programme would go ahead have done little for investor confidence. Lost opportunities and associated opportunity costs for customers must also have been substantial.

Indeed, this aspect of the programme does not display any positive innovations. On the contrary, contractual delays and institutional buck-passing have shown how innovation can be stifled, and how not to go about establishing a programme of this nature. Nevertheless, the process is still evolving, and it is hoped that, once final contracts have been signed, the off-grid programme will go from strength to strength.

6.1.3 Programme and procurement process

The concession-type model adopted is not innovative, when compared with other infrastructure delivery programmes in South Africa or energy programmes in other developing countries. Granting concessions for energy delivery in South Africa is, however, a pioneering step. Traditionally, energy has been delivered by public sector utilities, or offered by the private sector on its own terms.

International experience has highlighted the benefits of using a competitive bidding process to secure private sector partners. It has been shown that the burden on public funds can be significantly reduced and the programme made more sustainable, if potential concessionaires are required to propose subsidy amounts, and those proposing the lowest amounts are chosen. The fact that the DME and the National Electrification Coordinating Committee (NECC) did not adopt this approach has been seen as a lost opportunity.

6.1.4 Electrification planning

Box 1 outlines how electrification is planned at a macro level. There is little evidence that this has been innovative, but innovation should not necessarily be expected here. One area of concern is the extent to which grid and off-grid electrification planning is being integrated at this level. There is currently very little communication between the two programmes at this level. Generally, electrification is planned on the basis of need; it is assumed that grid will satisfy this need, and that off-grid investments should only be made where this is not the case. However, this is meant to change – when the off-grid programme is implemented at scale, the INEP BP (Integrated National Electrification Programme Business Planning) Unit will begin to plan off-grid projects in the same way as grid projects.

Possibly more relevant is the way in which electrification has been planned on a local or regional basis. Initially, concessionaires waited for Eskom to identify concession

areas. Alternatively, they could install solar systems for applicants living no less than one kilometre from grid infrastructure. In some concession areas, planning is now more collaborative and progressive; consultants are helping to draft electrification plans, and local/district municipalities are working with Eskom and the concessionaires to identify appropriate grid and off-grid areas. Again, while these integrated approaches are certainly worthwhile, they cannot really be regarded as innovative.

Box 1: Macro-level electrification planning in South Africa

Electrification in South Africa is currently planned on a macro and micro level. Micro planning is undertaken at the local or district level. It involves (or should involve) extensive discussions between local authorities (which have a constitutional right to deliver electricity within their jurisdiction), Eskom, and concessionaires. Local authorities must produce an annual integrated development plan (IDP) which includes proposals for grid and off-grid investments.

Macro planning is currently undertaken by the Integrated National Electrification Programme Business Planning (INEP BP) Unit. Previously housed within Eskom, this unit is now separate from it, though most of its staff have been seconded, on ministerial request, from Eskom.[7] This unit is tasked with country-wide electrification planning. It has undertaken performance planning, programme management, business planning, audits, and database modelling in order to support the planning process. Business planning includes data modelling supporting processes, aerial photography, statistics/data analysis, and data co-ordination. With support from the DME, the Development Bank of Southern Africa (DBSA), and Eskom, the unit has developed a tool for identifying grid or off-grid electrification requirements and the estimated cost of new connections. This leads to a business plan, which is used to distribute funds for annual grid and off-grid electrification investments. The unit is also working on South Africa's electricity infrastructure needs.[8]

The INEP BP Unit has been focusing on grid electrification needs, but has also been assessing and earmarking funds for off-grid requirements. The idea was that when the off-grid programme emerges from its pilot phase (which was expected to happen in 2004), the INEP BP Unit would start with truly integrated electrification planning.

Most decisions about electrification investments and planning are made by the National Electrification Advisory Committee (NEAC), successor to the National Electrification Co-ordinating Committee (NECC). While the NECC was established to advise the Minister of Minerals and Energy on the way forward for electrification in South Africa, the mandate of the NEAC (a far more streamlined, action-oriented group) is to guide the implementation process.

[7] This team was seconded from Eskom to support the DME with electrification planning. The idea is not to lose Eskom's competency in this area. It is unclear what will happen to this unit in the future – it may be housed within the EDI Holdings Company (the new structure being established to facilitate the rationalisation of EDI reform, or it might be assimilated into the DME.

[8] Its latest assessment is that an investment of R900 million is needed.

6.1.5 Off-grid regulation

The NER has established a light-handed regulatory framework for off-grid regulation, based on international best practice. It includes a technical standard – NRS 052 – that broadly specifies which technologies are acceptable. By early 2004, a new service standard – NRS 070 – was being developed. It was said to be fairly demanding of rural energy service providers, and thus likely to be revised downwards.

6.2 Financing arrangements

6.2.1 Public–private partnerships

The financial aspects of the off-grid electrification programme also involve public–private partnership arrangements.[9] As noted earlier, one of the key objectives of the partnerships between the public sector and private off-grid service providers has been to foster new investment in this area, and to eventually reduce the financial burden on the public sector. Interestingly, the government has adopted a phased approach: it acknowledges that, until each concessionaire has substantially increased its customer base, it will not be feasible to reduce the current capital subsidy. As noted earlier, public—private partnerships have been successfully adopted in other sectors of the energy industry, and can therefore not be regarded as innovative in this one, but again the arrangements made here are appropriate and effective.

6.2.2 Capital subsidies

Off-grid service providers have exclusive access to capital subsidies aimed at helping them to install solar home systems in specified rural areas. Initially, these subsidies were to be provided from the national budget via the DME. When it became clear that adequate state funds would not be available, the NER agreed to provide them from interest earned from electrification funds it has been administering.[10] At present, the subsidies are provided by the fiscus via the National Electrification Fund and the DME.

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[9] Technically, and according to the Treasury's definition of a PPP, the model adopted here does not constitute a true public–private partnership. This term here is used broadly and loosely to describe a situation in which both the public and private sectors participate in a particular venture, as designed and initiated by the public sector.

[10] For some time, the NER had been handling funds received from Eskom for grid electrification projects by municipalities and local authorities. These funds had beene raised by Eskom in the period 1994--1999 through a small surcharge on the wholesale tariff. When the NER agreed to administer the interim contracts between the government and concessionaires, it also agreed to use the interest from these funds to support the concessions programme financially. The idea was was that once these contracts were in up and running they would be transferred to the DME, which would then assume full responsibility for the integrated electrification programme.

This capital subsidy covers about 80 per cent of the cost of the solar home system; the remaining 20 per cent is financed by the off-grid service providers themselves. All the current concessionaires are either international utilities, or have international partners contributing substantially to the programme. This is one of the main reasons why they are able to sustain their participation in the programme. In fact, without international support it is questionable whether the off-grid programme would have existed today.

Public capital subsidies for solar home system installation by the private sector are not a new or innovative concept; it has been tried and tested in many other developing countries.

6.2.3 Operating subsidies

In December 2002 the cabinet finally approved the government's long-awaited plan to provide free basic electricity (FBE) to the poor. FBE is currently offered to grid as well as off-grid electricity consumers. While poor grid customers receive 50 kWh of free electricity a month, off-grid customers are meant to receive an operational subsidy of about R40 a month (expected to be about 80 per cent of off-grid operating costs). They do not receive these subsidies themselves; to date they have been transferred directly from the DME and NET to concessionaires, in partial payment for their fee-for-service arrangements with off-grid households. This fee covers operational costs such as servicing, replacing and maintaining batteries; replacing special bulbs; maintaining solar panels and replacing them where necessary; and maintaining control systems. At the time of writing, the idea was that, when the off-grid programme moved out if its pilot phase, the government would pay subsidies to service providers via the Department of Provincial and Local Government (DPLG), local authorities, and the Equitable Share mechanism.[11] Indeed, this funding mechanism was already being piloted.

Recently, there has been an active discussion about the feasibility and sustainability of the off-grid programme, focusing on the operating subsidy. One of the concessionaires has argued that it makes better business sense for the government to allow companies to sell the solar home systems to households outright and then to use the operating subsidy to service and maintain those systems. The subsidy would incentivise the concessionaires to maintain a long-standing local presence.

This company argues that it does not make financial sense for it to collect R18 a month from its customers (the difference between the total monthly fee of about R58 and the operational subsidy of R40), and it is also concerned that the government is

[11] This is cause for additional uncertainty for off-grid service providers, which are not necessarily assured of receiving the full R40 for services rendered. While local authorities are obliged to establish a clear set of rules for allocating Equitable Share subsidies, they have the discretion to decide whether or not to allocate these amounts to off-grid service providers.

not providing enough of a guarantee that the capital and operating subsides will remain available in the short to medium term. The other concessionaires argue that they have established themselves as utility companies in order to provide a continuing service to rural customers. They believe it is important to maintain the fee-for-service model, particularly because it is unclear for how long the government will be able to sustain the distribution of operating subsidies. These companies also contend that it is important for them to encourage a culture of payment among their customers, even if it does mean collecting an additional R18 a month which, they also say, helps plays a significant role in making the programme more sustainable.

It is not uncommon in developing countries for small monthly amounts of free electricity to be offered to grid-based customers. The value of requiring customers, the private sector, and the public sector to contribute to either capital or operating expenses is also fairly well accepted. However, it is indeed novel and progressive for free electricity to be offered to both grid and off-grid customers. This forms part of the government's attempt to 'level the playing field' between its grid and off-grid electrification programmes. It will be interesting to see whether this initiative can be sustained.

6.3 Process innovation

The business models of four concessionaires which had begun to operate by early 2004 are presented in Figures 1 and 2.

All the models differ from one another, though not significantly. All the concessionaires maintain a local presence, as required by the government, but to different extents. The Eskom/Shell JV, perhaps the most established of the off-grid service providers, has chosen to work with established spaza shops or other retail outlets in deep rural areas to create a local presence. Customers travel to these outlets to purchase credit units. They are supported by five regional centres (RESCOs), which also accept applications for new systems. EDF/Total has established two energy centres in the permission area in which they are currently working. Again, customers travel to these energy centres to purchase credit for the following month, or to apply for a new system. While the Eskom/Shell JV relies on established outlets to sell credit, NuRa has established its own energy stores in deep rural areas. These stores are reasonably accessible to customers, who can purchase units in advance or apply for new installations. By contrast, SolarVision is contracting local-level vendors who visit customers for payments for the following month's usage. SolarVision also employs local 'runners' to collect applications for new systems. Interestingly, both SolarVision and the Eskom/Shell JV require that vendors, spaza shops, or other outlets pay for units, which they then on-sell. In this way, sales are incentivised and malpractice discouraged.

Figure 1 – Business models currently adopted

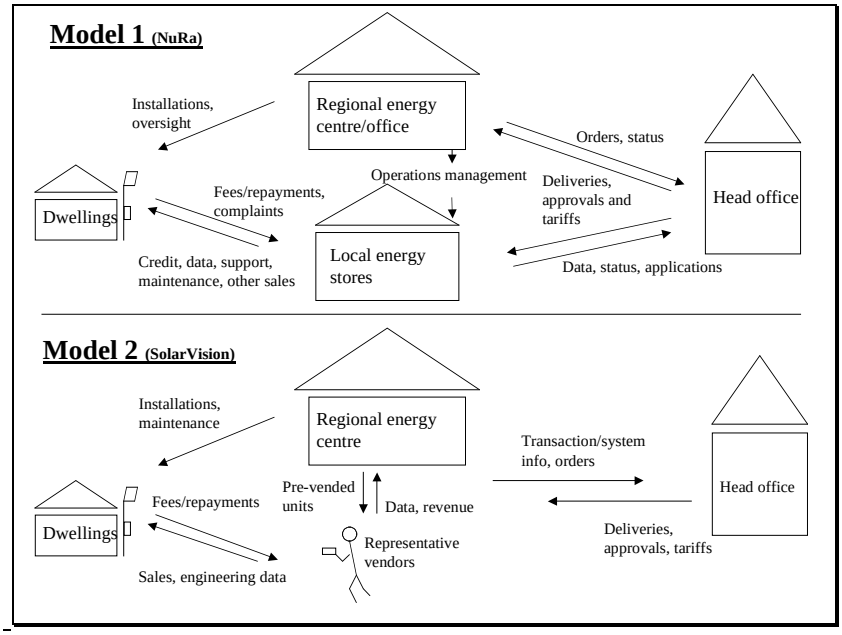
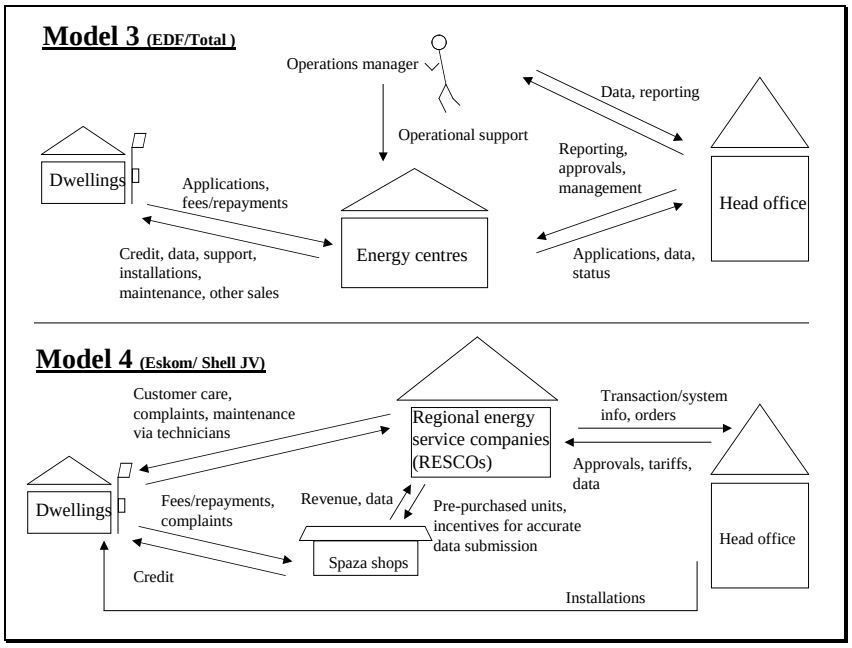


Figure 2 –Business models currently adopted



Both these approaches emphasise participation and ownership by communities. For example, NuRa eventually wants its energy stores to be owned by local entrepreneurs. EDF/Total and SolarVision try to buy poles and cables from local businesses, and EDF/Total have invested significantly in training technicians to install and maintain its systems. The Eskom/Shell JV relies heavily on established rural outlets, including spaza shops, and rewards good performance. SolarVision works with traditional leaders to identify vendors, and is currently trying to build up vendors' businesses so that these primary rather than secondary sources of income.

Each of the concessionaires relies heavily on data communication with its head offices. These are all in Gauteng, except for that of Eskom/Shell, which is closer to its concession area in the Eastern Cape. Lines of communication among regional centres, local stores, vendors, technicians, and so on are all very important for the efficacy of the concessionaires, which explains their continuing quest to improve or refine them.

NuRa has recently achieved tremendous success with selling LPG through its local energy stores. It is the first concession company to do so, and it claims that its revenues from selling other products, LPG in particular, are higher than those from installing solar systems. SolarVision is planning to investigate the feasibility of doing so as well, though its model will need to be different, given that it has not opened local energy stores. Indeed, it believes one approach might be to encourage and assist its vendor representatives to open distribution outlets in deep rural areas. The Eskom/Shell JV is not considering the sales of other energy solutions: it argues that it first wants to get the fundamentals of its business working well. Finally, EDF/Total acknowledges the importance of providing a solution to households' thermal requirements. It is currently extending one of its energy stores for the purpose of selling LPG. Total is able to produce a mobile unit to assist with this, and to set the price at which the gas will be sold. Importantly, this means that it can cross-subsidise sales in rural areas. This consortium also plans to sell LPG appliances, and is looking into more efficient and effective cookers. Until it can be shown that paraffin can be used safely, it will not sell it.

Thus, viewed broadly, these models display fairly similar characteristics, including the establishment of a local presence, the encouragement of local participation and ownership, business diversification, attention to business principles, and a quest to improve rural energy provision. These are challenges that most developing countries continue to grapple with. The ideas behind the models chosen by these concession companies are not novel; beyond the energy sector, these types of models are fairly common. For instance, the Coca-Cola company's method of penetrating deep rural communities is fairly similar, as is that of other popular consumer products.

Therefore, the emerging models 'make sense' rather than being innovative. They involve elements of programmes implemented in other countries, and have been adapted to the challenges at hand as well as government requirements. The models chosen are not static; indeed, they continue to evolve to achieve the best results. The manner in which solar home systems are being installed is a useful example. Initially, head offices expected to rely on local entrepreneurs to install these systems, but, even though these entrepreneurs have received the required training, this has not usually

happened. Over time, several of the concession companies have chosen to install the systems directly on from their head office or regional offices.

Interestingly, the models currently being adopted seem to be converging. All the concessionaires started off with their own models; now, a best practice model seems to be emerging. Other developing countries are closely watching this process, in the expectation that the results will be good enough to warrant similar business models to be adopted in their own deep rural areas.

6.4 Product innovation

6.4.1 Background

Before assessing the nature of innovation in respect of the products evolved for this programme, aspects of its background need to be recalled.

The DME initially intended to give concessionaires room to develop their own technologies. Thus the reference document sent out to prospective concessionaires in late 1999[12] stated that, 'as an interim measure, it will be a requirement that solar home systems provided as part of the National Electrification Programme satisfy the specification NRS 052 Photovoltaic systems for use in individual homes, Draft 7. Deviations from this specification may be accepted, provided such deviations are clearly explained, reasons for the deviations given and support warranties issued.'

The NET argued that benchmarks should be set, which the concessionaires would need to adhere to. When the concessionaires argued that they needed more 'space' in which to operate, the NER chose to 'stand back so as not to restrict the innovation process' (Banks 2003b). He goes on to say that 'the concessions do operate within the constraints of a national specification, but have sufficient motivation and lobby capability to explore reasonable deviations from the specifications' (2003b).

As noted earlier, the contracting process dragged on for years. The interim period, between establishing a memorandum of understanding with the government and signing interim agreements, was very difficult for the concessionaires. Because of the uncertainties surrounding the programme, and funding in particular, they were understandably reluctant to start implementation.[13] Yet they knew that as soon as the

[12] These terms of reference are presented in Appendix B of this document.

[13] However, two concessionaires did begin installations prior to official approval of the programme. Eskom Shell Solar Home Systems launched its off-grid programme in 1999 before it started receiving capital or operating subsidies. It achieved a great d eal during the initial years (installing 6 000 systems in the Eastern Cape), but at great cost to shareholders in the joint venture. Indeed, the JV has incurred considerable losses in the four years since start-up. Shareholders are now demanding evidence of positive

contracts were signed, they would be expected to perform. This presented them with a significant challenge: before any installation took place, staff had to be identified, teams trained, bank accounts opened and insurance organised, premises established, equipment commissioned and purchased, and so on. All of this took time.

The RAPS Group was outstandingly active during this period of uncertainty. It took this opportunity to diversify into other areas, including consultations on rural energy, and to develop products and technologies that would be required upon when installations began. As noted by RAPS Group personnel, they 'realised from an early stage that the success of these utilities would be based on sound business principles incorporating among other things: energy service delivery, customer service, revenue management and asset management. All of this had to be provided in a cost-effective manner' (Banks & Niemand 2003). This led to the development of the ENERGYStream™ product range.

6.4.2 Evolution of innovation

The story behind ENERGYStream™ is not particularly complex. In essence, as RAPS Group staff note, it involved a process of 'taking certain ideas and moulding them to work in a particular space'. That 'space' was rural energy provision and its associated challenges, as well as the terms of reference for the programme, as published by the DME.

The RAPS Group rose to this challenge. Perhaps it was able to do this so effectively because of the outstanding entrepreneurial spirit and drive of its founders and staff. They were able to see the challenge, delve into the details through developing a strong understanding of the rural energy challenge, develop concepts, tinker with technologies, and come up with this product. A team worked on the ENERGYStream product range for more than a year. RAPS invested about R2 million in this activity, and also took a loan from a fund specialising in solar energy development. This loan has now been repaid. The team sought advice from industry specialists (including specialists in the electronics and pre-payment metering industries). In some instances, these specialists were subcontracted to develop elements of the system. In return, they earn royalties per system sold. Restraint of trade agreements have enabled the group to retain control over these products.

This investment in development has begun to pay off: three of the four companies actively installing solar home systems, namely NuRa (the Nuon RAPS utility), KwaZulu Energy Services (KES) (EDF/Total utility) and SolarVision, are using ENERGYStream products. RAPS Technology also offers its clients some product variations. Elements of ENERGYStream are illustrated in Figure 3 and described below.

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returns before investing further in this venture. NuRa secured funding from the Dutch government which covered the cost of the first 400 solar home systems, installed from December 2001 onwards.

6.4.3 ENERGYStream product range[14]

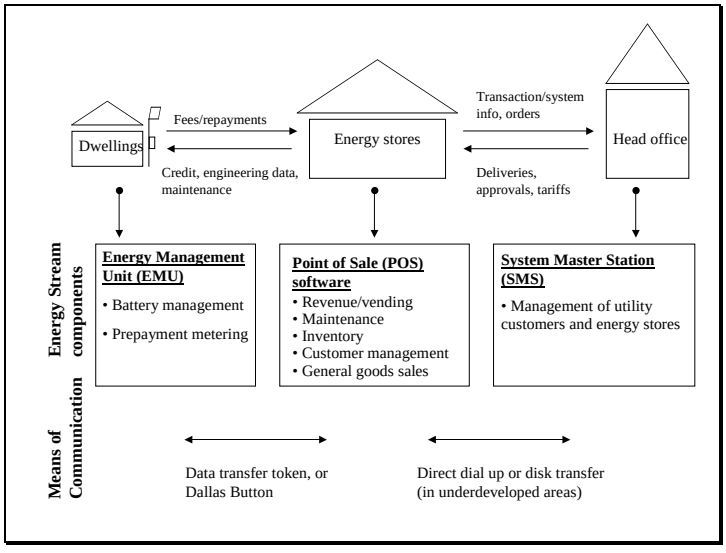
Broadly, ENERGYStream consists of key components: the Energy Management Unit, the Point of Sale, and the System Master Station.

6.4.4 The Energy Management Unit

The Energy Management Unit (EMU) manages household credit as well as the battery required to power the system. It is situated within the household, and is effectively a prepaid meter that disconnects the customer's load when the credit has expired. The EMU continues to act as a regulator when credit has expired, to ensure that the battery remains adequately charged. Additional credit purchased from the point of sale (the energy stores in the case of NuRa and EDF/Total, and mobile units in SolarVision's case) is loaded from the Data Transfer token, or a 'dallas' button, which carries electronic data (credit units) from the vendor to the household. The EMU incorporates a unique tariff methodology which allows the management of arrears payments.

Should a customer not use the system, he or she is still responsible for payment (because of the principle of fee-for-service rather than fee-for-energy). The patented ENERGYStream tariff gives the utility the flexibility to impose no penalty for arrears, or to impose extreme or intermediate penalties.

Figure 3 – ENERGYStream from RAPS Technology



[14] This section draws extensively on Banks and Niemand (2003).

Once credit has expired, the load can be reconnected every day for about five minutes. The purpose of this is to remind the customer of the system's value. The system incorporates numerous other technical innovations.

Importantly, the EMU records specific information about the operation of the charge controller, the battery, and the customer in general. This information is loaded on to a data transfer token, and transferred to the POS (Point of Sale) when the customer buys new credit. This facility provides vital information about the state of the customer's system, and allows preventive maintenance.

The EMU also contains an anti-tampering switch. Should the circuit be broken, the unit will go into tamper mode. This unit can also drive an electro-magnetic lock. Interlinked with these two features is a maintenance token, which is initialised at the POS and used to open meters for maintenance. Inserting the maintenance token operates the lock, allowing access to the battery. The maintenance token also records the date and time when the meter was opened and the remaining credit. This information is then downloaded at the POS for analysis.

Finally, the EMU has a simple interface to help customers manage credit and battery life.

6.4.5 The Point of Sale (POS)

The POS was developed primarily to sell solar credit. It also provides a total solution for managing local energy stores. The inventory master list and prices are defined at the system master station. The software provides for full inventory management, which includes receiving material, logging material movement (used for installations/maintenance), generating low stock notifications to the SMS (System Master Station), and so on. The software also simplifies stock-taking.

The POS helps the energy store to manage customers. Applications received are logged at the POS, and are then forwarded to the SMS for evaluation and approval. Various job cards can be generated at a POS (i.e. energy store or mobile unit). Job cards record new installations, routine maintenance, breakdown maintenance, and other engineering feedback. The software also provides a complete cashbook for accounting purposes, as well as a revenue-control management function that manages non-paying customers in a structured fashion. Customer complaints are logged on the POS, and reports on every customer can be easily generated.

6.4.6 The System Master Station (SMS)

All Points of Sale are managed from the SMS. Indeed, the SMS can 'turn off' a POS and prevent it from further vending. All customers are recorded at the SMS. Applications received from the individual energy stores are approved at the SMS. At this point, the customer is assigned a controlling energy store as well as a tariff based on the type of system he or she is applying for. Customers can also be assigned to maintenance areas, which facilitate logistical maintenance planning. The SMS controls routine maintenance.

It also manages inventory. Inventory classes can be created, each holding several inventory items. Sales prices and minimum stock levels are assigned to each item, and can vary depending on the energy store in question. Stock levels can also be monitored.

Other functions of the SMS include tariff definition, the flagging and tracking of non-paying customers, financial management/tracking of energy store performance, and interconnectivity with Geographical Information System (GIS) software in order to allow the detailed management of customers.

6.4.7 ENERGYStream™ and other available products

Three of the four concessionaires use the ENERGYStream product range. The fourth, Eskom/Shell, uses the PowerHouse™ Solar Home System, which includes a tower, a battery with an integrated SmartSwitch™, a PV panel with an integrated SmartSwitch™ and associated mounting hardware, a plug and play harnesses, lights and shades, and an enclosure base and cover. Interestingly, the SmartSwitch™ technology was developed and is owned by Conlog, and may be licensed to RAPS Technologies for integration with the ENERGYStream system.

The PowerHouse system is older than ENERGYStream. Developed by the Eskom/Shell JV in conjunction with Conlog in the early days of its programme, it is regarded as the first prepayment solar home system in existence. The system, which has evolved over time, essentially compares with ENERGYStream's Energy Management Unit (EMU). It uses a magnetic card reader rather than a data transfer token or 'dallas button', thus generating more engineering feedback than the ENERGYStream system. This has proven to be very useful with respect to preventive maintenance. Both the EMU and the PowerHouse system manage credit and battery charging with digital/electronic components. Both have a feature to cut out the system if it is tampered with. Both also cut out the system if it is significantly in arrears, though how this is achieved is based on different principles and timing. Both have a simple customer interface that allows the customer to gather information on the extent of credit and battery life. PowerHouse switches off households' external light at dawn, whereas ENERGYStream does not. EMU allows the utility to handle customers whose payments are in arrears by varying the penalty, whereas the PowerHouse system does not. PowerHouse identifies customers through barcodes, while ENERGYStream assigns customers unique customer numbers which are also linked to a meter number; thus customers can be identified by both customer and meter number.

6.4.8 Nature of the innovation

As a member of the RAPS Group notes, ENERGYStream™ is a 'brand new' product. It is unique for two important reasons. Firstly, it seeks to address the rural energy situation comprehensively. The outstanding innovation in ENERGYStream is

not so much the individual components, but the system as a whole.[15] It is effectively designed to link households to local energy stores and the concession head office. If any of the three elements cease to operate, ENERGYStream loses its value.

ENERGYStream also does well to understand the rural energy context. For example, there is very little reliable infrastructure, customers continually struggle to afford energy, housing is informal, and so on. The system is flexible enough to deal with these types of constraints.

Secondly, concessionaires using ENERGYStream argue that it provides a cost-effective solution. When questioned about the usefulness and the drawbacks of this product, a spokesperson for one of them noted that ENERGYStream was 'a very simple system' but that this was a strength rather than a weakness, because it rendered the system useable by relatively unskilled personnel. Most importantly, its simplicity enabled costs to be kept to a minimum. Indeed, there are far more sophisticated components on the market, but they are far more expensive.

The RAPS Group says the system is still evolving. This is due partly to the requirements of ENERGYStream clients and partly to continued attempts by RAPS Technology to improve it. RAPS Group staff note that ENERGYStream could still be improved – particularly in respect of effective business and financial management, and the management of information. Since NuRa is now also beginning to swell LPG and related appliances, it also notes a need to better integrate the sales of solar home systems with other services. RAPS Technology has registered two patents: the ENERGYStream™ product itself, and the Revenue Control System (a component of ENERGYStream). It is working on exporting both products to various countries in Africa.

6.4.9 A different perspective on product innovation

In April 2003, Shell Solar prepared a document for the DME containing suggestions on how policies could be changed to facilitate the rapid roll-out of solar home systems. It suggested that an outright sales approach rather than a fee-for-services model should be adopted. In response, the other operating concessionaires stated a clear preference for the fee-for-service approach. This interaction was one of the reasons why the government decided to commission a comprehensive review of the off-grid electrification programme. Another was that final contracts were due to be signed in March 2004, thus ending the pilot phase of the off-grid programme. The review process was to be completed by end January 2004 in time for analysis before the new contracts were concluded. A team headed by Africon Consulting Engineers carried out the review.

[15] This is not to say that none of the components is new. For instance, RAPS Technology has developed a revenue control system, which it has patented and which the RAPS Group hopes to export to other African countries.

In the document, Shell Solar argued that the fee-for-service model resulted in 'inconvenience for the customer, entails excessive costs for the rural private sector operator, and will cost the government more money that it needs to'. In August 2003, it began to test an alternative delivery model for solar home systems. It still involves a fee-for-service arrangement with prepayment requirements, but seeks to provide the service at a lower cost. The Mnyamana project is testing the installation of 100 solar home systems with different specifications from those of the standard PowerHouse systems. Broadly, these systems are cheaper because they are simpler, and because of this Eskom Shell argues that they are more robust. The fundamental differences between the PowerHouse system and these pilot systems are outlined in Table 2.

Table 2 – PowerHouse versus Mnyamana PV systems

Powerhouse system	Mnyamana System
50 Wp module	50 Wp module
Pole mount	Roof mount
95 Ahr battery	95 Ahr battery
Conlog charge controller with card reader and detailed customer interface	Basic 10A charge controller with no card reader and simple LEDs
Electronic security in battery, panel and charge controller	No electronic smart switches
Customers purchase cards for R58 which are then inserted every 30 days to avoid the system from switching off	Customers 'buy' receipts every 30 days but the system never switches off
PowerHouse controller costs more than R600	Controller costs less than R100

Source: Eskom Shell JV 2003

The objectives of this pilot project are to:

- Try to reduce the level of panel theft;
- Reduce capital costs;
- Improve system reliability (i.e. reduce maintenance call-outs);
- Introduce a system that does not switch off, thus reducing the need for tampering; and
- Test cash collection without the assistance of technical devices.

By November 2003 the following results had been recorded:

- The roof mount had been introduced at the request of customers who believed that this intervention could reduce theft. No thefts had been reported.
- Cash collection was 100 per cent.
- One customer had complained about an intermittent problem, which was later found to be the result of a faulty installation. There were no other complaints

- Customers were said to be 'extremely happy', particularly with the fact that the system does not switch off. They were happy with its general performance and reliability.
- There was considerable further demand for similar systems.

This is a new project, and time will have to tell whether the encouraging results recorded during the first four months can be maintained. If they can, it must be asked whether the systems developed for managing revenues, guard against tampering, and so on are in fact necessary and/or cost effective. If it is found that customers can be trusted to make payments on time, and panel theft can be prevented in simpler ways, perhaps ENERGYStream and also PowerHouse may, in some instances at least, prove to be cases of technology overkill. In the meantime, however, they must be regarded as instances of genuine innovation in this sector.

7. Lessons in innovation

As government officials emphasise, the off-grid concessions programme is still in a pilot phase, and the jury is still out on its future and sustainability. Some aspects seem to be solid and moving forward, while others still seem uncertain.[16] Unfortunately, ongoing public funding is one of the uncertainties. Indeed, there is a concern that, especially since the World Summit on Sustainable Development (WSSD) of September 2002, the programme may be losing momentum.

Have the services delivered thus far been worth the investment and effort involved? From a consumer point of view, the answer seems to be yes, because they have already improved the lives of many rural dwellers.[17] This is confirmed by the following excerpts from customer surveys and interviews conducted in each of the concession areas in November and December 2003:

> *Khanyisile (Pomeroy) says that her family are very pleased with the solar home system. The lights make her very happy. She says that 'the lights are as beautiful as flowers'.*
>
> *Thembi (Mbazwane) says that the solar home system gives her household good light and that they 'would not like to be without this convenience again'.*
>
> *Landina (Limpopo) says that the lights are better and she does not have to buy candles. Referring to the outside light above the front door, she says that 'it is no longer dark in the yard and no thieves will enter'.*

[16] For instance, each of the concession companies has international partners. Without this external investment – which has been largely in the social rather than private interest to date – the future of the off-grid programme is uncertain.

[17] This is not to say that the programme is without problems. As noted earlier, customers would prefer grid electricity, they would prefer to have a system that they can cook with, and they would prefer to pay less for the service each month, but on the whole, they are pleased with the systems, and would not like to go back to living without solar energy.

> *Otto Mshibe (Pomeroy) says that his father has installed two solar home systems at the spaza shop. He says that their shop stays open late 'and the customers really like the music'.*

From an organisational, financial, and technological point of view, progress has been mixed. Concessionaires have made significant progress in setting up rural infrastructure, identifying households, and developing, installing, and maintaining systems. Less success has been achieved in delivering a comprehensive energy package, achieving sustainability, and establishing sound procurement procedures and contractual and institutional arrangements. Importantly, there are lessons to be learnt from both the successful and unsuccessful aspects of the programme.

The South African off-grid programme is unique; no similar programme exists anywhere in the developing world. Therefore, many people are keenly watching its progress.

Is the programme innovative? Yes, and no. Viewed as a whole, it is. It has used elements of the business models, financing and institutional arrangements, and technologies used in other countries to forge a new approach to off-grid energy service provision. New products, including charge controllers, revenue management systems, battery boxes, module mounts, and lights and switches, have been developed, and new business or implementation models evolved. Financing mechanisms and institutional arrangements have been fraught with difficulties and challenges, and it is hard to make a verdict in these areas. Again, the extent to which the programme can be deemed innovative should be assessed in the light of customer perceptions. These, as noted earlier, are generally positive, though many customers believe there is room for further innovation in each of the above areas.

The principal lessons in respect of innovation include the following:

Private sector concessionaires have been given the space to innovate, and technologies and delivery models have not been strictly specified.

This has allowed concessionaires to be innovative about infrastructure, business models, and technology. Without this flexibility, it is unlikely that the private sector would have invested in innovation to the extent that they have.

The public sector has produced guidelines on the anticipated end state.

The government has provided broad guidelines for the type of programme it would like to see developed in rural areas. These have played an important role in keeping the programme on track, and within the ambit of government policy. Without them, it is highly debatable whether the programme would look the way it does today. Given, for example, the dissatisfaction of concessionaires with the fee-for-service model, it is probable that without these broad guidelines it would have been abandoned in favour of an outright sales approach.

The government's approach has allowed for a diversity of approaches that have increased the value of the solutions.

Diversity has emerged in terms of business and service delivery models as well as technologies (the EnergyStream versus Shell-Solar approach). More diverse solutions increase the potential for economic value to emerge by creating a larger pool of options to choose from. This avoids an early commitment to options that could be inferior, makes it more likely that the solutions that emerge will have greater value.

Innovation is fostered by a supportive policy, planning, and political environment.

Private sector players need certainty and reduced risk to involve themselves happily in partnerships with the public sector. If the risks are higher, private sector participants require higher returns on their investments. A supportive government framework helps to reduce this risk, and increase certainty. The *White Paper on Energy Policy (*1998) highlights the government's commitment to rural electrification through grid investments. It is less clear on off-grid rural electrification, though it does call for a level playing field for grid and off-grid electrification, and states that 'as far as possible, the government commits itself to maintaining stable targets and subsidy levels'. Indeed, the equalising of subsidies for off-grid and grid electrification has boosted private sector interest in the programme. Arguably, the private sector's significant investment in the programme is a clear indication of strong links between a supportive policy framework and meaningful innovation. Interestingly, there is evidence that this relationship also works the other way: that an unsupportive or wavering policy environment and associated uncertainties about funding will quickly discourage private sector investment and associated innovation. This was perhaps the dominant feature of the programme up to late 2003, when the government drastically reduced the number of installations eligible for subsidy, and commissioned a full review of the programme. As a result, installations and development were largely frozen.

Innovation is best enhanced in an entrepreneurial environment, and requires champions who consistently work at making improvements.

The South African off-grid electrification programme is a good example of the contribution the private sector can make to the process of innovation. It contributes an entrepreneurial spirit, a drive to succeed, exposure to new models and experiences, and additional financing that are lacking in public sector institutions.

Private sector companies have to innovate if they are to be competitive. Innovation has given at least one concessionaire a significant comparative advantage over the others; indeed, it is now selling some of its products to others which are facing similar challenges and do not have the time and infrastructure to initiate a similar process of innovation. Off-grid electrification does not offer large financial returns in the short to medium term. It takes special private sector institutions, and probably champions within those institutions, to maintain their commitment to the programme, and therefore innovation.

Protracted contracting periods create uncertainty and discourage investment.

The South African off-grid programme clearly demonstrates the negative effects that poor and lengthy contracting procedures and delays and uncertainties emanating from within the public sector can have on private sector participation and investment. If not handled properly, these processes can permanently damage the relationship between the private and public sector. In the case of the off-grid programme, two of the seven private sector consortia withdrew from the negotiations, partly because it was taking so long to complete the interim agreements, and partly because the electrification had changed so much during this period. Trusting relationships and co-ordinated effort are key to workable public–private partnerships and sustained investment in product and process development.

The role of international participation and investment must be acknowledged in an assessment of the overall innovation.

As noted earlier, it is unlikely that the off-grid electrification programme would have been able to fly had it not been for off-shore investments, which have played a critical role in sustaining the programme. These investments are still critical – indeed, if the international funding partners dropped out of the process it is unlikely that the local partners would be able to carry on operating as service providers in their current form. Assessing the extent and nature of the innovation must thus be viewed in the light of international support. Interestingly, the off-grid concession programme experience indicates that international participation and investment have not defined the kind of technology used or its innovations, or the prevailing institutional and contracting processes. Rather, international involvement and funds have tended to be very supportive of a home-grown programme, defined primarily by local partners.

An in-depth understanding of the environment/target market helps to get the innovation right.

An innovation is ultimately successful to the extent that end-users or recipients of the innovation are happy with it. Thus, the greater the innovators' understanding of the dynamics and needs of the 'target market', the better things will work. In the context of the South African off-grid programme, 'innovators' include both public- and private sector participants.

This programme is currently questioning the assumption that more technology or more complexity is always better. It seems that this may not always be the case: end-users may, in some instances, be more at ease with a simpler product or process. This is not to say then that the product or process is no longer innovative. Indeed, the simpler the product or process, the more innovative it might actually be. This is certainly the case with the contracting procedures currently in place, as well as with the current funding flows.

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Appendix A: List of interviewees

Name	Designation, Institution
1. Wolsey Barnard	General manager (regulation and compliance), NE R
2. Yaw Afrane-Okese	Renewable energy officer, NER (formerly programme leader, Energy and Development Research Centre, University of Cape Town)
3. George F.C. van der Merwe	Chief consultant to NER on off-grid electrification programme (Ndizani Networks Group)
4. Isak Kotze	Director of electrification, Department of Minerals and Energy
5. Douglas Banks	Director, RAPS Consulting and NuRa Utility
6. Gary Whalley	Managing director, SolarVision
7. Henry Geldenhuys	Eskom Distribution, also director, Eskom/Shell Solar JV
8. Clive Horlock	Managing director, Eskom/Shell Joint Venture
9. Danie van der Walt	Strategic Electrification Planning, Eskom (Megawatt Park)
10. Vicki Mundell	Programme manager EDF, Southern Africa
11. Anton Eberhard	Professor, Infrastructure Industries Reform and Regulation Programme, Graduate School of Business, University of Cape Town.
12. Sarah Adams	ACCESS Programme, EDF, France

Appendix B: Update on off-grid electrification programme

Prepared by Riaan de Villiers, October 2005

This study was written in late 2003, and updated in early 2004. A brief update to October 2005, on the Off-Grid Electrification programme seemed worthwhile, given its time-bound character.

In the course of 2004, the DME concluded new contracts with three major concessionaires: KES and NuRA in KwaZulu-Natal, and SolarVision in Limpopo. The fourth operating concessionaire, Eskom Shell Solar Home Systems, closed down, stating that its operation had become uneconomical.

It is understood that, following its successful pilot of an outright sales model, Eskom Shell Solar Home Systems asked the DME to allow concessionaires to utilise other models. When this did not happen, it decided to wind down. Maintenance of its systems in the Eastern Cape has been handed to three SMMEs, which are employing former Eskom Shell personnel.

The contracts with the three major concessionaires will run until March 2006. They provide for a maximum number of new installations which will fully subsidised by DME. Operating subsidies are now paid by municipalities, and are essentially the free basic electricity grants paid for both grid and off-grid electricity.

While the recommended subsidy is R40 a month, subsidies have the discretion to pay less. (In some cases, analysts say, municipalities are paying no subsidies at all, as a result of which the concessionaires concerted have reverted to charging customers the full monthly rates of R85.)

The German government (via the KfW Development Bank) has provided the DME with funding for a new concession in the Eastern Cape. The DME will subsidise installations by 80 per cent, with the concessionaire contributing the rest. This contract will also run for two to three years.

When these contracts expire, the DME will recede, and all concessionaires will have to form contractual relationships with local authorities. Capital subsidies will be drawn from state municipal infrastructure grants, and paid by municipalities as advised by the DME. However, all service providers will remain obliged to maintain the systems in their concession areas for a period of 20 years, or until their business become unviable due to grid encroachment.

In an interview in early October, a senior spokesperson for the DME stated that, while a number of challenges remained, the programme was functioning 'relatively well'. Up until end September 2005, about 29 000 home solar systems had been installed. De-installation rates due to payment defaults varied from 2 per cent to 5 per cent a year in various concession areas. Ways had been found of reducing theft.

Importantly, he stated that the aim of the off-grid programme was to provide temporary access to electricity in deep rural areas, pending the supply of grid electricity throughout the country. In this context, the off-grid programme would probably continue to grow for about three years, and then begin to wind down.

Appendix C: International experiences of off-grid electrification

Over the past few years there has been growing interest in the use of solar home systems in rural areas in developing countries, and numerous models have been explored. Many of these explorations have been well documented. However, the literature contains very few descriptions of the types of technologies used in off-grid concessions programmes. Some key lessons are extracted below.

On private–public partnerships, concessions and competitive subsidies

The Argentine off-grid programme (Covarrubias and Reiche 2000) is interesting and innovative in that off-grid services are to be provided by private companies requiring the lowest subsidy for serving a given area. Because of political and bureaucratic factors this programme has not yet taken off, but the results of pilot studies are very encouraging.

Concessionaires do not have obligatory coverage targets, but are required to serve customers who ask for it. Once a concession has been awarded, the concessionaire chooses the technology best suited to demand and the willingness to pay in a given area. Subsidies cover a share of the installation cost and, for the very poor, a share of the monthly tariff. They are linked to the service level and chosen technology; for example, higher subsidies are paid for renewable energy options. Subsidies will gradually diminish over the 15-year concession period. In the early years, when they will be at their highest, they will be funded by international donor agencies (Covarrubias and Reiche 2000).

Concession systems have also been adopted in Argentina, Benin, Togo, and Cape Verde. In Benin and Togo, monopoly concessions have been granted on a competitive basis. In Cape Verde a regulated monopoly was initially granted, but over time the system was successfully opened up to competition.

Delivery methods, business models and financing arrangements

Martinot (2000) summarises off-grid experiences in South Africa, Bangladesh, the Dominican Republic, Mexico, and Morocco. Implemented by Grameen Shakti, the Bangladeshi system is one of few examples of solar home systems creating income-generating opportunities. These systems are sold on credit. In the Dominican Republic, a fee-for-service approach has been adopted. The aim of the programme is to reach a 'proof of concept' where the programme will break even. The business model employed by the US firm Soluz involves 5 000-customer business units, multiple 'service centres' serving 1 000 to 5 000 customers, 'zones' within service centres of 500 to 750 customers, and 'collection points' for 20 to 100 customers. Cost-effective collection management has been an important lesson: collection has been expensive, largely because it has required visits to some households. This programme has also demonstrated the need to educate consumers about the use of

batteries, chargers, and other technical aspects of the system. The Mexican model involves the leveraging of communal funds to pay for solar home systems, and these funds have not always been well managed. A lesson from Morocco is that beneficiary participation is important, as are adequate financing schemes, efficient payment collection mechanisms, and close after-sales service centres.

Martinot, Ramankutty and Ritter (2000) argue that there has been inadequate experience with the service model (involving fee-for-service arrangements) to say conclusively whether the outright sales or service model is preferable. However, they lean towards the service model, primarily because of its after-sales benefits.

After its workshop on financing mechanisms and business models for solar PV in Africa held in Pretoria in May 2003 (see box 2), the UNDP commissioned an overview (Banks (2003c) of the main methods of delivering solar home systems. The main models identified were:

- Supplier/dealer-led models (with or without dealer credit) evolving in response to purchasing capability, with relatively little outside control (eg Kenya).
- Project-focused models, typically providing consumer credit, involving a project management unit and more than one PV supplier or dealer (eg Kenya and Zimbabwe).
- Utility-type models, typically involving a subsidy, with exclusive access to a defined geographical area and a 'fee-for-service' payment method, with longer-term maintenance integrated into the package. Revenue may be collected either manually or via pre-payment systems aimed at reducing the cost of collection.
- Institutional focus models, involving market entry via projects intended to provide energy services to rural institutions such as schools or clinics.
- Productive use-led models, focusing on supporting economic activity in rural communities with renewable energy technology or other modern energy forms. PV energy is generally sold as part of a small business package, or in partnership with a range of village-level entrepreneurial development services (eg Uganda).

Box 2: African solar PV workshop: financing mechanisms and business models

In May 2003, the United Nations Development Programme/Global Environment Facility (UNDP/GEF) held a workshop in Pretoria on financing mechanisms and business models for solar PV in Africa. More specifically, it was aimed at promoting cross-project learning and the sharing of experiences among African PV programmes. The 57 participants included representatives of 15 PV programmes in 13 countries; donor agencies such as the World Bank, GEF, and UNDP; and dealers, consulting companies, and industry associations. Participating countries were Uganda, Kenya, Tanzania, Ethiopia, Ghana, Zimbabwe, Malawi, Mozambique, Botswana, Namibia, Zambia, South Africa, and Lesotho.

Three distinct business models were identified:

- *Cash sales*, where the consumer buys the PV system for cash or via a credit arrangement with dealer;
- *Consumer credit*, involving a specialised finance partner and a maintenance contract during the finance term; and
- *Fee for service*, a large-scale 'utility-type' approach usually involving subsidies. Variations and hybrids of these three basic models are also found.

As regards financing mechanisms, three basic categories -- financing the consumer, financing the PV business, and financing the financiers -- were distinguished, and a variety of financing tools for each category presented. Tools such as hire purchase, salary withholding schemes, co-operative loans, credit lines to companies, risk guarantees, and many others were explained and discussed.

A key finding was that there was no single best business model, financing mechanism, or market development approach for PV in Africa. Careful analysis was needed to determine which models were best suited to particular markets, and other contextual parameters. Depending on whether the market was at a pioneering, emerging, or mature stage, and also on the strength of the local financial sector and a realistic demand forecast, an appropriate mix of financing tools along the delivery chain needed to be chosen in conjunction with the most suitable business model. These and other parameters would determine whether it was more appropriate to finance the consumer, the PV companies, or the financiers, and whether a cash sales, consumer credit, or fee-for-service model should be adopted.

Other criteria and variables also needed to be considered. The choice of the right business approach and financing tools depended, for example, on government policy, strategy, and action on rural electrification. In countries whose governments were strongly committed to providing energy and particularly (subsidised) electricity to rural areas, market development of PV systems and the choice of business approaches and financing tools would be different from situations where the government lacked the commitment and/or financial resources to provide subsidised access to electricity. In the latter setting, developing a fully commercial PV market with a profitable delivery infrastructure and appropriate financing mechanisms was a huge challenge. In the former setting, a large customer base and long-term perspectives were needed to break even using the fee-for-service approach.

In 2001 the UNEP Collaborating Centre on Energy and Environment published a booklet on experiences with PV systems in Africa (Wamukonya 2001). It notes that various small-scale solar PV initiatives have been implemented in different parts of Africa, driven either by governments or the private sector. Responding to a perceived 'information gap' on these initiatives, the booklet outlines experiences in Botswana, Namibia, Zimbabwe, Kenya, Uganda, Ghana, Mali, Swaziland, Zambia, Morocco, Senegal, South Africa, and Lesotho, and discusses business models and financing arrangements for each of the projects.

According to Martinot, Cabraal, and Mathur (2000), there is growing interest internationally in the energy service company (ESCO) model for delivering solar home systems, in terms of which the ESCO owns the system, charges the household or end user a monthly service fee, and is responsible for service. The ESCO may be a monopoly concession regulated by the government to serve specific geographic areas (as in Argentina, Benin and Togo), or it may operate competitively without an explicit monopoly status (as in the Dominican Republic). Combinations of these two forms of ESCO start with monopoly concessions and progressively open up markets to competition after some years (as in the Cape Verde).

Approaches to regulation

As a component of the review of the South African off-grid electricity programme, Clark (2003) also reviewed best practices in developing countries. Based on the findings, she suggested that that the objectives of the local programme should be re-evaluated. International experiences pointed to two basic approaches: quick-fix approaches that rapidly helped to alleviate poverty, or those that built sustainable solutions. Both had merits and demerits. Besides this, South African policy-makers and planners should examine the following issues:

- *Whether it is worthwhile subsidising capital and operating costs to the extent that this is currently done.* These subsidies places a tremendous burden on the public sector, and it is debatable whether they create a sustainable solution. Experience indicates the importance of customer contributions.
- *Whether diminishing grants may be a useful tool.* In some cases, subsidies cannot be avoided; they are needed to help poor households to move out of dire poverty, and to help establish a market for solar home systems. Recognising this, some countries are offering diminishing grants, with the diminutions made known up-front.
- *Whether it is worthwhile introducing more competition into the selection of concessionaires.* International experience indicates the benefits of selecting private sector partners competitively or on the basis of the lowest subsidy required for high-quality systems and service. This approach allows the private sector to create innovative solutions for reducing costs. An interesting example of this is where customers are taught to conduct routine maintenance, and service providers are only called out when there is a second-level problem.

- *Whether it is appropriate to distinguish between on-grid electrification projects and off-grid pre-electrification projects.* A distinction between electrification and pre-electrification projects can help the government to get 'the right message' across to customers, thus ensuring that expectations are not unrealistically raised. Furthermore, a distinction between these different levels of electrification can help to remove the need for creating a level playing field between grid and off-grid solutions.
- *Whether sales and service models should be implemented concurrently.* Experiences elsewhere show that these models can be implemented at the same time. Customers can choose the option that suits them best, and different policies and regulations can be formulated for each.
- *If the sales model is implemented, whether it is worthwhile working with micro financiers to reduce the costs of debt.* Micro financing has been successfully utilised in several countries to facilitate the sales of solar home systems. Credit risk should be built into the models from the outset. Flexible repayment systems are crucial. The modular purchase of solar home systems has also been successful.
- *Whether adequate public sector resources have been allocated to administering the programme.* International experience indicates that administering these programmes requires significant time and human resources.
- *Whether the private sector's role in the programme can be protected.* International experience indicates the importance of ensuring that the private sector is able to make a profit from its involvement. Dialogue, co-operation, and trust between public institutions and private entrepreneurs must be prioritised.
- *Whether the programme's alignment with other aspects of public policy can be improved.* International experience indicates that solar programmes can be permanently harmed when they are not properly harmonised with other aspects of government policy, including grid electrification.

Box 3: Overview of international experiences (1)

Programme	Argentina (Renewable energy in the rural market)	Benin/Togo (Decentralised rural energy)	Cape Verde (Energy & water sector reform)	Peru (Photovoltaic-based rural electrification	Bolivia (Renewable energy-based rural electrification)
Geographic monopoly for concession	Yes; by province	Yes; selected 'project areas'	No; gains market rights and subsidies, but must compete with others	Community-based, but not necessarily monopoly	Community- based, but not necessarily monopoly
Regulator	Provincial governments and existing provincial utility regulatory agency	Newly established national agency 'Agence d'Electrification Rurale'	Project Management Unit during project; thereafter 'independent utilities regulator'	Ministry of Energy and Mines	Municipal governments (also through equity investments in the concession)
Concession term	15 years	15 years	10 years	Not stated	Not stated
Concession renewable	Yes, to 45 years	Yes, to 40 years	No	Not stated	Not stated
Bundling with other services	Possible	No	Possible	Possible	No
Competitive bidding vs negotiated contracts	Negotiate with urban concession, else bidding	Competitive bidding	Competitive bidding	Not stated	Not stated
Purchase vs leasing by concession	Purchase on open market	Lease from govt agency	Purchase on open market	Purchase on open market	Not stated
Technology choice	By concession	By govt agency (regulator)	By concession	By concession	Initially by project/regulator
Initial customer fee	Yes; ± $100 (for 50 Wp)	Yes	Decided by concession	Yes; ± $100	Yes; 10% of system cost
Subsidies	Up-front grant of ±65% of installed system costs; GEF grant diminishes over time Low-income: also monthly subsidies	Up-front grant and yearly grant for up to five years, covering up to 30% of installed system costs; diminishes in later years of project	Up-front grants of 30% for 20 Wp household system; 15% for 50 Wp household system; 25% for 50 Wp public lighting system	80% subsidy for installed system costs; constant over life of project	At least 35% for PV projects and 20% for mini-hydro projects
Service standards and monitoring	PV system performance standards Certification procedures for installers	PV code of practice PV technical standards Accreditation programme for technicians Inspections on installed systems Customer surveys	International standards used Equipment meets 'certain minimum standards' Project Management Unit supervision	PV systems standards Recommended certification practices Training for installation technicians Random inspections	Equipment standards Certification programme

Box 4: Overview of international experiences (2)

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
Argentina	Fee-for-service, regulated monopoly concession, concession granted on competitive basis	ESCO sells, installs and services	Provincial and federal government World Bank provides grants on diminishing scale	Concession companies must provide services for a period of at least 15 years
Bangladesh	Credit sales, credit extended by non-profit dealer	Grameen Shakti sells, installs, services, collections, providers guarantees and three-year credit	IFC – Business loans	Marketing and education costs are high
Benin and Togo	Fee-for-service, regulated monopoly concession granted on competitive basis	N/a	World Bank provides grants to concessions on a diminishing scale	Diminishing grants entail added administrative burden
Brazil	Fee-for-service/rental scheme	Electric utility selects, installs, sells, services	Utility International funding	Low degree of subsidy User pays a service and rental fee
Bolivia (before 2001)	Fee-for-service/rental scheme	Electric utility (CRE) selects, sells and installs	Electric utility International funding	Fee collection undertaken through local savings and credit cooperatives that have few means and incentives to minimise defaulters (less than ½ of end-users by 2001 were making payments) CRE believes that it is more expensive to set up a strong fee collection system than to cover the losses
Bolivia (2001 onwards)	Cash sales, flexible credit scheme	(NGO) Energetica	Dutch funds Local credit organisation	Credit organisation allows built in flexible debt rescheduling according to agricultural situation and calendar
Cape Verde	Fee-for-service, regulated monopoly concession that progressively opened up to competition.	N/a	World Bank provides diminishing grants to concession companies	Diminishing grants entail added administrative burden

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
China	Credit sales, then later cash sales	Company (Gansu PV) to manufacture, install and service	Customers Donors subsidising cash purchases	Initially customers did not understand the concept of 'credit' User is responsible for operation and maintenance Customers pay ½ the price before installation, and ½ after installation
Dominican Republic	Fee-for-service, regulated concession (no monopoly status)	Company (Soluz) and subsidiaries and service centres and collection points	IFC – business financing for dealers available	Cost-effective collection has been challenging Customer education important
Gambia	Credit sales	Small private companies	N/a	High risks involved so sales are restricted to well-known intermediaries or customers
Honduras	Fee-for-service, cash and credit sales, dealer credit	Company (Soluz Inc.) and subsidiaries sell, install, service	Rural NGO financier Soluz Inc.	Fee-for-service is most common (maintenance costs included) For credit sales, customers pay for maintenance if past warranty Resolving non-payment problem more difficult with credit customers Soluz has experience in fee-for-service, cash and credit which helps
Indonesia (Phase 1)	Cash sales and hire purchase	ESCO (PT. Sudimara) sells, installs and services	PT Sudimara provides hire purchase facility	Cash flow problems Banks unwilling to give loans as no collateral High overhead costs
Indonesia (Phase 2)	Cash sales and hire purchase	ESCO (PT Mambruk Energy International) Franchised solar shops install and service	PT Mambruk provides hire purchase facility World Bank/GEF provides grants to dealers who provider credit on sales	Franchising approach reduces costs Slow start-up owing to infrastructural requirements

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
Kenya	Cash sales (modular and outright) Hire purchase	Private dealers but installation advice not common for hire purchase arrangements	IFC – business financing though competitive solicitation and selection of business plans Commercial funding support Cooperative funding	Very few local enterprises sell higher-quality systems or provide installation services Limited government support Modular sales most common Warranty offered Hire purchase works well due to a well developed credit infrastructure in rural areas.
Mexico	Cash sales and subsidised government programmes	Local government and private dealers	Communal funds Donor support	Coordination between grid extensions and PV programmes necessary
Morocco	Cash sales, hire purchase and fee-for-service	State electric utility (ONE) to design programme and provide some finance Private company (Sunlight Power Maroc) sells, installs, services and helps to finance.	Local councils, end-users and ONE (from levy on electricity sales) IFC – competitive solicitation and selection of business plans Micro-credit organisations Small subsidy content	Fee-for-service is most popular User undertakes basic maintenance For cash sales, customers may agree to a maintenance agreement and pay an annual fee, or they pay for costs linked to each repair. Capital-intensive business Performance achieved largely without help of financing arrangements
Namibia	Credit sales	Accredited ESCOs sell, install and service. National development authority manages revolving fund	Peri-Urban and Rural Solar Electrification Revolving Fund International funding	High payment records Sustainability of revolving fund questioned Quality control and maintenance problems Moderate degree of subsidy (35%)

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
Philippines	Credit sales and renting	Electric Cooperatives contract with end-user and collect service fees which are repaid to NEA	National Energy Administration lends to ECs (subsidies) International funding too	End-user must purchase balance of system components at own cost High degree of subsidy Credit: user owns BOS, EC finances solar generator, user pays combined service fees (O&M and debt service) Rental: user owns Bos, EC owns solar generator, user pays combined service fees (O&M, rental fee)
Sri Lanka	Cash sales and end-user credit	ESCO (SELCO Solar Lanka Limited) markets, sells, installs and services and helps to finance Micro-financier does collections	World Bank grant (subsidy to financier to reduce monthly payments) Micro-financier ESCO (SELCO Solar Lanka Limited)	Monthly collection costs prohibitive when fee for service approach tried. Micro-finance option preferable. Sales contract states that the ESCO must provide high-quality after-sales service. ESCOs had difficulties in maintaining service agreements on credit sales

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
Tunisia	Energy service (but no fee for service is requested)	National energy authority installs and services for two years PV dealers sell to AME	Donor and government supported	High degree of subsidy Customers place a down payment (about 7% of installed system) but do not pay a regular fee for installation, maintenance or replacement Financial sector is not involved because no credit Programme dependent on availability of govt/donor funds After two years, customer is responsible for O&M Quality problems and poor technical design PV dealers do not have opportunity to develop market
Uganda	Cash and credit sales	Village bank procures systems through competitive bidding by private dealers who also install	Habitat for Humanity and donors Solar Electric Light Fund HIVOS Revolving credit funds Village banking – micro-financing	Community-driven approach Credit funds are not sustainable

Case study country	SHS delivery model	Implementing agent	Sources of finance	Notes
Vietnam	Cash sales and credit sales, ESCO concession now considered	Private dealer installs and services, provides guarantees VMU markets and collects payments Loans provided by VBARD	Vietnam Women's Union (VMU) Vietnam Bank for Agriculture and Rural Development Dealer IFC – business financing for dealers available	N/a
Zimbabwe	Cash sales and dealer credit and some hire purchase Bulk purchasing of equipment duty free	ESCO (Solar Energy Supplies) store, credit stores or other network partners Installation by customer	Initially GEF funded. Cooperative funding Agricultural Finance Corporation loan	Cost of system is less because of no installation and travel costs Cash sales are more popular than credit sales Modular cash purchase is popular (i.e purchasing system over time)

Sources for above tables: International Energy Agency (IEA) (2002a); IEA (2003a,b), Martinot (2000), Martinot, Cabraal and Mathur (2001), Banks (2003), Hankins (2003)