

Village Electricity in Lao PDR

by Adam Harvey, Project Adviser Off-Grid Promotion and Support Office, Lao PDR

Over the past five years, a team of Lao experts has been training small companies to become village energy service specialists, to work in areas not due for electricity grid connection. The companies offer a choice of electricity supply technology, so that there is a solution for each village. Most villages have chosen solar home systems (SHS), but as the companies begin to work in the remoter cloudy and hilly areas, more villagers are choosing village-scale hydro systems.



The Solar Home System is very popular in the provinces of Laos

Photo: Adam Harvey, OES

high re-sale value. They choose a Village Electricity Manager (VEM) to provide technical support over this period and beyond. In the case of hydro and engine-generators, this “VEM” hire-purchases the equipment personally, using it to run a small business selling electricity. In both cases, prospective ownership has proved in practice to be an excellent motivation to take care of the equipment.

next fifteen years, and providing ongoing service support to large numbers of operational systems.

The Village Electricity Manager and the Electricity Service Company (Esco), both receive a portion of each monthly hire-purchase payment. In this way, a technical and management structure is permanently in place to support the long-term needs of operational customers. Both the Company and the VEM have a strong incentive to maintain the equipment in good working order, as they lose income if villagers with-hold payments for any reason.

The challenge has been to develop a framework within which the companies can operate consistently over many years into the future. An ambitious goal for Laos is to connect 75% of rural families to the grid by 2020, and to help at least another 15% to receive off-grid electricity by this time. This would mean companies delivering 10,000 connections on average per year over the

Although the focus of the programme so far has been on electricity supply, the regulatory framework and financing approach has been designed to work for a wide range of renewable energy options for rural communities. The energy service companies are able to diversify into technologies such as biogas-based cooking, using the same financing and administration structure. With respect to electricity supply, the modality accommodates options such as bio-fuels for engine generators.

The programme has been developed



Photo: Adam Harvey, OES

The OPS team training two Escos, the Alek and Bolikamsay Electricity Companies in the Sayabouri Province, Laos

A key challenge has been to make sure the stand-alone electricity installations operate reliably for many years. The solution has been to develop a “rent-to-buy” or hire-purchase mechanism. In the case of villagers choosing solar home systems, they buy the equipment by monthly payments over a period of several years. The solar panel then becomes an important economic asset to poor families, since it retains

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Photo: Adam Harvey, OPS

The VEM introduces consumers to safe use of electricity and explains the purpose of the current limiter

by an Off-Grid Promotion and Support (OPS) office located within the Ministry of Industry and Handicraft (MIH) in Vientiane. The team includes Government officials, and personnel recruited from the private sector. The work is funded by a soft loan from the World Bank, combined with a GEF grant.

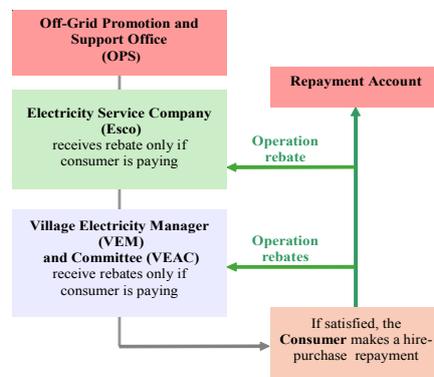
This article outlines progress with the programme so far, focusing on “best practices” – that is, choices we have made through careful testing of options, to ensure reliable service for Lao villagers and a self-sustaining framework for implementing companies. We have tried to move from project-cycle vulnerability, to a solid national programme providing real opportunity for the private sector and for the majority of Lao villagers.

Reliability

Our delivery system is designed to create reliability. The main mechanism is financial incentive. This works in three ways:

First, the SHS user is buying the equipment, and is motivated to take care of it so as to not lose his investment. In the

case of VHGS (Village Hydro, Gen-Sets) the VEM makes a significant private investment and looks forward to increased income at the end of the hire-purchase period, so he is motivated to keep the equipment in good condition. He depends on tariff payments for his livelihood, and so is interested to provide reliable supply every night.



Our record of 95% repayment indicates reliable supply and satisfied users. The other 5% is not default but acceptable late payment.

Figure 1: The financing system is common to all technologies and is based on performance rebates which assure long-term reliability. In the case of VHGS and other central distribution arrangements, the VEM is the one making hire-purchase payments, and the consumer is paying tariffs to the VEM

Second, you can see from Figure 1 that the VEM, VEAC (Village Electricity Advisory Committee) and Esco receive a portion of each users payment. These portions are called “operational rebates”, which means they are received only if the user payment is actually made. An unreliable system results from the customer not paying, so the VEM, VEAC, and Esco don’t receive their rebate. They are therefore motivated to think ahead, keep spare parts in stock, check for early warning signs of faults, and make sure

the customer knows how to use his equipment well and avoid problems. They become experts at preventive maintenance. They want their customers to be satisfied.

Third, OPS does not approve plans for installations in new villages, if the Esco is not maintaining an average repayment rate above 95% from all the villages. If the Esco allows reliability to slip, repayments will slip and his business will fail. He is in competition with other Escos, who would then expand their business in his area. OPS has designed the Esco license agreement to open each area up to competition two years from date of signing.

Another method of ensuring reliability is the progressive increase in private investment by VEMs and Escos. This is recouped through reliable payments by customers over many years.

In general the Escos need to market themselves effectively and build good customer relations in order to grow and survive. At present they distribute a standard price and tariff leaflet which carries the motto “Every Night, Light”. As competition grows, they will develop their own distinctive styles of marketing strategy and support systems. The Lao Government/World Bank programme provides business training on marketing, planning, and organisation aimed ultimately at securing reliable supply for villagers.

If repayment performance is good, reliability is good. The prescribed delivery system has a repayment performance from consumers of over 95%, the shortfall being acceptable late payments rather than defaults. 3,000 villagers are receiving “every night, light” some already for four years.

The Stockholm Environment Institute (SEI) is an international research institute focusing on sustainable development. The Institute works through an international network of centres, associates, and field staff around the world.

The Climate and Energy Resources Programme is concerned with improving access to environmentally friendly energy services, promoting renewable energy and energy efficiency, and advancing global cooperation on climate change.

This newsletter is supported by the **Swedish International Development Cooperation Agency (Sida)**. The newsletter is distributed free of charge and

is also available through the SEI website.

The views expressed in the articles in this newsletter are those of the authors and not necessarily those of SEI nor of Sida.

For further information contact **Solveig Nilsson**, SEI. solveig.nilsson@sei.se

Managing Editor: **Helena Forslund**

Editor: **Francis X. Johnson**

Publisher: **Arno Rosemarin**

Layout: **SEI/Solveig Nilsson**

Printer: **Elanders Gotab**

ISSN 1101-8267

Printed on chlorine-free, 100 % recycled paper

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Box 2142

SE-103 14 Stockholm, Sweden

Tel +46 8 412 1400,

Fax +46 8 723 0348

E-mail postmaster@sei.se

www.sei.se



Photo: Adam Harvey, OPS

Teenagers watching TV thanks to a 20W solar panel. In the front the battery in a ventilated box

Sustainability

We have designed a delivery mechanism to be robust, by building in financial incentives and ownership incentive to achieve reliable performance. Nevertheless this is not enough, as sustainability will depend on the effective day-to-day practical application of the mechanism which requires steering through progressive stages of further development. For example it includes steps toward increasing private investment by Escos as their businesses grow larger (one step in doing this will be the removal of planning rebates for Escos achieving high consumer volumes).

Practical management of the processes involved in enabling the private sector, is a major challenge. An example is the need to manage healthy competition between Escos, such that proficient Escos serve more customers, and inefficient ones are led by example to improve their skills. Although clear and simple procedures are already in place, their application remains a challenge for forthcoming years.

Although one aspect of sustainability is full commercialisation, it is unrealistic to expect that most rural families can afford off-grid under fully commercial conditions. Wealthy villagers, possibly only 10% of the rural population, would be the sole beneficiaries leaving the majority worse off. Sufficient soft loan funding for 200,000 off-grid connections is almost certainly available to Laos. In the context of this credit, our programme makes sure that villagers experience com-

mercial conditions, interacting with private companies on the basis of clear price lists and payment terms.

The programme is already financially self-supporting, within the context of soft credit. Even now grant finance is not essential – it is needed only for auxiliary inputs to introduce renewable energy technologies and capabilities.

Figure 2 shows that operational costs are met by consumer repayments, and as the volume of customers grows, a repayment reserve is accumulated. Even at the current low connection rate, there is already enough reserve to finance the administration of the programme for about one year. After a few more years, administration can be permanently funded by the repayment account. This means the Laos Government has created a National Programme which can continue to function regardless of fluctuations in external support. It is not dependent on project funding cycles.

Drawing from the reserve, customers with off-grid connections continue

to receive back-up support from VEMs and Escos, who themselves receive back-up from OPS, even if for a period no external inflow of credit is available for new equipment installations. As the reserve grows larger, it is possible for it to also cover loan repayment costs and to provide credit for new installations.

Implementation by private companies

Figure 3 shows the five companies so far licensed to work in a particular area, either a group of districts or a whole province. Licensed companies are referred to as Electricity Service Companies or Escos's.

The Escos's specific services are participative planning for off-grid villages, selecting and training village off-grid entrepreneurs, supporting the villages in the long-term management, maintenance, and financing of their equipment.

Companies compete for the Esco license following public announcements. Individuals may also enter the competi-

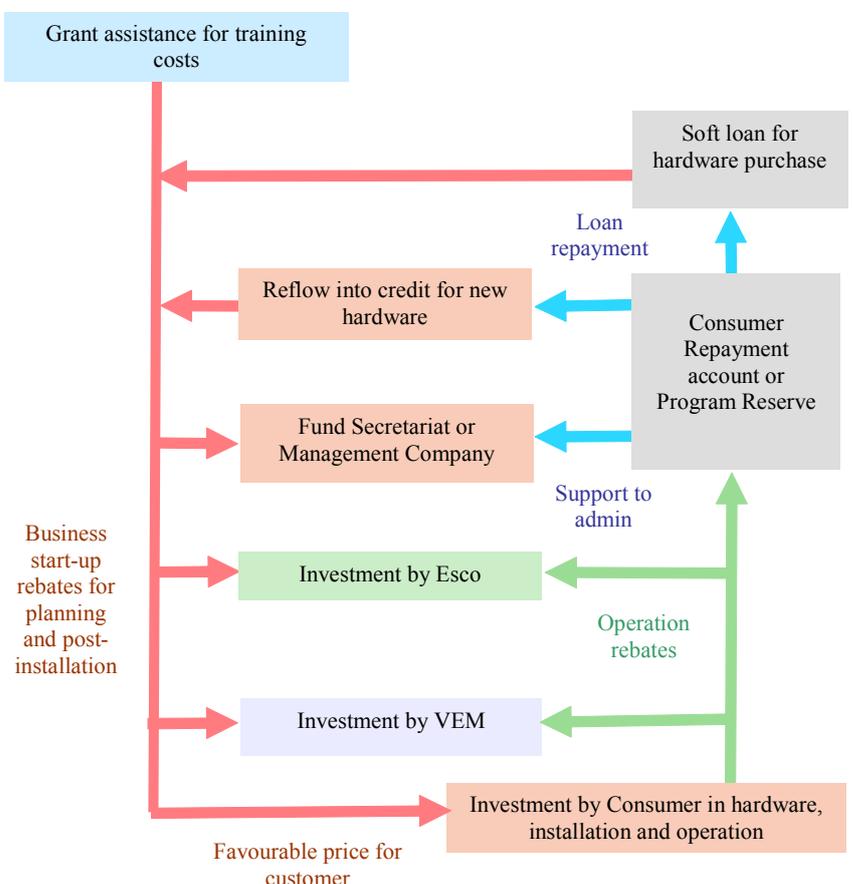


Figure 2: Contributions to investment and operational costs

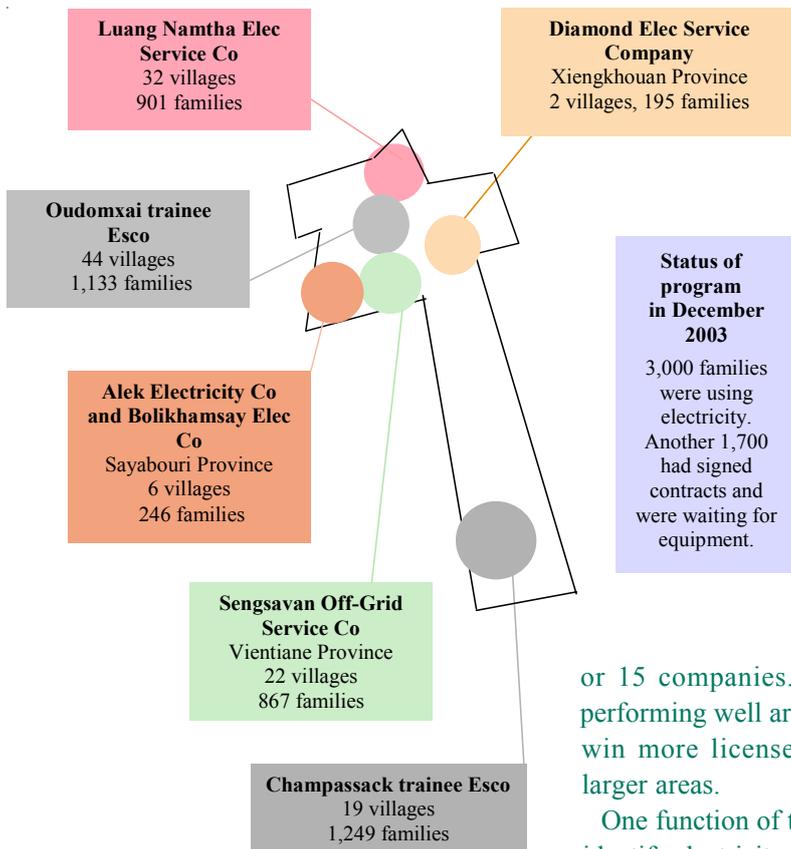


Figure 3: Escos and trainees in December 2003

tion, but only to become trainees operating on a trial basis. Two graduate trainees are now considering Esco status, as shown in Figure 3.

The number of Esco area licenses is expected to grow over the next three or four years, for award to an estimated 10



Photo: Adam Harvey, OPS

Weaving with solar light

or 15 companies. Companies performing well are expected to win more licenses and cover larger areas.

One function of the Esco is to identify electricity entrepreneurs in villages. There are already over 80 such Village Electricity Managers. Most of these are acting as franchisees of the Escos, handling consumer contracts, financial management, maintenance and spare parts supply for villagers using solar home systems.

Other VEMs are operating engine-based or hydro businesses supplying villagers with conventional 220V AC by cable to each house. All the VEMs sign contracts with the Escos agreeing to pay or transfer monthly hire-purchase payments for equipment provided by the Escos.

Productive opportunities

Villagers in Laos are quick to use small electricity supply for income generation.

For example in one village taking SHS, most of the houses immediately moved their weaving looms upstairs. The teenagers were very happy to contribute extra income weaving in the evenings. This income paid back the cost of the solar panel and weaving materials after which there was additional money for the family. In the same village, we were told the solar lights had helped incomes by allowing net mending to take place at



Photo: Adam Harvey, OPS

A small sewing business in Tapen village, Laos

night, and also by allowing charging of batteries used for fishing and for hunting frogs at night.

In one village with hydro supply, the villagers have told us the electric light has increased their incomes significantly. Many of the families make small baskets for sale to tourists. Now that the extra hours of good quality light are available from the hydro, they are making significant extra incomes. With these returns they are more than happy to pay the monthly hydro tariff.

One lady uses the light to sew in the evenings for her customers, one uses a fridge to make cold sweets for sale. A carpenter is using power tools in the day time, and the VEM is charging batteries for fee-payment. At one stage ice production started as it proved to be a profitable application. One man is hoping to rear poultry with the help of electric bulbs.

More information on this programme is available by email in the form of a 1.5MB image file. To receive a copy, please contact:

Adam Harvey, Project Adviser,
adamharvey@compuserve.com

Increasing Gender Sensitivity when Planning for Energy and Transport Services

by *Mattias Nordström, SEI*

On 9 December 2003, the Swedish Ministry of Environment, on behalf of the Network of Women Ministers for the Environment, organised a side event to the UNFCCC COP 9 in Milan titled “Promoting Gender Equality, Providing Energy Solutions, and Preventing Climate Change”. The seminar was partly based on a discussion paper prepared by the Stockholm Environment Institute.

The event was chaired by Hon. Lena Sommestad, the Swedish Minister for Environment. Four experts presented their work: Ms. Aster Zaoude, Gender Specialist for the United Nations Development Programme, Dr. Fatima Denton, Gender and Energy Analyst for ENDA Tiers-Monde in Senegal, Mrs. Fatou Ndeye Gaye, Head of the Gambian delegation, and Dr. Hermann Ott of the Wuppertal Institute in Germany.

A gender perspective

The overall question for the seminar was how a gender equality perspective can be mainstreamed in the energy and transport planning cycle, while at the same time economic, political, social and environmental requirements are addressed.

In order to achieve the targets set out in the Millennium Development Goals, the WSSD Plan of Implementation as well as other national and international development programmes, substantial improvements will have to be made towards the provision of modern energy and transport services. There is also an urgent need for a more equitable distribution of these services. Moreover, with a view to achieving the objectives of the climate convention, energy services will have to become more sustainable with an increasing share of renewable energy and more efficient use of energy. This would lead to benefi-



A woman's daily chore in many developing countries

cial side effects, e.g. reduced emissions of pollutants such as particles and volatile organic.

The shift to modern, flick-of-the-switch energy and transport services, has freed women to access higher education and wage labour while remaining responsible for the mainstay of household work. No matter how convenient and efficient household energy services have become, women still carry out a majority of the household work – in all countries in all social groups. The ac-

cess to convenient and sufficient household energy and transport services is not the only requirement for equal opportunities in education or on the labour market. It is, however, a prerequisite for allowing more household members to be active outside the household, as well as for a greater degree of sharing of household work by both sexes.

How can a transition to sustainable energy and transport infrasystems that contribute to the objectives of the climate convention be made more sensitive to differences in access and needs of men and women? How can these systems be made to service the needs for public goods, private enterprise as well as individual households?

There are no universal solutions that will suit every country, or every group within a country. Hence, when extensions of basic services are planned, it is important that there are adequate resources set aside for decentralised and flexible solutions to cater for those who will not get access to the centrally planned system.

Main challenges

A number of key challenges have emerged concerning reforms of traditionally state-run bodies and the increasing emphasis on sustainability and equity:

1. **A gender equality perspective** should be one of the fundamental considerations used in designing energy and transportation systems in order to make sure that the right questions are asked to the right people in terms of needs and priorities. It is thus a highly consultative and iterative process. It is not acceptable to restrict the analysis to a small number of specialists that fail to understand the complexity of these questions Restricting the diversity of ex-

pertise involved has often led to limited impact assessments well after development plans have already been made.

2. In order to provide basic household energy services for large proportions of poor populations, **decentralised and cheaper systems will have to be available**. These can take the form of small independent grids around a locally available energy resource (a factory with surplus electricity generation capacity or a stream used for hydroelectric generation), or of individual diesel or gasoline generators (maybe converted to run on bio-fuel that can be locally produced). Using renewable energy such as solar photovoltaics, wind electricity generators, hydropower or bio-fuelled power generation will simultaneously contribute to the objectives of the Climate Convention and enhance sustainable development. While large centralised grid-based systems provide unique advantages in terms of economy of scale and access to large volumes of energy, they are not always the most cost-effective solution and they are too expensive to cater to poor com-

munities without being heavily subsidised.

3. Even in times of large-scale deregulation and privatisation of public energy and transport service providers, **governments should continue to supervise the planning process**. Otherwise, there is a risk that the accessibility of important public sector functions and institutions is diminished. In particular, rural and peri-urban health clinics and schools appear to be affected, which is part of the explanation why they are routinely deprived of modern energy and transport services, while at the same time catering to the segments of the population most in need of health care and education.

4. **Government policy should include giving the same status, conditions and public backing to small private companies and cooperatives** as to larger state utilities in servicing poor and dispersed populations. Locally-based energy utilities can have the advantage of being flexible, sensitive and above all accountable to paying customers or members.

The last few decades have shown that the issue of reducing poverty globally and providing a growing world population with the energy and transport services demanded will probably not be straightforward. While the trend is that economic development allows people to reduce local environmental and health impacts away from themselves – both spatially and temporally¹ – vast shares of today's world population will not see this shift completed in their lifetimes. In many countries, people will face simultaneously energy- and transport impacts on local health, regional pollution and global climate change. This will put high demands on policymakers to address a range of issues in parallel. ■

¹ Negative impacts are moved from the immediate user level (toxics and soot), to regional level (eutrophication, acidification) to global level (climate change). The impacts are also shifted in time, from the directly inhaled, to the indirect effects on water and forests, to extremely complex and diffuse impacts on a global scale.

The full report from the seminar can be downloaded at www.sei.se/html

For more information please contact mattias.nordstrom@sei.se



Woman in search of firewood, India

Photo: Mattias Nordstrom, SEI

Improving the Cost-Effectiveness of Small Hydro through Intelligent Load Management

by N P A Smith, Sustainable Control Systems Ltd, UK and P Taylor, Econnect Ltd, UK

Stand-alone hydro schemes are often characterised by high peak and low average demand. This is particularly the case with community electrification schemes in developing countries where average demand can be as low as 15 to 20% of the peak demand¹. However, little attention has been given to improving load factors in order to maximise the benefits from schemes. This paper introduces two technologies for demand-side management that together tackle the problems of overloading and low load factors. Their application to overcome load management problems at a rural hospital in Uganda is described.



PowerProvider

Peak demand control by means of current limiters

At present, fitting current limiters to all connections is a solution to control the maximum consumers' demand of electricity within the capacity of the generator, thus avoiding overload. However, demand growth can be managed by only allowing upgrading to higher rated current limiters in the event that there is surplus capacity.

A purpose-designed current limiter, called PowerProvider has recently been introduced which auto-resets after a fixed time delay. These are more convenient to users since, in the event of a trip or overload, they can just reduce their load and wait for the power to come back on. In addition, the limiters are more secure against tampering and bypassing as they can be mounted on a service or distribution pole outside the house.

¹ "Best Practices for Sustainable Development of Micro Hydro Power in Developing Countries", Smail Khennas and Andrew Barnett, Report for DFID and World Bank, March 2000. (www.itdg.org.uk).

The fixed monthly payments for a PowerProvider make budgeting easier for the consumer and reduce the likelihood of defaults on payments. An annual advance payment option can be offered to enable farmers to pay for their service when income is generated at harvest time².

PowerProvider is not restricted to only hydro applications, but can be used for all stand alone schemes. It is a patented product, the function of which is described more in detail on [scs web-site](http://scs-web-site)³.

Improved off-peak energy utilisation through distributed load controllers

For small hydro schemes below 250kW capacity the Distributed Intelligent Load Controller (DILC) allows productive use to be made of the surplus power available without overloading the system⁴. A number of DILCs are fitted at convenient points on the distribution system, each

^{2,3} www.scs-www.com

⁴ www.mini-grid.com and www.econnect.co.uk

controlling a low priority load. Typical loads are water heaters or room heaters. The DILCs sense the generated frequency and switch on their loads when the frequency is normal. Overloading will cause the frequency to fall and the DILCs sense this and switch out the loads that they control. The DILCs can be set at different frequency thresholds so that the low priority loads can be prioritised. The use of DILCs enables more productive use of the generated power, reducing the amount of dissipated energy.

The following case study shows how, by using both DILCs and PowerProviders, problems with overloading can be solved and more productive use of energy can be achieved.

A case study – Kisiizi Hospital, Uganda

In the mid 1980s a 60kW hydro system was installed for improving electrification in the Kisiizi hospital, using a turgo turbine, synchronous generator



Hospital staff at work, Kisiizi Hospital, Uganda

and electronic load controller. The demand has since been rising along with the growing staff numbers, even exceeding the power generated at peak times and thus leading to blackouts sometimes during an operation.

After a number of temporarily successful attempts, an isolation switch had to be fitted in 2001 so that the entire residential supply could be disconnected if necessary. This was a drastic measure in view of the effect on the staff and their families.

Load management package

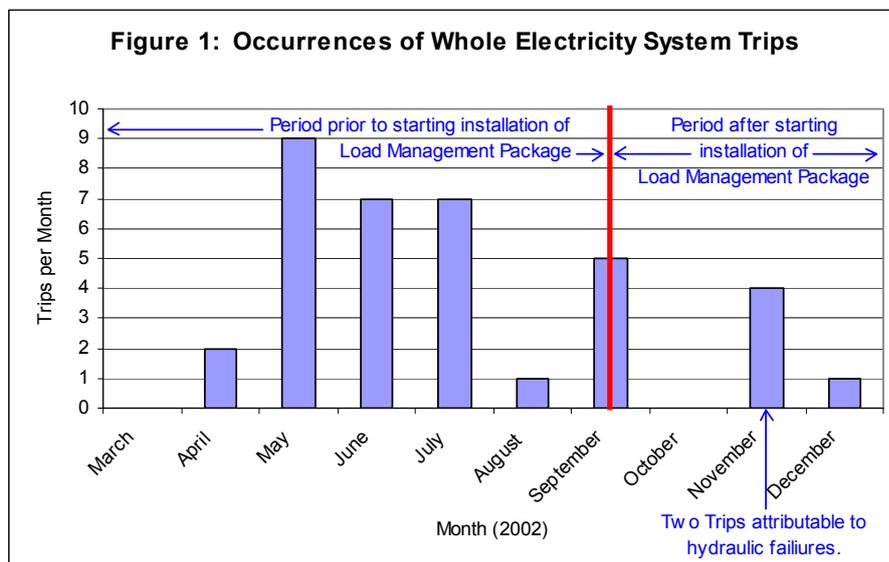
After discussions with management and staff at the hospital, a new load management package was designed to provide the following:

1. A secure supply to the hospital.
2. Limited secure supplies to the staff houses for essential loads, such as lights and refrigerators.
3. Additional power to the staff houses at off-peak times, such that water heaters and other high power appliances can be used when sufficient power is available.

The limited secure supplies were made using 83 PowerProvider type current limiters, which were fitted one per house. The current ratings were 1 Amp, 2.5 Amps and 5 Amps, which correspond to 230VA, 575VA and 1150VA respectively. The current rating fitted was determined according to seniority and needs of the particular staff member. If a household tried to exceed the current rating of their PowerProvider supply only they were inconvenienced by temporary disconnection and the supply to the hospital and other residences is safeguarded.

DILCs were used to provide extra power to the staff houses at off-peak times. Forty DILCs were fitted in senior staff houses and communal buildings such as the nurses' hostels. A dedicated electrical circuit, separate from the circuits limited by the PowerProvider, was supplied for the DILC and provided a bonus supply of up to 13 Amps.

Some DILCs were designed to replace the time switches on the water heaters and the others were fitted with a standard



socket so that other high power appliances such as cookers, irons and kettles could be used. The trip frequencies were set at between 47 and 49 Hertz for the water heater DILCs and between 46 and 47 Hertz for the other DILCs. As a result, at the rated frequency of 50 Hertz all the DILCs were switched on. When the hospital load was increased so that the generator output was exceeded, the frequency fell and caused some or all of the water heater DILCs to switch off. At higher hospital loads, some or all of the other DILCs were switched off. Hence, the supply to the hospital was secured and the high power domestic appliances had a higher priority over the water heaters.

The PowerProviders and DILCs were fitted between September and December 2002. Generator performance data, prior to and after fitting of the units, was obtained by a computer based monitoring system that was installed in March 2002.

Results to date

Figure 1 shows the number of system trips before March 2002 and December 2002. There was a clear reduction in the number of trips, which indicates that the load management package was producing a marked benefit. Some system trips were due to trashrack blockages or problems with the turbine-generator and not a result of overload and therefore it is possible that none of the trips in No-

vember or December were due to overload.

As well as the improvement in terms of fewer system trips there was a noticeable increase in the amount of power consumed in the hospital and residences and hence a reduction in power dissipated in the ballast. With all the DILCs and PowerProviders installed there was an increase of more than 15% in the power consumed in the hospital and residences and little or no power was dissipated in the ballast most of time.

Conclusion

DILCs and PowerProviders are complementary technologies, which are now proven to improve the reliability and productive use of power from small hydro schemes. They can be used to overcome problems with overloading and poor energy utilisation on existing schemes, provided that there is strong management. However, they are best installed at the beginning of hydro projects so that good practice is introduced from the outset.

Acknowledgements

We would like to thank Dr Bill Cave and the management and staff at Kisiizi Hospital for their assistance with the project and to acknowledge the financial support of the UK Department of Trade and Industry.

For more information, please contact n.smith@scs-www.com or paula.little@connect.co.uk

