



## ELECTRIFICATION IN TONGA OUTER ISLANDS USING SOLAR HOME SYSTEMS (SHS)

The Tonga Outer Islands Solar Electrification Program has been in operation since 1987, covering the Vava'u and Ha'apai island groups. Almost 90% of the population of these outer islands now has electricity, which equates to approximately 2000 systems, 230 kWp of solar energy and 2600 kWh of stored energy. The aim of the program is to provide basic energy services at the lowest cost to the greatest number of people.

Over the years, experience has improved the technical and institutional quality of the systems, which are provided by Shoreline Power Ltd, a locally-owned private company.

Each system comprises:

- 4 X fluorescent DC lights (2 x 7 W, 1 x 11 W and 1 x 13 W);
- 2 X DC/DC converter sockets for radio and mobile phone; and
- And 1 X LED type night-light (orange) to act as street lighting.

### WHO OWNS IT?

The systems are owned by either the government, or a cooperative/community group and fees are charged to offset the cost of maintenance. All solar development at the village scale is organised by an energy service company, which moves the direct management away from government, leaving them only an advisory and policy role, empowering the communities to have a stronger say in the system management.

### Quick Summary

- Components and electrical enclosures must be suitable for the harsh environmental conditions
- Solar home projects require strong institutional support (in the form of technical, financial and managerial expertise) which maybe difficult to establish among a community/cooperative group
- Projects need to build on prior experience to prevent repeat mistakes
- Preventive maintenance improves long-term reliability; most problems with PV systems are the result of an accumulation of small problems, not catastrophic failures

### WHO PAYS FOR IT?

Funding of solar home system (SHS) power supplies, including recent upgrades, have all been provided by various donor grants. Therefore, size and design have not always been able to fully address the community's needs and aspirations. Many changes have been implemented that have improved the system management, including a major change from a government-run SHS model to an incorporated community-run SHS model in 2002. Efforts have been made to reduce the installation costs but revenue collection continues to be unsustainable.

## WHO RUNS IT?

Projects are now managed by individual village committees. They collect the fees and give them to Tonga's Energy Planning Unit (EPU) to offset the cost of maintenance. Basic system maintenance is the responsibility of the committees and EPU is called on for more complex maintenance.

## CONSTRAINTS

The outer islands are dispersed and some are difficult to access. This complicates installation and maintenance programmes. Repairs often take a long time, and there is concern about the delays in the provision of replacement lights. Spare parts are a concern, particularly for the lamps, with one survey showing 47% of lights not working. And it is difficult for users to control their consumption, as they do not know the state of the batteries. Fee collection problems makes it difficult to impose a rigid disconnection policy.

## HOW MUCH DO THE CONSUMERS PAY?

TOP 13–20, depending on their location.

## WHO COLLECTS THE FEES?

Committees collect the fees and give them to the Energy Planning Unit (EPU) to offset the cost of maintenance, but fee collection is unsatisfactory (no more than 40% typically). The monthly fee is supposed to cover maintenance and replacement when needed, but it is doubtful the figure covers all the costs.

## SYSTEM DESIGN

The technical design of the 2002 PREFACE (Pacific Rural/Renewable Energy France-Australia Common Endeavour) installations include:

- 2 X 75 Wp photowatt PV panels providing 150 Wp per installation;
- A 12 V Hawker-Oldham open cell, a tubular positive plate, a deep discharge battery with a capacity of 108 Ah at C10; and
- A Total Energie charge controller.

The system is sized to allow the external light to be left on all night to act as street lighting, thereby avoiding the problems associated with installing and maintaining separate systems for public lighting.

## ENERGY STORAGE

Recent installations use external poles and battery boxes in order to avoid roof damage and to ensure the panel is mounted in sunny areas. Batteries and controllers are now in a locked, weather-tight box placed at the base of a pole instead of in the house as in earlier projects.



## HOW WELL DOES IT WORK?

Recent system designs have much better reliability, with battery life in excess of eight years being achieved for the majority of systems.

## MONITORING AND MAINTENANCE

Monitoring relies on informal assessment and occasional surveys carried out by technicians during planned and unplanned maintenance.

## BENEFITS

Electrification improves the lives of women, men, school children, youths and the elderly. There are more social gatherings and church functions, and more time for making handicrafts. Radios can be used in classrooms, children have better light for evening studies; there are fewer harmful emissions than from kerosene lamps, fire safety is improved, and there are fewer respiratory and skin problems. The evening hours can be used more productively than hitherto.

## POTENTIAL IMPROVEMENTS

A simple solution to fee payment problems would be the use of pre-pay meters, which ensure 100% collection and automate the disconnection and reconnection procedure. If payment is not made, power is disconnected. Reconnection would be made once the user had purchased credit for their meter.

There are, problems with external battery boxes which they are sometimes shifted by pigs rubbing against them and. During heavy rains, some have also been flooded. In many cases boxes get too hot, reaching 40°C, which significantly shortens the life of the battery. They could possibly be raised to the top of the pole to prevent pig and flood damage and then, being under the panel, would be shaded by the solar panel.

Users also have trouble monitoring battery charge levels, which is of paramount importance for ensuring the healthy operation of any solar home system.



Tonga single house system

A simple traffic light indicator, or state of charge meter that displayed battery levels, would improve the user's ability to monitor battery health and avoid early battery failure for their solar home systems.

The single home system does not address the different needs and priorities between and within communities. Some people want, need and can afford more power than the system can deliver. A well-designed solar hybrid mini-grid will cater for these differences, as long as charges are based on consumption, and give higher reliability of supply and allow for system upgrade as the demand grows.

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