Demand-Side Management Project
South Pacific Island States

**DSM PROGRAM DESIGN REPORT**

**ELECTRIC POWER CORPORATION, SAMOA**

prepared for

[SOPAC]

**SOUTH PACIFIC APPLIED GEOSCIENCE COMMISSION (SOPAC)**
Suva, Fiji Islands

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*November 2004*
1 Project Background

The United Nations Development Programme (UNDP) funded a project titled “Support to the Pacific Islands Power Sector” (RAS/92/363) which was implemented through the Energy Division of the South Pacific Forum Secretariat (ForSec) from 1993 to 1996. This project was a part of the Core Regional Energy Program administered by ForSec. The project was implemented with the support of the Pacific Power Association (PPA) – a newly formed association of electric utilities in the South Pacific region and utility service providers. Building regional capability in all aspects of Demand-side Management (DSM) program design and implementation was one of the key objectives of the project. In January 1998, in accord with the desire and direction of the Forum Leaders, the Regional Energy Program was relocated at the South Pacific Applied Geoscience Commission (SOPAC).

One of the objectives of the Regional Energy Program is the reduction in the demand for electricity and the use of fossil fuels for electricity generation in conjunction with the adoption of renewable energy technologies where financially and economically feasible. Most Pacific Islands (with the exception of PNG, Fiji, Solomon Islands and Samoa) are primarily dependent on imported petroleum products for electricity generation. In addition, lack of importance placed on energy efficiency and constraints due to economies of scale has compounded the situation.

The current DSM Project, approved by member countries of SOPAC and the Secretariat for the Pacific Community (SPC) and included in the 1999 Regional Energy Program Design Report, aims to follow-up on the recommendations on the initial UNDP DSM Program. This includes assisting participating utilities in the implementation of pilot DSM projects and subsequent refinement into to full-scale programs that benefit the utility, consumer and society as a whole.

The International Institute for Energy Conservation (IIEC) was appointed by SOPAC and UNDP to provide technical assistance for the implementation of this DSM Project. In the first phase, an assessment of DSM activities was conducted in four utilities – Fiji Electricity Authority (FEA), American Samoa Power Authority (ASPA), Tuvalu Electric Corporation (TEC) and Electric Power Corporation (EPC) Samoa. Following this assessment, FEA and EPC were selected as host-sites for the implementation of pilot DSM projects.

This report provides details of the program designs for EPC and the implementation plan.

1.1 Project Objectives

Pacific Island utilities are adopting the concepts of Integrated Resource Planning (IRP) where supply and demand side options are considered in future least-cost supply planning scenarios. Hence, the evaluation of achievable DSM potential is of significant importance in future capacity planning. Since the UNDP Power Sector Project was completed in August 1996, DSM activities have not been pursued in any coordinated manner and have been a low priority activity in most utilities in the region.

The aim of this project is to re-establish and continue the development of a DSM Program for the electric power utilities in the region with benefits flowing to all customer sectors – Residential, Commercial and Industrial. In meeting this objective the following are proposed:
– Determination the current status of DSM activities within electric utilities of SOPAC Member Countries;

– Determination of the most appropriate technologies and the methodology for implementation of DSM in the region;

– Conduct of detailed design of appropriate DSM Programs; and

– Implementation, monitoring and evaluation of at least two to three demonstration DSM projects.

The programme is aimed at being a practical exercise in the review, identification, design and application of appropriate DSM technologies through the development of replicable demonstration projects.
2 OVERVIEW OF CURRENT OPERATIONS

The Electricity Power Corporation (EPC) is a wholly government-owned utility, established under the Electricity Power Corporation Act of 1972. EPC is in charge for most of the power facilities’ operation in Samoa including planning, generation, transmission, and distribution of electricity.

EPC provides about 95% of the total installed generation capacity of Samoa, supplied through its networks in Savai‘i and Upolu. The Upolu system constitutes about 90% of EPC’s total capacity, generated by integrated hydro-diesel networks. EPC’s system in Savai‘i is entirely diesel generation. The two largest islands, consumes about 95% of EPC’s generated capacity with total household electrification of 98%.

2.1 Generation Capacity

Majority of electricity in Samoa, particularly within the urban grids is generated from diesel and hydropower, while small amount of electricity is produced from biomass (coconut and saw mill residues) and solar energy resources. In 2002, the total contribution of hydropower and diesel generation was to 47% and 53% respectively. Power generation from saw mills, predominantly supplied by Samoan Forest Products in Asau is not always sufficiently available most of the time due to saw mill residue shortages, while coconut residue is used mainly for household cooking and operation of small industrial and commercial sectors. Contribution of solar energy to power generation is minimal and limited to water heating and photovoltaic system on small islands and rural lighting and communication.

EPC’s current total installed capacity is 30.8 MW, in hydro-diesel generation ratio of 40:60. In 2002, the total generation was 91 GWh with hydro generation accounting for 42.5 GWh (47%) and diesel accounting for 48.437 GWh (53%).

2.2 Demand Characteristics

The peak demand occurs during the summer season, which in 2002 was 15.6 MW compared to the rainy season peak demand of 14.7 MW. Analysis of the load profiles showed that the system has a base load of around 7-8 MW and system peaks around mid-day during summer and early evening (7pm) during rainy season. The major contributors to daytime load are Industrial (primarily base load) and commercial customers (primarily air-conditioning and lighting). The decrease in commercial sector activity in the afternoon (around 5pm) is replaced by the increase in the residential sector activity (primarily lighting, cooling/heating and cooking) resulting in an evening peak around 7 pm during wet season.

A typical load profile on a weekday during the summer season is shown in Graph 2.1 below.
2.3 Energy Sales Characteristics

The energy sales by sector in 2002 are given in Chart 2.1 below. The Commercial sector accounted for the largest share (40%), followed by Residential (29%), Others (24%) and Industrial sector (7%). The “Others” sector consists of government offices, educational institutions, religious institutions, recreational centers and street lighting facilities.

Chart 2.1: EPC’s Sales Volume by Sector in 2002
2.4 Customer Characteristics

A summary of customer numbers of each sector in 2002 is illustrated in Chart 2.2. The Residential sector has the highest number of consumers (92%) but accounts for only 29% of the total sales. The Commercial sector with 5% of consumers accounts for 40% of the sales.

Chart 2.2: Sectoral Customer Mix in 2002

- Residential: 17,193 (91.94%)
- Commercial: 853 (4.56%)
- Industrial: 56 (0.30%)
- Others: 598 (3.20%)
3 DSM Objectives and Program Options

3.1.1 Corporate Objectives

EPC’s corporate objectives are to provide reliable and responsive electricity service to all its customers at a reasonable cost, increase electrification to uplift quality of life in rural areas, and reduce electricity demand and use of fossil fuels for the generation of electricity.

Currently diesel accounts for 53% of the total generation and this is a severe burden on EPC’s financial position compounded by high oil prices and stagnant electricity tariffs. Hence, the reduction of thermal generation is the key corporate DSM objective of EPC.

3.1.2 Load Shape Objectives

The load profile recorded in January 2003 shows a maximum demand of 15.6 MW and a base load of around 7.8 MW during weekdays. For weekends, maximum demand and base load are 13.2 MW and 7.7 MW respectively. The summary of maximum demand and period is shown in Table 3.1 below:

<table>
<thead>
<tr>
<th>Day (Jan 2003)</th>
<th>Max Demand</th>
<th>Base Load (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>Peak period</td>
</tr>
<tr>
<td>Mon-Fri (Excluding public holidays)</td>
<td>15.6</td>
<td>9.00-11.00 a.m. and 7.00-9.00 p.m.</td>
</tr>
<tr>
<td>Sat-Sun (Including public holidays)</td>
<td>13.2</td>
<td>7.30-8.30 p.m.</td>
</tr>
</tbody>
</table>

The major contributors to the base load of EPC are the engineering industry of Samoa including food processing, metal fabrication, plastics, boat building, paper products, automotive products and engineering services that normally operate continuously throughout the week. The weekday morning and early afternoon peak is normally caused by the Commercial sector and the major end-use could be attributed to air conditioning. The system also shows an evening peak of around 15 MW and this could be attributed to the residential sector from lighting and other domestic appliances (TV, electric cookers, fans etc). As seen from the table above, the ratio of base load to max demand of EPC is about 50%.

The current emphasis for EPC is the reduction in thermal generation and this could be achieved by restricting the system demand at or around the hydro capacity (approximately 12.4 MW in 2003). Hence, peak clipping and load shifting could be considered as primary load shape objectives applicable for EPC.

The EPC system load shape indicates two peaks – daytime and evening caused by the Commercial sector and Residential sector respectively. Hence, in order to meet the load shape objectives DSM programs should be undertaken in both sectors.
3.1.3 Non-Load Shape Objectives

The non-load shape objectives include improving customer relations, expanding electrification in rural areas, improving quality and reliability of service, distribution system (technical and non-technical) losses, and considering environmental impacts from the use of fossil fuel for electricity generation.

3.2 DSM Program Options

3.2.1 Base Load Reduction from Industrial Sector

Because the major contributors to base load are a few strategic industries, i.e. food processing, metal fabrication, plastics, boat building, paper products, automotive products and engineering services, and the industrial sector is the highest energy consumption per customer (MWh/year), base load reduction from industrial sector is set as first priority to be examined. A full-scale detailed energy audit is required to identify potential energy saving measures in interesting participants.

Some energy saving measures may not directly reduce the energy consumption but they aim to reduce peak demand. For example, ice storage systems for refrigeration and/or air conditioning aims to eschew electricity consumption during peak period. During off-peak periods, the system consumes electricity to store cooling medium such as water or ice and the stored cooling medium would be used during peak period.

3.2.2 Energy Efficiency and Management Program in Commercial Sector

The Commercial sector is the biggest electricity consumer of EPC accounting for around 39.8% of the total sales in 2002. It also contributes to the maximum demand during the weekdays. From the historical data, commercial sector represents the steadiest growth of energy consumption per customer with forecast expansion at approximately 4% annually.

There are two major electricity end-uses in commercial sector, namely, air conditioning and lighting systems. Air conditioning systems generally account for about 50-60%, while lighting system accounts for 10-15%, of end-use consumption.

Full-scale detailed energy audits are required to identify cost-effective opportunities for efficient technologies specific to each customer.

3.2.3 Efficient Lighting and Appliances in Residential Sector

The EPC system load shapes indicate an evening peak demand of around 13 to 16 MW primarily caused by increased residential sector load between 7 to 9 pm. Studies in other countries have shown that residential lighting to have a significant impact on the peak demand and efficient lighting programs – CFLs and high efficiency fluorescent lighting have the potential for peak clipping.

At a growth rate of 4 percent for both electricity demand and customers number, average energy use of household which is estimated to be 1.4 MWh per annum would further increase in actual value as households beginning to acquire high load devices of which the
less efficient varieties that are cheaper and so more common may consume up to 10% - 30% more. This is likely to effect maximum peak consumption as households turned on simultaneously to operate appliances during peak hours. In addition, the use of high efficiency refrigerators and air-conditioners has the potential for peak reduction and subsequent lower energy consumption.

Customer awareness program aimed to effect changes in customer behavior or improvements in maintenance practices is required to educate consumers on energy saving measures that could be undertaken by them to reduce electricity costs. For example, distribution of “user friendly” brochure with information on the running costs of the appliances along with suggestions on how to attain energy saving through keeping their refrigerator coils clean, or preventing inefficient operation due to air conditioner filters lack of maintenance.

### 3.3 Program Selection

Following discussions with EPC management, the following DSM programs were selected for design and implementation under this program:

1. Commercial Sector Energy Efficiency Program (CSEEP)
2. Residential Energy Efficient Lighting Program (REELP)

The CSEEP will include the conduct of a detailed energy audit in an office building and implementing energy efficiency measures. Pre and post installation monitoring will be conducted and the benefits will be evaluated. It is intended to prepare a case study for promotion by EPC.

The REELP will include the implementation of an efficient lighting program (CFLs and high EE fluorescent lighting) in a selected and measuring the energy impacts. The program will also aim to establish a sustainable model to overcome the major barrier of CFLs – high capital costs. EPC and the lighting retailers have several options and a model will be developed following discussions with the key stakeholders.
# 4 Program Design

## 4.1 Commercial Sector Energy Efficiency Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Commercial Sector Energy Efficiency Program</th>
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</table>
| Rationale | The Commercial sector accounts for over 60% of EPC’s energy sales and is the primary contributor to the daytime system peak. This sector includes office buildings (private and government), hotels, commercial enterprises and educational institutions. The reduction in demand and energy consumption in this sector will assist in reducing thermal generation which is the key DSM objective of EPC. In addition, the Government sector makes up the largest accounts receivable for EPC and hence it would be in the interest of EPC if the consumption in this sector is reduced. 

The major end-uses include air conditioning and lighting. Window and split-type air conditioners are widely used in commercial establishments. Preliminary surveys in Apia have shown that a significant number of air conditioners are left running when the rooms are unoccupied and are reliant on occupants switching off units. There is no regular maintenance program for air conditioners. 

Lighting is another major end-use in the commercial sector and energy efficient lighting technologies (36W fluorescent lighting, electronic ballasts etc) offer significant potential for reduction in energy consumption while maintaining or improving current comfort levels. |
| Strategy | The strategy is to encourage optimal operation and improved maintenance of commercial sector air conditioning equipment through case studies and provision of advice through EPC and trade allies. In addition, the aim will be to address the current misuse of air conditioners, mainly in government offices, by leaving the units running in unoccupied offices. The program includes customer education, installation of AC timer controls, adoption of energy efficient lighting technologies and implementing a regular maintenance program. |
| Target Market Segments | Commercial Office Buildings, Government Offices, Hotels |
| Program Objectives | This program aims to demonstrate the energy savings that could be achieved by optimal operation and regular maintenance of Window and Split-Type air conditioners and the retrofit of energy efficient lighting. Similar programs undertaken in other countries have achieved energy savings in the order of 20% to 30%. The program will also include a customer education program promoted by EPC. |
| Program - Tasks | 1. Conduct of Pilot Program in a selected Government building  
2. Preparation of Case Studies and promotion |
| Selected site | Site: EPC Head Office |
| Program - Activities | 1. Pilot Program at EPC Head Office  
- Conduct energy audit at EPC office and prepare a list of energy efficiency measures in relation to air conditioning, lighting and maintenance requirements  
- Prepare an inventory of AC units in operation and identify suitable AC timer control units |
## DSM Program Design

### Conduct a lighting survey and prepare inventory of light fittings (lamps, ballasts, reflectors) for retrofitting.

### Conduct continuous on-site metering of electricity demand and consumption to determine existing usage.

### Procure AC timers and light fittings required for the two sites.

### Carry out building maintenance work identified in the energy audit.

### Install energy efficient equipment.

### Conduct continuous on-site monitoring of electricity demand and consumption after installation of timer controls and lighting.

### Implement a regular maintenance program for ACs.

## 2. Case Studies and Program Promotion

- Monitor and evaluate the results of the pilot program and prepare case study reports.
- Prepare promotional materials and distribute to relevant customer segments.
- Prepare a plan for full scale implementation in Government Offices.
4.2 Residential Energy Efficient Lighting Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Residential Energy Efficient Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rationale</strong></td>
<td>The residential sector represents around 92% of the total customer base, 29% of the total sales but accounts for only 20% of the total revenue. The residential sector tariff comes in 3 blocks - &lt;50 kWh per month, between 50 – 200 kWh per month and &gt;200 kWh per month. Under the existing tariff structure, the first two blocks in the residential sector is subsidized and this subsidy is expected to remain in the foreseeable future. With the current trend in rising oil prices, there are significant benefits to EPC in reducing the energy consumption of residential customers in the first and second tariff blocks. It would also help to reduce the evening peak which is caused by increased activity in the residential sector.</td>
</tr>
<tr>
<td><strong>Strategy</strong></td>
<td>Recent surveys have indicated a high use of incandescent lamps and standard fluorescent (40W) lighting in the residential sector. There is potential to use CFLs as an alternative to incandescent lamps and the 36W fluorescents instead of the standard fluorescent tube lights (FTLs). However, there are several barriers to overcome, primarily the high initial cost of CFLs compared to incandescent lamps. There are several examples of similar DSM programs that have been implemented (or being implemented) in the region, namely, Sri Lanka, Thailand, India and Vietnam. Hence, the strategy is to learn from international experience and design a program customized to the situation in Samoa.</td>
</tr>
<tr>
<td><strong>Target Market Segment</strong></td>
<td>Residential</td>
</tr>
<tr>
<td><strong>Program Objectives</strong></td>
<td>The objective of the program is to encourage residential customers to install compact fluorescent lamps (CFLs) to replace existing incandescent lamps. The program aims to overcome the major barrier – the high up-front cost of CFLs – either by EPC providing customers with the facility of paying in installments on their electricity bills or outright purchase at discounted prices (EPC in association with suppliers). In addition, the program aims to conduct an advertising campaign that will help overcome any lack of customer awareness, complimented by EPC endorsement of the technology will help overcome customer mistrust of the manufacturers’ claims about energy savings and lamp life.</td>
</tr>
</tbody>
</table>
| **Program - Tasks** | 1. Market surveys  
2. Pilot Program design and Implementation |
| **Program - Activities** | 1. **Market Surveys**  
- Conduct customer surveys in the residential sector to determine penetration of incandescent lamps and 40W standard FTLs and potential for replacement with CFLs and 36W FTLs.  
- Conduct surveys of lighting retailers to determine existing barriers to the promotion of CFLs and 36W FTLs. |
2. Pilot Program Design and Implementation

- In consultation with EPC determine a suitable area for conducting a pilot program and determine the most suitable implementing option for the program. The implementing options include:
  
  - EPC purchases the CFLs in bulk directly from the manufacturers and then offers the lamps to the residential customers, and allows the customer to pay for the lamps in fixed monthly instalments, with their electricity bill, over a period of 12 months.
  
  - The customers purchase the CFLs from approved retailers and pay for the lamps to EPC in fixed monthly instalments with their electricity bills, over a period of 12 months. EPC will reimburse the retailers at regular intervals.
  
  - EPC in association with approved retailers advertise the CFL program with an offer of a discounted price for a specified period. The customers purchases the CFLs outright from approved retail stores.

- Design Pilot Program and issue tenders for lamp supplier selection - Lamp suppliers are required to comply with international technical specifications (IEC), provide a minimum of 1-year warranty for lamps sold under the program.

- Prepare Program marketing Plan - Program marketing will be done through EPC who will endorse the technology and indicating the brands of CFLs being promoted under the program. The 36W FTLs will be promoted solely through the marketing campaign since the retail price is similar (slightly cheaper) to standard 40W FTLs.

- Implement Pilot program

- Pilot Program Monitoring and evaluation - Participating suppliers will be required to submit historical sales figures to establish baseline prior to the launch of the program. Suppliers will provide monthly sales data and other information (e.g. lamp failures). Customer satisfaction surveys will be conducted through EPC.
5 PROGRAM IMPLEMENTATION

5.1 Commercial Sector Energy Efficiency Program

A detailed energy audit of the EPC Head Office will be conducted focusing primarily on lighting and air-conditioning. The outcome of the audit will be a detailed lighting design for the two floors occupied by EPC, an inventory of the light fittings and air conditioner controls and specifications.

EPC will conduct pre-installation load monitoring of the office for a period of at least one month, to establish baselines for program evaluation. EPC will invite tenders from local electrical contractors for the supply and installation of light fittings and air-conditioner controls.

Following installation, EPC will conduct post-installation load monitoring for a period of two months. Program evaluation will be conducted jointly by EPC and IIEC.

Promotional material will be prepared for dissemination by EPC.

5.2 Residential Energy Efficient Lighting Program

The pilot program will be implemented in a typical village of around 100-200 houses and EPC will identify a suitable site. Following site identification, market surveys will be conducted to determine the scope for the introduction of CFLs and 36W FTLs as a replacement for incandescent lamps and 40W standard fluorescent tubes.

IIEC in coordination with EPC will determine the most suitable option for implementing the CFL program. Considering the availability of funding from UNDESA for implementation, one option to consider is the establishment of a “Revolving Fund” and EPC procuring the lamps and distributing to the customers who will pay in instalments through their electricity bills. The program could then be extended to other villages to ensure sustainability.