Introduction to Energy Efficiency and Renewable Energy for Hotels in Fiji

with applications to other Pacific Island countries

Pacific Community
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german cooperation
DEUTSCHE ZUSAMMENARBEIT

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Acronyms and abbreviations

A/C	air conditioning
CCCPIR	Coping with Climate Change in the Pacific Island Region
CFL	compact fluorescent light
CHP	combined heat, cooling and power
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ECDB	East Coast Designer Builders
EMP	energy management plan
ESCO	energy service company
EUR	Euro
FEA	Fiji Electricity Authority
FJD	Fiji dollar
FTL	fluorescent tube light (or lamp)
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HVAC	heating, ventilation and air conditioning
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
kW	kilowatt
kWh	kilowatt hour
LED	light emitting diode
LPG	liquid petroleum gas
MEPS	minimum energy performance standards
MEPSL	minimum energy performance standards and labelling
PV	photovoltaic
RET	renewable energy technology
SPC	Pacific Community
SWAC	seawater air conditioning
SWH	solar water heating
USD	United States dollar
W	watt
Wh	watt hour

Foreword

This document was produced as part of the Pacific regional programme 'Coping with Climate Change in the Pacific Island Region' (CCCPIR), which is supported by the German government and implemented by the Pacific Community (SPC) and the German Agency for International Cooperation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Component Four of the CCCPIR regional programme focused on 'Sustainable Tourism and Climate Change', and aimed to strengthen the capacity of Pacific Island countries to cope with and mitigate climate change in the tourism sector.

This introductory guide to energy efficiency and renewable energy for hotels focuses on Fiji's hotel sector, with some broader applications to hotels across the Pacific Islands region. The aim of the guide is to present information on options for energy efficiency and renewable energy investments within the hotel sector to enable tourism operators to save energy and costs.

This guide has been designed as a practical tool to assist hotel operators in Fiji (and the wider Pacific) to:

- learn about how to measure energy use and develop energy management plans;
- identify where cost-effective energy savings can be made through either renewable energy or energy efficiency measures;
- utilise knowledge and 'best practices' regarding energy use from Fiji's hotel sector;
- consider options for training their management and staff; and
- reduce fossil fuel use, which contributes to lower greenhouse gas emissions and increased resilience to the effects of climate change.

Currently, the use of energy efficient measures and renewable energy by Fiji's hotel sector is far below its potential, with the majority of hotels relying on older, less efficient equipment. This is changing and there are increasing opportunities for cost-effective investments in renewable and energy efficiency in hotels in Fiji.

This guide will show how – by using energy efficient and renewable energy technologies and implementing energy management plans – hotels can reduce operational costs and increase resilience to climate change, while also helping to reduce the industry's greenhouse gas emissions and impact on the environment but, crucially, not at the expense of the standards of service and comfort that hotel clients require.

1. Introduction

1.1 Why implement sustainable energy measures?

Why should hotels save on energy consumption and/or implement renewable energy technologies (RETs)? While energy is a fundamental resource for maintaining the comfort levels and standards in a hotel, it is important that this energy be used as efficiently as possible. Like water and waste management efficiencies, the benefits of being energy efficient are:

- cost savings on energy bills;
- increasing a hotel's resilience to climate change impacts;
- reducing a hotel's greenhouse gas emissions and environmental impact;
- enhancing a hotel's reputation for protecting the environment; and
- complying with recommended potential future changes to the Fiji Building Code, including possible energy standards.

Energy is the largest producer of human-induced greenhouse gas (GHG) emissions in the Pacific. The rapid increase in global GHG emissions is resulting in highly disruptive climate change, sometimes referred to as 'global warming'. In the Pacific Islands region, global warming is not only detrimental to the environment but is also having negative impacts on communities and livelihoods.

Some of the effects in Fiji are:

- a rise in sea level causing coastal damage and saltwater intrusion;
- an increase in ocean acidification, which results in damage to coral reefs and marine ecosystems;
- health impacts due to the spread of vector-borne diseases mainly caused by increased temperature and flooding;
- damage to ecosystems and species diversity
- reduced agricultural output and disruption in food supply; and
- more frequent or more intense extreme weather conditions such as droughts or cyclones.

The worst impacts of climate change on Fiji and the rest of the world can be reduced by cutting GHG emissions. Further information on climate change scenarios and expected impacts on Fiji and the rest of the Pacific can be found in the latest reports from the Intergovernmental Panel on Climate Change (IPCC) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which are referenced in the bibliography.

From an energy cost perspective, potential climate change impacts on hotels include increased electricity bills for cooling and water pumping as average temperatures rise, and increased costs or unreliability of the supply of fossil fuels if supplies are disrupted due to more frequent or more intense extreme weather conditions. Low-lying energy facilities (transformers, generators) and overhead wiring could also sustain damage from floods and strong winds respectively and incur repair costs. Therefore, any new renewable energy (and non-renewable energy) installations should be designed for robustness (i.e. integrating resilience to climate change).

Implementing energy efficiency and RETs can reduce energy costs today while also contributing to mitigating possible future climate change impacts and, therefore, increasing a hotel's resilience. A recent report by the International Renewable Energy Agency (IRENA 2014) argues that RETs represent an economically attractive option for the island tourism sector. The cost of air conditioning and water heating from RETs is said to be considerably lower than using electricity generated from diesel for the same service, while solar photovoltaic (PV) systems can generate electricity less expensively than utility tariffs or self-generation from diesel in most islands.

IRENA (2015a) also argues that with balanced investment in both RETs and energy efficiency, they can complement each other, with synergies reducing costs further.

> "The fact is that Island Hotels worldwide are increasingly investing in RE [renewable energy] and EE [energy efficiency] as a cost-competitive option for their energy supply with good payback periods." (IRENA 2014).

For Fiji specifically, IRENA (2015b) reports that:

> "At current prices, roof-mounted solar PV shows levelised cost on the order of USD 0.14/kWh, which is lower than FEA's retail tariffs. Levelised cost of solar would be less than 50% of what can be expected from FEA's latest investment in 35 MW of heavy fuel oil generation … The favourable generation cost of solar PV has already allowed commercial investors, mainly in the tourism industry, to install roof-mounted solar to partially generate their own power."

Reducing the energy consumption in hotels and/or using RETs also helps reduce GHG emissions. There is now a common global understanding that a reduction of GHG emissions is crucial, and that to achieve this, it is necessary to substantially reduce the amount of energy used from fossil fuels, and to increase the amount supplied from renewable energy sources. It is also necessary to increase the efficiency with which all types of energy are used.

Also, by saving energy and reducing fossil fuel use, hotels contribute to improving the environment. By cutting its GHG emissions a hotel is making its own, albeit very small, contribution towards slowing global warming and, thus, protecting biodiversity. Environmentally friendly tourism is a small but growing sector with many travel sites, such as Expedia, now providing the ability to search for 'green' or eco-friendly hotels. Visitors to Fiji, who generally come to enjoy the country's beautiful natural environment, are often also interested in knowing how Fiji and its islands are being protected and conserved, and are interested to find out the contribution, if any, that each hotel they visit makes.

Finally, a revision of Fiji's National Building Code is underway. Fiji may decide to introduce minimum energy performance standards (MEPS) for large and commercial buildings, which may also include hotels. In this case, hotels would be obligated to consider energy efficiency for new structures and for major renovations. Therefore in terms of planning ahead it could be worth starting to think about energy efficiency and renewable energy options today.

1.2 What this guide covers

In the following sections, this guide will introduce some energy management options which a hotel can consider, such as:

- measuring energy use;
- renewable energy options;
- energy efficiency options;
- developing an energy management plan;
- ideas for training;
- opportunities for funding.

The guide is targeted at medium and large sized hotels in Fiji, and aims to show where there are opportunities to save energy and reduce operational costs through implementing energy efficiency and RETs. The guide may also be useful to smaller hotels in Fiji, and hotels in other Pacific Island countries, government energy offices, utilities, non-governmental organizations, tourism associations and other stakeholders in the energy sector of Fiji and other Pacific Island countries.

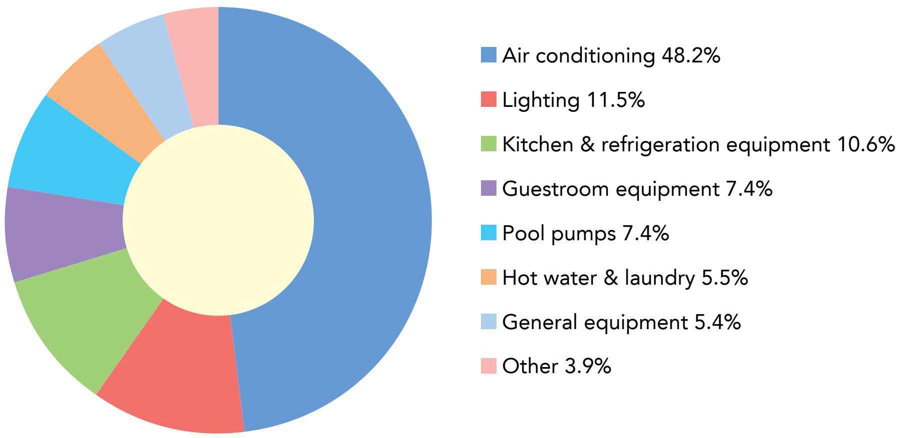
2. Energy management in hotels

Before energy use and costs can be reduced in a hotel, or any other type of building, it is necessary to understand how and where energy is being consumed; in other words, to measure energy consumption, and to understand where in the hotel energy is being used and why. It is also helpful to compare a hotel's energy consumption with similar hotels.

2.1 Energy use, sources and costs for tropical island hotels

The pie chart below shows where and how electricity is commonly used in a typical hotel in a tropical environment.

Figure 1: Electricity use and percentage of overall energy consumption for a typical hotel in the tropics.



Source: IRENA 2014.

As in tropical hotels elsewhere, electricity consumption in Fijian hotels is typically dominated by air conditioning (A/C), followed by lighting. Often, there are major energy savings to be made in these two areas alone. Other major consumers of energy are kitchens (cooking), refrigeration, water heating, water pumping, laundry drying, and transport.

A feasibility study carried out in 2011 estimated that in Fiji, A/C and lighting accounts for 70% of electricity use and that for 10 hotels assessed with an average of 146 guest rooms, lighting costs averaged FJD 5,900 per guest room per year. The study also found that there was a potential for energy savings of 43% on lighting alone, with a corresponding 9% reduction in the electricity bill (WWF 2011).

The most common sources of energy supply and their usage in hotels are:

- electricity;
- thermal energy (liquid petroleum gas, or LPG) and other forms of fuel for thermal applications; and
- petrol and diesel fuel for transport.

In Fiji, many hotels also use backup generators that use diesel fuel. Both diesel and LPG are fossil fuels that emit significant amounts of GHG, although LPG emits less than diesel and is, therefore, considered to be a 'cleaner' fuel.

Grid electricity in Fiji is supplied by the Fiji Electricity Authority (FEA) and is produced from a mix of diesel and hydropower. The contribution of hydropower to electricity generation varies from year to year, depending on rainfall. From 2006–2012 hydropower provided between 58% and 68% of FEA annual generation, dropping to 50% by 2014 due to drought conditions (FEA 2014). As the percentage of diesel used to generate electricity increases, so does the cost, which then is reflected in the tariffs charged by FEA. Although Fiji enjoys one of the lowest electricity tariffs in the Pacific Islands region (see Table 1), there is no guarantee that tariffs will remain at their current level.

Table 1: Cost of electricity in hotels in tropical island countries and regions.

Year	Region/Country	Costs (USD/kWh)
2012	Caribbean	0.33
2012	Mauritius	0.33
2012	USA (Hawaii)	0.43
2010	Pacific Islands	0.21–0.51
2014	Fiji	0.21–0.23

Source: IRENA 2014 and FEA 2014.

2.2 Measuring energy use and setting a baseline and targets for improvement

There is a saying: 'You can't manage what you don't measure'. Only when a hotel quantifies and understands its energy use can it make informed decisions to take action and save energy and money.

2.2.1 Performance indicators

It is important to know how energy efficient a hotel is and where potential savings could be made by: a) establishing a baseline or benchmark of current energy use, b) setting targets and performance indicators to improve on that baseline, and then c) implementing cost-effective energy efficiency measures.

Benchmarking initial energy use is a convenient way to compare the energy efficiency of hotels. It is important when comparing energy use across different hotels to consider the quality rating of a hotel (e.g. 3-star, 4-star), its size and location, and its main target market (services and activities offered) so that the comparison is meaningful. A 3-star hotel aimed at business travellers should not compare its energy consumption with that of a 5-star resort aimed at families and big groups.

Benchmarks are 'performance indicators'. Energy performance benchmarking is an internal (and sometimes also external) management tool designed to provide ongoing, reliable and verifiable tracking of the hotel's energy performance. If a hotel wants to be eco-certified, energy performance benchmarking is typically among the external evaluation tools used. Realistic targets can be set by hotel management for improving energy efficiency. Some useful performance indicators of hotels are:

- electricity use per square meter or per guest room;
- overall energy consumption per square meter or per guest room; and
- energy cost per square meter or per guest room.

2.2.2 Conducting an energy audit

An energy audit is an exercise that ascertains how much energy and what types of energy a hotel (or other business or organisation) is using, where it is used, and by what equipment and how much it costs. It involves collecting energy costs and consumption information, identifying the equipment or plants responsible for the consumption of that energy and the hours of operation, and calculating actual energy consumed by each piece of equipment. An audit also identifies more energy efficient and cost-efficient options of providing those services and makes recommendations on how the energy audit should be implemented, through a range of energy efficiency actions, usually outlined in an energy management plan (EMP). More information on EMPs is available in Section 2.3.

An energy audit involves a number of steps. The most important step is actually making the decision to invest resources in an energy audit, after which the audit would normally proceed as follows.

- Collecting data on costs and consumption, and identifying areas of consumption. (In some cases, energy logging equipment may need to be installed to measure consumption within specific areas or equipment.)
- Collating data. Preparing daily, weekly or annual records for comparison.
- Analysing and identifying areas of largest practical energy savings.
- Searching for alternatives, and determining possible solutions.
- Evaluating solutions against benefits and costs.
- Making recommendations based on the energy audit, and preparing a report.
- Adopting and implementing the energy audit.

Energy audits can be undertaken on different levels of detail depending on the amount of information required. According to Australian/New Zealand Standard (AS/NZS 3598:2000) energy audits can be performed at three levels:

- Level 1 Audit – An overview of energy use and comparison with accepted benchmarks, may require an onsite visit. Estimated energy savings have an accuracy range of only +/- 40%.
- Level 2 Audit – A general onsite investigation required producing an approximate (+/-20%) assessment of costs and savings identified through some measurement and energy monitoring.
- Level 3 Audit – A detailed onsite investigation producing accurate (+/-10%) assessment of costs and savings identified through extensive measuring and energy monitoring. It can be site or process specific and may involve energy simulation modelling.

One of the most common procedures is a 'walk-through energy audit', roughly a Level 1 audit under the AS/NZS. It is worth noting that this can often be sufficient to justify an investment in energy efficiency and/or RETs, and so a more detailed audit may not be necessary. A walk-through energy audit usually takes a few days to complete, including reporting (although this depends on the size of the property). The survey will identify simple energy efficiency measures with estimated savings and costs for each measure. The report will usually include a summary of electricity use based on power utility data, an equipment inventory and amount of energy used per equipment, and an estimate of potential savings. The final report usually includes a simple payback period calculation (usually in months) for each recommended measure.

More thorough energy audits can be carried out as a follow up to a walk-through audit when a potentially large investment is identified. This would include a detailed description of the hotel and its facilities, an equipment inventory, detailed energy savings and costs associated with each measure (e.g. cost–benefit analysis and financial analysis of each recommended measure, identification and estimates of capital costs and savings and a recommended monitoring and verification plan for each measure).

Where additional information is needed for more expensive capital investment projects, trend analysis and data loggers are often used to better understand how buildings react to changes in ambient conditions and occupancy levels. In this case, measurements may be taken over a few weeks or months to establish patterns, and the whole audit process is generally much longer. More detailed costing estimates are provided as are life cycle cost assessments. Typically, depending on the scope of work and technical specifications of equipment required, engineering drawings and electrical schematics are provided with the energy audit to enable competitive tendering for contractors to carry out the installation of energy efficiency measures and/or RETs.

2.2.3 Creating a hotel energy database

To achieve sustainable energy savings it is important to monitor and track energy consumption, with regular reporting. The reporting can be as simple or as complex as the hotel management considers necessary to keep track of its energy consumption. Hotels and hotel groups can easily create their own simple database that is suited to their specific needs.

Some of the key methods for tracking energy efficiency are:

- comparing electricity bills from month to month, seasonally (e.g. low/high; dry/humid seasons) and annually;
- comparing consumption of other sources of energy (e.g. LPG, diesel) monthly, seasonally and annually;
- comparing energy consumption and key performance indicators over a year and then multiple years using graphs (pie charts, bar diagrams and line graphs) of energy use to allow trend analysis; and
- comparing actual energy use against targeted savings. The target for each indicator (or for selected key indicators) can be set by the hotel according to the benchmarked baseline compared with similar hotels in a similar environment.

2.3 Developing and implementing an Energy Management Plan

After a preliminary energy audit (e.g. a walk-through audit), adopting a realistic EMP is a common next step. When developing an EMP, it is recommended to get the full support of management (hotel board of directors, owners) and key staff (engineering, maintenance and housekeeping) because they will be the main implementers. The following are typical steps in developing and implementing an EMP.

2.3.1 Corporate energy policy

If there is a corporate energy policy, this can be the basis on which an EMP can be developed. This policy would be approved by senior management and endorsed by the owners and shareholders. The policy should be circulated to all staff to ensure a common understanding by staff at all levels. The corporate energy policy should also link to other environmental policies, primarily waste and water management. Alternatively, an overarching environmental policy can be developed, including energy, waste and water management. A corporate policy can be relatively simply for a single hotel, or more detailed for a hotel chain (e.g. including certification).

2.3.2 Energy Management Plan

After measuring and documenting energy use (energy auditing, data logging, trend analysis covered in section 2.2), a hotel can develop its own EMP, using hotel staff alone or with the assistance of an external consultant or facilitator. It is important to provide all staff with opportunities to contribute ideas through meetings, questionnaires or other means. This may take time to organise but will increase ownership and assist with implementation in the long run. The EMP is the energy efficiency action plan with a clear timetable, objectives, targets, responsibilities of specific staff, and a budget for implementation. The EMP could also include a target on the use of renewable energy, for example as a percentage of total electricity use.

2.3.3 Energy management coordinator

An energy management coordinator is useful for implementing an EMP. This responsibility is often delegated to the chief engineer or head of maintenance. As the energy management coordinator, he or she would manage and coordinate all energy management activities, monitor implementation, and report results to management.

2.3.4 Energy champions

Energy champions are staff members who assist with the day-to-day activities of the EMP. Hotel service engineers and other supervisory staff are the ideal people to be designated as energy champions. Energy champions may require some training to achieve satisfactory outcomes, and this can be a good professional development opportunity for motivated staff.

2.3.5 Energy awareness programmes

The typical components of an energy awareness programme, discussed later in this guide, are:

- an education programme to make staff aware of the company's energy policy (if any), the EMP, and their roles and responsibilities;
- a display of corporate commitment in staff member common areas (e.g. posters and leaflets); and

- the promotion of energy management to staff and customers through various marketing communication tools (e.g. posters, leaflets, stickers, notice at the check-in desk).

2.4 Eco-certification schemes for hotels

A preliminary assessment of Green Hotels Ratings Schemes and their suitability for the Pacific Islands was undertaken in 2013 by the International Institute for Energy Conservation (IIEC) as part of the Asian Development Bank's 'Promoting Energy Efficiency in the Pacific' (PEEP, Phase 2) project.

A review of seven schemes was undertaken, with a more detailed analysis done for three of the most suitable to the southern Pacific Islands region: EarthCheck, Green Globe and Green Key.

- EarthCheck provides verification of a hotel's environmental and social performance against the EarthCheck Company Standard by an approved and independent third-party EarthCheck Auditor. EarthCheck has been active in 70 countries worldwide (with projects that are either benchmarked or certified), and is based in Queensland, Australia. The cost to be EarthCheck assessed or benchmarked at the time of this study was AUD 38 per month[1], and the cost to be EarthCheck certified was AUD 317 per month. Energy auditing and consulting fees are additional to this. Updated prices can be found on the EarthCheck website.
- Green Globe is one of the most recognised programmes worldwide, used in 83 countries. The certification scheme is aligned to the United Nations Agenda 21 principles of sustainable development, and deals with the overall travel and tourism business and associated sectors. It also conforms to several international protocols and standards. In the past, Green Globe has had several certified projects in the Pacific Islands region, and continues to have some projects that are either certified or affiliated with the programme. It reportedly plans to increase its presence in the region. The cost for Green Globe annual membership (not including consulting and auditing fees) is from USD 750–5,000, based on the number of rooms and number of employees, and may differ regionally.
- Green Key is one of the largest, global ecolabels for accommodations, and is administered locally with an independent national administration centre in each participating country. It is used in 50 countries and by 2,400 establishments. One of its key goals is the education of staff, clients and owners towards increased sustainable development and environmental awareness. It has strong accreditation criteria and is a stringent certification programme that is continually being improved. Annual membership fees are from EUR 1,800–5,2002, depending on the country's gross domestic product. Additional fees are charged for administration and auditing, based on the number of rooms.

Of these, EarthCheck was regarded by the IIEC report as the most suitable for the southern Pacific Islands region, in part because it is based in Australia. EarthCheck recognises 39 sectors in the travel and tourism business, and helps operators to monitor, measure and manage their environmental, social and economic impacts. For hotels, there are eight mandatory sections of indicators along with other optional indicators. Of the eight mandatory sections covering 14 indicators, one is energy related. The energy section has three indicators covering energy consumption, renewable energy use and GHG emissions, for which the property is benchmarked against the EarthCheck database.

1 1 AUD equals approximately 1.5 FJD in 2016

2 1 EUR equals approximately 2.3 FJD in 2016

3. Energy efficiency options for hotels

Energy efficiency means using less energy to perform the same tasks and functions, with no reduction in quality of service. For hotels, this means reducing the amount of energy needed for a wide range of hotel operations, while maintaining or even improving standards of service and comfort.

3.1 Lighting

3.1.1 Lighting comfort

Lighting is one of the largest areas of electrical energy consumption in hotels, typically accounting for 10–15% of the total electricity consumption in air conditioned hotels. Therefore, installing energy-saving lights is generally one of the quickest and easiest ways to reduce energy consumption and electricity bills. When changing lights, adequate levels of illumination must be maintained for safety and security, as well as creating a pleasant environment with a sense of comfort.

Lighting colour and warmth, as well as intensity (lux or lumens/m^2), are factors that affect lighting comfort for users. Lighting intensity needs to be set for each building zone within the hotel, some of which may be subject to building regulations. When changing to more efficient light bulbs, checking that lux levels are correct for various tasks can not only save energy but also may improve comfort for guests and working conditions for staff.

The following table shows the recommended lux level for some tasks and activities relevant to hotels under the Australian and New Zealand Standard AS/NZS 1680.2.2 – Interior and workplace lighting.

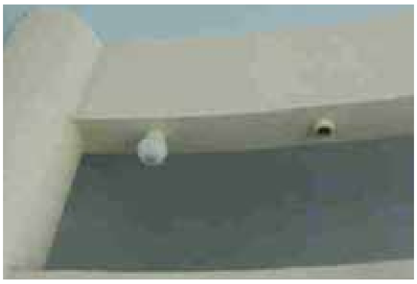
Table 2: Recommended lux levels for tasks and activities relevant to the hotel sector.

Characteristics of areas and activities	Examples	Recommended illumination (lux)
Interiors rarely visited where lighting is only required to aid movement and orientation	Passing through corridors and walkways.	40
Areas of intermittent use for tasks of coarse detail	Movement, orientation and tasks of coarse detail in areas such as change rooms, storage rooms, loading bays.	80
Areas that are continually used for tasks of coarse detail	Simple tasks such as occasional reading of clearly printed documents for short periods, or rough bench or machine work in areas such as waiting rooms and entrance halls.	160
Continuously occupied interiors used for ordinary tasks with high contrasts or large detail	Food preparation areas; counters for transactions; school boards; medium woodworking.	240
Areas where visual tasks are moderately difficult and include moderate detail or have lower contrasts	Routine office tasks such as reading, typing and writing in office spaces or enquiry desks.	320

3.1.2 Energy efficient lights

Only about 20% of the energy from incandescent and halogen lights is actually converted to light; the remaining 80% is lost as heat. More energy efficient lights such as fluorescent tube lamps (FTLs), compact fluorescent lights (or CFLs) and light emitting diodes (LEDs) are able to convert energy to light with less heat loss. Light bulb technology is continually evolving, and there are several types of energy efficient lighting and affordable lighting technology, as shown below with older, less efficient lighting.

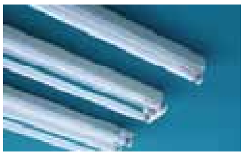
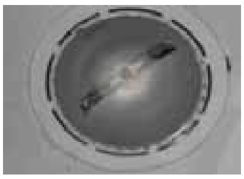
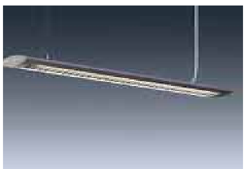
Figure 2: Lighting types.

Fluorescent tube lamp (28 W, 36 W and 40 W)	CFL (self-ballasted)	CFL (without internal ballast)
		
Incandescent lighting	**LED ceiling panel (40 W)**	**Mercury vapour (250 W)**
		

Source: IIEC 2015

Often, when replacing lights, the luminaires (fittings) may also need to be changed in order to better diffuse the light. This is particularly true for FTLs. Some light fittings are shown in the illustration below.

Figure 3: Light fittings. Source: IIEC 2015.

Mounting	Louver type with reflector	Acrylic diffuser	Bare type	Down light
Surface mounted or ceiling mounted				
Recessed or concealed			 inefficient halogen light	
Suspended				

Source: IIEC 2015

CFLs use four times less energy than incandescent bulbs of the same luminosity, and last 10–15 times longer if good quality CFLs are chosen. They also fit into existing screw-type or bayonet sockets. CFL downlights (7–13W) use four to five times less energy and last up to 10 times longer than an inefficient halogen downlight (45–50W). Replacing low voltage halogen downlights with CFLs will also save an additional 8–10 W per bulb because a transformer is no longer necessary.

Although CFLs are generally durable, they are susceptible to damage from voltage fluctuations and this can considerably reduce their lifespan. Also, when replacing and disposing of CFLs or any fluorescent light, the user must be aware that all fluorescent lights contain a trace amount of mercury. Therefore, CFLs must be disposed of in an environmentally safe manner at the end of their life. Recycling CFLs and other fluorescent bulbs allows the mercury to be recovered, as well as the reuse of the glass and other materials that make up fluorescent lights. Virtually all components of a fluorescent bulb can be recycled.

LED tube lights (particularly the T8 and T5 FTL replacements), which do not contain mercury, are designed to be a more environmentally friendly direct replacement for fluorescent tube lights. LEDs offer the same quality of light output as incandescent lights, while delivering significant energy savings. LEDs and CFLs save similar amounts of energy but because LED technology is evolving quickly, LEDs will soon be more energy efficient than CFLs. In addition, because of their solid-state design, LED lights require no warm up time and are lightweight. Good quality LEDs are durable, require virtually no maintenance, and have a long life expectancy, with some manufacturers claiming a lifespan of 50,000 hours.

LEDs can be used for a wide range of applications, including down lighting, floodlighting, decorative lighting and exit signs. It is also worth noting that well-designed LEDs are more robust and are far less liable to damage from voltage surges than are CFLs. However, there are, as yet, no international standards for LEDs so it can be difficult to be sure which LEDs being sold are of good quality.

Table 3: Examples of possible lighting energy efficiency upgrades.

Initial situation	Possible upgrade
Incandescent lamps	CFLs (same light output but with lower wattage)
T8 or older T12 fluorescent tubes	More energy-efficient T5 fluorescent tubes
Incandescent exit signs	LED exit signs

When considering replacing existing lamps with CFLs or LEDs, hotel management, maintenance and procurement teams should be aware that many CFLs and LEDs sold in Fiji are of poor quality. Therefore, technical specifications need to be prepared to source a selection of good quality CFLs and LEDs. Hotels should request quotes from different suppliers, specifying the number of hours of operation, voltage fluctuation resistance, and other technical specifications. It is worth requesting warrantee certificates and quality certifications (e.g. EU standards), and researching name brands that have been proven to provide reliable and high quality lights at other hotels and projects within and outside of Fiji. Another option is to contact other hotels in Fiji to find out what brands they use and their experience with these, or to ask for a second opinion from an independent organisation before selecting the final lighting product to be purchased.

3.1.3 Regulating and controlling lighting

Hotel lighting is frequently used when there is sufficient daylight, or lights are left on when nobody is in the room. With simple switches, lights tend to be left on, wasting energy and money. There are many simple lighting control techniques that improve energy efficiency. Lighting controls are often low cost and it is worth considering options such as the following:

- **Timer controls** switch lights on and off at pre-set times each day in areas of regular use.
- **Occupancy sensor controls** switch on lights when movement is detected and switch them off after a pre-set period of inactivity. These tend to be used in areas of infrequent use by staff and the public, such as washrooms in public areas, or sections of the property that are not much used during times of low occupancy.
- **Photocell controls** switch off or dim lights when adequate daylight is available.
- **Automatic controls with a key card** switch off lights and all electrical appliances (except the mini-fridge) in unoccupied guestrooms, and turn them back on when the guest inserts the card upon their return. For this to function properly, the electrical circuits of the guestroom must be connected to the key card system.

Energy efficiency tip: *Follow the main principles of lighting control. Only light areas that are occupied or need light, and use appropriate technologies, such as movement sensors. Excessive lighting wastes energy and increases costs.*

3.2 Regulating the use of cooling systems

Heating and cooling generally account for the largest energy use within a hotel. In tropical climates, keeping guests cool and comfortable is often a high priority. While shaded outdoor areas such as swimming pools, balconies, bars and restaurants all add to the charm of the experience, most guests will eventually seek the comfort of a cooler indoor area, particularly their guest room.

To reduce energy consumption, regulate temperatures to the needs and occupancy of the different zones of the hotel. Controlling the temperature in guest rooms is important and can reduce energy use by keeping the temperature at a standby level that can quickly be lowered when needed.

Autonomous air conditioning control systems can save between 20% and 30% of electricity consumption. The length of time specific facilities are 'in use' is the most important factor regarding energy consumption. Common means of temperature regulation include the following:

- **Individual temperature remote control systems**, which enable guests to regulate the room temperature according to their individual preference.
- **Automatic control systems** can switch heating and air conditioning on and off. For example, occupancy-linked controls can be used to isolate guest rooms and automatically cool them to a 'set-back' temperature when guests enter or leave their rooms, or when they check in at reception. Automatic devices can also be used to turn off air conditioners when windows or balcony doors are open.
- **Timers or programmers** are quite suitable for areas such as function rooms and eating areas where temperature rarely needs to be kept at full comfort level.
- **Programmable 'set-back' thermostats** are a combination of a thermostat and timer and allow two or more temperature settings for times with lower demand such as night-time or when rooms are unoccupied.

Energy efficiency tip: *Good management and housekeeping protocols are also key elements for the appropriate regulation of temperature. If there are no automatic control systems, housekeepers need to check, and if necessary adjust, temperature settings manually. Maintenance staff also need to regularly check that thermostats are accurate.*

3.3 Managing and maintaining air conditioning and ventilation

Heating, ventilation and air conditioning (HVAC) installations are engineered to respond to different needs. Depending on a hotel's conditions and requirements, air may be heated, cooled, humidified, dehumidified and/or filtered. Some energy-saving measures for hotel HVAC, apart from building design considerations, include:

- installing frequency controllers on fans;
- recovering heat from the extraction air;
- optimising the operating hours; and
- optimising the temperature and humidity.

Poor ventilation can greatly reduce comfort levels, but excessive ventilation wastes energy. Improved management of ventilation can often increase energy efficiency significantly. The quantity of fresh air needed depends on room occupancy and on special-use areas (such as bathrooms), which require dependable air renewal. Ventilation systems only operate efficiently if air filtration at doors and windows is controlled in the first place. Therefore air gaps should be found and fixed where necessary. The main types of mechanical ventilation are:

- **Exhaust-only or supply-only ventilation**. Only the air exhaust (or incoming supply) is operated mechanically. In a guest room, for example, air can be extracted mechanically from the bathroom and supplied naturally through openings in the room.
- **Supply and exhaust ventilation.** Two fans are used: one to bring fresh air in, and another to propel indoor air out. This provides better ventilation by controlling the volume of air supply. Although this requires additional electricity consumption for the second fan, energy savings can result from extra ventilation, lowering the need for air conditioning.
- **Heat pump.** A small, reversible heat pump may be coupled with the ventilation system to provide improved air heating and cooling. This is especially suited to noisy environments.

Ventilation can also be operated with 'all air' central air conditioning systems. The energy efficient approach is to adjust airflows to actual needs, by using controls such as the following:

- **Humidity control.** Air inflow and extraction units can incorporate humidity-sensitive technologies, using humidity as an indicator of a room's occupancy. When the humidity of a room is high, the controls increase the rate of airflow.
- **Time programmers.** These switch a ventilation system on and off at specific times.
- **Presence detectors.** Carbon dioxide (CO_2) detectors or movement sensors can be used to switch a system on or off in direct response to room occupancy.

Routine maintenance of HVAC equipment reduces energy costs and extends the life of equipment, particularly for air conditioning units. Maintenance and servicing of a mechanical ventilation system (e.g. cleaning filters) is essential for ensuring good hygiene and maintaining high energy efficiency over time. When a new system is installed or upgraded, particular attention should be paid to providing easy access for servicing.

Some regular maintenance procedures include:

- replacing filters in air handling units and fan coil units. The filters should be cleaned or replaced about twice a year (depending on local conditions) which improves energy efficiency as well as room air quality;
- regularly calibrating thermostat controls for the air conditioning system;
- cleaning motor casings and checking the belt drive tension to suit the transmission efficiency of the motor; and
- regularly checking the damper control on the economy cycle of the air conditioning unit.

Energy efficiency tip: *The choice of a particular type of ventilation system depends on a number of factors, such as occupancy level, purpose of different rooms and/or areas, and cost. Given the technical complexity and options for HVAC, it is advisable to consult a qualified HVAC design company and/or installer to choose equipment suited to the hotel's needs.*

Ensure that the HVAC design company and/or installer provides sufficient training to hotel staff, particularly the maintenance and/or engineering staff so that they can carry out the servicing and maintenance effectively on a regular basis. This will extend the life of the equipment and reduce operational costs.

3.4 Installing window, roof and building insulation

Good design of the building envelope[3] at the outset can reduce long-term energy costs. In new buildings, the owner must consider which areas will be cooled primarily by air conditioning, and which will be cooled primarily by natural airflows and design the building accordingly. For example, in larger hotels, bedrooms will, in most (but not all) cases, have air conditioning. However, in lobbies, corridors and large or outdoor restaurant areas, natural ventilation flows may be the preferred system for cooling.

For small hotels and eco-hotels, the aim may be to minimise the use of air conditioning. In such cases, good design of the building envelope, including natural airflows, insulation, shading and passive bioclimatic design will be very important. These elements are covered in this section and in Section 3.5.

For older buildings, a retrofit can assist with reducing energy costs, and the principles are the same as with the design of a new building (although retrofit options are limited because of cost considerations). Insulation is the most direct way to reduce energy use for heating or cooling in older buildings. Heat and cool air are lost due to transmission through external building elements such as walls, windows, floors and roofs. The better a building is insulated, the less heat or cold is lost. Better insulation, therefore, means less energy use. In the Pacific, this generally means less energy is required for air conditioning.

3.4.1 Roof and building insulation

Besides installing insulation in areas of a building that are air conditioned, it is important to ensure that air conditioned rooms have well-fitted doors and windows (for example, sliding doors and louvres that seal well) because ventilation and air infiltration losses through cracks, crevices and holes account for much of the wasted energy from air conditioners. This will also reduce the amount of draft and moisture entering the building, thereby better protecting the interior features. Proper insulation requires significant additional outlay when building or renovating, but this can be recouped by reduced energy and maintenance costs.

In the tropical Pacific, thermal insulation also serves as a barrier to solar radiation, which reduces the need for cooling. To be efficient, however, insulation needs to be combined with sun protection, cooling ventilation and air cooling, preferably through natural ventilation flows. Thermal mass is also important. This is a concept in building design that describes how the mass of the building provides 'inertia' against temperature fluctuations. The thermal mass comes from the materials used for the walls and other construction elements, and keeps heat (in winter) and cooling (in summer) inside the hotel for longer periods.

Exterior walls can be insulated either from inside or outside. When feasible, insulation is best placed on the outside of the wall because this enables the building to benefit from the thermal mass of the walls. The use of a light colour or white roof paint, or specialised solar coating, can also help deflect solar radiation.

3.4.2 Window insulation, glazing and shading

Windows can be major conduits for energy losses. Unprotected glass windows are among the major contributors to air conditioning load and, hence, hotel energy costs. Whether windows are relatively small, decorative openings in the building façade, or a large window surface sometimes taking up whole walls, they are usually a relatively dominant feature of the hotel's exterior appearance.

They also have a significant impact on the view for the occupant, thermal comfort, and space heating and cooling needs (and costs). Windows also transfer natural light, which can improve comfort while reducing lighting needs and costs.

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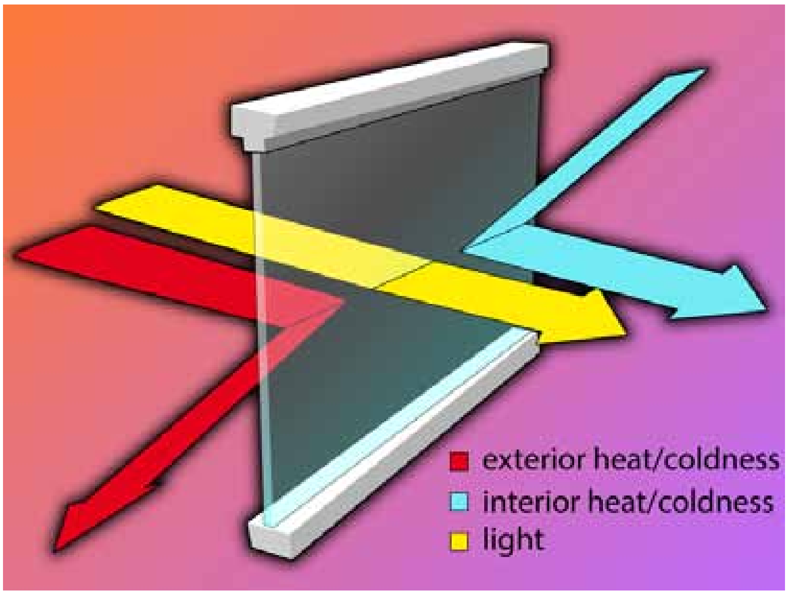
3 A building envelope is the physical separator between the interior and exterior of a building, and typically includes walls, windows, floors, roofs and doors.

Figure 4: Exterior and interior heat/coldness and light passing through a window.



Some practical energy-saving measures include:

- windows can be shaded with curtains, blinds and outside awnings or movable sun-shades;
- double-glazed windows not only reduce the cooling and heating load of the room but can also reduce noise levels;
- reflective architectural glass is an ordinary float glass[4] with a metallic coating applied to reduce solar heat. This special metallic coating also produces a mirror effect that prevents a subject from seeing through the glass from the coated side. Different types of colour coatings are available and can be combined strategically with a building's architectural design to optimise investment efficiency and to lower the operating costs of air conditioning units;
- tinted un-coated architectural glass provides significant improvements in solar performance. However, natural views from the interior are maintained with low exterior reflectance. These are readily available and can be fabricated similarly to float glass to provide a less expensive option for reducing air conditioning loads and costs; and
- in Fiji and the Pacific, the use of louvres is a common and effective way for allowing natural breezes into a room, while also being able to close the room and switch on air conditioning; in this case, a good seal around the louvres is needed.

Joinery for window frames needs to be chosen with particular care because of its impact on the thermal insulation capacity of the window, on waterproofing, and on the room's ventilation.

Finally, the smart use of landscaping by planting trees and shrubs around east- and west-facing sides of the building can also provide extra shade for the lower levels of buildings.

Energy efficiency tip: *A good opportunity to insulate a hotel building occurs when the façade or roof is being renovated. When choosing window shading look for light colours and durability such as wind, rain and sun fading resistance.*

4 Float glass is made by allowing it to solidify on molten metal, typically resulting in a flat and even finish.

3.5 Adopting bioclimatic architecture

Bioclimatic architecture refers to the design of buildings and spaces, including interior, exterior and outdoor areas, based on local climatic conditions. It is aimed at improving thermal and visual comfort, making use of solar energy, natural breezes and generally using the natural environment within which the building is placed to maximise the comfort of the occupier and increase savings in operational costs.

Basic bioclimatic design incorporates passive systems such as sun, air, wind, vegetation, water, soil and sky for heating, cooling and lighting.

Bioclimatic architecture, or design, is most easily applied to new buildings, although some elements can be added by retrofitting them to existing buildings. Bioclimatic features can also be considered when expanding a hotel (e.g. building additional separate buildings, huts or 'traditional *bures*').

Many features of a traditional Fijian home (*bure*) design are bioclimatic and were developed for the comfort of the family. Therefore, in Fiji, bioclimatic design can often begin by looking at traditional building practices.

3.5.1 Bioclimatic design for hotels in tropical regions

Bioclimatic design for tropical regions includes the following elements:

- **Building form.** Passive building takes into account the natural environment. Long, thin buildings and smaller separated shells with breezeways are best suited to hot humid climates. Positioned to achieve shaded exterior walls, passive buildings provide greater expanses of surface area and act as a vehicle for heat loss from cooler night air (ECDB 2014). Raised floor areas, as seen in many houses and traditional *bure*s in Fiji and used by hotels around the Pacific, can also provide additional cross ventilation, contributing to additional heat loss.
- **Building façade.** Buildings can be protected from the sun, through shading and the use of reflective external colours and surfaces. Trees and other vegetation planted strategically can help protect walls from the full glare of the sun. Building insulation, as described earlier, is another option.
- **Roof design.** The roofing system is subject to the highest thermal impact. Energy efficient approaches include adding generous eves and awnings that minimise solar exposure to walls and windows, vents in the eves and roof spaces, skylights for natural lighting, reflective light colours and smooth fabrics to reduce heat gain into the building, and clerestory windows, which are often incorporated into skillion roofing[5] and can improve airflow and the escape of hot air. Increased insulation in the roof spaces greatly improves energy efficiency and thermal comfort. Reflective insulation with low emission properties assists in minimising heat transfer from the ceiling and wall spaces into the building (ECDB 2014).
- **Thermal mass.** Lightweight construction systems in tropical environments with minimal annual temperature variation make efficient solar passive building design easier. Lightweight construction materials such as insulated and cladded timber frame construction with low thermal mass respond faster to temperature changes. Properties with high thermal mass, such as concrete and masonry, readily absorb, store and release heat. In tropical environments poorly designed homes incorporating high thermal mass materials can reduce both user comfort and energy efficiency because the heat stored within the materials is transferred from high temperature areas toward cooler zones and often back into the building envelope (Cairns Region Council 2011).
- **Orientation.** A building's orientation can help minimise solar gain, harness prevailing breezes, and improve energy efficiency. Sun path analysis can determine the appropriate orientation for a building and assist with good roof design. North-facing living areas can help achieve naturally cooler spaces.[6]

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5 Skillion roofs are monopitched roofs (also known as shed roofs, pent roofs and lean-to roofs). They differ considerably from the conventional gabled roofs in shape and construction. While a gabled roof is always pitched in two directions, the monopitch always slants in a single direction. Monopitch roofs consist of a single surface of sloping roof that is generally not attached to another roof surface.

6 Free or relatively cheap, simple computer, tablet and smartphone apps for solar path diagram analysis are available online. Some examples are: SunCalc, Skyview and Sun Tracker.

- **Landscape and shading.** The strategic positioning of landscape features such as trees, hedges and rockery can modify radiation penetration and reduce air temperatures adjacent to the building envelope by providing shade, redirecting breezes and aiding in natural ventilation. Larger trees can reduce the external wall temperatures and minimise sun exposure to windows and openings, greatly aiding in improving thermal performance (ECDB 2014).
- **Building materials.** Building materials can reflect, transmit and absorb solar radiation. Light colours and smooth textures are beneficial to minimising heat transfer. Lightweight construction systems are advantageous in tropical environments for their thermal properties (ABCB – Residential Housing 2013).
- **Ventilation.** Operable ventilation systems such as louvered clerestory[7] windows can improve natural ventilation, promote constant air circulation and cool internal areas of the building. Clerestory windows promote convection airflow, expelling the rising internal hot air and drawing cooler air from lower windows. This can be more efficient if it draws air from a shaded northern façade of the building (ECDB 2014). For natural ventilation the design needs to keep the breeze flowing and this means cross ventilation or openings on at least two sides of a room where possible. The layout of rooms should be considered carefully so they can achieve cross ventilation (Studio Mango 2011).
- **Glazing and windows.** The design and positioning of windows is fundamental to enhancing building performance (as mentioned above for ventilation). Properly positioned windows allow light and cooling breezes to enter the building while providing shading during the warmest times of the day reducing exposure to solar radiation. Window glazing, tinting and reflective glass can also be considered.
- **Space.** The adoption of large open spaces can improve ventilation and circulation. Including wide hallways and double doorways, where practical, and raising the ceiling height to 2,800 mm, allows hot air to rise away from occupants. If a ceiling fan is used, a raked ceiling is also beneficial (ECDB 2014). The design of new buildings should provide natural lighting during the day.

Some of the above features are illustrated in Figure 5.

Figure 5: Elements of a Passive Bioclimatic Design.

Source: East Coast Designer Builders 2015

7 A clerestory is a high wall with a band of narrow windows along the very top. The clerestory wall usually rises above adjoining roofs.

3.5.2 Outside bioclimatic landscape design

Outside works to improve comfort — through bioclimatic consideration of exterior spaces and the built environment in general, and adhering to the above principles — can also improve energy efficiency. A well-designed landscape can reduce heat gain and cooling needs by 20–100%. Planting indigenous shrubs, or installing open pools or fountains, can provide evaporative cooling. Well-placed trees can help keep the hotel cool by providing the building with shade from the sun.

- Plants and trees not only provide shade, they also cool through evapotranspiration, or heat removal from evaporation of water from leaves.
- Plants and trees are also important carbon sinks, helping to remove CO_2.
- Planting trees and shrubs to shade the outdoor parts of the air conditioning units can increase the efficiency of the units by as much as 10%.
- The ground cover of any outdoor area, distinct from paving, is also important because it influences heat radiation and reflection onto windows and walls. It is best to choose ground cover that minimises ground reflection and keeps the ground surface cooler.
- 'Green walls' or walls covered with plants and moist soil can reduce the temperature of walls by as much as 10°C, thereby lowering the cooling needs inside the building. Similarly, 'green roofs' can also provide thermal insulation to decrease thermal load in warm seasons. Their insulating efficiency increases as moisture content increases. However, green walls and roofs do have additional operational and maintenance costs and the cost to benefit ratio has not yet been proven.

Energy efficiency tip: *Hotel buildings must be managed conscientiously with both indoor and outdoor bioclimatic principles in order to improve energy efficiency and effectively utilise energy saving techniques.*

3.6 Using electrical appliances that have high energy efficiency ratings

3.6.1 Appliances with an energy efficient label

Energy labelling and minimum energy performance standards (MEPS) programmes work in combination. Legally binding MEPS prevent less efficient products from entering the country, and labelling allows buyers to seek out the most efficient products on the market. Efficient appliances do not necessarily cost more to buy, but they will certainly cost less to run.

Figure 6: Example of an energy performance label in Fiji.

Source: Fiji Department of Energy 2015

In Fiji, minimum energy performance standards and labelling (MEPSL) for household refrigerators and freezers has been mandatory since 2012. The requirements are stipulated under the Trades Standards (Household Electric Refrigerating Appliances) Order 2007. Energy labels on refrigerators and freezers rate them from 1 star to 5 stars, with five being the most efficient. An example of a refrigerator energy label is shown in Figure 6. The Consumer Council of Fiji also endorses the use of the website www.energyrating.gov.au so that consumers can learn about and compare energy-saving appliances.

3.6.2 Energy use in kitchens

Kitchens and laundries can be the most energy-intensive hotel areas per square meter of floor space. For kitchens, energy consumption is dependent on the number of meals served daily, and the type of food prepared. In Europe, kitchens can account for 25% of total hotel energy usage (UNWTO 2011), although in a tropical environment, such as in Fiji, this can drop to around 10%. Within the kitchen, typically 60–70% of energy use is for appliances (freezers and refrigerators) and cooking. There is a substantial base load during the night and early morning due to refrigeration of foodstuffs.

Other relevant characteristics of energy usage in kitchens include:

- The most common source of energy for cooking in Fiji's hotels is LPG, which is often the most cost-effective option.
- Hot water and refrigeration are the main sources of electricity consumption.
- Ventilation in kitchens is very important because smoke produced during cooking needs to be quickly expelled for health and safety reasons. Fans and extractor fans can make up a large proportion of energy consumption in kitchens.
- Kitchen lighting also uses significant amounts of electricity.

It is recommended that hotels install efficient lighting throughout the kitchen area and intelligent fan controls with cooking sensors on kitchen hoods. These controls reduce the speed of the kitchen hood fan when there is little or no cooking. Similarly, when replacing a freezer or refrigerator, new models with high efficiency ratings should be selected.

For energy-efficient food heating induction cooktops have about twice the efficiency of conventional hot plates. For ovens, forced convection increases heat transfer efficiency compared with conventional static ovens, both reducing energy consumption and allowing faster and more uniform baking. A disadvantage is that they require electricity to operate, thereby increasing the electrical power needs of the kitchen. Where kitchens already use LPG ovens, ovens using electricity are likely to be more expensive to run, even with the increased heat transfer efficiency.

Microwave ovens save 50–70% of energy compared with conventional ovens but are not appropriate for all types of foods or all types of cooking.

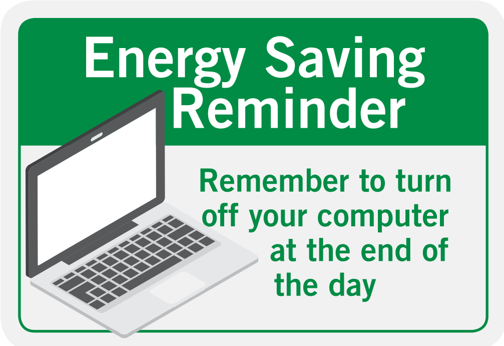
Kitchens are equipped with freezers, refrigerators, icemakers, chillers and coolers that often disperse waste heat into the ambient air. It is recommended that this waste heat be carried away by an efficient and well-maintained air exhaust system that moves it directly out of the building so that heat does not result in a need for additional air conditioning.

3.6.3 Energy use in laundries

The energy used for laundry services in hotels also constitutes a significant share of energy consumption. The main related energy functions are water heating, washing, drying and ironing. Steam is also sometimes used for sterilisation. Average electricity consumption in European laundries is 2–3 kWh per kilogram of clothes, divided among washing (at temperatures of 60–80°C), drying, ironing and general consumption (UNWTO 2011). However, equivalent data are not available for Fiji so this figure should be treated with caution.

One interesting characteristic of hotel laundries is that energy use often remains fairly constant regardless of occupancy. This indicates that certain equipment and lighting are turned on for the same time periods each day, regardless of workload; suggesting that there should be some potential for more energy-efficient laundries with better planning and management.

Figure 7: A sticker to help remind hotel staff to switch off a computer at the end of the day.



3.6.4 Other electrical equipment

Other hotel appliances include mini-bar refrigerators, TVs and radios, mainly in guestrooms and staffrooms, audio and lighting equipment in nightclubs and office equipment such as computers, fax machines, printers, scanners and photocopying machines. Stickers to help remind staff to switch off such equipment at the end of the day (see Figure 7) can be placed on the wall near the equipment or on the equipment itself.

When hotel management decides to replace or upgrade old appliances, it is worth selecting products with high energy efficiency ratings. These may be slightly more expensive in the short term but will save electricity and operational costs in the long term. Energy Star labels as shown in Figure 8 (see www.energystar.gov), can be found on computers and other electronic goods.

The Australian and New Zealand Energy star ratings or Fiji MEPSL labels are good indicators of energy efficiency. The more stars on the label, the more efficient the appliance.

Figure 8: Energy Star Label.

Energy efficiency tip: *1) turn off lights, fans, air conditioners and electrical appliances when not in use; and 2) buy high Energy Star-rated equipment, appliances and devices for use in all hotel departments.*

3.6.5 Investigate cogeneration and trigeneration

For larger hotels with the technical and financial resources, cogeneration or trigeneration may be alternatives worth investigating. Cogeneration, or combined heat and power (CHP) is the simultaneous production of electricity and heat. Trigeneration, or combined heat, cooling and power (CHCP), refers to the simultaneous production of electricity, heat and cooling, with the latter generated by residual heat using absorption chillers. Trigeneration is a potentially useful way of increasing energy efficiency because the energy demands of hotels can match these kinds of installations.

CHP systems can generate both electricity and thermal energy from a single fuel source, such as natural gas. Exhaust gases from combustion can be used for heating water. This heat can also be used by absorption machines to produce cold for refrigeration. Overall the process can increase efficiency and use less fuel. The demand and number of operational hours determines in part whether a CHP cogeneration unit will be viable. CHP units are best suited to medium-size (100–150 rooms) to larger hotels (150 rooms and more).

Micro CHP systems for smaller hotels can heat water and generate up to 50 kW of electricity. Most micro CHP systems use gas although some can be fueled with biomass. Cogeneration using biomass converts a renewable energy source into heat and power and has the potential to reduce GHG emissions when compared with fossil fuels, as long as the biomass used is from a renewable supply.

Hotels should, however, investigate lower cost energy efficiency options first because CHP systems that use gas or biomass require specialist technical skills for operation and maintenance and, therefore, costs are likely to be higher using them than existing systems.

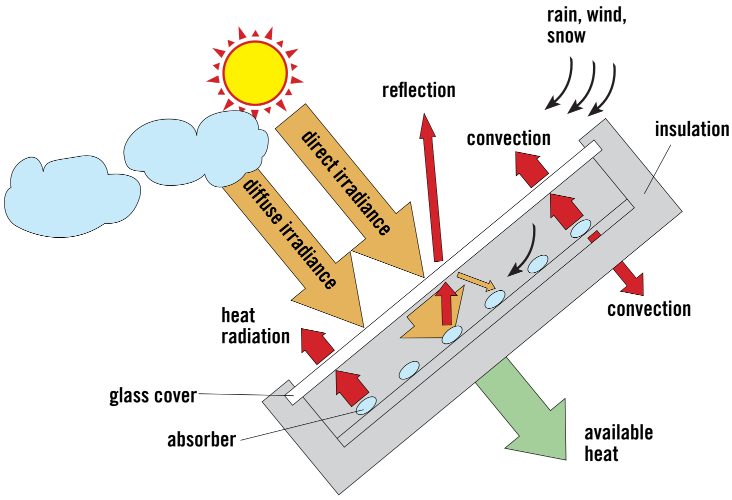
4. Renewable energy opportunities for hotels

The main renewable energy technologies (RETs) that are proven, commercially available and relevant to Fiji are solar energy for water heating and solar photovoltaics (PV), wind energy and hydropower for electricity production. Biomass technologies for heating, cooking and electricity production as well as seawater air conditioning systems are also briefly discussed.

4.1 Solar thermal energy

For the purposes of this guide, solar thermal energy refers to solar water heating (SWH), a technology that uses energy from the sun to heat water. SWH systems include storage tanks and solar collectors. Sunlight strikes and heats an absorber surface within a solar collector (flat plate collectors or evacuated tube collectors) or an actual storage tank. Either a heat-transfer fluid or the actual water to be used flows through tubes attached to the absorber and picks up the heat from it. The heated water is stored in a separate preheat tank or a conventional water heater tank until needed. If additional heat is needed, it is provided by electricity or fossil-fuel energy (usually gas) through a conventional water heating system.

Figure 9: Solar water heating system principles.



Source: IIEC 2013.

SWH systems have been in use for over 30 years all around the world, although they are most prevalent in countries with high solar resource. SWH systems are already widespread in the tourism industries in the Mediterranean and the Caribbean. Barbados, an island nation of 300,000, has installed over 50,000 solar water heaters, saving 100,000 MWh per year (CDKN 2012).

Solar panels placed on the roof of a hotel collect the sun's rays to heat water that then flows to a storage tank supplying hot water mainly for showers and cooking. There are many different types of SWH technologies available, and choosing the most suitable technology for a particular hotel will depend on several factors, such as:

- solar resource available;
- characteristics of the hotel roof (e.g. materials, orientation);
- water quality; and
- available space.

Considerations that need to be taken into account include the selection of solar collector technology, boosting system (electric or LPG top-up heating when there is insufficient sun), tank type and size, and where to position the tank. Sizing the system appropriately for the accommodation facility is critical to achieving an efficient operation. There are two types of SWH systems: active, which includes circulating pumps and controls; and passive, which does not. Active direct circulation systems use pumps to circulate water through the collectors and into the rooms. Passive SWH systems are typically less expensive than active systems, but they are usually not as efficient. However, passive systems can be more reliable and may last longer, particularly with a proper maintenance programme (USDOE 2015).

Predominant types of SWH systems in tropical environments include flat plate collectors and evacuated tube collectors. Flat plate collectors use copper tubing embedded in black-coated sheets. Evacuated tube collectors either have glass-in-glass tubes or tube-in-glass tubes. The systems use thermo-syphon principles to push the heated water into an insulated collection tank. Most solar water heater insulated tanks also have auxiliary electric water heating coils embedded in the design to ensure that a constant temperature is maintained in the tanks. Typically, the hot water collected in the tanks is stored at a temperature of 45–65°C (IIEC 2013).

Figure 10: Two types of passive solar water heaters.

Flat plate collectors	Evacuated tube collectors
	

Source: IIEC 2013.

All SWH systems require a backup system or storage for cloudy days and perhaps in times of increased demand. Conventional storage water heaters (LPG or electric) usually provide backup and should be part of a hotel SWH system. Systems can be tailored to an accommodation facility by selecting a suitable tank capacity and a suitable number of collectors (panels). The tank can be located on the roof, on the ground, or in a roof cavity. An SWH system will work best if its collectors can receive full sunshine during the middle of the day when the sun is high in the sky and at its strongest. It is best to locate collectors away from any shaded areas, such as below trees or adjacent to buildings.

SWH is a proven technology with a typical payback period of between 1.5 and 3.0 years, depending on the specific technology used and the local cost of the energy source it is substituting (usually gas or electricity). The upfront cost of purchasing and installing an SWH system is lower than other RETs. SWH systems are more energy efficient than electric water heaters and a well maintained SWH system can have a normal lifetime of 15–20 years before it needs replacing. Some maintenance is required to achieve a long life-span. This may include checking and replacing parts every three to five years, fitting insulation around the tank and pipes, cleaning collectors and trimming trees, which may shade the collectors.

Renewable energy tip*: Use a reputable professional to install the SWH system. Roof-mounted panels and tanks can be heavy, so it is important to check that the roof is strong enough to support this added weight, particularly for older buildings. The installation should also be cyclone proof as far as possible.*

4.2 Solar photovoltaic energy

Solar PV systems convert sunlight into electricity. Solar PV allows a hotel to produce electricity without noise or air pollution, from a clean renewable resource: the sun. In the Pacific, solar PV is the most widespread RET in use, and has been used for over 30 years. Like SWH systems, solar PV today is a proven technology with many suppliers and installers based in Fiji. Solar PV can be used as either an alternative energy source or a supplement to a main grid connection. Solar PV can also be a viable option for electricity cost savings and upgrading of electricity reliability for hotels in rural areas and on islands, which are not connected to the main FEA utility grid.

Solar PV systems can either be connected to the utility grid (referred to as 'grid-connected' PV systems), or not connected and completely independent of the grid (often referred to as 'off-grid' or 'stand-alone' PV systems). Off-grid PV systems can also form their own small grid to supply multiple buildings and this is referred to as a 'mini-grid'.

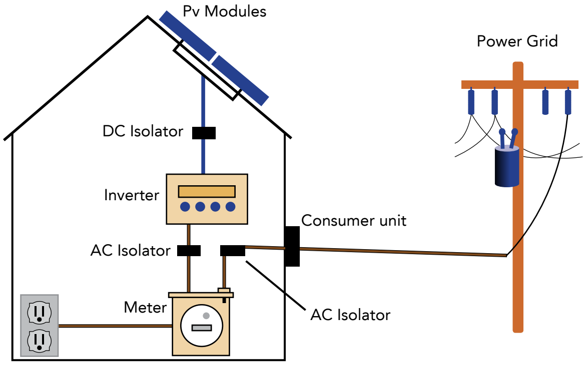
A PV system that is connected to the utility grid has two main components:

- one or more PV modules or panels that convert sunlight into direct current (DC) electricity; and
- one or more inverters that convert the system's DC electricity to alternating current (AC), to power AC electrical appliances and equipment.

Figure 11: Solar photo voltaic panels.

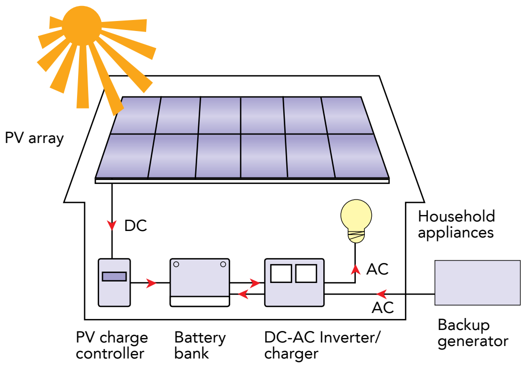
For off-grid solar PV systems, batteries and controllers (also called regulators) are additional main components of the system. Depending on whether the PV system is grid-connected or off-grid, and whether there are payment arrangements, a special meter or several meters may be installed to track production from the PV system, onsite electricity use, and export to the main grid. In order for a grid-connected PV system to export to the FEA grid, there must be a pre-arranged agreement with FEA.

Figure 12a: Schematic of a grid-connected solar PV system.



Source: Murdoch University 2015.

Figure 12b: Schematic of an off-grid solar PV system.



Source: Vorks energy 2011.

Solar PV systems can work anywhere in the world, but the amount of electricity they produce depends on how much sunlight they receive. Within Fiji, different locations receive different amounts of sunlight. Even on the same island, different locations can be significantly different in terms of the amount of solar energy received (measured as insolation, or kWh/m^2/day). Table 4 shows the differences in the amounts of sunshine received between Nadi and Suva. Nadi receives consistently higher amounts of solar energy than Suva. Therefore, solar PV systems in Nadi will produce more electricity than PV systems in Suva, all other parameters being equal. Usually, the summer months, with longer days, produce greater amounts of solar energy as shown in the example below, where the months of October to February have the highest levels of solar energy.

Table 4: Solar insolation on a horizontal surface for Nadi and Suva, measured in kWh/m²/day.

Nadi

Longitude 177.4°	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
22-year average	6.56	6.36	5.78	5.08	4.50	4.21	4.47	5.01	5.68	6.51	6.75	6.76	5.63

Suva

Longitude 178.4°	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
22-year average	6.29	6.20	5.54	4.67	4.05	3.72	3.89	4.44	5.08	6.04	6.32	6.38	5.21

Source: NASA 2015.

There are three main ways to install a solar PV system (IRENA 2014):

1. roof mounted, where PV panels are mounted onto the existing roof space of a hotel or other resort building;
2. building integrated, where PV panels are directly integrated into the building during construction or remodelling (e.g. PV on parking shade structures); and
3. ground mounted, where PV panels are mounted on a dedicated structure somewhere near the hotel or resort.

It is important to install solar PV panels at the right orientation (also called azimuth) and tilt, to optimise electricity production. In the southern hemisphere, the optimum orientation is north, while the tilt of solar panels should not be less than 10 degrees (to allow for rainwater run-off, which will clean the surface of the panels).[8]

Once installed, solar PV systems generally require very little maintenance because they have no moving parts and, thus, have low operating costs. The biggest cost after installation for grid-connected systems is replacement of the inverters every 8–10 years. The biggest cost for off-grid systems is usually the replacement of batteries after 5–8 years. Batteries need to be disposed of with care at the end of their life. The panels of the solar PV system are generally guaranteed by the manufacturer to produce electricity for a minimum of 20 years, and many will last between 25 and 30 years before needing to be replaced. However, older panels will be less efficient at converting sunlight into electricity and, so electricity production will generally decline after the first 20 years.

Because solar PV systems are made up of modular panels, they can be easily sized to suit a hotel's electricity needs. The more electricity a hotel uses, especially during the middle of the day when solar PV can generate maximum energy, the more panels will need to be installed to meet that need, provided there is sufficient space either on the ground or on roofs. Older roofs may need to be checked for structural strength to support the weight of the solar panels. Some space will also be required for the inverters and, in the case of off-grid systems, for batteries. A separate battery house is recommended for safety reasons. Installation of the solar PV and battery house construction (if needed) should be cyclone proof.

Solar PV system costs have fallen significantly in the last five years, with payback periods varying between three to eight years, depending on the type of system installed (grid-connected or off-grid) and source of electricity that is being substituted (grid-electricity or electricity from an off-grid diesel genset). When installing a solar PV system in remote areas or islands, the need to transport fuel at regular intervals can be avoided, and environmental risks and pollution are reduced.

***Renewable energy tip:** PV systems are a cost-effective, proven and flexible technology that can be easily adapted to a hotel's various electricity needs. Use an individual or company certified/accredited by SEIAPI to carry out the installation.*

8 Relatively inexpensive online tools can be used to work out the best orientation and tilt for solar PV or thermal collectors at specific locations (e.g. PV Watts developed by the US National Renewable Energy Laboratory, or NREL).

4.3 Biomass energy

Biomass energy is produced by using plants, manure and other organic material as fuel. Biomass can also be in the form of wood chips, or biomass pellets, which can be bought on the market, although their supply in Fiji is currently limited. Biomass energy can be renewable: plants grow using sunlight, which they convert into chemical energy and store in their roots, shoots and leaves. Burning biomass releases most of that energy as heat, which can be used directly as a fuel for cooking or water heating or to generate electricity.

Biomass is more environmentally friendly and sustainable than fossil fuels such as coal, for three main reasons: 1) biomass can be produced quickly, and the resource can be replenished relatively quickly by growing new plants or trees to replace the ones that have been cut down and burned; 2) plants absorb as much carbon dioxide from the air when they grow as they release when they burn, so in theory, there is no net carbon dioxide release and burning biomass does not add to the problem of global warming; and 3) materials that could be used as biomass for fuel, such as waste woodchips, leaves and chicken manure, are often simply thrown away or sent to landfill.

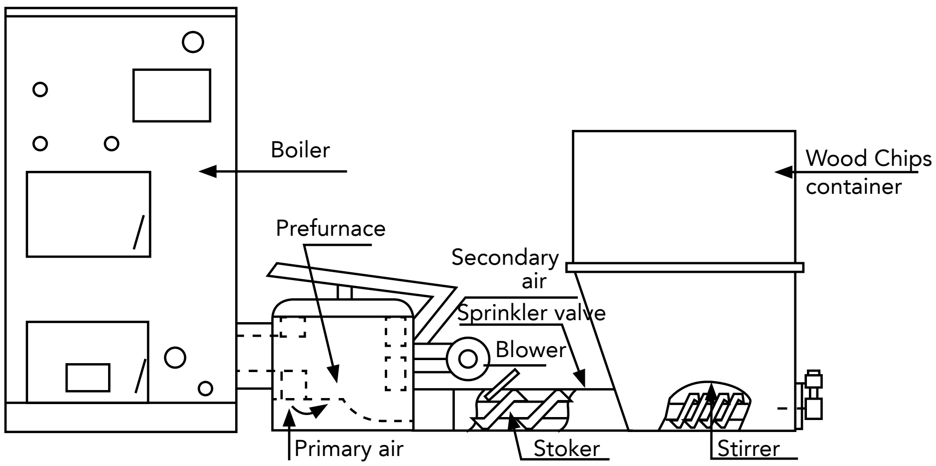
Biomass energy can be used in different forms. It can be burned directly to produce heat, and it can be converted into gas (biogas) and used for cooking or used to generate electricity. Finally, biomass can also become biofuel, for example, from coconut oil or ethanol from bagasse. Therefore, there are many possible ways to use biomass energy at a hotel. In this guide we will look at two of the most common commercial technologies worldwide: biomass boilers and biogas for cooking.

Hotels that have access to wood waste or collect a lot of organic food waste or garden waste can explore the opportunity for using biomass energy. Hotels should also consider operating and maintenance costs of biomass installation, which require specialist technical skills. Costs, therefore, are likely to be higher than existing systems, at least in the short term until onsite staff are trained. There is also limited technical expertise in biomass systems in Fiji, with few local suppliers or experienced installers.

4.3.1 Biomass boiler

A biomass boiler is a boiler designed to burn solid fuels classed as biomass. Such boilers can be supplied to burn every form of biomass from woodchips, wood pellets or logs to waste agricultural materials such as coconut husks, rice and the dust from any of these, including sawdust. Boilers need to be designed to burn specific materials, with any given boiler able to burn a limited range of biomass. Therefore, it is important to select a boiler that matches the materials available to the hotel.

Figure 13: Example of a pre-furnace biomass boiler suitable for wood chip combustion.



Source: Inforse, undated.

A biomass boiler is a technology that can perform the same job as a central heating boiler powered by gas, oil or electricity. In many Pacific Island hotels, it could provide the hotel heating (drying) and hot water needs. A biomass boiler can also be operated in conjunction with a SWH system.

The most important criterion for a hotel to consider when deciding on whether to start using solid fuel biomass for heating is whether there is a reliable supply of sufficient quantity of a specific type of biomass (e.g. wood pellets, coconut husks or bagasse[9]) readily available for the hotel to use at a reasonable cost. Using only one type of biomass is best because mixing different fuels can lead to unreliable operation and increased maintenance needs of a biomass boiler.

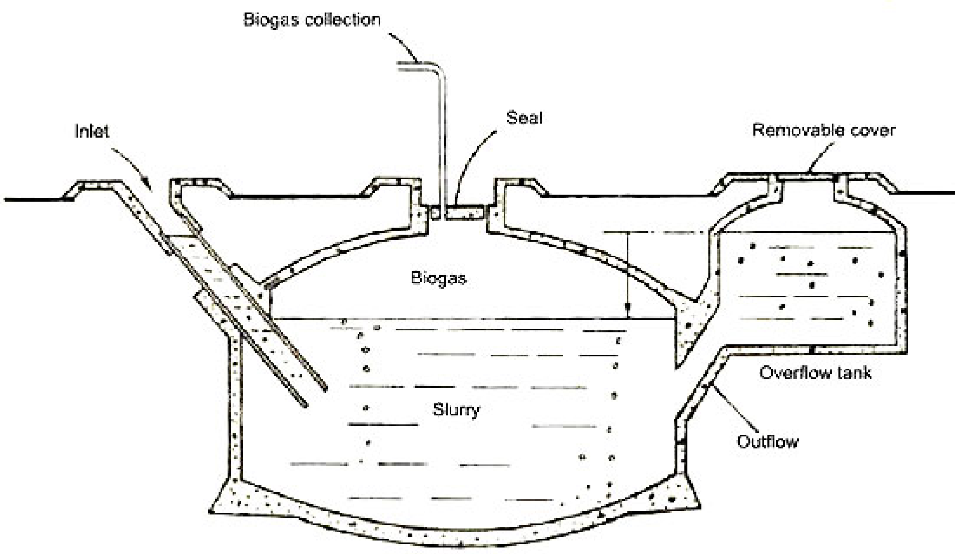
4.3.2 Biogas for cooking

Biogas typically refers to a methane gas produced by the biological breakdown of organic matter in the absence of oxygen (commonly called anaerobic digestion). Organic waste such as dead plant and animal material, animal (and human) faeces, and kitchen waste can be converted into biogas using this process. In the hotel industry, there are often questions of how to deal with waste from canteens and kitchens in an environmentally friendly manner, while dealing with limited knowledge of suitable disposal techniques, lack of space for disposal and need to comply with environmental solid waste management regulations. In some cases, conversion of organic waste to biogas may provide an answer.

Biogas is most efficiently used directly as a clean cooking fuel but it can also be used for electricity production when coupled with a generator. This increases the complexity of the operation and costs. Biogas digesters also produce valuable by-products such as fertiliser. Using waste to produce biogas may also have co-benefits for a business such as savings on garbage disposal costs; and increased resilience and ability to cope with shortages in cooking fuel (such as LPG) if a disruption in supply occurs.

There are many biogas technologies (also called biogas digesters) ranging in size from those requiring many hundreds of tonnes of organic matter per day to those that can function on 50 kg per day. For example, one tonne of food waste has the capacity to generate approximately 70 m^3 of biogas. Biogas technologies can be above ground or below ground, depending on the type of digester and process used.

Figure 14: **Example of an underground dome-type biogas digester.**



Source: The Institute of Science in Society 2015.

9 Bagasse is the residue left after the extraction of juice from sugar cane.

Again, an important consideration before embarking on a biogas project is whether a suitable quantity of organic waste is readily and reliably available at a reasonable cost to the hotel. This can be waste from onsite sources (e.g. kitchen and food waste) and/or from offsite sources (e.g. a nearby pig farm or restaurants). Because the biogas will most likely be replacing LPG use for cooking, a comparison can be made with LPG costs and reliability of supply to judge whether switching to biogas is a good investment. Given the right conditions, the payback period on a biogas digester for cooking can be as little as two years.

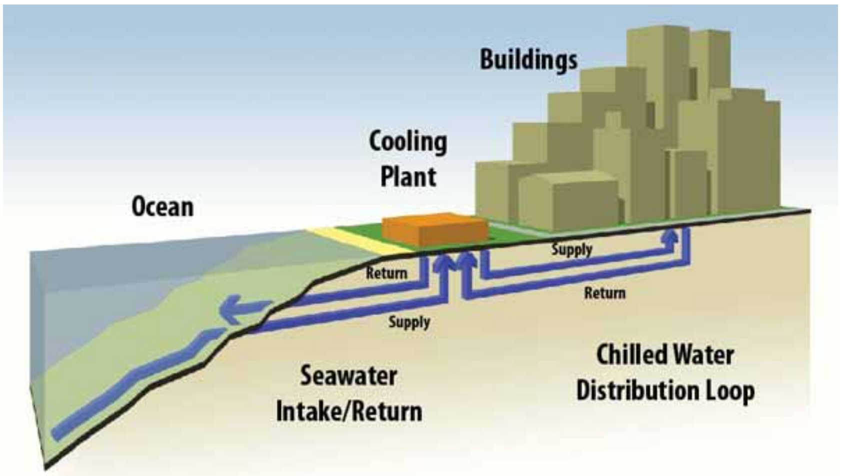
Renewable energy tip: *Examine the biomass supply chains and organic waste available and if feasible use a biomass project to combine waste management with energy management to save on energy costs and protect the natural environment.*

4.4 Seawater air conditioning systems

SWAC systems use cold water from the ocean depths to provide air conditioning service in hotel rooms and facilities. Although SWAC systems are relatively new, they have been planned or are already installed at island hotels and resorts in Aruba, Hawaii, Mauritius, Tahiti and Tetiaroa Atoll in French Polynesia (IRENA 2014).

SWAC technology requires an upfront investment that is greater than that for SAC systems, but is viable, and overall more economical, if the tourism facility is close to a deepwater resource, and has a large cooling demand. SWAC technology can generate considerable savings that offset its higher capital costs, and the typical payback period is between 5 and 11 years (IRENA 2014).

Figure 15: Seawater air conditioning system.



Source: Kaiuli Energy.

In SWAC systems, cold water is pumped up from the ocean and passed through a heat exchanger to cool the hotel building's chilled water down to 7°C for air conditioning (Hotel Energy Solutions 2011a). SWAC heat exchangers are generally expensive because they are made of titanium to avoid corrosion from salt (IRENA 2014).

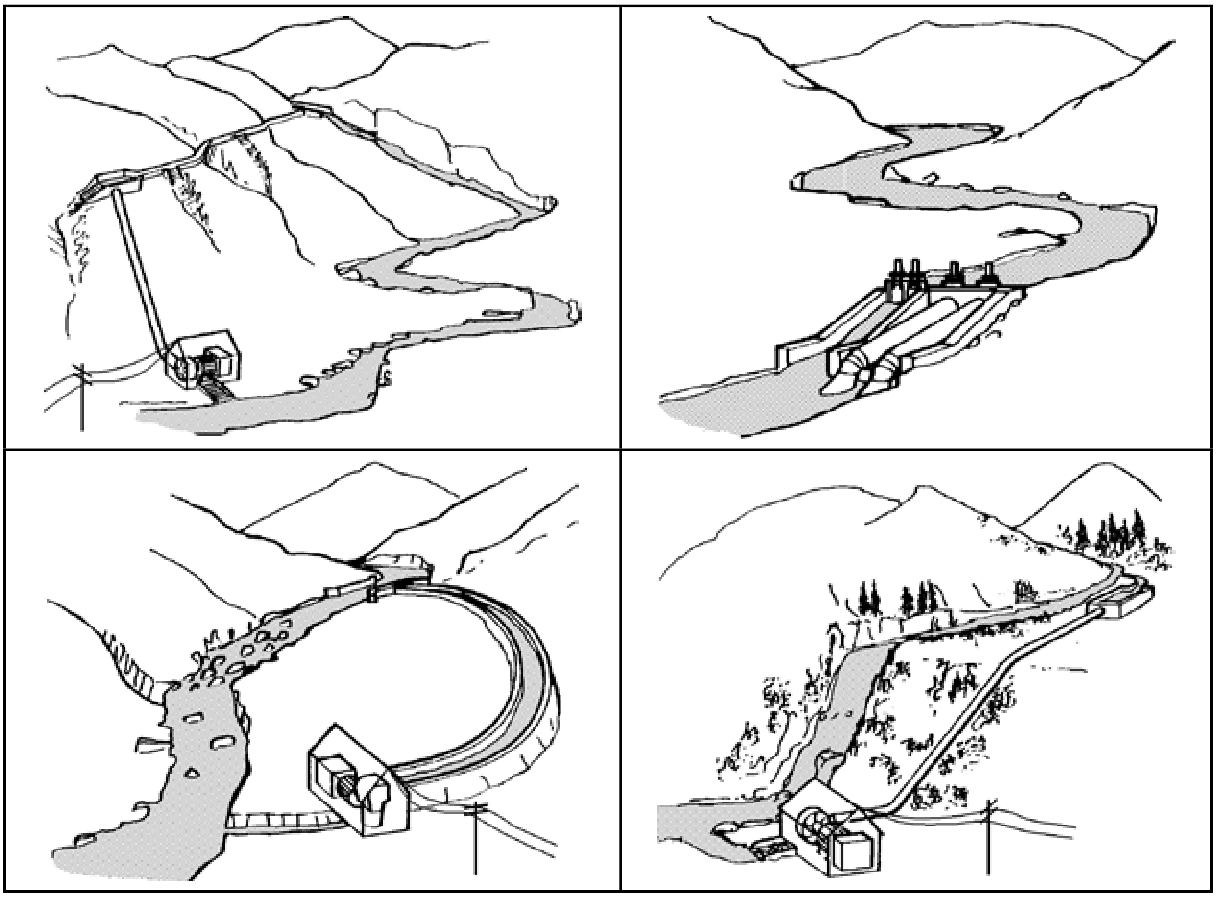
The cost of installing SWAC systems mainly depends on the depth required to reach sufficiently cold seawater and the distance from the sea to the hotel. This means that this technology is potentially suitable to hotels in Fiji, which are generally very close to the ocean. The technology is also particularly suited to the tropics because the upfront investment is repaid faster in hotels that have a large, year-round air conditioning load. This, and the upfront capital cost, means that the technology will probably be more appropriate for larger hotels rather than smaller ones.

SWAC systems can satisfy up to 90% of the cooling load, with a proportionate reduction in electricity bills for air conditioning in most hotels (Hotel Energy Solutions 2011a). The upfront investment for the purchase and installation of a SWAC system depends on several variables, including the required water flow rate, the length of pipes, and the measures needed to protect the pipes. There will also be a need to carry out an environmental impact assessment which would add to the cost. In general, SWAC systems require high initial investments but have low operating and maintenance costs. Having multiple investors join forces to purchase and install SWAC systems might be an effective way of sharing high upfront costs (IRENA 2014).

4.5 Micro-hydropower systems

The energy in flowing water can be converted into electrical energy or into mechanical energy by using it to power hydraulic turbines. In the past, hydropower stations were often built as a part of large dam projects. Due to the size, scale, cost, and environmental impacts of these dams (and their reservoirs), hydropower development today is increasingly focused on smaller-scale projects. Small and micro-hydropower technology has much lower environmental impacts and can often be set up as a run-of-river[10] scheme, with no dam and minimal disruption to the flow of the river or stream.

Figure 16: Typical site layout for micro-hydropower.



Source: IT Power, undated.

Small or micro-scale hydropower technology is an efficient and commercially proven; technology; however, hydropower potential is very site specific. It could be considered an option for hotels near rivers or streams that have strong and constant year-round flow and a sharp downward gradient (called head in hydropower). A hydropower plant could produce enough electricity to operate a large, medium or small hotel. However, the upfront capital costs would be higher than for other technologies, and thus such a project would only likely be viable if the excess electricity not used by the hotel could be sold, either to FEA or to other customers outside the hotel.

10 Run-of-river hydropower projects use the natural downward flow of rivers and smaller turbine generators to capture the kinetic energy carried by water. There is no dam for water storage. Typically water is taken from the river at a high point and diverted to a channel, pipeline, or pressurised pipeline (or penstock). The technology is applied best where there is a considerably fast moving river with steady seasonal water. How much electrical energy can be generated by a hydroelectric turbine depends on the flow/quantity of water, and the height from which it has fallen (the head). Adapted from ClimateTechWiki.

Any small river or large stream with a reasonably constant water flow throughout the year can be considered. Small-scale hydropower systems are modular and can generally be sized to meet individual needs. Operation and maintenance needs are reasonable but specialist skills are required, which may increase costs. The financial viability of a project is also subject to the location of the available water resource and the distance the generated electricity must be transmitted. Well sited micro-hydropower energy systems can usually pay for themselves within 5–10 years. The payback period depends on electricity not used onsite by the hotel being sold to generate income.

In planning a micro-hydropower investment, an environmental impact assessment would need to be undertaken. In addition, the hotel should consider that the land and river may belong to one or many communities, and so an agreement to use the river for the purpose of electricity production would have to be negotiated with the owner(s). It is likely that setting up and installing a hydropower installation will take longer than implementing other RETs.

A management and investment model for undertaking a hydropower plant investment —which may reduce risks and maximise benefits — is to consider a scheme where the local community and landowners are an integral part of the hydropower project, being part-owners, making a contribution towards the costs and benefiting from the electricity generated.

Renewable energy tip: *Properly planned and installed micro-hydropower schemes will require considerable upfront capital investment, time and effort to establish but can produce a continuous supply of low cost electricity during the day and night.*

4.6 Small-scale wind energy

Generating electricity from wind is a proven technology that is economically competitive with most fossil fuel applications, depending on the location and size. Wind turbines suitable for hotels are smaller in size than the most cost-effective, multi-megawatt installations, however, and are typically in the range of 1–50 kW in size. These are classed as 'small wind turbines' and can offer an alternative source of electricity if the hotel is in a location that is windy year-round. In Fiji, small wind turbines will be most competitive in off-grid situations where they are replacing diesel for gensets. Small wind systems can complement solar PV because wind energy can supply electricity for charging batteries during the night, while solar PV cannot.

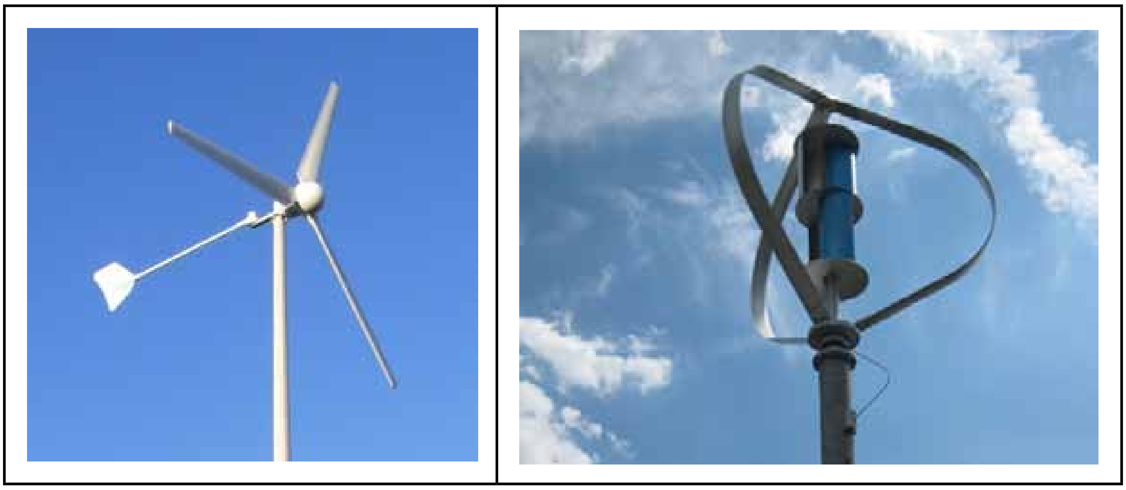
Wind energy is worth exploring for hotels that are situated in coastal areas, on flat open plains or on mountain passes exposed to consistent wind flow. Obstacles such as buildings and trees need to be avoided when deciding where to place a wind turbine.

The most common small wind turbines for generating electricity are horizontal axis and use three rotor blades connected to a generator. However, there are also vertical axis small wind turbines, although these tend to be less efficient in producing electricity. Small wind turbines are usually mounted on concrete or steel towers on the ground but smaller models can also be mounted directly onto a building. Apart from installing a tower or pole and the rotor, a small wind turbine system normally includes a gearbox, generator, and other supporting electrical equipment such as controllers, inverters and batteries (for off-grid installations).

In cyclone-prone areas such as Fiji, consideration must be given to the ability of the wind turbine to withstand hurricane-speed winds. This can be achieved by having a mechanism to lower the turbine to the ground, or a mechanism to allow the generator to switch off, in which case the rotors would spin but electricity would not be generated. Some small wind turbines claim to be able to generate electricity even during cyclones.

The power that can be generated from a modern wind turbine is related to the cube of the wind speed. Consequently, the availability of good wind speed data is critical for assessing the feasibility of any wind project. Usually, monitoring masts are set up to collect the data, ideally in the exact location where the wind turbine is to be located. If this is not possible, then as nearby as possible is recommended. The mast should be free of obstacles to wind flow (e.g. buildings, trees) just as for the potential wind turbine. Wind data should be collected for a minimum of one year.

Figure 17: Horizontal and vertical axis small wind turbines.



Source: Anhui Hummer Dynamo Co. Ltd 2012 and Green Ninjas 2013–2014.

The data collection adds to the time and cost to install a wind turbine but is recommended for systems that are over 10 kW in size. For smaller systems, it may be possible to extrapolate approximate wind speeds from existing meteorological data and world wind resource maps, although these are usually based on square kilometer readings at 50 m and so cannot be relied on for accuracy at any particular location. The need for accurate knowledge of wind speed and the moving parts of a wind turbine which add complexity to its operation and maintenance, are two disadvantages of this technology.

Most commercial wind turbines operating today are placed at sites with average wind speeds greater than 6 meters/second (m/s) or 22 km/h, although annual wind speeds over 5.5 m/s can also be viable. A high quality wind site will have an annual average wind speed in excess of 7.5 m/s (27 km/h). Wind speeds recorded in Fiji show typical winds in the range of 4–6 m/s and, thus, wind energy has low to medium potential. However, there is no comprehensive wind mapping of the whole of Fiji and wind speeds are very sensitive to location.

For hotels in remote areas that remain open year-round, a hybrid system combining wind power with solar PV or other generating options offers several advantages over a single-generator system. In many cases, wind speeds are lowest when there is excess solar energy and vice versa, and highest when solar energy is minimal. Wind energy systems can also be used to power electric water pumps. However, renewable energy systems and particularly hybrid systems are more complex and need additional maintenance, which adds to their overall cost.

A small wind electric system could be suitable for a hotel if it: 1) receives plenty of wind; 2) has no large obstacles such as buildings, trees or hills nearby; 3) has enough space on the ground or on the roof; and 4) is comfortable with longer-term investments (because the payback period for small wind can be 10 years or more). A hotel should also consider potential noise from the wind turbine, although the technology has improved to minimise noise levels. Finally, technical skills and the market in small wind turbine installation in Fiji are limited and so maintenance and replacement parts may be expensive. Similarly to solar PV, in order for a small wind system to export electricity to the FEA grid, there must be a pre-arranged agreement with FEA.

Renewable energy tip: *A properly maintained wind turbine energy system can last for 20 years and can be cost effective, particularly if used in conjunction with other complementary renewable energy sources such as solar PV. However, it is important to make sure reliable wind speed and direction data for the hotel site are obtained as a good wind resource is crucial for this technology to be economically viable.*

5. Hotel training programmes for energy efficiency and renewable energy

Involving hotel staff in the energy management plan (EMP) is not only essential for the hotel energy plan to be successful, it is also a method to give them ownership of the plan and promote a joint effort to achieve the objectives. As long as the hotelier explains to staff members that energy efficiency and renewable energy are now part of the hotel's environmental and business strategy plan, and if the hotel provides the necessary training to its staff to be able to implement any new energy-related requirements, staff members will be able to contribute to the hotel's efforts for a more sustainable business. To increase effectiveness and participation of staff, the hotel should review the roles of staff and adjust job description if needed and as well as training, consider adjusting salary scales where new responsibilities have been added.

5.1 Behavioural strategies and considerations

It is strongly recommended to actively involve the hotel's staff members, and for the hotel to provide its staff with information and training on the actions to be taken to support the hotel's EMP. The hotel management should also invite its staff to provide their feedback and ideas on how to save more energy. Staff information and training is an effective way to improve the way energy is used in the hotel.

Although it may cost some time and money to inform and train the hotel staff, the resulting benefits will show up in a very short time because staff behaviour has a direct impact on energy consumption, just like guests' behaviour. Changing the way people use energy should not imply any reduction in comfort or convenience for staff or guests, and should not mean excessive restrictions.

5.2 Staff training programmes

Staff training programmes should be used to motivate staff to conserve energy. The focus of an energy awareness programme should be to improve the environmental friendliness of the hotel, reduce the impact of climate change, and provide cost savings to the hotel. Two ways to raise staff members' energy awareness is through trainings and seminars.

Energy awareness trainings

These trainings are intended for key technical and operational personnel who are energy coordinators and energy champions, as described in Section 2.3. The duration of such a programme can vary, depending on the level of awareness of key personnel, and so could be anywhere from four to six hours, to a one- to three-day training course. Topics covered could include:

- a basic understanding of energy and our environment;
- how to improve the energy efficiency of hotels in general;
- a basic understanding of energy efficient operations; and
- energy efficient technologies.

Energy awareness seminars

These seminars are designed to educate and motivate all staff members. The seminars should be short, imparting a basic understanding of energy consumption and the associated environmental impacts, and guidelines on how to improve energy efficiency through behavioural and operational practices. The recommended course outline includes:

- a discussion about global issues (energy and the environment);
- an explanation of benefits to the company and staff;
- a presentation about energy misuse based on historical analyses of users;
- a brief discussion of recommended energy saving opportunities, mainly through
- operational change;
- personnel participation to develop methods of reducing energy consumption;
- achievements in energy conservation and reduction in GHG emissions; and
- clear messages that everyone can help reduce energy and GHG emissions.

If a hotel decides to invest in RETs (e.g. SWH or solar PV), specific training on that technology's operation and maintenance should be provided to staff, particularly the engineering and maintenance staff.

5.3 Information and incentives for guests

For a hotel's energy efficiency policy and EMP to be successful, it is essential to involve guests. The hotel can inform guests of the actions it is taking to reduce its environmental footprint and invite them to take simple actions to support the hotel's efforts (e.g. guests can agree to not request that their towels not be renewed every day, thereby saving both water and energy).

Most hotel guests will be happy to know that the hotel they are staying at is committed to reducing its negative environmental impacts, and will be keen to learn about the simple actions they can adopt to limit waste of energy and improve the environmental friendliness of their stay.

The hotel should make it known that it has established environmental objectives, and should provide guests with information on the actions it is taking to reduce its environmental footprint. It is important to explain that the hotel is reducing its energy consumption as part of its environmental strategy. Hotel guests can also be motivated or reminded to reduce energy use through posters and stickers (see Figure 18) on energy and climate change and the commitment of the hotel to be 'green'. Stickers such as 'please turn off the light' or 'be an energy saver!'

Figure 18: Energy saver sticker in Fiji.

The hotel should provide guests with a leaflet or brochure outlining its environmental policy and EMP. This can be handed out at the reception desk upon arrival, placed in guestrooms, and/or included on the hotel's website. The main point is to maintain active communication (written, oral and/or visual) with a message that says, for example:

> *"By improving the energy efficiency of our hotel and by avoiding any waste of energy, our hotel is taking important steps toward reducing its greenhouse gas emissions and is thereby contributing to the preservation of the earth's natural resources."*

6. Policies and financing for sustainable energy projects

Over the past seven years, a number of Pacific Island countries have introduced policy instruments and financial incentives to support renewable energy and energy efficiency programmes and projects. Among these are the energy road maps developed in Tonga, Cook Islands, Vanuatu and Tuvalu, all of which have stated policies which aim to reach high levels (between 65% and 100%) of renewable energy use for the electricity sector. Many countries have also lowered or removed duties on solar equipment and/or introduced feed-in tariffs for renewable energy exported into the main utility grid, which has enabled even relatively small consumers to install their own renewable energy system (most often solar PV) with reasonable return on investment. This section specifically focuses on policies and financial incentives in Fiji, as well as possible sources of financing for renewable energy and energy efficiency projects.

6.1 Fijian government's policy

The Fijian government has committed to increasing the renewable energy share in electricity generation from 61% in 2013 to approximately 99% by 2030, while also continuing to support increased energy efficiency. In particular, the government has committed to investing more in renewable energy projects that are feasible in Fiji, such as solar (off-grid and grid-connected), biofuel, wind, micro-hydropower and biogas power generation (agricultural waste) (Government of Fiji 2014). The government will support voluntary efforts by the business community to improve energy efficiency, including public recognition of best performers, providing information on potential measures, disseminating best practice guidelines, and encouraging energy efficiency programmes that include a development partner (and donor agency) (Government of Fiji 2014).

For the tourism industry, the government has laid out plans to encourage the adoption of energy efficiency technologies, make energy auditing mandatory in the tourism industry, and institute energy efficiency practices, as well as introduce an additional award category in the National Awards for greening initiatives in tourism (Government of Fiji 2014).

6.1.1 Biofuel standards

In April 2011, the Fijian government approved the introduction of Biodiesel and Ethanol Standards, including the Trade Standards (Fuel Standards) National Diesel Standards (Amendment) Order 2011. The diesel standards have been modified to allow 5% by volume of biodiesel in diesel fuel, and the petroleum standards already have a provision 10% ethanol by volume.

6.1.2 Minimum energy performance standards

In January 2012, MEPS and energy labelling was approved by the Fijian government for refrigerators, freezers and refrigerator-freezers, including the incorporation of Trade Standards (Household Electric Refrigerating Appliances Order 2007) into the Customs Act. As per the regulations, all imported household refrigerators and freezers must comply with the standards.

Fiji's Department of Energy is exploring the expansion of the MEPS programme to include air conditioners and lights, and other high energy consumption electrical appliances.

6.1.3 National building code

The Department of Energy is currently undertaking a review of the National Building Code with the intended outcome of including energy efficiency measures. Initial recommendations made for inclusion into the National Building Code include the following (Fiji Department of Energy 2014):

- Codification of current best practices, including:
    - Daylighting
    - Exterior shading of wall and window areas
    - Tinted windows (based on shading and orientation)
    - Reduced lighting loads (measured in watts/meter2)
    - Standards for natural ventilation

- Augment current best practices to codify:
  - Cool roofs and/or roofing insulation (to be determined based on modelling in Phase II of the project)
  - Standards for mixed-mode (naturally ventilated and cooled buildings)
- Development of a prototype village house and government mixed-mode building plans based on current practices modified for greater efficiency.
- Adopt lease agreement standards for efficiency of all federal buildings.
- Establish equipment efficiencies for lighting ballasts and air cooling, specifically to eliminate the use of incandescent bulbs nationwide, eliminate use of magnetic ballast fluorescent fixtures in urban areas with stable power supplies, and set a minimum efficiency standard for all air cooling equipment sold.
- Establish standards for new subdivision development and land use policies to address building orientation, heat island mitigation, solar access, and solar ready construction.
- Establish a Tier II standard above the Fiji National Building Code for a comprehensive 'green' building, which is encouraged through an adopted incentive programme.

6.2 Financial incentives for renewable energy in Fiji

Under the 2009 Foreign Investment Regulations and Foreign Investment (Amendment) Regulation 2013, undertaking any activities in the energy sector does not have any minimum investment requirement. Various investment incentives have been offered to encourage the development of renewable energy and energy efficient projects (Investment Fiji 2015). Incentives for specific technologies are detailed below.

6.2.1 Biofuel

For biofuel production, duty-free concessions are given to plants, machinery and equipment for the initial establishment of a factory, and any chemicals required for biofuel production. To further encourage investments in biofuel production, an income tax exemption is given for a period of 10 years for companies that are involved in a new activity in processing agricultural commodities (e.g. sugar, coconut) into biofuels. To qualify, the taxpayer must have a minimum level of investment of FJD 1,000,000, and employ 20 local employees or more for every income year.

6.2.2 Renewable energy projects and power cogeneration

A five-year tax holiday is available to a taxpayer undertaking a new activity in renewable energy and cogeneration power projects. There is a five-year tax incentive (only value added tax paid) for imported renewable energy equipment, including solar, hydro, biomass, biogas, wind, solar water heaters, solar water pumps and geothermal. Solar batteries that are specifically for rural electrification purposes are also duty free.

6.2.3 Energy efficiency

With regard to energy efficiency, zero fiscal and import-excise duties apply to energy efficient 'lamps' with ratings less than 25 W and fluorescent tubes and bulbs that are less than 25 W.

6.2.4 Green transport

Zero fiscal and import-excise duties apply for bicycles. Zero import duties also apply for new hybrid electric vehicles. Import duties have also been reduced for vehicles carrying 10–22 people and for motorcycles. In addition duty on new vehicles with an engine capacity not exceeding 2500cc has been reduced to 5%. All new vehicles will now be EURO 4[11] compliant. Second hand vehicles will also be EURO 4 compliant and at the time of importation, must be less than five years since manufacture for unleaded and diesel and less than eight years for LPG, compressed natural gas, solar, electric and hybrid vehicles.

There is an incentive package for investment in setting up of electric vehicle charging stations. This includes a seven year tax holiday, a subsidy of between 5-7% of total capital outlay and loss carried forward of 8 years.

11 The Euro 4 is a fuel standard of the European Union that has been in use since 2005. The standard specifies a maximum of 50 ppm (parts per million) of sulfur in diesel fuel for most highway vehicles.

6.3 Feed-in tariffs for electricity generation in Fiji

In 2014, the Commerce Commission of Fiji raised the large-scale Independent Power Producer tariff rate to FJD 33.08 VEP[12] per unit (per kWh). This tariff applies to dedicated power producers supplying electricity to the FEA grid. Each power producer must also negotiate a power purchase agreement on a case-by-case basis with FEA.

Presently, FEA also offers a lower rate on a case-by-case basis to smaller-scale customers who have renewable energy systems connected and exporting to the grid. The Fijian government plans to carry out a study for the introduction of standardised feed-in tariffs for small-scale renewable energy systems, which may be differentiated by technology (different feed-in rate for solar, wind, hydro and others).

6.4 Financial incentive schemes in Fiji

6.4.1 Sustainable Energy Financing Program

In June 2008, the World Bank/Global Environment Facility-funded Sustainable Energy Financing Program (SEFP) was launched in Fiji. The project aims to increase the adoption and use of RETs through a package of incentives in order to encourage local financial institutions to participate in sustainable energy finance in support of equipment purchases. The Department of Energy acts as the executing agency and partially guaranteed loans, offered at concessional rates, are available to suppliers, businesses, communities, villages and individuals through the ANZ Bank (8.95% interest rate) and the Fiji Development Bank (6% interest rate). Approved projects can include solar PV systems, mini-hydro systems, and biofuel systems as well as energy efficient equipment (lighting, switches, cooling systems). The project will come to an end in 2017 but may be extended.

6.4.2 Import substitution and expert finance facility

In November 2010, the Reserve Bank of Fiji extended the eligibility list on its Import Substitution and Export Finance Facility to include renewable energy for import substitution funding. The Facility is set up to assist exporters, large-scale commercial agricultural farming, and renewable energy businesses to obtain credit at concessional rates of interest.

The Facility is provided through the commercial banks, Fiji Development Bank and licensed credit institutions that provide back-to-back finance with a limit of FJD 80 million (increased from FJD 40 million in December 2012). The amount of advance under the Facility is at the discretion of the lending institutions based on respective credit assessments. The lending institutions can borrow from the Reserve Bank of Fiji at 1% per annum and on-lend to businesses at a maximum rate of 5% per annum. Loans are limited to a maximum of FJD 1 million per business, allocated on a first-in basis, while amounts greater than FJD 1 million may also be granted in special circumstances.

6.4.3 Obligation of commercial lenders to provide finance to the renewable energy sector

In February 2012, the Reserve Bank of Fiji announced that under the provision of Section 44 of the Reserve Bank Act, each of the six commercial banks operating in Fiji (ANZ Bank, Bank of the South Pacific, BRED Bank, Bank of Baroda and Westpac) are required to hold 2% of their deposits and similar liabilities in loans to the renewable energy sector. For any project, financial institutions will estimate both the risks and returns of the project. Projected costs and revenues are verified and compared with the cost of the financing instruments to be used. The financing of any project is on a case-by-case basis, utilising the normal processes of each bank.

12 VAT excluded from price.

6.5 Types of commercial financing for energy projects

6.5.1 Equity

Equity can take the form of direct investment of one's own capital resources (i.e. investing from the capital resources of the hotel and its owners), or as third party capital inputs, in the form of risk capital provided by venture capital funds, usually at very high interest rates, or simply through wealthy individuals or families investing their money. Using the hotelier internal resources as equity is the simplest method of energy efficiency and renewable energy project financing, and makes sense if the hotel has sufficient cash reserves and a strong balance sheet. With this form of equity, all cost savings realised from the upgrade are immediately available to the hotel and the hotel is able to realise the tax benefit of the equipment's depreciation. However, the hotel incurs an opportunity cost in that it no longer has that capital available for other investments. This financing method is good for relatively inexpensive and simple efficiency measures that are likely to pay for themselves in about a year.

If the hotel decides to source part of the financing from outside its own resources, the contractual arrangement is typically structured as a fixed cost contract or possibly a per-unit cost guarantee. Debt providers expect all projects to be at least partly financed through equity. Lenders usually demand that a borrower take a direct equity stake themselves (usually to ensure their commitment to the success of the project). In practice, lenders normally look for a minimum of around 20% of the project cost to come in the form of the borrower's own equity. Higher-risk RETs are expected to have a correspondingly higher equity ratio.

However, most project developers have a limited amount of their own funds to make this essential contribution to the financial package. This creates the need for the participation of additional equity investors.

6.5.2 Commercial loans

A loan (debt finance) may be obtained to finance the project. In financing an energy efficiency or renewable energy project, a bank may ask for a personal guarantee from the hotel owner or board of directors, a minimum deposit or collateral as security against the loan. The lender's goal is for the client to make minimum payments dependably, so lenders may require a minimum payback period or internal rate of return for the project or other evidence of increased cash flow as a result of the project as proof that loan payments will be made on time. Lenders generally consider energy efficiency and renewable energy projects to be high risk, which results in less leverage, higher interest rates, and a shorter debt term.

6.5.3 Performance contracting

This option is attractive to many hotels because it requires no up-front cost because the project is paid for out of the energy savings from the efficiency project itself. An Energy Service Company (ESCO) provides the financing and assumes the performance risks associated with the project (USAID Undated). There are a few companies in Fiji that can provide this type of service.

Until the project has been fully paid for, the ESCO owns the upgraded equipment. That means that the equipment asset and debt do not appear on the hotel's balance sheet. Performance contracting relies on the financial strength of the hotel owner, and the cost savings potential of the project. Performance contracting is an operating budget issue more than a capital budget issue, despite the upgraded equipment provided through the project. Capital budgeting may typically require board approval, and may be decided upon only periodically. On the other hand, the utility payments are already in the operating budget, so any savings through the implementation of efficiency measures may free funds for discretionary spending. (USAID, Undated).

Under a performance contract, after the energy efficiency upgrade, the funds that were used to pay the energy bill cover the new (lower) energy bill and the payment to the ESCO for the equipment supplied. ESCOs try to meet clients' needs to reduce costs, improve energy efficiency, manage risks and consolidate services. To meet these needs, ESCOs offer integrated energy services including analysis, energy and equipment, installation, monitoring, and guarantees. Contracting arrangements with an ESCO usually mean flexible terms, financing, risk management, quality assurance, verifiable performance, and follow-up service.

Fundamentally, an ESCO makes money in a fashion similar to a general contractor. ESCOs typically mark up the cost of materials to cover overhead and profit. ESCOs will attempt to make a small margin on financing the project, consistent with the credit and performance risk involved. However, an ESCO may or may not make money from financing, particularly if it is offered through a third party. Additional costs are associated with monitoring the project that typically are not embedded in the interest rate cost or the installed cost. These are usually included as a separate line item or a fee for a savings guarantee.

6.5.4 Savings guarantee

A USAID report (USAID Undated) describes a savings guarantee as follows: "A savings guarantee can be entered into with an ESCO, separate from an installation agreement. This is recommended if the contractual arrangement is not a performance contract. Performance contracts already include an implicit savings guarantee. A savings guarantee reduces the customer's risk by guaranteeing that energy cost savings will meet or exceed an established minimum value. The guarantee acts like an insurance policy where the customer pays a premium that compensates the guarantor for the performance risk and monitoring costs."

6.5.5 Operating lease

Under an operating lease, the lessor owns the equipment and claims any tax benefits associated with the depreciation of the equipment. At the end of the contract term the customer can purchase the equipment at fair market value (or at a predetermined amount), renegotiate the lease, or have the equipment removed. An operating lease is also known as an 'off balance sheet' lease (USAID Undated). Firms often choose to lease long-term assets rather than buy them for a variety of reasons, including the tax benefits are greater to the lessor than the lessees, leases offer more flexibility in terms of adjusting to changes in technology, and capacity needs.

Lease payments create the same kind of obligation that interest payments on debt create, and have to be viewed in a similar way. In an operating lease, the lessor (or owner) transfers only the right to use the property to the lessee. At the end of the lease period, the lessee returns the property to the lessor. Because the lessee does not assume the risk of ownership, the lease expense is treated as an operating expense in the income statement and the lease does not affect the balance sheet.

7. Renewable energy and energy efficiency case studies in Fiji

This section provides some examples of renewable energy and energy efficiency projects in hotels in Fiji.

7.1 Radisson Blu Hotel Resort (Denarau Island, Viti Levu)

The Radisson Blu Resort is a 5-star, 270-room hotel on Denarau Island. It is an EarthCheck-accredited property but is still trying to implement a full EMP in order to comply with all of the benchmark and performance indicators to gain full EarthCheck Gold standard accreditation.

It provides a useful case study of how one of Fiji's major 5-star hotels is implementing energy efficiency and renewable energy programmes. The Radisson Blu calls it their 'Responsible Business' programme and has been implementing the following activities that are linked to the EarthCheck performance indicators:

- Consideration to the local landowning community. Because the resort is built on indigenous-owned land with a 99-year title lease, lease payments go to the local landowning community. Hotel management and staff must be aware of Fijian traditions and customs, and should employ a large number of staff from local villages.
- The transition from halogen to LED lights, as an energy efficiency measure has been completed in most practical areas and spaces throughout the property.
- A new solar PV energy system will provide up to 20% of daily electricity needs.
- Improved energy efficiency in air conditioning units through a number of measures, including: hot water being pre-heated by waste heat from AC chiller units; regular cleaning of ACs; the auto AC switch turning the unit off when balcony doors are opened; and other energy efficiency features for AC units.
- Adjusted variable speed drives on a significant number of water pumps for pools, water features and chilled water circulation.
- Initiatives to reduce water consumption, including: reduced size of water feature areas, with water saving through less evaporation and general usage; removed waterfall feature and re-lined polythene water features with concrete to minimise leakage; use of dual flush toilets; use of low flow water inhibitors in taps and shower heads.
- Initiatives to reduce solid waste generation, including: onsite recycling staff member now works six days a week going through waste to sort into recycling categories; sorting bins placed in the staff canteen to separate food waste from paper waste; key suppliers have been contacted about reducing packaging. For example, the fruit and vegetable deliveries are now packed into resort tubs rather than arriving in cardboard boxes.
- Adopting sustainable purchasing policies that include: only using biodegradable food, garbage and shopping bags; only using eco-labelled, certified and biodegradable cleaning chemicals; using hand sanitisers to reduce paper towel consumption; ongoing staff training in the handling and usage of all chemicals.
- Implementing an ongoing education and awareness programme for both staff and their local communities, including: holding Responsible Business Committee meetings once a month, with subcommittees formed to ensure that any initiatives are communicated to staff and key stakeholders, particularly guests, local community and Fiji government departments; always conducting sustainability policy and responsible business training during staff inductions; ongoing involvement in community events such as Clean Up campaigns, Earth Hour, Water Day, Medical Health Checks, Blood Drives and School Excursion Days.

7.2 Novotel Suva (Lami, Viti Levu)

Novotel Suva is a 4-star hotel in Lami, on the outskirts of Suva. The hotel is part of the French-owned Accor Hotel Management company. There are three other Accor-managed hotels in Fiji: the Sofitel on Denarau, Mercure in Nadi and Novotel in Nadi. Accor has around 4,000 hotels worldwide and established their own Environment Department in 1994 and a Hotel Environment Charter in 1998.

Accor now provides its own accreditation and certification programmes for performance and sustainable development standards, based on internal checklists that have been developed over the past 20 years. Accor launched its 'Planet 21' programme in April 2012, which is its internal EMP for all of its hotels worldwide. It aims to deliver a sustainable development business strategy, partnering with staff, guests, customers and suppliers. It covers all of the social, local community, societal and environmental commitments, with precise goals, and offers customers an opportunity to participate. The intention is a business model that is 'more respectful of natural resources and human beings'. It is also viewed as a powerful leverage to building brand competitiveness and loyalty. The 'Planet 21' programme is based on 7 pillars, with 21 commitments and quantifiable objectives as set out in the table below.

Table 5: Planet 21 – 7 Pillars, 21 Commitments and Quatifiable Objectives for 2015.

7 pillars	21 commitments	21 quantifiable objectives
Santó	1. Ensure healthy interiors	85% of hotels use eco-labeled products
	2. Promote responsible eating	80% of hotels promote balanced dishes
	3. Prevent diseases	95% of hotels organise disease prevenion training for employees
Nature	4. Reduce our water use	15% reduction in water use between 2011 and 2015 (owned/ leased hotels)
	5. Expand waste recycling	85% of hotels recycle their waste
	6. Protect biodiversity	60% of hotels participate in the Plant for the Planet reforestation project
Carbone	7. Reduce our energy use	10% reduction in energy use between 2011 and 2015 (owned/ leased hotels)
	8. Reduce our CO_2 emissions	10% reduction in CO_2 emissions between 2011 and 2015 (owned/ leased hotels)
	9. Increase the use of renewable energy	10% of hotels use renewable energy
Innovation	10. Encourage eco-design	40% of hotels have at least three eco-designed room components
	11. Promote sustainable building	21 new or renovated hotels are certified as sustainable buildings
	12. Introduce sustainable offers and technologies	20% of owned and leased hotels offer green meeting solutions
Local	13. Protect children from abuse	70% of hotels have commited to protecting children
	14. Support responsible purchasing	70% of hotels purchase and promote products originating in their host country
	15. Protect ecosystems	100% o fhotels ban endangered seafood species from restaurant menus
Emploi	16. Support employee growth and skills	75% of hotel managers are promoted from internal mobility
	17. Make diversity and asset	Women account for 35% of hotel managers†
	18. Improve quality of worklife	100% of host countries organise an employee opinion survey every two years
Dialogue	19. Conduct our business openly and transparently	Accor is included in 6 internationally-recognized socially responsible investment indices or standards
	20. Engage our franchised and managed hotels	40% of all hotels are ISO14001 or EarthCheck-certified‡
	21. Share our commitment with suppliers	100% of purchasing contracts are in compliance with our Procurement Charter 21

† outside Motel 6/Studio 6

‡ excl. economy segment

7.3 Turtle Island (Mamanuca Islands)

Turtle Island Resort is a 5-star hotel located on a private island. The following article illustrates the best practice example of Turtle Island (Pacific Power Association, 2013, reproduced with permission).

By: Wilhelm van Butselaar
Sales Manager Hybrid Energy Systems and Power Plant solutions
SMA Australia Pty.Ltd.

SMA products provide remote islands with secure and powerful off-grid energy supply. Turtle Island is one of the first ever clean energy resorts in the world and it is driving forward in achieving its sustainability goals with the help of a 240kW diesel hybrid PV system. The island will also benefit from significant financial savings, as well as protect its environmental integrity.

Turtle Island is a private Island approximately 80 kilometers north of Fiji. It is located in northern Yasawas, in the local government area known as the Nacula Tikina. The island is home to an exclusive resort that is now 100% sustainable. In early 2012, construction work began on the solar project, making Turtle Island one of the first ever clean energy resorts in the world.

The island is not connected to the Government operated network and is reliant on generating its own power. It is one of the world's leading sustainable tourism destinations and prides itself on its environmental stewardship.

Environmental integrity is key to the island's culture and a diesel hybrid PV system was the obvious solution to help reduce fuel consumption and lower electricity costs. Photovoltaic power systems can help achieve other clean initiatives. The island's other sustainable practices include preservation, composting, recycling and planting.

"The main ideology was to make the island resort more self-sustainable. They already source their own water (Via a reservoir) and now have electricity from their new solar power system", said Bruce Clay, Managing Director of Clay Energy. "Aside from sustainability, the project also offers significant financial saving as the resort saves close to 100,000 litres of diesel fuel per year. All of which used to be barged to the island in 200 litre drums."

The PV system is the first system of its size in the Fiji Islands. There are over 300 systems in the Pacific using this technology, with this being one of the five largest. The 240kW system comprises 76 SMA products; 24 Sunny Island 5048's, 32 Sunny Island Charger 50's and 10 Sunny Tripower 15000TL's. It also includes 968 solar panels, and a 120kVA backup generator, providing 100% of the power needs on the island.

An average of 1.2MWh of power is produced each day by the PV system; saving 220 tons of green house omissions per year. The island will also reduce its annual diesel costs by $250,000 a huge 90% reduction.

Storage and self-sufficiency are essential for remote islands such as Turtle Island and the off-grid PV system installed on the island provides a secure and powerful energy supply independent of the power distribution grid.

The biggest challenge to the project was logistics. Managing the transports of construction equipment from Europe required detailed planning and the distance, and remoteness of Turtle Island makes it difficult to transport goods there. Installing the off-grid system in a way that allowed the resort to continue to operate seamlessly also posed a challenge. Fortunately the resort has good infrastructure and was able to handle some of the heavier equipment and provide storage during construction.

A great advantage of an SMA off-grid PV system is that it can be freely expanded and so it allows for the design and incorporation of future requirements. Turtle Island's system performance will be reviewed to investigate a second phase of increasing system capacity, particularly of the battery bank and solar array.

SMA worked with Clay Energy, from Suva, Fiji to design and realize the system. Clay Energy has decades of experience in the Pacific and can lay claim as the company who installed the first SMA Sunny Island system in the Pacific in 2005. SMA has extensive experience in remote energy supply and is dedicated to helping the South Pacific achieve their demands for photovoltaic energy supply, however big or small.

Figure 19: Solar PV system at Turtle Island Resort

Source: Clay Energy

7.4 Matava Resort (Kadavu Island)

Matava Resort is a small-scale, 3.5-star, 10-room (25 beds) ecoadventure resort situated on the island of Kadavu. A small and intimate getaway designed to blend in with its natural environment. Traditional thatched Fijian *bure*s nestled on the edge of the rainforest look out over the Pacific Ocean and Great Astrolabe Reef, which is the world's fourth largest barrier reef. The reef extends along the entire southern side of Kadavu for over 120 km. It is rated as one of the world's best diving locations, offering a great diversity of coral structures and marine life.

The resort's conservation, environment and responsible tourism policy aims to minimise its impact on the environment and to promote and support ecologically sound conservation measures in the community, as well as provide guests with an authentic ecotourism experience.

Matava Resort promotes a 'Responsible Tourism' approach that is based on the principles endorsed by the International Ecotourism Society, of which they are a member. This ensures a commitment to a style of travel that is environmentally, culturally and socially responsible, and this shapes all of the resort's major decisions — from the concept that 'Small Groups Leave Fewer Footprints', to the choice of contractors and suppliers. This policy and business model is undertaken and implemented in a number of ways as shown below.

Solar power. All lighting in the Oceanview (bure) accommodation and the main *bure* is solar powered. The resort office derives all of its power from solar energy, and the entire resort does not operate any main generators, only a small emergency backup generator for the office should the need arise.

Solar hot water. All newly built accommodations are supplied with hot water derived from solar energy. Therefore as each of the older style *bure*s are replaced over time with a new-build Oceanview *bure*, a solar hot water system is installed at the same time.

Organic farm. To minimise the need to import vegetables (with associated transportation carbon emissions) the hotel maintains a large organic garden on the resort grounds. In addition, the resort supplies local village farmers with seeds and then purchases the fruit and vegetables back from them. Many of the banana and papaya fruit trees are also fully utilised to supply the resort. The resort also partners with local community bee keepers to produce, use and sell honey.

Waste management. All rubbish is sorted, and food waste is fed to local pigs. The resort composts as much waste as possible for the organic farm. Plastic and glass bottles, and aluminium cans are all recycled. Batteries and empty aerosol cans are impossible to dispose of and guests are requested to take these with them to their home country where suitable methods of disposal are available.

Land management. Areas of land around the resort are left uncultivated to encourage the growth of native wild flowers and ferns. Part of the resort foreshore consists of mangroves and has been left untouched. Mangroves prevent erosion and provide sanctuary for juvenile fish and marine invertebrates. No insecticides or herbicides are used on the property. Most plants found around the resort are native to Kadavu or already found in Fiji. No foreign plant species are brought to the island.

Water management. The primary reason for the location of Matava Resort is the abundance of natural spring water. During the drought of 2003, it was one of only two locations on the south side of Kadavu Island that still had a water supply. The water is naturally filtered through the limestone and is of excellent quality. Rainwater is collected at certain locations and used to supply the organic garden and supplement the supply to some of the Oceanview *bure*s. Matava Resort uses dual flush toilets, environmentally friendly cleaning products, unbleached paper products, no leaking taps, uses recycled water on gardens, and has a towel re-use and no change linen policy.

Buildings. All resort structures are built using locally grown pine or hardwoods planted for that purpose. They are then finished using traditional methods of thatching and palm weaving. The resort does not use local wild hardwood trees for lumber. All grey water is piped out to rubble drains for flowers and plants, and bures are designed and orientated to benefit from shade and sea breezes for cooling.

Marine reserves. Working in conjunction with the neighbouring village of Kadavu Koro, a marine reserve was established from the boundary of the Matava Resort foreshore and extending out to encompass the island of Waya. This area is protected from any sort of fishing, shell collecting and reef walking. The resort has also helped the village of Nacomoto establish a marine reserve in their waters. All dive trips make a contribution to the village, which benefits all parties — the village gets some income and the fish have a sanctuary to breed. Guests are asked to make a small voluntary contribution to these marine reserves when they check out, to promote marine conservation measures taken by the local villages.

Education. Each *bure* has an information pack that includes advice on how guests can avoid damaging coral and other marine life. Matava Resort is also supporting the efforts of local community school governors to have the Fiji national curriculum include a class on marine and terrestrial conservation and sustainable resource management. The resort also works with local guides who conduct educational tours on the uses of plants in natural medicines. Matava Resort also contributes to several important projects such as the Fiji Coral Reef Monitoring Network annual report, and the Fiji Biodiversity Inventory.

Diving. The resort has a 'look but don't touch' diving and snorkelling policy. Diving guests who are found damaging marine life through uncontrolled buoyancy or willful neglect will not be allowed to continue diving. Guests touching live coral or marine life will be asked to refrain from doing so.

Gamefishing. The resort has a 'tag and release' policy on all billfish other than an obvious world or Fiji national record. All fish not destined for the dinner plate are released. Matava Resort is a member of the International Game Fishing Association (IGFA) and the game boat's skipper is a member and supporter of the Billfish Foundation. They are also part of the International Shark-Free Marina Initiative that works with marinas, boaters and fishermen to develop policies designed to protect a vital component of the ocean's health, our sharks. To date, the Matava Restaurant is the only restaurant in Fiji to gain the 'Shark Safe' accreditation by using no commercially caught fish and having the ability to pinpoint the provenance of every fish served.

Native flora and fauna ecotours. Guests have the opportunity to experience and learn about a wide variety of species, including humpback and pilot whales, spinner dolphins, turtles, crabs, a wide variety of birds (four are endemic to the island), butterflies, insects, bats, iguanas, geckos and skinks, tropical fish, manta rays and numerous ocean animals. The flora is mainly rainforest, comprising hardwood trees, mangroves, bamboo and palms.

The Matava Foundation. In line with the company's Responsible Tourism, Conservation and Environment Policy, Matava is committed to improving the lives of local villagers through direct achievable projects. Most staff members come from the local villages. The Matava Foundation was established to implement this policy and also because guests wanted to make contributions to assist people they had met during their visits. The Matava Foundation focuses its funding in four main project areas:

- **Medical support** – the Matava Foundation is committed to ensuring that all communities on Kadavu have access to medical clinics and treatment.
- **Sustainable development** – sustainable agricultural projects help increase food security and income for local communities. Many of these projects benefit women, who bear more of the burden in the agricultural economy.
- **Environment** – the conservation of Fiji's natural resources is central to all Matava Foundation projects. Community cisterns and irrigation systems help communities secure safe and efficient water supplies while community reforestation projects curb deforestation.
- **Education** – help is provided for children's education in many of the villages of Fiji through funds for school buildings, scholarship programmes and inputs to curriculum and school excursions.

7.5 Smugglers Cove Resort (Nadi, Viti Levu)

As part of the CCCPIR programme, a memorandum of understanding was signed between GIZ and two selected Fiji-based hotels. These hotels became CCCPIR project partners and participated in energy auditing and renewable energy studies. The two hotels were Smugglers Cove Resort and Raffles Gateway Hotel. CCCPIR assisted these hotels with developing and implementing energy efficiency and renewable energy activities. The experiences gained from these hotels were presented at a tourism industry workshop in September 2014 and are summarised below to show how the hotels investigated their energy efficiency and renewable energy options.

Smugglers Cove Resort is a locally owned, medium-sized hotel on Wailoaloa Beach in Nadi on Viti Levu. For the work undertaken between CCCPIR and Smugglers Cove Resort it was agreed that the two key outputs would be:

- an energy audit and an energy management plan (EMP); and
- preparation of a briefing paper with potential funding options for energy efficiency initiatives, as identified by the energy audit.

After a competitive tender process, Irwin Alsop Pacific Ltd. (IAP), a Suva-based engineering company, was selected to undertake the energy audit, the costs for which were covered by CCCPIR. The specific requirements for the energy audit included the following activities:

- determining energy use, with a breakdown by different area of the hotel and current costs;
- determining where energy use and costs could be reduced, on the most cost effective basis, without compromising service standards;.
- advising on and assisting with specifying and locating energy efficiency equipment and technologies, particularly those that can be sourced, installed and maintained locally;
- analysing energy savings, including determining payback period, cost–benefit analysis and expected return on investment; and
- proposing an implementation timetable for installing the recommended energy efficiency equipment.

IAP conducted the energy audit at Smugglers Cove and delivered their final report at the end of May 2014. The energy audit report made the following recommendations in relation to Smugglers Cove Resort becoming a more energy efficient hotel:

- Install a power factor correction unit on the main switch board.
- Replace magnetic with electronic ballast in all fluorescent tube lights.
- Reduce wattage on all lighting where the same service can be provided with lower lighting levels.
- Reduce wattage on laundry equipment.
- Reduce wattage on guest room appliances.
- Reduce wattage on ceiling fans.
- Set AC thermostat controllers to 23–24^{0}C.
- Install 'Air con off' automatic switch units on all AC units.
- Improve maintenance and clean filters of all AC units.
- Replace condenser unit for the cool room.
- Clean and protect outdoor condenser unit for the freezer.
- Consider lighter colours and heat reflective paint when repainting buildings.
- Consider tinting windows to prevent heat loss and improve thermal performance of ACs and cool room.

It was estimated that if most of the recommended measures were undertaken it would cost Smugglers Cove FJD 37,636 but they could save approximately FJD 49,000 per annum on the current electricity bill of FJD 181,003 per annum, a savings of 27%, with an excellent estimated payback period of 0.75 years, or 9 months.

However, once Smugglers Cove added the cost of getting the energy audit done, the extra staff hours required to implement the energy efficiency programme and the hiring of an electrical contractor to oversee some of the work, it was re-estimated that the costs would be closer to FJD 56,000, providing a payback period of just over a year rather than nine months. This was still considered a good payback period and the hotel directors decided

Figure 20: Smugglers Cove Resort

Source: Smugglers Cove Resort

that the capital required to support the various energy efficiency measures would be financed through the hotel's normal operating capital account. Therefore, external finance or funding was not required in this case. Smugglers Cove proceeded to implement 27 measures as recommended in the energy audit.

Development of an Energy Management Plan

In order to implement some of the energy audit recommendations, an EMP would need to be developed. CCCPIR supported Smugglers Cove in carrying out a number of meetings between the consultants and the owners, managers and staff to explain and agree on a work plan for developing an EMP.

An EMP working committee was formed with Smugglers Cove Resort senior management and key staff, including five representatives from housekeeping, four from maintenance and one each from marketing, accounts and human resources, for a total of 12 employees. The owner/director and the general manager would also play a supervisory role. The EMP Committee made the following decisions:

- The Maintenance Manager should be appointed as the Smugglers Cove Resort Energy Management Coordinator.
- The EMP should be an action plan based on the energy audit recommendations.
- The CCCPIR technical assistance team would draft an EMP action plan for consideration and adoption by the Smugglers Cover Resort and EMP Committee.

The EMP action plan included the following:

- a logframe based on the energy audit recommendations with a breakdown of the activities into: electrical work; improved maintenance work; purchase of new equipment or appliances; and energy efficiency management by staff.
- the Fiji Electricity Authority (FEA) undertaking data logging on the resort's electricity meters in order to conduct a tariff analysis on the monthly bills and power surcharges (the purpose of this monitoring was to determine whether the resort should switch to a different FEA tariff);
- a breakdown of departmental responsibilities, including adding any EMP responsibilities, duties and activities into job descriptions;
- EMP checklists for use by the key staff, particularly housekeeping and maintenance;
- a system for monitoring energy consumption, and GHG emissions;
- a link from the EMP to other environmental policies, such as waste and water management;
- EMP information for guests with a link to Smugglers Cove Resort marketing;
- a staff training program; and
- a recommendation to develop an energy efficiency operational budget that includes quotes for the purchase of energy efficient equipment and appliances, and quotes for electrical works and upgrading.

Based on the recommendations of the energy audit report and the meetings between the CCCPIR technical assistance team and the management and staff of the resort, the following EMP actions were implemented.

Table 6: Smugglers Cove Resort energy management action plan for implementation.

Energy category	Action to be implemented	Person responsible	Actions implemented during 2015
1. Electrical work	1.1. Install a power factor correction unit on the main switchboard.	Resort manager	FEA have checked. May need to hire a qualified electrical contractor.
	1.2. Commission the FEA to undertake data logging to check the resort's tariff rate in relation to power consumption.	Director	FEA to undertake early September. This will cost approx FJD 500 and take two weeks. Completed in 2015.
	1.3. Replace magnetic ballast with electronic ballast in all lights.	Resort manager	Have commenced and will change these progressively.
2. Improved maintenance	2.1. Set and check regularly that all A/C thermostat controls are switched to 23–24^{0}C.	Maintenance Dept.	Housekeeping staff are now checking regularly.
	2.2. Regularly check and clean all A/C filters.	Maintenance Dept.	Now being done twice weekly.
	2.3. Clean and build a better protection box for the freezer's outdoor condenser unit.	Maintenance Dept.	Not yet. But now on the job list.
	2.4. Put rubber seals on the ends of the wooden louvers in the Beach Wing rooms.	Maintenance Dept.	Have ordered new seals.
	2.5. Cleaning of compressor and fan units for coolers and ice machines.	Maintenance Dept.	Now done more regularly.
3. Purchase of new energy efficient equipment	3.1. Replace all incandescent light globes with new energy efficient LED or tube lights.	Purchasing and Maintenance Dept.	All light bulbs have been replaced by lower wattage bulbs and LED lights.
	3.2. Check and replace all electrical appliances in the guest rooms with energy efficient-rated appliances.	Purchasing and Maintenance Dept.	Have commenced. Will be undertaken progressively.
	3.3. Replace all ceiling fans with lower wattage fans	Purchasing and Maintenance Dept.	Have commenced. Will be undertaken progressively.
	3.4. Purchase automatic 'switch off' sensors for all A/C units.	Purchasing and Maintenance Dept.	New Zealand company, Vinguard, have set up a demonstration room with automatic sensor power switch off.
	3.5. Replace the condenser unit for the cool room.	Purchasing and Maintenance Dept.	Refrigeration mechanic to do after servicing A/C units.
	3.6. Purchase signs and stickers to place at strategic locations to remind staff and guests about energy efficient procedures.	Resort Manager	Sales Dept is doing this in-house.
4. Energy efficiency management by resort staff	4.1. Provide regular EMP updates at staff meetings.	EMP Coordinator	Updates done weekly at staff meetings.
	4.2. Monitor and log resort energy consumption.	Resort Manager	Staff training programme being implemented.
	4.3. Use energy efficiency and renewable energy in the marketing and promotion of the resort.	Marketing Manager	In progress.

Source: CCCPIR programme

7.6 Raffles Gateway Hotel (Nadi, Viti Levu)

Raffles Gateway Hotel was the second hotel assisted by the CCCPIR programme. It is a medium-sized hotel on the main road opposite Nadi International Airport on Viti Levu. For the work undertaken between CCCPIR and Raffles Gateway Hotel it was agreed that the two key outputs would be to:

- organise quotes for the inspection, assessment and installation of a solar water heating (SWH) system; and
- develop a briefing paper with funding options to cover the costs for installing SWH renewable energy.

The technical work required was a relatively straightforward site inspection and assessment. A hotel has the option of tendering for this type of work or approaching a contractor with a good professional reputation. Although tendering is usually recommended in order to be able to compare costs and technical competencies available on the market, if there are time constraints then a single service supplier can be approached. For the assessment and development of a proposal including costs for Raffles Gateway Hotel, WesLec Ltd was contacted. After a meeting between CCCPIR and the WesLec to explain the project, scope of work and expectations, WesLec submitted a proposal to undertake the work and provided evidence of their previous relevant experience in assessing and installing SWH systems in hotels in Fiji. The scope of work was to undertake the following tasks:

Figure 21: Raffles Gateway Hotel

Source: Raffles Gateway Hotel

- Undertake a site inspection at the hotel to assess what system and units are currently being used to generate hot water and to determine the best available renewable energy solution.
- Assess factors such as the available infrastructure (roof space and structural strength), the measurement and documentation of the current water heating energy costs, potential SWH and energy and cost savings, shading, configuration of tanks and panels and installation costs.
- Measure the current water heating system by isolating and measuring the energy usage by individual water heating units.
- Provide the collected information to Rheem Australia engineering who will then compare the current energy costs, installation costs and potential energy savings and provide an opinion on the best renewable energy solution in terms of overall costs and energy efficiency, in quantifiable figures. These figures will be fully disclosed to CCCPIR, including the calculations and any assumptions underpinning them.
- Provide a quote for the supply and installation of the required equipment and materials, including their local availability and timelines for the installation.
- Provide a report to CCCPIR outlining all of the above within three weeks of commencing the work on Friday, 30 May 2014 at the latest.

The final WesLec report was submitted to CCCPIR on 28 May 2014, and the following main recommendations were made.

- Replace the existing 45 electric water heaters (2,420 L storage capacity) with 48 x 300 L plus 2 x 160 L SWH units (to provide 14,720 L of water storage capacity). This would provide 150 L of solar hot water per room to allow for guests' total daily hot water requirements.
- This SWH system would provide up to 80% reliance on solar energy per annum and a corresponding 80% in energy savings for water heating.

- WesLec quoted a price of FJD 286,800.00 (VIP)[13] to supply and fully install this SWH system, including a five-year warranty.
- The end result would be an 80% energy savings on the current hot water costs, or an annual saving of FJD 94,298 based on current costs. This would provide a payback period on the initial investment of three years.

CCCPIR decided that the report, being from a supplier, needed an independent review from a renewable energy solar water heating specialist. Based on the advice received from the independent reviewer, the following recommendations were made to the hotel's directors:

Solar water heaters supply and installation. WesLec provided two options, with Option 1 being more expensive than Option 2. However, based on an occupancy of two people per room, Option 2 was likely to provide an adequate quantity of solar heated hot water for hotel guests and staff (according to the WesLec estimates already provided).

Option 2 was quoted at FJD 154,400.00 (VIP), fully supplied and installed, with a five-year warranty. Based on WesLec estimates, Option 2 could be reasonably expected to provide a 60% savings on current energy costs, or an annual savings of FJD 70,723. This would provide a payback period of 2.2 years.

Installation of timers. Installing timers was not mentioned in the WesLec report but this is an important detail. Timers should be included as part of the SWH installation, otherwise they may be forgotten, leading to an expensive and unnecessary overuse of electric boosters. When contacted WesLec suggested that the timers should be installed by a qualified electrical contractor, not by them, but preferably by the hotel's in-house electrician in order to save costs, and this would be the final activity to complete full installation. WesLec confirmed they could supply the timers at around FJD 80 each/per unit, so Option 1 would cost an extra FJD 4,000 and Option 2 would cost FJD 2,300.

Roof structure assessment. Although this is mentioned in the WesLec report no explanation nor costing for required roof strengthening was provided. A qualified structural engineer should be engaged by the hotel to assess the suitability and safety of the excess weight of the SWH system on the hotel's roofing structures in the various blocks prior to any installation. A structural assessment should also be included in the terms of Reference when commissioning a solar water heating study.

Internal support works. To complete the installation and ensure proper operation of the SWH system, a final electrical and plumbing connection works will need to be undertaken by the hotel's in-house maintenance department. WesLec has agreed to be available to assist with this but will not take full responsibility for the completion of works. It is strongly recommended that FEA be commissioned to check and approve the electrical connections.

Training for hotel maintenance staff. The hotel's maintenance staff should be fully trained in the operations, management and maintenance of the new SWH system. WesLec normally supplies a training manual and a training session as part of their support services to clients.

After further discussions with the hotel's directors, it was agreed that they would implement and install such a SWH system in the hotel but will do so in stages, probably one block of rooms at a time, so as to stagger the investment cost and to allow the hotel to monitor the energy use and potential savings, and to undertake staff training as part of this process.

However, the works did not start in 2015 due to delays in progressing decision-making at the hotel management board level.

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13 VAT included in price.

8. Bibliography

About.com. 2015. What is a clerestory window? http://architecture.about.com/od/structural/g/clerestory.htm

Anhui Hummer Dynamo Co. Ltd. 2012. Website accessed in August 2015. http://www.chinahummer.cn/

Build it Solar. 2015. The renewable energy site for do-it-yourselfers. Accessed in October 2015. http://www.builditsolar.com/References/SunChartRS.htm

Cairns Regional Council. 2011. Sustainable Tropical Building Design. Guidelines for Commercial Buildings. http://www.cairns.qld.gov.au/__data/assets/pdf_file/0003/45642/BuildingDesign.pdf

Climate and Development Knowledge Network. 2012. Inside stories on climate compatible development. Seizing the sunshine: Barbados' thriving solar water heater industry, September 2012.

ClimateTechWiki. Undated. Website accessed in August 2015. http://www.climatetechwiki.org/technology/ror

CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2011. Pacific Climate Change Science Program: Current and Future Climate of Fiji, CSIRO. http://www.pacificclimatechangescience.org/wp-content/uploads/2013/06/1_PCCSP_Fiji_8pp.pdf

CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2014. Climate variability, extremes and change in the western tropical Pacific. Chapter 5, Fiji Islands.

EarthCheck. 2015. Environmental and Energy Accreditation Scheme. Website accessed in August 2015. http://www.earthcheck.org

East Coast Designer Builders (ECDB). 2015. Building in the Tropics: Green Homes. Website accessed in August 2015. http://www.eastcoastdesignerbuilders.com.au/building-in-the-tropics/green-homes/

Energy Star. Website accessed August 2015. https://www.energystar.gov/

FEA (Fiji Electricity Authority). 2012. Fiji Electricity Authority Annual Report 2012.

FEA (Fiji Electricity Authority). 2014. Website accessed August 2015 for information on electricity tariff rates. www.fea.com.fj

FEA (Fiji Electricity Authority). 2015. FEA Annual Report 2014. http://www.fea.com.fj/wp-content/uploads/2015/09/FEA-Annual-Report-2014.pdf

Fiji DoE (Department of Energy). 2014. Incorporation of energy efficiency into the National Building Code (Fiji). Phase I, Status Report and Recommendation. Final report 28 February 2014. http://www.fdoe.gov.fj/images/Energy_Efficiency/phase1_report.pdf

Fiji DoE (Department of Energy). 2014. Public notice on the enforcement of the Minimum Energy Performance Standards and Labelling (MEPSL) programme.

Fiji DoE (Department of Energy). 2015. MEPSL (minimum energy performance standards and labelling), Frequently asked questions (FAQS). http://www.fdoe.gov.fj/images/EnergySecurity/mepsl_faqs.pdf

Government of Fiji. 2016. Economic and Fiscal Update: Supplement to the 2016-2017 Budget Address. Ministry of Economy, 22 June 2016.

Green Building Council of Australia. 2015. Website accessed October 2015. http://www.gbca.org.au/

Green Globe. 2015. Website accessed August 2015. http://greenglobe.com/

Green Key. 2015. Website accessed in August 2015. http://www.green-key.org/

Green Ninjas. 2013–2014. Website accessed in August 2015. http://greenninjas.org/south-africas-greenest-hotel-lives-up-to-its-name/

IIEC (International Institute for Energy Conservation). 2013. Assessment of unitary air conditioning technologies for commercial and public buildings in the Pacific. Prepared by the IIEC for the Asian Development Bank. www.ee-pacific.net/index.php/publications

IIEC (International Institute for Energy Conservation). 2013. Assessment of medium and large air conditioning technologies in commercial and public buildings in the Pacific. Prepared by the IIEC for the Asian Development Bank. www.ee-pacific.net/index.php/publications

IIEC (International Institute for Energy Conservation). 2013. Green Hotels Rating Schemes. Prepared by the IIEC for the Asian Development Bank.

IIEC (International Institute for Energy Conservation). 2015. Energy efficiency guidelines for hotels in the Pacific. Prepared by the IIEC for the Asian Development Bank. www.ee-pacific.net/index.php/publications

Inforse. Undated. Website accessed in August 2015. http://www.inforse.org/europe/dieret/Biomass/biomass.html

Institute of Science in Society. 2006. Biogas China. Website accessed in August 2015.

http://www.i-sis.org.uk/BiogasChina.php

Investment Fiji. 2015. Website accessed in August 2015. http://www.investmentfiji.org.fj/

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate change 2014 impacts, adaptation and vulnerability, IPCC 5th Assessment Report. Website accessed at http://www.ipcc.ch/report/ar5/wg2/

IRENA (International Renewable Energy Agency). 2014. Renewable Energy Opportunities for Island Tourism, August 2014. http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Island_Tourism_report_2014.pdf

IRENA (International Renewable Energy Agency). 2015a. Synergies Between Renewable Energy and Energy Efficiency. http://www.irena.org/DocumentDownloads/Publications/IRENA_C2E2_Synergies_RE_EE_paper_2015.pdf

IRENA (International Renewable Energy Agency). 2015b. Fiji Renewables Readiness Assessment. http://www.irena.org/DocumentDownloads/Publications/IRENA_RRA_Fiji_2015.pdf

IT Power. Undated. PowerPoint presentation. Micro Hydro, Renewable Energy training Programme, Duncan Brewer.

Kaiuli Energy. 2015. Website accessed in August 2015. http://kaiulienergy.com/

Murdoch University. 2015. Website accessed in August 2015. http://www.see.murdoch.edu.au/resources/info/Applic/Gridconnect/

NASA. 2015. Surface meteorology and Solar Energy. Website accessed in August 2015. https://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi?

Pacific Power Association.2013. Pacific Power Association Publications, Volume 21, Issue 2, p.9-10, June 2013.

Save the Polar Go Solar. 2013. Website accessed in August 2015. http://solar.upstime.com/hybrid-solar-air-conditioner/

Standards Australia. 2000. Australian/New Zealand Standard (AS/NZS 3598:2000) Energy audits.

Studio Mango. 2011. Building Strong and Cool in the Tropics. A free report for tropical residents by Studio Mango tropical architecture and planning.

UNWTO (United Nations World Trade Organization). 2011. Hotel energy solutions: Fostering innovation to fight climate change. Website accessed at www.hotelenergysolutions.net.

USAID (United States Agency for International Development). Undated. Best Practices Guide: Economic and Financial Evaluation of Energy Efficiency Projects and Programs, Prepared for Energy and Environment Training Program Office of Energy, Environment and Technology Global Bureau, Center for the Environment, USAID.

USDOE (United States Department of Energy). 2015. Website accessed at http://energy.gov/energysaver/solar-water-heaters.

USEPA (United States Environmental Protection Authority). 2015. Energy Star Guidelines for Energy Management. http://www.energystar.gov/sites/default/files/buildings/tools/Guidelines%20for%20Energy%20Management%206_2013.pdf

Vorks Energy. 2011. Website accessed in August 2015. http://www.vorks.com/offgrid.htm

WWF (World Wildlife Fund). 2011. PowerPoint presentation: Hotels Energy Efficiency Project: Results of Feasibility Study, October 2011, Fiji.

Annex 1: Energy software tools

For those hotels with the staff capability to undertake their own energy assessments there are some software available to assist. Some of these are free but others have to be bought, usually along with some data logging equipment. A few of the many available software packages are mentioned below.

RETScreen International (http://www.retscreen.net/ang/centre.php) (free)

The RETScreen Clean Energy Project Analysis Software is a decision-making support tool developed in cooperation with numerous experts from government, industry, and academia. The software, provided free of charge, can be used worldwide to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of renewable energy and energy efficient technologies (RETs). The software includes product, project, hydrology and climate databases, a detailed user manual, and a case study, university level training course, including an engineering e-textbook. However, RETScreen is a reasonably complex tool and requires training in using it before it can become useful.

Eniscope System – Eigin (http://www.enigin.co.uk/products/eniscope) (commercial)

Eniscope is an energy use analyser that plugs into a building's system and relays meaningful energy use data and graphical analysis locally, and over the web. It provides real-time energy consumption of buildings, departments, circuits and machines. Eniscope combines metering technology with an advanced energy network controller; producing live readings and real-time graphical logs which can be accessed, 24 hours a day, from a desk, laptop or mobile phone. A user can log into Eniscope's Energy Displays to see all the information – including kW consumption, peak demand, carbon output and money spent – and an analysis of the last few hours, days or weeks. It assists with identifying trends, anomalies and wastage.

E-link daily energy report – Efergy (http://efergy.com/us/elink) (commercial)

Efergy E2 meters and the elink software. This is a product that has been used in the Pacific with success, although internet access by Ethernet cable is needed in the range of max 50–80 meters from the electrical panels. Additionally, data download is not available yet through their portal (only total kW/day), while hourly data are available only by connecting the E2 display to a computer through a USB. However, the equipment is relatively easy to set-up and use and downloading data is not difficult.

Hotel Energy Calculator (http://www.hes-unwto.org/hes_root_asp/index.asp?LangID=1) (free)

This benchmarking tool developed by the UNWTO enables European Small and Medium Enterprises (SMEs) in the accommodation sector to assess their current energy use/efficiency and carbon footprint against similar enterprises. Because it is based on European Hotels, it may not be as relevant to hotels in Fiji. A user must fill out a questionnaire and once it has been completed, the e-toolkit automatically performs calculations to produce three reports among which the energy-related report which provides information on the hotel's current energy performance, and compares this with a predefined benchmark.

Annex 2: Directory of local suppliers

The lists below are not exhaustive but attempt to give a basis upon which to search for appropriate services and quotations for implementation of energy efficiency and renewable energy projects. The companies are presented in no particular order and no endorsement of any company is implied by their inclusion in this list. Some company services may have changed since the listing was compiled.

Renewable energy and energy efficiency product and services suppliers

Sunergise

Sunergise which began operations in late December 2012, is a solar photovoltaic (PV) system supply and installation company. The company's first installation in Fiji was a 122 kW system at Port Denarau Marina. They also work in other Pacific Island countries and in New Zealand. Their main product is a long-term solar lease/Power Purchase Agreement (PPA) for corporate clients. Sunergise offer both grid-connected and off-grid solar energy packages and tend to focus provision of larger size systems for businesses.

Tel.: + (679) 670 0064
Email: ajay.r@sunergisegroup.com
Website: www.sunergisegroup.com

CBS Power Solutions (Fiji) Ltd

CBS Power Solutions began operations in Australia in 1998 and opened an office in Fiji in 2006. Originally focusing on batteries and providing standby power to large organizations, the company has diversified and now focuses more on renewable energy systems, particularly solar PV systems. They have three offices in Fiji, in Suvam, Labasa and Ba. They provide services in commercial and residential scale grid-connected and off-grid solar PV systems, as well as small wind systems, hybrid systems, energy auditing, education and training packages and other related services.

Tel.: +679 3342428
Email: amir@cbspowersolutions.com
Website: www.cbspowersolutions.com

Energy Pro (Fiji) Ltd

Energy Pro was established in early 2010 with a focus on energy efficiency and conservation. The company provides energy related consultancy together with HVAC design-related services to its clients to provide improved energy efficiency and savings. Their range of services include power quality auditing, energy auditing, including data logging, mechanical HVAC design and thermal imaging. They also provide off-grid and grid connected solar power systems, and a range of energy efficiency lights.

Tel.: +679 9991886
Email: vineet@energypro.com.fj
Website: www.energypro.com.fj

Clay Energy

Clay Energy was established in Suva in 1998 and has carried out installations in Fiji, Tonga, Vanuatu, Samoa, Cook Islands, Solomon Islands and Kiribati. They offer power solar PV, wind and hybrid system design, installation and maintenance services and design solutions for remote and grid-connect power systems. The company's range of products includes telecommunications solutions, commercial DC systems, packaged solar lighting and refrigeration kits, standalone renewable energy power systems ranging from small to full scale systems with generator backup facilities, water pumping systems, including solar water pumping systems and solar PV grid-connect packages. They also sell solar panels, batteries (sealed and flooded), inverters and energy efficient fridges and freezers.

Tel.: +679 3363 880
Website: www.clayenergy.com.fj

Powerlite Generators (Fiji) Ltd.

Powerlite Generators (Fiji) Limited (www.powerlite.com.fj) began operations in 2003, providing rural communities with a solution to their lighting needs through generator power. Powerlite now also designs, supplies and installs RETs such as solar, wind and hydro power. Powerlite provide a range of products which include solar panels, wind turbines, water turbines, inverters, converters, LED lights, water pumps and prime and standby generators and all their parts.

Tel.: +679 3384 088 or 3384 095
Email: services@powerlite.com.fj

Western Lectric (WesLec) Co. Ltd

Western Lectric Co Ltd was originally established in Fiji in 1946, providing electrician services. It has been manufacturing and selling solar hot water systems in Fiji since the 1960s. They have had a distribution partnership with the Rheem Australia hot water systems since the 1980s. Western Lectric can provide a range of hot water systems and products for both domestic and commercial application. Their hot water solutions include new technology renewable energy and high energy efficient electric heat pumps, traditional solar, electrical or gas heaters.

Tel.: +679 666 0477 or 666 0356
Email: info@weslec.com.fj
Website: www.weslec.com.fj

Paradise Technologies

Paradise Technologies has been operating in Fiji since 2004 and specialises in selling and installing two energy saving products: 1) optimised refrigerant supply (ORS), which is a patented product which can be retrofitted or set up as a new system. It is designed to reduce operational costs whilst improving temperature stability, through dual temperature sensors. ORS incorporates: a priority on achieving and maintaining space set temperature; and protection against frequent stop/start of the compressor. ORS units can be deployed for energy savings on any refrigerant based air conditioner or refrigerator; and 2) energy efficient lighting equipment and products.

Tel.: +679 6728 207
Email: pranil@paradisetechfiji.com
Website: www.paradisetechfiji.com

MV Solar

MV Solar has recently opened its offices in Fiji, with its head office in Australia and also offices in New Zealand. The company has over 20 years' experience in the solar PV sector and provides both on-grid and off-grid solar PV systems.

Tel.: +679 6662648
Website: www.mvsolar.com.au

Renewable Energy Systems

Renewable Energy Systems is a small solar energy company with a number of years experience in the Fiji rural off-grid solar energy industry. The company is based in Labasa, Vanua Levu.

Tel.: +679 8812618 or 9291314
Email: resco@connect.com.fj

Greenco

Greenco, which was established in 2010, provides solar home and business systems, LED lights, solar-assisted hybrid air conditioning systems, desalination plants, solar powered lamps and charges, solar water pumps, solar panels and accessories, acid free batteries, solar street lights, solar garden lights and inverters.

Tel.: +679 8604 441
Email: greencofiji@gmail.com
Website: www.facebook.com/greencofiji

Dtronics Green

Dtronics Green is based in Suva and supplies the following products and services: batteries renewable energy systems, computer and electronic components, hybrid power systems, solar electric power systems, solar lighting systems, wind turbines (small), design, installation, engineering, project development services, education and training services, research services, site survey and assessment services, maintenance and repair services.

Hydro Developments Ltd

Hydro Developments Ltd was established in 2004 and is based in Walu Bay in Suva. The company has carried out a number of assessments and feasibility studies for small hydropower in Fiji.

Tel.: +679 3301882 / 9998725
Email: ross@hydrofiji.com

Fiji Gas

Fiji Gas was established in Fiji in 1956. The company deals in Liquid Petroleum Gas (LPG) for domestic and commercial cooking, for cars and for electricity generation. Fiji Gas also has capabilities in cogeneration and trigeneration. The company is presently planning expansion of their gas storage in Fiji to cater for the growing demand for LPG in the tourism and domestic sector.

Tel: +679 330 4188
Email: info@fijigas.com.fj
Website: www.fijigas.com.fj

Irwin Aslop Pacific

Irwin Alsop Pacific Ltd was established in 1987 and is a consulting building services engineering firm based in Fiji. Key areas of consulting services include mechanical, electrical, fire protection, hydraulics, vertical transportation and energy audits.

Tel.: +679 3302619
Email: office@iap.com.fj
Website: www.iap.com.fj

Other energy related product and services suppliers

Tinting

Tint A Car - **Specialised in Tinting Office Glass Frosting & Safety Security Film**

Address: 30 Ratu Mara Rd Samabula
Phone: +679 338 2777
Fax: +679 337 2276
Mobile: +679 999 9669
Mobile: +679 929 0484
Email: tintacar@connect.com.fj
Website: www.tintacar.com.fj

Tint & Cool - **Specialists in General Tinting of Cars & Offices also Safety Security Film**

Address: Suva Bhindi Subdivision
Phone: +679 360 0585
Mobile: +679 994 5884
Email: tintncool@yahoo.com

Tint Factory - **Window Tinting Solutions for your Car, Home & Office**

Address: Lot 1 Reservoir Road Walubay
Phone: +679 331 5666
Mobile: +679 997 9266
Fax: +679 331 5667
Email: windowtintingfiji@gmail.com

Electrical

Sigatoka Electric Ltd

Address: Grantham Plaza Raiwaqa
Phone: +679 338 6807
Fax: +679 338 6847
Mobile: +679 999 0771
Mobile: +679 999 0772
Email: selsuva@connect.com.fj
Website: www.sigatokaelectric.com.fj

Regent Electric Ltd

Address: Lot 17 Tubou Street Samabula
Phone: +679 337 0405
Fax: +679 337 0406
Mobile: +679 992 1027
Mobile: +679 992 1011
Email: regent03@connect.com.fj

Ajynk Electrical Ltd

Address: Lautoka 36-40 Ravouvou Street, Lautoka
Phone: +679 666 1179
Mobile: +679 999 3699
Email: info@ajynk.com
Email: afroz.ali@ajynk.com
Website: www.ajynk.com

Batteries

Pacific Batteries Ltd

Address: lot 21-22, Wailada Industrial Estate, Lami, Fiji Islands
Phone: +679 336 2708 or 336 2255
Website: www.pacificbatteries.com.fj

Lighting

Poly Products (Fiji) Ltd

(Philips lights)
Address: Grantham Plaza Raiwaqa
Phone: +679 338 5544
Mobile: +679 999 0547
Email: sales@polyproducts.com.fj
Website: www.polyproductsfiji.com

RC Manubhai

(Pierlite lights)
Address: Ba Head Office, P.O. Box 9 Ba
Phone: +679 667 4633
Fax: +679 667 0184
Email: info@rcmanubhai.com.fj
Website: www.rcmanubhai.com.fj

Sigatoka Electric Ltd

Address: Grantham Plaza Raiwaqa
Phone: +679 338 6807
Fax: +679 338 6847
Mobile: +679 999 0771
Mobile: +679 999 0772
Email: selsuva@connect.com.fj
Website: www.sigatokaelectric.com.fj

Vinod Patel & CO Ltd

(Thorn lights)
Address: 5 Nadi Back Road, Nadi
Phone: +679 666 2066
Fax: +679 650 0503
Mobile: +679 990 7278
Email: enquiry@vinodpatel.com.fj
Website: www.vinodpatel.com.fj

Air conditioning

Aircon Off

Address: Brisbane Queensland 4000
Phone: 1300 552 897
Mobile: 0438 302 033
Email: john.c@airconoff.com.au
Website: www.airconoff.com.au

Mechanical Services Ltd

Address: Lot 48 Namaka Industries, Nadi
Phone: +679 672 3535
Fax: +679 672 3435
Mobile: +679 999 9222
Email: mechanicalnadi@connect.com.fj
Website: www.mechanicalservicesfiji.com

Lincoln Refrigeration Ltd

Address: Lot 7 Nuqa Place, Lautoka
Phone: +679 664 5405
Fax: +679 666 9075
Mobile: +679 999 2474
Email: lautokamgr@lincolnrefrigerationfiji.com
Website: www. lincolnrefrigerationfiji.com

Electrical appliances

Narhari Electrical Co Ltd

Address: Main St, Nadi
Phone: +679 670 0028
Mobile: +679 999 7067
Email: infonadi@ narhari.com.fj
Website: www.narharifiji.com

Courts (Fiji) Ltd

Address: Level 2 Vivrass Plaza, LBE
Phone: +679 3381333
Email: customercare@courts.com.fj
Website: www.courts.com.fj

Morris Hedstrom (Homemaker)

Address: City Homemaker Rodwell Rd, Suva
Phone: +679 331 1811

Brijlal & Co Ltd

Address: Vanua House Victoria Parade, Suva
Phone: +679 330 4133
Fax: +679 330 2777
Email: kapadia@connect.com.fjw

Annex 3: Resource organizations in Fiji

For hotel management who wish to understand more about renewable energy and/or energy efficiency, or require assistance with energy auditing, benchmarking of energy consumption levels and monitoring performance indicators, another option is to pay a fee (usually there is an initial evaluation fee, perhaps additional fees for specific services, and an annual fee) and join one of 'green' certification schemes for hotels. If this option is too expensive, another possibility is to seek further information from organizations based in Fiji. Some of these are listed below.

Sustainable Energy Industry Association of the Pacific Islands (SEIAPI)

SEIAPI was established in 2011 and its mission is to create an enabling environment for the growth of sustainable energy business entities and technologies and their applications in the Pacific Islands. It currently has about 65 members from around the Pacific. The association may be able to provide a list of members in Fiji and a list of companies accredited to SEIAPI for solar installations.

E-mail: info@seiapi.com

Website: www.seiapi.com

Fiji Electricity Authority (FEA)

FEA is the state owned electricity utility of Fiji and operates on the three major islands, Viti Levu, Vanua Levu & Levuka (Ovalau), with a total peak load of about 138 MW and supplies about 740 GW of energy per annum. FEA serves a total customer base of over 147,000 comprising of over 134,000 domestic customers and with the remaining belonging to the commercial or industrial sector. The major sources of generation include the hydroelectric power station at Wailoa with the dam at Monasavu and thermal power stations at Vuda & Kinoya. There is a wind power station at Butoni and there are smaller thermal units at Sigatoka, Nadi, Rakiraki, Korovou, Labasa, Savusavu, and Levuka.

Tel.: +679 123 333

Website: www.fea.com.fj

Fiji Department of Energy (DoE)

The Fiji Department of Energy is part of the Ministry of Infrastructure & Transport and is made up of more than 50 staff. The Department of Energy focuses on four strategic areas for the development of a sustainable energy sector in Fiji: energy planning, renewable energy, energy security and the power sector. The Department of Energy has supported schemes to improve energy efficiency and use of renewable energy in hotels in the past.

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Email: info@fdoe.gov.fj
Website: www.energy.gov.fj

Fiji Institute of Engineers (FIE)

FIE is the locally recognised body representing Engineering Professionals in Fiji. The overall objective of the institution is the advancement of the science and profession of engineering. FIE is governed by a nine member council that is appointed by its members at its Annual General Meeting in accordance with the Rules of FIE. FIE membership is open to all who meet the minimum qualification requirements as stipulated in the Rules of FIE for its various grades of membership.

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