

## Module 3 - Trainers Guide

# Energy Efficiency Basics

ENGLISH - VANUATU

Funded by:

**KOICA**  
Korea International  
Cooperation Agency

In partnership with:



  
Pacific Islands  
Development Forum





## ACKNOWLEDGEMENTS

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This “**Energy Efficiency**” training module was developed by Ramesh Kumar under contract to GGGI, with inputs by the local people, for the local people.

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Valuable feedback and inputs on this module have also been provided by the following groups of people during the piloting, finalization and customization phases:

Belinda Strid and Thompson Alick (Power and Communication Solutions, Vanuatu), Erica Loli (Intern, Department of Strategic Policy, Planning and Aid Coordination, Vanuatu), Hannah Tamata, Stephen Mataitini (Pacific Vocational Training Center), Wade Evans (Vanuatu Institute of Technology) and Christopher Bartlett for providing review and feedback during the “Pilot training of trainer and feedback workshop” in 2020.

The people of Tisman community in South East Malekula and pilot trainer, John Boar for providing community and trainer feedback during the “Pilot training of remote communities” event in 2020.

Ian Iercet, Doreen Leona and Gary Erick (Department of Energy, Vanuatu), Hellen Wilson (National Green Energy Fund, Vanuatu), Devo Wari (Department of Local Authorities, Vanuatu) and consultant trainer, John Boar for providing validations of the feedback during the “Regional Validations Workshop” in 2020.

Thomas Jensen (UNDP) for externally reviewing and providing feedback for this training module.

Also acknowledging support from the Ministry of Climate Change Adaptation, Meteorology & Geo-hazards, Environment, Energy and Disaster management (Vanuatu), Korea International Cooperation Agency (KOICA) as well as all other stakeholders who have provided their inputs in any way.

Other information in this module is drawn from materials that are publicly available online, and any misrepresentation is truly regretted. Inclusion in this module does not constitute endorsement by GGGI or the authors. Information provided in the module has been adapted by the authors and any mistakes are the authors' own. Readers should always check for latest information with the relevant authorities as standards and requirements keep getting updated.

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## ABBREVIATIONS

AC	Alternating Current
°C	Degrees Celsius
BHP	Brake Horsepower
CFL	Compact Fluorescent Lamp
CO <sub>2</sub>	Carbon Di Oxide
CSR	Corporate Social Responsibility
DG	Diesel Generating
EC	Energy Conservation
EE	Energy Efficiency
GB	Green Business
GE	Green Economy
GGGI	Global Green Growth Institute
GLS	General Lighting Service Bulbs
HP	Horsepower
HSD	High Speed Diesel
HVAC	Heating Ventilation and Air Conditioning
KOICA	Korea International Corporation Agency
KM	Kilometer
KVA	Kilo Volt Ampere
LED	Light Emitting Diode
LPG	Liquified Petroleum Gas
LPH	Liters per Hour
LW	Learner's Workbook
MEPS	Minimum Energy Performance Standards
Mts	Minutes
MW	Mega Watts
PIDF	Pacific Islands Development Forum
PNG	Papua New Guinea
RE	Renewable Sources of Energy
RO	Reverse Osmosis
TG	Trainer's Guide
TOT	Training of Trainer
TV	Television
USA	United States of America
V	Volts
W	Watts

## GLOSSARY

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**Circuit Breaker** - An appliance to trip the electricity when there is an overload/short circuit.

**Combustion** - A mixture of air and fuel in the right quantity, right temperature, and right mix for the fuel to burn.

**Commercial Source of Energy** - Where you pay for the source of energy - coal, petrol, gas, electricity.

**Energy Audit**- A check on the expected energy consumption based on the rated power consumption as per name plate and actual energy consumption from meter / energy bill.

**Energy Conservation** - Avoiding use of energy when not required (e.g., Switching of lights and fans, wood stove when not required, TV when not watching, idle running of pumps).

**Energy Efficiency** - Using latest technology appliances that save energy due to use of advanced systems (e.g. - LEDs, Energy Efficient pumps, energy efficient refrigerators etc).

**Name Plate** - Details containing equipment details - Volts, Amps, watts.

**Noncommercial source of energy** - Where it is available free - Wood collected from forest, biogas.

**Pollution** - In this case due to smoke coming out by burning of fuels.

**Primary Source of Energy** - Available in the ground -coal, petroleum, gas, charcoal.

**Secondary source of energy** - Derived from primary source of energy - Electricity, steam, hot water.

The "Energy Efficiency Basics" training module is an introduction to the basics of energy efficiency to the community. This is in continuation to the "Green Economy General Principles module.

Upon completion of the course, the participants will achieve the following learning outcomes:

- Understand what energy efficiency is.
- Identify ways of promoting Energy Efficiency in the Community.
- Understand Energy Efficiency Standards in the country.
- Evaluation and Selection of High Efficiency appliances and equipment for residences and the community use.
- Develop an Energy Efficiency Initiative for the community



## HOW TO USE THIS GUIDE?

The trainer guide is provided with the class notes and includes activities which need to be done after each section of the course. The guide acts as a recommendation only. After seeing the situation on the ground in each community, the experienced trainers may use their judgment to modify their delivery and assessment techniques to achieve better results.

The Trainer Guide provides detailed notes written in the form that can be directly delivered to the learners. However, the very detailed notes are intended to broaden the knowledge of the learner as well. You are not required to read each paragraph from the Trainer Guide, but you are expected to know the materials sufficiently to train others. Firstly, you must know what key concepts the learners need to learn. These are normally called learning outcomes. The learning outcomes are all listed at the start of the Trainer Guide, and you must ensure that at minimum, every learner achieves those 5 learning outcomes. You are required to take at least a week to go over the TG and go through the activities in the Learner Workbook. During the actual training you can refer to the Trainer Guide and explain it to the learners in your own words. If you are unsure of something always refer to the TG notes. Also note to take heed of the time recommended for each session and activity.

In case where learner literacy levels are low, trainers are advised to adapt to the situations and modify activities as appropriate. It is advisable to keep a continuous record of competencies of learners. All competencies are achieved when learners fulfil all learning outcomes.

## HOW TO CONDUCT ACTIVITIES

- Activities are best done in groups or pairs. It is recommended that in each group there is at least one who is more literate or a more active learner who can help to translate and explain the training contents to learners who are slower to understand.
- You may divide the learners into groups of at least 2 and preferably 3-4 learners and ask them to carry out a rigorous discussion within the group. Some activities can be given to the groups for overnight preparation. The trainer needs to be aware of the dynamics of relationships in the community when dividing learners into groups. Sometimes women and youth are not free to share their

views when the men from the communities are present. The trainer should ideally ask learners for their guidance when organising them into groups for discussions.

- Ideally the learners may present the results of their activities to the class and have a class discussion based on their findings.
- It is not necessary that all groups present in the same activity.
- However, it is important that all groups are given opportunity to present or verbally discuss their answers.
- At all times, encourage learners to be interactive and participative in class.
- Learners must be encouraged to be vocal and to contribute actively in class discussions.
- To better improve learning, the learners must be encouraged to strongly inquire about the topics through questions.
- The activities allow trainers to observe if the learners have achieved the learning outcomes. If possible, do keep record of the learner's achievement of learning outcomes so that you can help them learn better. A sample record table is given in this guide.
- Adapt existing activities and/or alternative suitable activities in case the desired literacy levels of learners are not met or the desired resources are not available.

## TEACHING TOOLS

The following tools/items may be required to enhance learner learning:

- Laptop/ computer and projector to play videos or present notes to the whole class. This will depend on availability. In case this is not available, you are recommended to take large prints of the key concepts and display to the learners while teaching.
- Provide each learner with pen or pencil, and paper to allow them to participate.
- Whiteboard and markers or black board and chalk can be made available to allow both facilitator and learner to state a point.

The Learner Progress Record sample given below can be used to observe learners, note their feedback, and assess if they have achieved the specific learning outcome. This recording is useful for both the learner and trainer so you can focus on those who are falling behind. Note there are no marks to be awarded and the record is only to improve learning. This is entirely optional.

**TABLE 1: Learner's Progress Record-Optional for trainers to use**

Participant Progress Record (Optional)		Date:
Learner Name:		
Learning Outcome	Achieved Outcome (Yes or No) and Comments	
1. Define Energy Efficiency		
2. Identify and describe ways of promoting energy efficiency in the community		
3. Demonstrate an understanding of energy efficiency standards of the country		
4. Evaluate and select high efficiency appliances and equipment for residential and community use		
5. Develop an energy efficiency initiative for the community		

## LESSON PLAN AND TIMES

**TABLE 2: Lesson Plan and Recommended timing of each session**

Chapter	Lesson Type	Recommended Time (mts)
Inaugural Session		15
1. Ice Breaker - Introductions	Theory and activity 1	15
2. Energy Efficiency Basics	Theory	40
	Activity 2	15
3. Energy Efficiency and Conservation	Theory	60
	Activity 3	15
4. Energy Conservation Measures	Theory	40
	Activity 4	15
5. Energy Efficient Technologies	Theory	30
	Activity 5	15
6. Energy Efficiency Labelling	Theory	30
	Activity 6	10
7. Energy Efficiency - Community Initiatives	Theory	40
	Activity 7	10

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# Ice Breaker Introduction

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Trainers must understand that the learners who are attending the module have taken time from their usual daily activities which sustains their livelihood. Most will also be very nervous and unclear regarding what the module is all about. Hence the trainer must ensure that the learners are comfortable and not too nervous. It is important to make them feel at ease so that they can focus on the module and absorb as much knowledge as possible.

Tell them that this is an informative module and there will be no tests or marks in this. You must inform them that this module is being run so that they can take the information to help themselves to transition to renewable energy. Even if they do not use it, they can always use the knowledge to help others. In any way this module will better equip them to help grow their communities. Tell them to be at ease and focus on enjoying the day and asking as many questions as they want. Also tell them to not worry too much about complicated things as you will guide them through this.

## ACTIVITY 1

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Introduce yourself briefly to the learners. Ask if they are all comfortable at the venue. One by one ask them their names and tell them to give some details about themselves – such as what they would normally be doing at that time and what they hope to gain from the module at the end of the day. In addition, if time permits – ask them what they think about energy efficiency. There is no correct answer, and the goal of this activity is simply to get them relaxed and engaged into

the session. You may crack few light jokes as laughter always lightens the mood and helps learners relax. Ask the learners about their prior experiences in energy efficiency and how much they know about the topic. Also ask them what they wish to gain from this training session and record their answers on paper so that it helps the trainer in setting a direction to the course. This input will help the trainer direct the training to the learners needs.

# 2

## Energy Efficiency Basics

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The Green Economy General Principles module gives the basics of green economy principles. This module on energy efficiency is one of the road maps to 'Go Green'. The practice of energy efficiency and energy conservation will result not only in energy savings but also a green economy as energy saved leads to reduction in carbon footprint.

**FIGURE 1: SDG Goals<sup>1</sup>**



## 2.1 Energy Basics

The importance of green economy has been explained in the Green Economy General Principles Module. This module on energy efficiency is based on green economy principles as when you save energy, you save on carbon emissions into the atmosphere.

The energy scenario of the countries covered are given below:

**TABLE 3: Energy Scene at a Glance**

Particulars	Fiji	PNG	Solomon Islands	Vanuatu
Price of Grid Power (USD/kWh)	0.07 to 0.15	0.21	0.79	0.44
Price of power charged by local – mini /micro-grid for solar power (USD per kWh)	0.78 solar hybrid	NA	NA	NA
Price of Firewood (USD per MT)	4.34	NA	2.96 to 3.56 per bundle	2.73 per bundle
Price of kerosene (USD per liter)	0.69	0.85	0.93	No usage
Price of HSD (USD per liter)	0.81	0.91	1.00	2.2

The communities use electricity predominantly for lighting, water pumping and home appliances while firewood is used mostly for cooking. Fuel used for cooking is mostly picked from the forest, such as biomass (crop residue), and has little commercial value. A small percentage of the community has access to the central grid power in each of the countries covered. Some of them have small DG (generator) sets to meet the electricity requirements.

High Speed Diesel (HSD) used for Diesel Generating sets, Boats is imported. Crude oil is being produced in Papua New Guinea (PNG). The production in PNG during 2019-20 is about 40 to 50 BBL/D/1K (thousand barrel per day).<sup>2</sup>

The communities are realizing the importance of generating power from solar and it is expected that this will pick up momentum. The laying of national grid is slowly progressing in these countries. This requires a lot of money and time to implement. Solar power is more localized and can be implemented in less time. Furthermore, these countries have small, spread-out

islands with inaccessible terrains. Therefore, the development of a centralized grid is a major challenge.

The power generated in this country from the electricity concessions is mostly from diesel fuel. This makes cost of power expensive and other countries in the Pacific have similar problems. Most of the rural communities have limited access or cannot afford basic energy services for lighting, cooking and entertainment.

Building renewable energy systems require high up-front costs. On the other hand, use of generator sets have recurring fuel and maintenance costs. Therefore, the Department of Energy has developed a National Energy Road Map, with strong focus on renewable energy and electricity access for citizens. Therefore, the donor partners are focusing more on RE and electricity access with very little focus on energy efficiency. Implementing Energy Conservation and Energy Efficiency is important as it could lead to money being saved.

<sup>1</sup> Source: Adapted from Sustainable Development Goals Homepage, <https://spp.cmu.ac.th/category/sustainable-development-goals/>

<sup>2</sup> Source: U.S. Energy Information Administration adapted from Trading Economics, "Papua New Guinea Crude Oil Production, <https://tradingeconomics.com/papua-new-guinea/crude-oil-production>

About 80% of the households use wood as fuel source for cooking, while the reminder use LPG gas. The national development goals set by these countries expect that by 2030 most of the households and businesses have access to clean and reliable sources of energy. The usage of cooking gas very minimal in rural communities.

The Department of Energy with support from Pacific regional partners such as GGGI, the Secretariat of the Pacific Community (SPC) and the Asian Development Bank (ADB) have taken initiatives to promote energy efficiency for the electricity, the manufacturing, agricultural and domestic sectors. The Vanuatu National Energy Road Map 2016-2030 outlines measures to promote use of EE in Vanuatu. In 2016, the national parliament passed the Energy Efficiency of Electrical Appliances, Equipment and Lighting Products Act, which provides for minimum energy performance standards, energy labelling and for registration of electrical appliances, equipment and lighting products that are energy efficient and for related purposes.<sup>3</sup>

## 2.2 Primary and Secondary Sources

The primary source of energy is the sun. Energy from the sun is used to grow trees, and when they die, their remains decompose over the years to form peat, coal, crude oil etc. As they come from mother earth, the community should appreciate that these resources get exhausted very fast. They take millions of years to develop from the mother earth. All the countries in the Pacific including but not limited to Fiji, Solomon Islands, Vanuatu, PNG import fossil fuels so the government has to spend a lot of money. It is therefore essential to take measures to move away from this dependency, save money, and divest into a green economy.

Energy in most of these countries is supplied in these forms as presented in Table 4 below:

**TABLE 4: Types and Sources of Energy**

Types of Energy	Sources of Energy
Biomass/ wood for cooking in rural areas. The biomass used is wood and agricultural waste (coconut husk and shells).	Primary Source
Some portion of biomass is used in wood and sugar industries for generating power.	Primary Source
Imported Fossil Fuels mainly petroleum products for use in transport, power generation through DG sets.	Primary Source
Electricity generation mostly from hydro power with smaller contribution from wind / solar energy.	Secondary Source

The term secondary energy is used for electricity and steam. These need other sources of fuel (e.g wood, Diesel etc. to be created. All other energy sources are primary sources of energy.

The wood you use for cooking is also a primary source of energy.

The electricity which you all use for lighting, water pumps etc. is a secondary source of energy. The electricity is generated using diesel or other petroleum fuels and using renewable energy sources as much as possible. For example, the windmill on Efate and Sarakata Hydro in Santo. The use of renewable energy sources is picking up.

## 2.3 Commercial and non-commercial source of energy

Whatever energy you buy (charcoal, kerosene, petrol, diesel, etc.) with money, it is a commercial source of energy. The non-commercial source of energy does not require money to buy. They are readily available to you. For instance, you collect the twigs, firewood, animal dung cake, agricultural waste from nearby fields or sometimes from forests. These are non-commercial as you don't pay for them.

The difference between commercial and non – commercial sources is given in the Table 5 below.

<sup>3</sup> Department of Energy, [https://doe.gov.vu/images/meps-l-pad/Official\\_Act\\_No.%2025\\_of\\_2017\\_\(dated\\_29%20March\\_2017\).pdf](https://doe.gov.vu/images/meps-l-pad/Official_Act_No.%2025_of_2017_(dated_29%20March_2017).pdf)

**TABLE 5: Commercial and Non-Commercial Energy**

Types of Energy	Market Price Availability	Examples
Commercial Energy	Yes	Electricity, coal, lignite, oil and natural gas
Non-Commercial Energy	No	Firewood, cattle waste, agricultural waste, solar energy, wind energy etc.

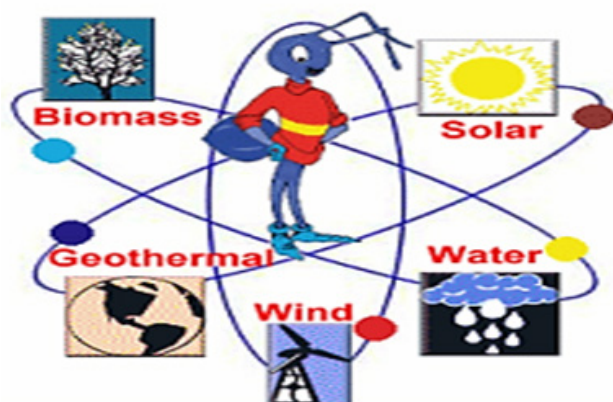
The above table gives you an idea of universally available commercial energy sources. Coal and lignite are not used in Pacific islands. Similarly, cattle waste is not used in Pacific Islands.

Coal is obtained from coal mines, by digging below the ground. The mines take many years to develop. Crude Oil and natural gas are extracted from the crude oil wells and gas wells. The crude oil is used for converting it to petrol, kerosene, and diesel. There are no coal mines in the countries covered and very small amount of Petroleum wells in Fiji, PNG. We need to be very careful in using these resources as these are imported from other countries.

- Solar Energy
- Wind Energy
- Biomass Energy
- Geothermal Energy
- Tidal Energy
- Wave Energy

**Non-Renewable Energy** (Figure 3) - is a natural resource that cannot be readily replaced by natural means at a quick enough pace to keep up with consumption such as fossil fuels: Coal, diesel, petrol, natural gas etc.

## 2.4 Renewable and non-renewable source of energy

**FIGURE 2: Renewable Energy Sources<sup>4</sup>**

**Renewable Energy** (Figure 2)- is energy that is collected from resources, which are naturally replaced on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat etc. Renewable energy often provides energy in four important areas: electricity generation, heating/cooling, transportation. The following are the renewable energy sources:

**FIGURE 3: Non- Renewable Energy Sources<sup>4</sup>**

Some of the non-renewable sources of energy are:

- Nuclear Energy
- Fossil Fuels (Natural Gas, Oil, Coal, Petrol etc.)

Some electricity generation initiatives are given below for Vanuatu, in Table 6 below.

<sup>4</sup> Adapted from Slideshare.net, "Renewable and Non-Renewable Sources of Energy", <https://www.slideshare.net/oneworld.abhiraj/renewable-and-non-renewable-sources-of-energy>



**TABLE 6: Renewable Energy Sources in Vanuatu**

No.	Name of Community	No. of Households	Population	Island	Province	RE Related Projects
1	Talise, Narovorovo and Nasawa	260	1,300	Maewo	Penana	Mini hydro
2	Loltong village	100	427	Pentecost	Penama	Mini-grid, hydro and solar PV hybrid system
3	Malekula Concession	1,198 customers		Malekula	Malampa	Diesel Generator, Solar Home System, earmarked hydro
4	Tanna Concessioni	1506 customers		Tanna	Tafea	Diesel Generator, Solar Home Systems

The Table 6 above gives a representative of the initiatives in Vanuatu. PNG, Solomon Islands and Fiji have similar initiatives.

Whenever you burn any type of fuel (firewood, kerosene), this creates smoke. Inhaling the smoke is dangerous to health and this impacts women's health, in particular, given the roles they play in cooking and food preparation as primary caregivers. Power plants and other industries emit a lot of smoke and other harmful chemicals into the atmosphere. Burning generates ash which has to be properly disposed. Otherwise, there will be health problems. Transport vehicles also emit smoke (buses, trucks, motorcycle). The engine driven equipment (diesel driven pumps, generators) also contributes to pollution. Though it is not possible to eliminate smoke in transport vehicles, you can reduce it by following good maintenance practices and adhere to the emission standards.

Use of electricity also generates pollution. This depends on where you get electricity from / gas, diesel-based power plants. Electricity generated from solar /wind/ Pico hydro is pollution free.

**FIGURE 4: Sarakata Hydro-Santo, Vanuatu<sup>5</sup>**

Larger hydro plants (in many MW)-Figure 4, usually results in large scale destruction of forests/ floods villages. The larger hydro plants are planned and located in mountainous terrains along major perennial rivers, where there are forests. The greenery of the forest is destroyed by cutting trees and for making roads and buildings. A dam is built to store water up stream of the river and after power generation the water flows downstream. Due to this many villages / communities have a high chance of being flooded. This can also dislocate the community and the governments spend huge money to relocate them. The green cover is lost due to cutting of trees and results in higher temperature. The mountain is cut for buildings and tunnels. This results in earthquake.

5 Source: Catalogue of Rivers for Pacific Islands, Vanuatu, [http://www.pacificwater.org/\\_resources/article/files/Vanuatu.pdf](http://www.pacificwater.org/_resources/article/files/Vanuatu.pdf)

**FIGURE 5: Pollutants and their Sources<sup>6</sup>**

The sources of some major pollutants are given in Figure 5. You also have large forest fires. This not only destroys forests, but the smoke travels many kilometers causing health issues to the people along its travel route.

Any human activity generates pollution. You use fuels for cooking and heating, bathing and washing, waste disposal (animal, vegetable waste), burn waste, you travel in a motorcycle. The burning activities and transport emit smoke and causes pollution.

**FIGURE 6: Human Activities and Pollution<sup>7</sup>**

In Figure 6 above shows bush clearing and burning before planting of crops. The use of firewood also emanates smoke. While firewood is free in the community smoke emitted from the stove causes pollution and results in respiratory diseases. This is very harmful for the women and children.

While human activity must continue, it is essential to take measures to reduce pollution (no smoke, dust, water).

## ACTIVITY 2

**Target:** Local government officials, Provincial Councils, District Councils, Town Councils, Island Councils, etc.

### 1. What are the energy sources you would like to promote localized to the community?

Biomass, biogas, solar (thermal and electrical) and Pico hydro (where possible).

### 2. What are the non-renewable sources of energy you should aim to reduce consumption?

Petrol, diesel, gas.

### 3. Why is electrical energy called as secondary source of energy?

Because it needs a fuel to generate electricity.

### 4. How to reduce pollution in your community?

Reduce smoke, use the equipment (cooking stove, boat engine) properly.

**Target:** Traditional community/religious leaders, women and youth and vulnerable groups (single mothers, elderly), etc.





### 1. Name the energy sources used in Fiji, Vanuatu, PNG, and Solomon Islands?

Solar, Pico hydro, firewood, diesel and petrol, biomass.

<sup>6</sup> Adapted from the Climate and Clean Air Coalition; World Health Organization Releases New Global Air Pollution Data; <https://www.ccacoalition.org/en/news/world-health-organization-releases-new-global-air-pollution-data>

<sup>7</sup> Source: GGGI Vanuatu

## 2. Look at the picture and name as renewable and non-renewable sources of energy

Picture	Renewable/ Not renewable?
 8	Renewable
 9	Non-Renewable
 10	Renewable
 11	Renewable

### 3. Why is electricity called a secondary source of Energy?

Electricity needs some other energy source to generate power like solar, diesel, water, tidal. So, it is called secondary source of energy.

### 4. What are the sources of pollution in the community?

Smoke from cooking, wastewater and solid waste, motorcycle emissions, burning agricultural and vegetable waste.

### 5. Why are large hydro electrical plants not environmentally friendly?

Large hydro electrical plants are located in mountains and forest trees. When you cut trees, it damages the environment. Diversion of water and backwaters cause flooding. Communities are displaced. Further digging of mountains lead to earthquake.

**Target:** Local electricians, people with technical aptitude, etc.

### 1. What steps you will take to move away from conventional energy sources?

Use of solar energy for lighting, heating, and cooking. Proper wiring connections for solar energy. Proper plumbing for water flow. Make use of carpentry waste efficiently.

**Target:** Small Business

### 1. What are the business activities you may consider based on this chapter?

To examine business opportunities other than solar photovoltaic. To work on biomass and biogas plants.

### 2. How will you ensure pollution is reduced in your business activities?

Will ensure proper use of energy sources, no wastage and proper operation.

8 Source: Wikipedia, <https://en.wikipedia.org/wiki/Firewood>

9 Source: Smell of Petrol/gasoline Liquid Facebook page, <https://www.facebook.com/Smell-Of-Petrolgasoline-Liquid-112870246813830/>

10 Source: Hyperleap, Micro hydro, [https://hyperleap.com/topic/Micro\\_hydro](https://hyperleap.com/topic/Micro_hydro)

11 Source: Power info Today, <https://www.powerinfotoday.com/wind-energy/dubai-to-build-uaes-first-wind-farm/>

3

**Energy Efficiency and  
Energy Conservation** —

We need to understand the difference between energy conservation and energy efficiency. Energy Conservation is to avoid wasteful uses of energy. This includes switching off lights when not required, use of natural light. Extinguish the cooking fire when not required, turning off the TV when not in use, disconnecting mobile charger after mobile fully charged, turning off motorcycle engine/car/boat engine running after use are some examples.

Please remember the message in Figure 7 below.

**FIGURE 7: Energy Conservation- example<sup>12</sup>**



We need to save on energy (fuel and electricity) to reduce pollution, and to make it last longer. For example, in solar lights, the battery gets charged during the daytime for use in the night. If you don't switch it off after use the battery will get discharged faster and you will need to wait till the next day's sunlight to recharge it. We also need to save on energy to save money and conserve natural resources. The natural resources (diesel, petrol etc.) will get exhausted fast by wastage. When you conserve energy, they last longer you help to save the money used to buy them.

It is very common to find lights and fans turned on, even when not required. As a matter of habit, remember to switch off lights and fans when not in use. Keeping the community economic status in view automatic systems are not recommended. Remember you have enough sunlight and the sun's energy is free, so use it as much as possible!

The stove fire is kept on even after finishing cooking. This is done because you need the fire after an hour or so. It is understood that lighting a fire in fire-wood stove is time consuming and difficult. Nevertheless, it is recommended to extinguish the fire and re-light when required. Probably the fuel may be free today, but tomorrow you may need to pay for it. Secondly, leaving the fire on adds to pollution as smoke is emitted.

The other resource you need to conserve is water. Some communities have enough water (probably seasonal), while some may not, and villagers will need to trek long distances to fetch water by pots, balloons, jerry cans, which often spills during transportation. Therefore, it is important to use water wisely in such communities. Excessive use of water for washing, bathing, etc., must be avoided, where there are water tanks, or community water supply systems, villagers need to ensure water taps and broken pipes are fixed to avoid water wastages.

**FIGURE 8: Energy Efficient Technology- Normal Vs LED**

**Normal Bulb<sup>13</sup>**



**LED<sup>14</sup>**



On the other hand, Energy Efficiency involves use of energy efficient equipment and appliances. Some examples are energy efficient lights, appliances etc. Figure 8 shows a normal bulb and energy efficient LED. A normal bulb consumes 60W of electrical power whereas LED consumes only 7W for delivering same amount of light. The normal (or GLS) lamp emits more heat whereas the LED emits far less heat. A normal bulb costs less than 20 US cents. The cost of good quality LED is about 1 USD. Also, the LED type light lasts longer. lights brighter and uses less energy as well. Whenever you save energy, it also reduces heat emitted to the atmosphere. This makes your surroundings clean and helps in a small way in reducing global warming. There are other energy efficient technologies which are covered in the later part of the report.

<sup>12</sup> Source: The Cure Inc., [https://www.thecuresafety.com/NOTICE\\_Turn\\_Off\\_When\\_Not\\_In\\_Use\\_Large\\_p/nga23pb.htm](https://www.thecuresafety.com/NOTICE_Turn_Off_When_Not_In_Use_Large_p/nga23pb.htm)

<sup>13</sup> ANY-LAMP.COM, <https://www.any-lamp.com/standard-incandescent-low-volt-clear-a55-e27-60w-36v-8719157999748>

<sup>14</sup> Source: Media-amazon, Led bulb, <https://m.media-amazon.com/images/I/31R-yJ3hstL.jpg>

The other very clean route to energy conservation and efficiency is 'Renewable Energy'. You can use solar lamps, electrical from pico-hydro, solar pumps, etc. Though these cost a large amount of money to purchase, it helps save a lot more

money later on and also helps save the environment. The above guidelines will reduce smoke, reduce heat and your health improves. This means lesser visits to the hospital, reduces medical expenses, and also reduced use of local medicines.

**TABLE 7: Energy Conservation vs Energy Efficiency**

Energy Conservation	Energy Efficiency
Switch off lights and fans when not required	Use of LEDs and Energy Efficient fans
Use right type of pot (vessel) for cooking 1liter/ 0.5 liter and cover with a lid	Energy Efficient Wood stove for cooking
Switch off TV when not required	Buy energy efficient star rated TV
Avoid idle running of pump	Buy energy efficient pump
Avoid idle running of boat engine	Buy energy efficient engine for boats

Developed countries are more advanced, that they have reached a stage whereby they are using a lot of energy and have already tried a lot of methods to help reduce energy consumption including energy efficiency initiatives. However, for the Pacific Islands, we are still developing, and our energy needs are growing still as we develop, hence there are still a lot of inefficient use of energy, which means we still have a lot of options to help reduce our energy usage and become much more energy efficient as we develop and grow. Becoming or practicing energy efficiency while we are developing is much easier and cheaper than performing energy efficiency on an already developed system. This is a great opportunity for the Pacific Island countries.

### 3.1 Energy Audit

The term 'Energy Audit' is perhaps too broad to describe to the target audience in question. This is used for very large industries, buildings, and tourist resorts. Simply, this means understanding each equipment installed, and understanding how much energy is consumed, depending on the hours of operation. This is then compared with the energy bill (electricity, fuel, gas) and then measures are initiated to save energy and also plan for buying energy. A representative guideline is given below:

**TABLE 8: Energy Audit Guideline**

Appliance	No of units	Power	no of Hours	Energy
		w	use	kWh/day
LED Bulbs	2	9	4	0.072
Fans	1	70	12	0.84
Fridge	0	200	0	0
TV	1	100	6	0.6
Cell charge				0.05
Total (kWh/day)				1.562
Total (kWh/month)				46.86

## ACTIVITY 3

**Target:** Local government officials, Provincial Councils, District Councils, Town Councils, Island Councils, etc.

### 1. What are the energy conservation and energy efficiency measure you will take in your offices?

The energy conservation measures are switching off lights and fans when not required. Educate staff to follow energy conservation principles, use stickers near switches to remind people to switch off power, when not required (specially in toilets).

### 2. How will you conduct energy audit for your offices?

- Make a list of power consuming equipment and their rating.
- Estimate power consumption based on hours of operation.
- Compare with electricity bills.
- Initiate measures for energy conservation.
- Provide budget and shift to energy efficient equipment.

**Target:** Traditional community/religious leaders and vulnerable groups (women, young leaders), etc.

### 1. What is the difference between energy conservation and energy efficiency?

Energy Conservation is avoiding wasteful uses of energy. The examples are switching off lights and fans when not in use, using firewood judiciously without waste. There is no money required.

Energy Efficiency is using more efficient equipment. The examples are energy efficient stoves, using LED lights in place of GLS/kerosene lamps. Here you require money.

Energy Efficiency requires money to buy energy efficient equipment.

Renewable Energy though very environment friendly requires lot of money.

**Target:** Local electricians, people with technical aptitude, etc.

### 1. How will you practice energy conservation and energy efficiency in your day-to-day work?

- Avoiding idle running of equipment.
- Use of correct tools and quality wire.
- Only procure energy efficient equipment.

**Target:** Small Businesses.

### 1. What measures you will take for energy conservation and energy efficiency?

- Switch off lights and fans when not required.
- Ensure bottle coolers are set at right temperature.
- Will procure only energy efficient equipment (LED lights, solar systems, efficient cook stoves).

# 4

## Energy Conservation Measures

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## 4.1 Cooking

**FIGURE 9: A lady carrying wood<sup>15</sup>**



Firewood is the major fuel used for cooking, and the use of gas (LPG) is used in a very limited. The discussion on cooking is limited to use of firewood as fuel. Firewood is collected from the nearby forest or gardens etc. The collected firewood is tied into a bundle. The people carry them on their head and trek back home (Figure 9). Some firewood falls off the bundle on the road. This is wastage of fuel in transport. Probably 2 to 5% of the firewood falls off while transporting.

This firewood cut into pieces of various sizes (Figure 10) and fired in a very elementary firewood stove. This are generally bricking on three sides, with the fourth side used to place the wood.

**FIGURE 10: Energy Conservation – Cooking<sup>16</sup>**



The important element here is the flame. Everyone agrees that any firing (cooking,) requires good quality flame. In order to burn the fuel in this case the firewood requires oxygen to burn. The oxygen used from the air which is naturally available. Therefore, it is important to give right amount of air. If there is black smoke, this means less air is being given. It is also not important to give enough air but also to distribute the air properly.

The community members are experts in cooking with firewood. Nevertheless, the following may help.

There is no control for air distribution in most simple style stoves. Sometimes you keep a big pot over a small stove, which leads to poor air distribution. You keep a large size log along with a small size one. You think the large log fires for a longer time. What really happens is due to different size of firewood, the air distribution is inefficient, resulting in black smoke. Though the larger one burns for a longer time, the quality of flame is bad, which results in longer time for cooking. The first step is therefore to use near uniform size of firewood. If you have a larger size log, after it catches fire, the flame is so long, it engulfs the pots on the sides, resulting in blackening of the pot. Here again wood sizing is important. You also have a pulsating flame sometimes. This is because larger logs have longer flame length, while shorter ones have a shorter flame length. Sometimes the logs can be wet, resulting in white smoke. You should leave the logs out in the sun to dry first.

<sup>15</sup> Source: Vanuatu Images, <https://vanuatuimages.wordpress.com/2015/03/16/the-happy-people-of-vanuatu-2/>

<sup>16</sup> GGGI Vanuatu.

**FIGURE 11: Covering a Vessel (pot) with a lid<sup>17</sup>**

Depending on the size and shape of the pot, the flame needs to be distributed in the bottom. The energy efficiency of cooking also depends on size of the pots. It needs to be selected as per the quantity to be cooked. If you need to boil a cup of milk, choose a smaller pot. To boil one liter of water use a larger pot. Please refrain from using a large pot for smaller quantity. It is also essential to keep a lid on the pot to avoid heat loss (Figure 11).

The burning of firewood results in ash. The conventional stove has no place where ash is collected. This needs to be periodically removed and cleaned. If not, then flames may not burn properly.

**FIGURE 12: Energy Efficient Cook Stove<sup>18</sup>****FIGURE 13: Energy Efficient Cook Stove Demonstration in Vanuatu<sup>19</sup>**

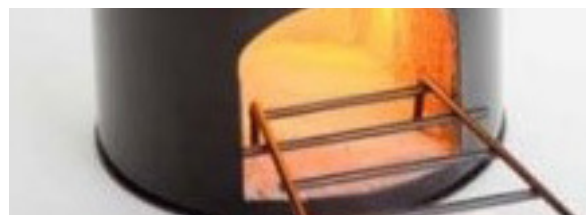
Figure 12 shows an energy efficiency cook stove and Figure 13 shows cook stove demonstration in Vanuatu.

The energy efficient stove working principle is given below:

- A grate or fuel magazine to place fuel



- Combustion Chamber where air enters at the bottom and mixes with the fuel



- Top for placing pot for cooking and exhaust gases



17 Source: Wikipedia, "Clay pot cooking", [https://en.wikipedia.org/wiki/Clay\\_pot\\_cooking](https://en.wikipedia.org/wiki/Clay_pot_cooking)

18 Source: GGGI Vanuatu

19 Rotary Club Vanuatu; "Vanuatu Smokeless Cook Stove Project", <https://portal.clubrunner.ca/3761/sitepage/vanuatu-project>



## 4.2 Energy Conservation Practices- Home Appliances

**FIGURE 14: Home Appliances**<sup>20</sup>



Figure 14 shows home appliances used. This is a representative list and varies from community to community. Apart from this power is used for mobile chargers and music systems. The tips to conserve energy in the domestic households are:

- Switch of lights, fans and TV when not required.
- Use day light when enough sun is available – probably being practiced better in rural areas than urban areas.
- Keep windows open as this allows fresh air and fan will give better air.
- Please remember to remove mobile charges from the socket, once when charging is completed.
- Refrain from connecting too many gadgets to a single socket (Figure 15).
- Check and replace any cut wires immediately (Figure 15).

**FIGURE 15: Improper Wiring**<sup>21</sup>



The wire size should be chosen as per the load demand of the house and also should be well protected with the right type of fuse /circuit breaker. The wire should not be cut and there cannot be too many connections from a single point. This will damage the system and sometimes lead to sparking and fire. The wire jointing should be proper, and no wire should be exposed. If the insulation of the wire is exposed, it will spark when water falls on it and it could cause an accident if anyone touches the exposed wire, this should be avoided. The solar panel should be cleaned with a cloth at least once a week. The battery charging should be tested regularly. The other training modules on Solar PV cover all the details and safety aspects related to Solar PV systems.

## 4.3 Energy Conservation Practices- Water Pumps

Water is used by the community for drinking, washing, cooking and for agriculture. The simplest water pump is the hand pump. This uses human energy, where the women/men operate the pump. The normal pump can be either electrically driven or via fuel. The other is the submersible pump for drawing out surface water. Some communities are switching to solar powered pumps as well. The most important component of the pump is the impeller, which is rotated by the electrical motor through a coupling. A mono bloc pump is one where motor and pump are located on the same shaft. The pump impeller should be designed efficiently for the type of operation. (i.e. Agriculture/filling overhead tank etc.). The motor driving the pump should be efficient and should be suitable to the pump.

<sup>20</sup> Prime Reviews, How Many Watts Do Appliances use?, <https://primereviews.org/how-many-watts-do-appliances-use/>

<sup>21</sup> iStock, "Overcrowded power board", <https://www.istockphoto.com/photo/overcrowded-power-board-gm497064074-78919287>

**FIGURE 16:** Types of Pumps**A**<sup>22</sup>**B**<sup>23</sup>**C**<sup>24</sup>**D**<sup>25</sup>**E**<sup>26</sup>

Figure 16 shows the types of pumps available for domestic/ agricultural. They are:

- A. Hand Pump No electrical power. Only human power Cost about VT5,000
- B. Horizontal Pump – 3HP about VT20,000
- C. Submersible Pump- 3HP about K300
- D. Solar Pump -VT150,000
- E. Diesel Engine Driven Pump- VT50,000

<sup>22</sup> National Geographic, "Freshwater pump", <https://www.nationalgeographic.org/encyclopedia/freshwater-access/>

<sup>23</sup> Amazon.in, "Kirkoskar Aqua 50 Water pump", <https://www.amazon.in/Kirkoskar-0-5hp-Aqua-Water-Pump/dp/B07DRJ5QXM/ref=>

<sup>24</sup> India MART, "Agricultural Submersible Pump", <https://www.indiamart.com/proddetail/agricultural-submersible-pump-21280879233.html>

<sup>25</sup> India MART, "Solar Water Pump", <https://dir.indiamart.com/udaipur/solar-water-pump.html>

<sup>26</sup> Sunny Power, "Diesel Engine and Electric Self-Priming Centrifugal Pump", <https://wfsunny-machinery.en.made-in-china.com/product/nwxfgsFvfrkO/China-Diesel-Engine-and-Electric-Self-Priming-Centrifugal-Sewage-Pump-Sh-24-Inches-Water-3170m3-H-Power-400kw.html>

**TABLE 9: Types of Water Pumps**

No	Type of Pump	Cost (VT) basis net prices	Use
A	Hand Pump – No Power	5,000	Water pumping up to 100 feet
B	Horizontal Pump- 3 HP	20,000	Water pumping to overhead tanks
C	Submersible Pump 3HP	30,000	Ground Water Pumping 500 feet depth
D	Solar Pump	150,000	Ground water Pumping
E	Petrol Engine Driven Water Pump	50,000	Water pumping Agriculture

The above is just an insight into the different types of water pumps available. In some places where power is not available Diesel Engine Driven pumps are used for watering the plants in the agriculture field. Other than solar pump, the others may or may not be available in the community. This is given for information purposes. Irrespective of the type of pump, the following tips need to be practiced:

### Selection of Energy Efficient Pump

- The pump should be sized based on the available water (ground, stream river).
- The depth of water below ground and the height to which water should be pumped. (Roof top overhead tank).
- A bigger pump does not mean more water. The system works depending on the availability of water.
- A big pump not suited to the requirement wastes electricity.
- If there is ground water pumping the pump cannot run continuously. The ground water regenerates periodically. There should be time for ground water to regenerate. Continuous running of bore well pump reduces water output and sometimes the pump runs dry. The ground water needs to be regenerated. Therefore, it is recommended to switch off pump for 30 minutes every 4 hours. This can be reduced during rainy season.
- There is a chance of pump running dry. Perhaps the roof top tank does not have water here could be less water in the stream or ground water. Dry running of the pumps will damage the pump and therefore should have a dry run protection.
- The pump should have a foot valve and also a filter. The filter will keep the dust off from entering the pump. The foot valve will ensure that water will not flow back when the pump is stopped.
- The normal damaging parts in the pump are foot valve, motor, coupling, gland packing. Foot valve leak can be identified when water flows back to the sump or bore. Gland packing leak can be visible at the pump.

- The coupling damage could be identified by the noise. Whenever you replace any of these parts, the spares should be purchased from an authorized supplier. It is noted that you may not have an authorized supplier close to your house and it must be in the nearest town. It is preferable to keep a list of essential spares with you.

The key element of the pump is the motor. Here again the motor should match the size of the pump. The motor can get burnt or damaged due to:

- High voltage supply
- Overload
- Dry run
- Oversize of the fuse / circuit breaker. In case of oversize, the fuse does not blow, or the breaker does not trip. It damages the motor as it will burn.

In a properly balanced system, motor burn outs are rare. In the event of a motor burning, it is essential to give it to an authorized winder. When the motor is coupled and installed after re-winding, the alignment should be proper.

## 4.4 Energy Conservation – Outboard Motor Engines

**FIGURE 17: Petrol Engine of a Boat<sup>27</sup>**



Sometimes petrol engine is used to drive the alternator (generator) to generate power. The diesel engine is also used to drive a pump for water supply. The Diesel Engine Driven Pumps do not exist in Pacific Islands. Though there are Diesel Generators (DG) of varying sizes (3 kVA upwards), the objective of the programme is use of cleaner energy source. All the generators using diesel should be replaced with solar systems. Hence, the above will not be elaborated further.

The petrol engine is used to drive boat (Figure 17). As per the data provided by the survey reports, the HP (power) of the engine is about 40 HP. This depends on size of boat. Following guidelines will help to conserve fuel and reduce marine pollution.

- The petrol engine should be selected to match the needs of the end use. For a boat, it is the weight of the boat, number of people travelling, cargo weight.
- The petrol engine uses a blend of petrol and oil (zoom) as fuel. This is two a stroke engine. The four-stroke petrol engine uses petrol as fuel and oil for lubrication. The engine can also be run on biogas, ethanol and blended fuels.
- It is essential to buy good quality fuel from a good petrol pump. The fuel if procured through other sources might be adulterated. It can be adulterated with kerosene, lube oil.
- Refrain from buying fuel from other sources lest your engine power output will be less, you will be stuck in the boat.

- The Engines will have a tank attached to the engine and then petrol will flow to the engine. The connecting pipeline could be metal, plastic, rubber. Plastic and rubber pipes are prone to damage and the diesel can leak. This can also lead to theft of fuel. Preferable to use metal pipes as it is not easy to cut a metal pipe. It is a good practice to use braided hose.
- Like firewood Zoom, diesel, petrol also requires air for combustion. Here you don't see the flame as it is inside the engine and the temperatures are very much higher. The indication of proper combustion here is the smoke. A very high quantity of smoke means the exhaust gases are not freely flowing out of the engine to the atmosphere. Thick black smoke means less air or unclean air. White smoke means water. The smoke should be light brown and mildly visible away about a meter from the exhaust.

The next important aspect of petrol Engines is maintenance. There are manufacturer recommendations on maintenance (Oil change, filter change, spark plugs, cleaning of carburetor etc.). A brief on maintenance is given later. The engine requires engine oil for lubrication. The oil needs to be topped up and after some hours of operation needs to be changed. The oil that is drained when there is an oil change is sometimes sold to an oil recycler. It is a good practice to use fresh oil for oil change and recycled oil for top up.

## ACTIVITY 4

**Target:** Local government officials, Provincial Councils, District Councils, Town Councils, Island Councils, etc.

### 1. What are the energy inefficient measures in your community?

- Lights / TVs/ chargers always on.
- No access to energy efficient equipment in the community.
- No money to buy energy efficient equipment.

### 2. How will you help your community to be energy efficient?

- Policy decisions to promote energy efficiency and conservation.
- Facilitate sourcing of funds for procurement of energy efficient equipment (lights, fans, pumps).
- Understand the maintenance issues of already installed equipment and facilitate rectification.

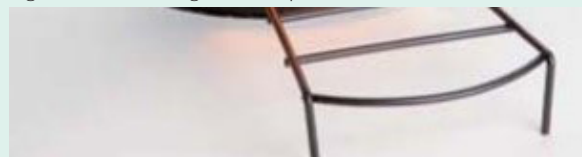
**Target:** Traditional community/religious leaders, women, youth(s) and vulnerable groups (single mothers and elderly).

### 1. What are the harmful effects of present method of cooking in the community?

The community uses waste wood, leaves and others from the forest. They are used in conventional stoves. The smoke from the stove, dust from handling firewood are inhaled by the women and children and these lead to respiratory diseases.

### 2. What are the basic principles of energy efficient stove?

- The energy efficient stove working principle is given below:
- A grate or fuel magazine to place fuel





- Combustion Chamber where air enters at the bottom and mixes with the fuel






- Top for placing pot for cooking and exhaust gases



**3. List some steps for energy conservation?**

- Switch of lights, fans and TV when not required.
- Use day light when enough sun is available – probably being practiced better in rural areas than urban areas.
- Keep windows open as this allows fresh air and fan will give better air.
- Remember to remove mobile charges from the socket, once when charging is completed.
- Refrain from connecting too many gadgets to a single socket.
- Check and replace any cut wires immediately.

**4. Match the type of Pumps looking at each figure in the table below**

Picture	
	Hand Pump
	Normal Pump
	Submersible Pump



Solar Pump

### 5. What are the tips for energy conservation in pumps?

- The pump should be sized based on the available water (ground, stream river).
- The depth of water below ground and the height to which water should be pumped. (Roof top overhead tank).
- A bigger pump does not mean more water. The system works depending on the availability of water.
- A big pump not suited to the requirement wastes electricity.
- If there is ground water pumping the pump cannot run continuously. The ground water needs to be regenerated. Therefore, it is recommended to switch off pump for 30 minutes every 4 hours.

**Target:** Local electricians, people with technical aptitude, etc.

#### 1. List measures you would practice in your work for energy efficiency.

- Help in selection of proper equipment (lights, pumps, boat engine).
- Ensure they are serviced properly by following preventive maintenance schedules (oil changes/inspection of electrical systems, rating of fuses etc.).
- Ensure proper safety practices.

**Target:** Small Business

#### 1. How will you ensure your business activities are energy efficient?

- Source and procure efficient equipment with correct name plate details.
- Understand and ensure guarantees are implemented.
- Help in servicing the equipment.
- Proper disposal of waste generated so that inefficient equipment does not get back into the market.



5

Energy Efficient  
Technologies

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## 5.1 Alternate Fuels

**FIGURE 18: Biomass Pellets<sup>28</sup>**



Biomass pellets are made from shrubs, firewood and logging waste from the forest and used for fuel purposes, and their advantage is that fuel for cooking is free and has zero value in terms of money, plus produces less smoke and less pollution.

**This technology is not in use in the countries covered. Nevertheless, this is given as an example for development in the future as good green business initiative.**

Biomass is collected shredded to size. This is then mixed with a binder and extruded in an extruding machine. This is given as an example, as the community needs to pay money for buying pellets. However, this improves the health of women, as they spend long hours in cooking and are exposed to smoke.

The community generates various type of wastes (animal dung, vegetable, and animal waste). Presently some are converting it to compost. This uses the fertilizer value, and the energy value is lost. A biogas plant can be used for recovering biogas for cooking and the outlet of the biogas plant as fertilizer. Apart from cooking, biogas can be used in engines and gas lights.

**FIGURE 19: Launching of biogas plant at Vanuatu Agricultural College<sup>29</sup>**



The business options for both biomass pellets and biogas plants are covered in Green Business Basics.

## 5.2 Energy Efficiency Technologies – Lights and Fans, Refrigerators

**FIGURE 20: Lighting Sources**

A<sup>30</sup>



B<sup>31</sup>



28 India MART, "Biomass Pellets", <https://www.indiamart.com/utsav-biofuel-industries/biomass-wood-pellet.html>

29 Energy Focus Newsletter, "Official launching of the Vanuatu Agriculture College Biogas System", [https://doe.gov.vu/images/docs/News-Events/ENERGY-Newsletter\\_One.pdf](https://doe.gov.vu/images/docs/News-Events/ENERGY-Newsletter_One.pdf)

30 Shutterstock Images, "Kerosene lamp", <https://www.shutterstock.com/image-photo/kerosene-lamp-lantern-on-wooden-background-560089849>

31 Source: ANY-LAMP.COM "Standard Incandescent Low volt Clear", <https://www.any-lamp.com/standard-incandescent-low-volt-clear-a55-e27-60w-36v-8719157999748>

C<sup>32</sup>



D<sup>33</sup>



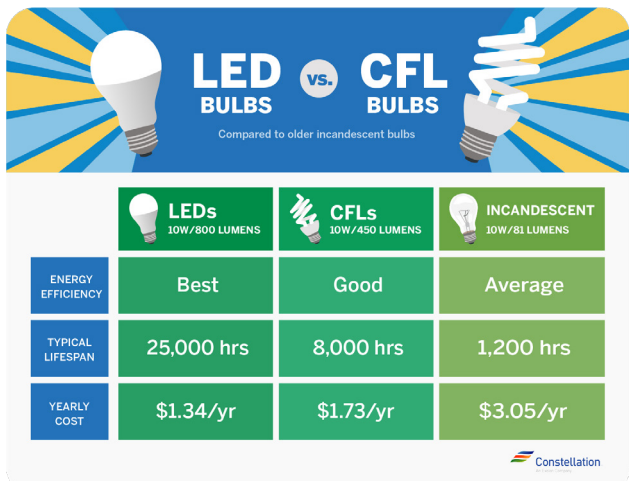
Some communities in other Pacific Island countries still use kerosene lamps (Figure 20A) and candles for lighting. The kerosene lamp generates smoke. The glass of the lamps needs to be cleaned often. The objective of this programme is to promote weaning away from kerosene by energy efficient lighting.

Figure 20B shows the general incandescent lamp (bulb). This is the earliest version of the light source and is cheap. The second figure (Figure 20C) is the compact fluorescent lamp (CFL) and the latest version is LED -20D (Light Emitting Diode).

Apart from cooking the major energy need of the community is energy efficient Lighting.

A normal consumes 60 W of electrical power. The CFL consumes 18W, whereas LED consumes only 7W for delivering same amount of light. The GLS lamp emits more heat whereas the LED emits far less heat. A normal bulb costs less than 20 US cents. The cost of good quality LED is about 1 USD. Also, the LED type light lasts longer, gives more light and uses less energy as well. Whenever you save energy, it also reduces heat emitted to the atmosphere. The comparison is given below in Figure 21 (energy cost in USD):

FIGURE 21: Comparison of Light Sources<sup>34</sup>



The solar lantern using a small panel or solar home lighting systems are the answer to the community's lighting needs. They all use LED lights. Solar based systems have been covered separately in the RE part.

The LED consumes 60% less energy and 30% less energy than CFLs. Though costly, the life of the LEDs are more than 5 years. Many lamp suppliers give a guarantee of up to 2 years. Compared to the kerosene lamp, the light output of LED is many times higher. This makes one feel comfortable while readings books, which is especially useful for children studying under proper and well light room.

FIGURE 22: Energy Efficient Equipment<sup>35</sup>



32 Source: Amazon.in, "Philips Essential CFL (Cool Day Light, 14W)", <https://www.amazon.in/Philips-ESSENTIAL-14-00-Watts-Light/dp/B00K9096LK>

33 Source: Amazon.in, "Luker 3- Watt Led Bulb (Pack of 3, Cool Day Light)", <https://www.amazon.in/Luker-3-Watt-Bulb-Pack-Light/dp/B0756BMR35>

34 LED Vs CFL Bulbs: Which is More Energy, <https://blog.constellation.com/wp-content/uploads/2016/03/CFL-vs-LED-bulbs.png>

35 Red refrigerator, <https://www.spiele-schenken.top/ProductDetail.aspx?id=191426532&pr=87.99>

A typical energy efficient fan and refrigerator are given in Figure 22. The Comparison is given below in Table 10.

**TABLE 10: Comparison Energy Efficiency Fan and Fridge**

Equipment FAN	Conventional	Energy Efficient
Power Consumption – Ceiling (W)	70	30
Average Energy consumption for 1000 Hrs. (kWh)	70	30
Energy Consumption at lower speed	No change	Lower due to electronic regulation
Cost (VT)	1,500	4,500

Equipment Refrigerator	Conventional	Energy Efficient
Normal Operating Temperature (°C)	Deep Freezer (-18) Fridge 3 – Manual Control	Deep Freezer (-18) Fridge 3 – Automatic Control
Approximate Energy consumption (kWh) 250 liters	700	400
Cost (VT)	50,000	65,000

The life span of a ceiling fan, pedestal fan and table fans are very long. Some of them go beyond 10 years, however, most of them only rotate and the air delivery / circulation is poor. On the contrary energy efficient fans have an improved blade design which gives better air flow. They consume 50% less energy and come with guarantees. The community uses pedestal fans. There is no energy efficient version for this at present.

There might be few refrigerators/ bottle coolers used by shop keepers in the community. These may be very old and may consume more energy. Furthermore, there is little / no temperature control. For vegetables, milk, eggs, soft drinks the cooling temperature is 15 to 18°C. For meat items, ice creams the temperature is -5°C. The old fridges consume 30% more energy compared to the latest new energy efficient ones. The new fridge, though expensive, is a viable option for replacement.

## 5.3 Energy Efficient Technologies- Entertainment and Communication

The difference between noise and music must be appreciated. Probably what is noise to some may be music to others. Poor quality and poorly wired music system consume energy, and the music quality is poor. An old TV though cheaply priced, usually has bad sound and picture quality is bad and consume more energy.

**FIGURE 23: Mobile Charger and TV<sup>36</sup>**



36 Energy Star "Television", <https://www.energystar.gov/products/televisions>

In these days of modern communication, the cell phone charger (Figure 23) is more of a necessity. The voltage, capacity of the cell phone charger must match the phone. Poor quality chargers use up more power and take longer time for charging. There have been cases where the cell phones have been damaged due to poor quality charger and poor quality of power supply.

In order to save energy and be safe, use a good quality charger and ensure it is connected to a proper socket with the correct voltage. Remember to remove the cell charger from the socket. Most solar power kits come with USB ports for phone charging, which makes it easier to charge different phones form the same USB port safely.

### 5.4 Identification of Energy Efficient Equipment

Any Gadget will come with a name plate. Check on the voltage to be used (230 V) and power consumption (w). [A representative name plate is given below:](#)

FIGURE 24: Name Plate – LED<sup>37</sup>



The name plate shows 10W which is the power consumption, and the operating voltage is 220 to 240V.

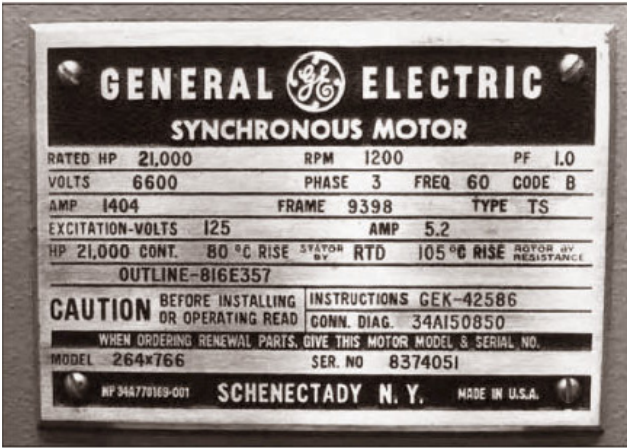
- Energy Efficient Labelling. This is described later.
- All the energy efficient equipment come with a guarantee. (5 years for LEDs, 3 years for fan, 10 years for refrigeration compressor). These are examples and can vary from country to country. Insist on a guarantee.
- Take care of the supply voltage.

FIGURE 25: Name Plate Motors

A – Normal Motor<sup>38</sup>



B – Energy Efficient Motor (see IE4 and 86.5% efficient)<sup>39</sup>



GE Motor Name Plate Details

<sup>37</sup> Power Electronics talk; LED bulb with CE mark: <https://www.powerelectronicstalks.com/2018/10/ce-and-ce-mark-process.html>

<sup>38</sup> Source: Electrical4 u, Nameplate, <https://www.google.com/search?q=tps%3A%2F%2Fwww.electrical4u.net%2Fnameplate-details%2Fsynchrous-motor-nameplate-details-explanations%2F&rlz=>

<sup>39</sup> Montana Resource Efficiency Project; <https://www.electrical4u.net/nameplate-details/synchronous-motor-nameplate-details-explanations/%20/www.mtefficiency.org/energy-efficient-motors-toolkit/>



## ACTIVITY 5 for all target groups

### 1. What is the difference between biomass pellets and biogas?

Biomass pellets is collection of biomasses, segregate and make pellets. This is a solid fuel.

Biogas is generated from a digester and generates Biogas. This burns like a gas.

### 2. State whether the following statements are true /false

Light Source		True or false
	Least Polluting	False
	Cheapest Light Source	False
	Generates large heat	True
	Moderately efficient	True

### 3. What is the energy consumption of energy efficient fan and energy efficient refrigerator?

An Energy Efficient fan consumes 30 kWh per annum for a running of 1000 hrs. The energy efficient fridge consumes 400 kWh per annum runs continuously.

### 4. What are the normal operating temperatures of a fridge?

For Deep Freezer -18°C and fridge 3°C.

6

Energy Efficiency  
Labelling

---

What is an energy star rating? The government specifies certain Minimum Energy Performance Standards (MEPS). These are set by the law for few of the equipment. The equipment procured and used are to comply with the standard. This applies to both indigenous and imported equipment. There are specified test procedures to ensure that the energy consumption of the product is within the limits prescribed. The label of the energy star equipment clearly specifies the energy consumption per hour.

Energy labelling—mandatory on-product labels will provide buyers with consistent, reliable information so that consumers can take running costs into account when they purchase new appliances. Minimum Energy Performance Standards (MEPS)—set legally enforceable minimum levels of energy efficiency for appliances to be sold in Vanuatu. The program will initially only apply to refrigerators and freezers. (Figure 26).

**FIGURE 26: MEPS Star ratings for Refrigerators<sup>40</sup>**



Vanuatu has Enforcement of Electrical Appliances and Equipment Lighting Products Act. As per this act the appliances should meet the standards of Fiji/ Australia and New Zealand. There are no known standards in PNG and Solomon Islands. What is an energy star rating? The government specifies certain Minimum Energy Performance Standards (MEPS). These are set by the law for few of the equipment. The equipment procured

and used are to comply with the standard. This applies to both indigenous and imported equipment. There are specified test procedures to ensure that the energy consumption of the product is within the limits prescribed. The label of the energy star equipment clearly specifies the energy consumption per hour. The aim of each community member is to use only energy star rated equipment.

## ACTIVITY 6

**Target:** For all target groups.

### 1. What is energy star rating?

The government specifies certain Minimum Energy Performance Standards (MEPS). These are set by the law for few of the equipment. The equipment procured and used are to comply with the standard. This applies to both local and imported equipment. There are specified test procedures to ensure that the energy consumption of the product is within the limits prescribed. The label of the energy star equipment clearly specifies the energy consumption per hour.

<sup>40</sup> Sustainability Victoria, "Energy rating labels", <https://www.sustainability.vic.gov.au/energy-efficiency-and-reducing-emissions/save-energy-in-the-home/energy-rating-labels>



A large, white, stylized number '7' is positioned on the left side of the page. The background is a gradient of teal and blue, with a vertical line separating the blue section on the left from the teal section on the right. The number '7' spans across this line.

**Energy Efficiency  
Community Initiatives —**

The community (men, women, and children) play a major role to conserve energy, initiate measures to procure energy efficient equipment. As per the data available, the community use firewood, charcoal etc. for cooking- this is the primary need. The secondary need is they need electricity for lighting, TV, mobile charging. They need water for domestic and agricultural uses. Every member of the community should appreciate the need to conserve energy, buy energy efficient equipment and use renewable sources of energy.

**FIGURE 27: Energy Efficiency Initiatives<sup>41</sup>**



Figure 27 explains the concept of energy Efficiency. In energy efficiency when you save a watt of power this can be used by others. This will save money on investing in power plants, power lines.

The community members can initiate the following to conserve energy and make it last longer:

- Use of firewood properly. This could be done by transporting it properly, storing them properly and using it meticulously. Progressively use energy efficient cooking stoves. This is essential as LPG cooking is still a far cry.
- Move away from kerosene either for cooking or lighting. This is a polluting fuel, gives lesser light.
- Move towards use of solar lanterns, solar home lighting systems etc. The community leader can ensure every member of the community follows this.
- Examine setting up community biogas plants both for energy and fertilizer. Sensitize your government to invest on it.
- The other important source is water. The community leader ensures water is used meticulously and not wasted. Plan and invest on proper clean water supply.
- Recycle wastewater for agricultural purposes.
- The community leader also ensures everybody has access to safe and clean drinking water.
- Shift from Generator to solar power.
- The community leader also ensures solar pumps are used and also there is no over exploitation of ground water.
- The community leader should also have the authority to prevent people from adopting energy inefficient practices.

- People should make a habit of switching off lights, TVs when not required. They also remind others to follow.
- All equipment consuming energy should be maintained properly so that they last longer.
- With proper facilitation, the community can work on and implement suitable financing model to raise money for energy efficiency and renewable energy equipment.

## 7.1 Role of Women, single mothers, widows, orphans (vulnerable groups)

Very vital for this topic. They are the ones who walk miles to get firewood and water. They are the ones who face the smoke while cooking. After a hard day's work, they are the ones who sit next to the kerosene lamp. Energy efficient initiatives will improve the quality of life for women.

**FIGURE 28: Role of Women<sup>42</sup>**



Therefore, the women (Figure 28) are the key beneficiaries of energy efficient initiatives. Cleaner cooking improves health (energy efficient stoves), reduces cooking time. LED lamps and solar system gives them more time to work and children to study. This reduces pollution from kerosene lamps.

Women, single mothers, widows, and orphans must also be recognized as equal partners in this initiative and encouraged to participate in the community discussions so that they get an opportunity to share their experiences.

<sup>41</sup> Source: Energy and Climate partnership of the Americas, <https://ecpamericas.org/news/today-is-the-world-energy-efficiency-day/>

<sup>42</sup> World Bank Vanuatu Rural Electrification Project, <https://www.worldbank.org/en/news/feature/2017/05/22/vanuatu-rural-electrification-program-benefits-remote-communities>

## ACTIVITY 7

**Target:** Local government officials, Provincial Councils, District Councils, Town Councils, Island Councils, etc.

### 1. How do you promote energy efficiency initiatives in your community?

- Government funded awareness campaigns.
- To start with target and implement all government offices use renewable sources of energy and also energy efficient equipment. Later move to the community for implementation.
- Ensure any donor equipment (individuals/ foreign agencies) include a cost component of at least 10 years to maintain the equipment.
- Take measures to dispose of any inefficient equipment are properly disposed.

### 2. How do you ensure participation of women and other vulnerable groups participate in these activities?

Ensure that in any government initiatives (training, campaigns) at least 30% of the women and those of these vulnerable groups are included.

**Target:** Traditional community/religious leaders, women, youth, and vulnerable groups (single mothers elderly), etc. Local electricians, people with technical aptitude, etc.

### 1. Name of some of the energy efficiency initiatives for the community?

- Proper use of firewood. For example, proper transport, storage and use of the resource. Progressively use energy efficient cooking stoves. This is essential as LPG cooking is still a far cry.
- Move away from kerosene either for cooking or lighting. This is a polluting fuel, gives lesser light.
- Move towards the use of solar lanterns, solar home lighting systems etc. The community leader can ensure every member of the community follows this.
- Examine setting up community biogas plants both for energy and fertilizer. Sensitize your government to invest on it.
- The other important source is water. The community leader ensures water is used meticulously and not wasted. Plan and invest on proper clean water supply.
- Recycle wastewater for agricultural purposes.
- The community leader also ensures everybody has access to safe and clean drinking water.
- Shift from Generator to solar power.

- The community leader also ensures solar pumps are used and also there is no over exploitation of ground water.
- The community leader should also have the authority to prevent people from adopting energy inefficient practices.
- People should make a habit of switching off lights, TVs when not required. They also remind others to follow.
- All equipment consuming energy should be maintained properly so that they last longer.
- With proper facilitation, the community can work on and implement suitable financing model to raise money for energy efficiency and renewable energy equipment.

### 2. How do women benefit from energy efficiency initiatives?

The women are the key beneficiaries of energy efficient initiatives. Cleaner cooking improves health (energy efficient stoves), reduces cooking time. LED lamps and solar system gives them more time to work and children to study. This reduces pollution from kerosene lamps.

Women must also be encouraged to participate in the community discussions on the so that they get an opportunity to share their experiences.

**Target:** Small Businesses.

### 1. How does this chapter help you in business?

- Looking for new products (stoves/biogas plants etc.).
- Ensure appropriate guarantees are given by the original equipment manufacturers.
- Understand the basic technical details.
- Refrain from marketing inefficient products.
- Convince people that additional cost of buying energy efficient appliances will save money in the long run.

## Conclusion

**FIGURE 29: Energy Conservation<sup>43</sup>**



Prolonged and continuous education and awareness campaign is a must for them to appreciate the positive impacts of energy conservation. Once the community starts practicing energy conservation, they will see the benefits of using energy efficient equipment and also shift to localized renewable sources of energy – this results in a more energy efficient economy, reducing pollution, improving the quality of life.

Improving the above measures and continual improvement results in a more sustainable community.

### THIS IS THE ROUTE TO ENERGY EFFICIENT SOCIETY

## Role Play

The members of the community are to then act out a role play. For this, learners may volunteer, or trainer can choose learners to act out certain roles. For this role play, 5 people are needed to play the roles of Kensie (Dad), Vivian (Mom), Paul (son), Ana (teacher) and Moses (principal).

Kensie and Vivian live in one of the rural communities. Kensie works as a mechanic in the nearby town. He cycles his way to the town every day and returns late in the evening. They both have a 10-year-old son named Paul. He goes to a nearby school. Vivian gets up early, cooks food packs lunch for Kensie and Paul. After Kensie lives for work and Paul to school, Vivian goes to fetch water from a stream about 2 km away and also collects firewood on the way. Their cooking needs are met by firewood collected from the forest and they have a small kerosene lamp. The smoke from the firewood makes Vivian and Paul cough. Paul strains his eyes to read.

Paul's teacher, Ana attended a training program on renewable energy. Ana has been asked by the school management to teach the children about the benefits of renewable energy. She gladly does it, hoping at least some of them will acquire these systems.

In the evening, while Vivian is cooking food and Kensie relaxing, after a day's hard work. Paul is studying and remembers his teacher's class.

**Paul:** Dad!!! Mummy is cooking in firewood stove, and I am

studying in the kerosene lamp. I often heard mummy coughing due to the smoke from the stove. I am also straining my eyes as the light is not enough from the kerosene lamp. My teacher today told me about smokeless stove and also solar powered lighting. She also told me you can charge your mobile phone from it.

**Dad:** Yes, my son!!!, Have also heard about solar lights. Have seen it in some of the huts when I go to work. The lights are bright.

**Paul:** Dad, why can't we buy one?

**Dad:** They are costly and with my meagre income cannot afford it. Probably when I earn more, we can save money to buy a smokeless stove and solar light.

Paul was not convinced about his dad's answer and starts thinking. He later falls asleep.

Next Day as he enters his school, he meets his teacher.

**Paul:** Good Morning Teacher.

**Ana:** Good Morning, Paul. Did you tell your parents about what we discussed about renewable energy?

**Paul:** Yes Teacher. I did.

**Ana:** What did your father say?

<sup>43</sup> India Mart; "Energy Conservation Building and Green building", <https://www.indiamart.com/protek-consult/power-conservation-products.html>

**Paul:** He said, we are poor, and we can't afford one.

**Ana:** OH! Let me see how you can help you

**Paul:** Thanks Teacher, we would really appreciate your help.

After some time, the principal (Moses) of the school asks Ana about her class on renewable energy. Ana told the principal that her students are poor. The principal says that is no problem. The nearby bank has some schemes for giving loan for renewable energy system. The investment on both energy efficient stove, solar panels and lights should be about VT20,000. This can be paid back over 36 Months period.

Next day at school

**Paul:** Good Morning Teacher.

**Ana:** Good Morning, Paul. I spoke to the principal, and he told me that he can arrange money from the bank for you to buy stove and lamp. If our dad is interested, please bring him and I will tell him the details.

**Paul:** I will tell him and bring him.

In the evening

**Paul:** Dad my teacher told me that the school principal will arrange a loan from the bank and told me to bring you to the school. She said she will explain you how to go about it.

**Kensie:** OK. I will come and meet the teacher.

Next Day:

Paul and Kensie go to the school.

**Kensie:** Good Morning teacher. Paul told me about solar energy and also the loan from the bank.

**Ana:** Yes. You have a smart son. If you have good lighting he can study for more time, grow up to become a good professional.

**Kensie:** Madam! I realize the importance of good light and reduced smoke by a better stove. I can't afford due to poverty.

Just then the principal Moses walks in

**Ana:** Good Morning Sir.

**Moses:** Good Morning Ana. What's Happening?

**Ana:** Meet Kensie- Paul's Father.

**Moses:** Halo Kensie. What can I do you for you?

**Kensie:** Paul told me about the stove and solar system. Though would like to use smokeless cooking in my house and solar

system, I can't afford one.

**Moses:** Don't worry Kensie. Tomorrow you take a day off from work and I will take you to the bank. I will arrange a loan for you.

**Kensie:** Thank you sir will see you tomorrow.

Next day the principal takes Kensie to the bank and requests for loan to Kensie for solar system and stove. The bank manager agrees to give the loan. He told the principal the money will directly be given to the suppliers of the equipment approved by the bank. The monthly instalment will be paid by Kensie to the bank. Kensie and the principal returned after completing the formalities.

A week later the equipment supplier arrives with the following:

- An Energy Efficient Stove using firewood.
- A solar system with one LED lamp, battery, and a fan. The system has one mobile charging point.

The system has been installed. Vivian is very happy at the stove and extremely low smoke. No more recurring coughs. Paul is thrilled at the bright light for him to study.

Two days later Kensie goes to Paul's School and thanks the teacher and the principal for the help. He invites them home to see the systems.

Ana and Moses arrive at Kensie's house the following evening.

**Kensie:** Welcome Ana and Moses. This is Vivian, my wife and you know Paul.

**Moses:** Good evening. Nice to see good light and cooking facility.

Ana explains and compares with the material she trained.

**Ana:** The solar panel is the one that generates power and the battery stores power. The battery can give power for about 4 hours. The use of LED light reduces energy consumption by about 60% compared to the normal bulb. The fan is also energy efficient. What about your stove Vivian?

**Vivian:** Great! No smoke faster cooking with reduced fuel consumption. My cooking time has reduced by half. Thanks a lot.

**Moses:** Wonderful! Remember to maintain them properly. Olive, please remember to pay loan money every month regularly. If you clear this loan, can request the manager to give you more money. Emma!! Now since you have more light study well and shine well.

**Kensie:** Thank you very much for the help. Will take care to pay the loan promptly.

**Paul:** Thank you sir and teacher. Will study well.

Ana and Moses leave feeling satisfied for helping a family.

# 8

## Annex: Tips -Electricians / Technical Aptitude —————

## 8.1 Electrician

**Note:** Check the name plate details voltage/current/single phase/ three phases.

**FIGURE 30: Electric Maintenance<sup>44</sup>**



Electric maintenance is an important requisite in our household but can be very dangerous if handled callously. Most of the electricity-related accidents that occur in homes are due to lack of knowledge on electrical safety & knowhow. Here are some tips to prevent accidents & electrical oversights:

### 1. All electrical equipment should be in proper working condition

One of the primary causes for short circuits in the electrical system is equipment that is not working or plugged in properly. Hence, all the electrical equipment in the house should be checked for malfunctions.

### 2. Main Power Off

Power switched on during any work on the home's electrical system can be a major reason for shocks & accidents. Always switch off the main power during major electrical maintenance activities. In case of small power outlet related maintenance, always switch off the plug point and work.

### 3. Warm & Cold Power Outlets

At times, warm power outlets can signal a variety of problems, from overloaded electrical circuit to shot up wiring. Hence, check all the outlets in the house once every month by placing your hand on the outlets in your home. Warm or hot outlets signal trouble.

## 4. Fire Extinguisher

Always have a fire extinguisher handy in the house. Water is a good conductor of electricity & hence should never be used to put out any electric fire, big or small.

## 5. Ground Older Appliances

Your old appliances might develop grounding issues as a result of normal wear & tear. This can put you at a risk of shock. Ensure all of your appliances have three-pronged plugs that can properly connect to a grounded outlet. Any kitchen appliances with just two-pronged plugs should be replaced.

## 6. Expert Intervention

In case of any doubt, one should consider the help of an expert. Always reach out to a well-trained electrician if an issue seems out of hand and needs more intervention.

## 7. Rooms with running water need to be equipped with Ground Fault Circuit Interrupters

GFCI's shut off the electrical current from a circuit whenever it detects that the circuit has become a shock hazard. It is imperative that they are installed in the bathroom, kitchen and laundry room to avoid any mishaps.

## 8. Do not use extension cords for longer durations time

Extension cords should never be considered as a permanent source of power. Though they are great for temporary usage, but if you end up using an extension cord all the time, then you should think of getting an outlet installed instead.

## 9. Overloading

Always avoid overloading a single outlet. Outlets are made to put out a certain amount of energy. Multiple high-wattage appliances plugged into the same outlet can be very unsafe. If you can't rearrange your appliances to different outlets, consider installing a new outlet to relieve some of the stress on the original outlet.

Electrical work is hazardous if not handled properly. Professional electricians receive years of training and on-the-job experience before they start their careers as one. Use discretion when attempting your own electrical work. To make sure all the electrical systems in your home are safe, up to code and working as they should, hire a trusted electrician to handle the job.

<sup>44</sup> Source: Kolibri, "Coaxial Network Installation", <https://kolibri.ca/wp-content/uploads/2019/10/multipleutilisation-328x328.jpg>



## 8.2 Plumbing

**FIGURE 31: Plumbing**<sup>45</sup>



- Fix leaking faucets and showerheads. Dripping faucets can waste a lot of water and that can add to your bill. And if you don't fix a dripping faucet or showerhead, the drip can get worse over time. Those problems can cause water damage. To prevent problems, check your faucets regularly for leaks and make repairs as needed. Check the handles to make sure no water drips when the handles are turned to the off position and check underneath the sinks for water stains or drips when the water is running.
- Unclog slow drains. When the water is slow to drain there may be a problem. Before it gets out of hand, use a homemade mixture of vinegar and hot water to flush down the drain and unclog any debris. This preventative maintenance tip can be done every few months and will get the drain flowing again.
- Check all exposed pipes and appliances for water leaks. Your disposal, refrigerator, or water heater can be the source of a leak. Look at any manufacturer's requirements for maintaining your appliances. Watch for visible signs of a leak such as water stains on walls and ceilings, or puddles of water. Also be wary of mildew. Installing a drip tray underneath your water heater and washing machine can help limit damage if a leak were to occur.
- Fix leaking toilets. Sometimes a faulty seal around the valve seat can cause your toilet to run even when it is not flushed. Over time, gunk will form around the valve seat and flapper. This gunk will prevent the flapper to seal properly, which will cause the water to continue to run. Another problem could be with the handle or tank stopper. The repair that is needed is often quick and inexpensive maintenance.
- Be careful what you flush or pour down the drain! The problem with drains and toilets is that so many things can get flushed down them. The easiest way to prevent problems with your pipes is to be careful what you flush or pour down them to begin with. Don't flush anything other than toilet paper and human waste down the toilet. Don't pour anything that can be reactive down the drain.
- Check the water pressure. Water pressure is how much force is coming out of your faucets and shower heads. You can test the water pressure on your system with a pressure gauge to make sure it is at a safe level. One other preventative measure is to add a pressure regulator to maintain your water pressure at a safe level.
- Remove and clean your shower head of any sediment that may have accumulated. This can improve the water pressure of your shower head.
- Drain your water heater to remove sediment annually to semi-annually. Over time your water heater can get sediment in it and become less effective.
- Look inside the burner chamber of your water heater. You shouldn't see any flakes of rust inside of the chamber. And verify the flame of the water heater is a blue color with no signs of yellow in the flame. If you see a yellow color, this may mean that the jets need to be cleaned.
- Check the hoses for signs of cracks, brittleness, or leaking. Replace your hoses as needed.
- If you have a septic tank, you should have it regularly inspected. Add pumping your septic tank to your list as an important part of maintenance.
- If you have a sewer system, it is good to understand how your lines run and inspect for tree roots that could potentially damage your sewer lines. A preventative measure would be to have your sewer lines checked periodically to avoid clogging.

<sup>45</sup> Workever.com, <https://workever.com/blog/streamlining-planned-and-preventative-maintenance-ppm-for-the-plumbing-industry/>

### 8.3 Petrol Engines

FIGURE 32: Diesel Fuel Cap<sup>46</sup>



- Monitor Your Coolant. Your engine's coolant is one of its most important maintenance needs. ...
- Keep It Clean. Keeping your engine clean is very important for its preservation. ...
- Fuel Filter Changes.
- Effective Air Filters changes.
- Appropriate Oil Changes.
- Follow Engine Manufacturer maintenance schedule.
- Regular Spark Plug Cleaning and maintenance.
- Used Authorised Spares.

<sup>46</sup> Source: Dreamstime.com "Diesel fuel cap", <https://www.dreamstime.com/stock-photo-diesel-fuel-cap-filter-labeled-use-image59501926>







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