
Rotary Club Suva Presentation

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Renewable Energy Explained

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Renewable energy explained - outline

Outline

- 1. Introduction – what is Renewable Energy?*
- 2. The Global perspective*
- 3. A brief survey of renewable energy and technologies*
- 4. Requirements for a Renewable Energy industry*
- 5. What Fiji needs now*

1. What is renewable energy?

- Renewable Energy is energy that can be replaced, i.e. energy that will “not run out”
- It is energy that comes from the sun.
- Fossil fuels (petrol, diesel, natural gas) are non-renewable, i.e. will run out eventually
- Nuclear energy is also non-renewable
- Renewable energy is energy that is “recently derived” from solar energy

Renewable energy intro.(cont.)

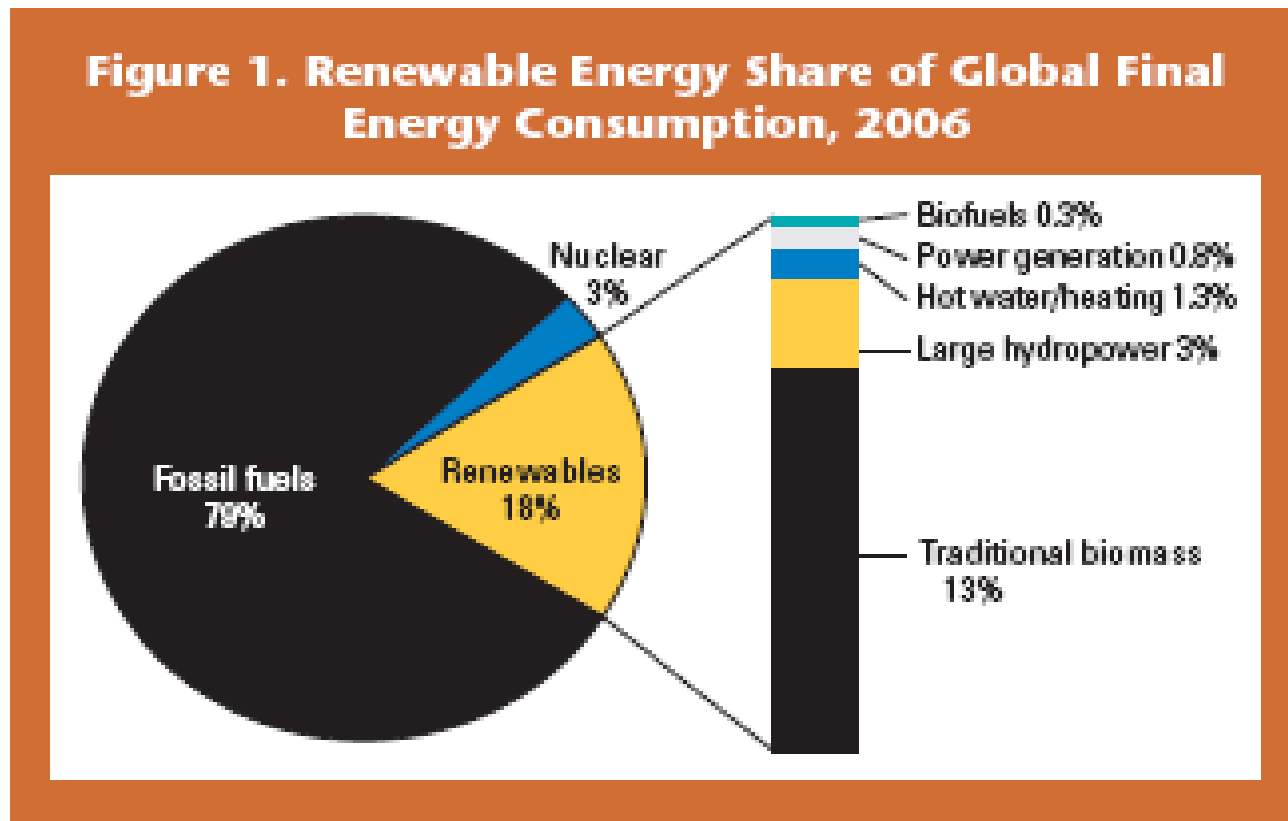
Examples are

- ❑ Hydro-energy
- ❑ Solar energy (PV and solar-thermal)
- ❑ Wind energy
- ❑ biomass and biofuel
- ❑ Geothermal
- ❑ ocean energy

2. The Global perspective

- share of global total energy

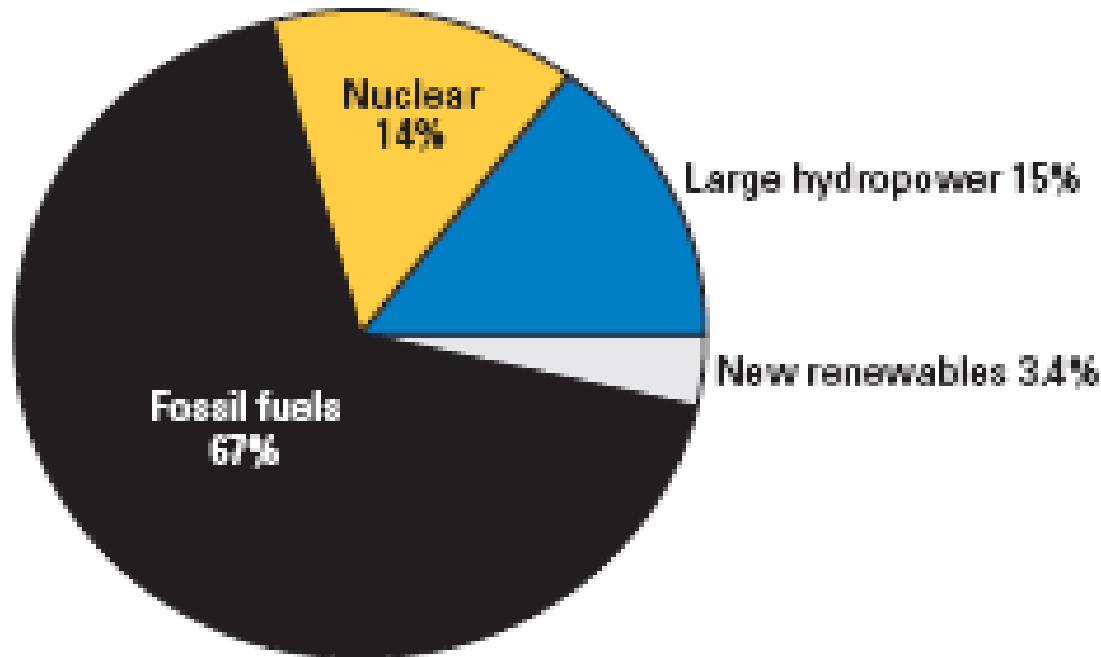
Source: (REN21) Renewables 2007: Global Status Report



Global perspective – RE in power generation

Source: Renewables 2007: Global Status Report

Figure 2. Share of Global Electricity from Renewable Energy, 2006



Renewable energy and the environment

- Renewable energy is clean energy
 - Less pollutants than fossil fuels
 - Global warming:
 - Three main GHGs are carbon dioxide, methane and nitrous oxide
 - wind, hydro, solar, ocean energy have zero emissions
 - But beware carbon debt situations
 - Biomass is “carbon neutral”
 - But recent studies show large carbon debts can be incurred during planting of biofuel crops

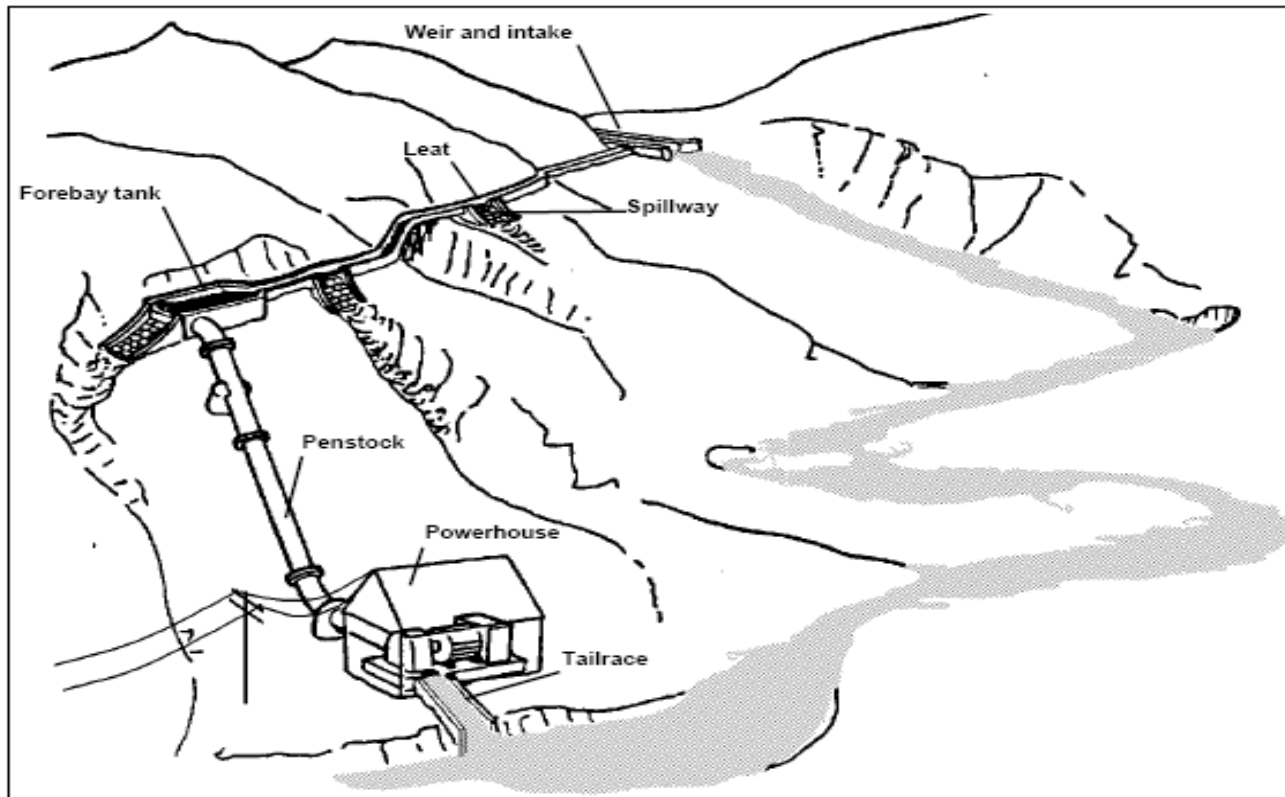
3. A brief survey of renewable energy technologies: a) Hydropower

Hydro-power is the most established form of renewable energy

- ❑ Technology started ~ 100 years ago (water-wheels for mechanical power), turbines last 50 yrs
- ❑ rapid response for power generation – used for both load and peak demand
- ❑ high efficiencies (~ 90%)
- ❑ Large hydro provides 770 GW, or 15% of global electrical power requirements
- ❑ Small hydro provides 73 GW, or 1.4%

Principles

Hydro-scheme components



The effective head H_a is the vertical height of the Penstock less head losses, and the flow rate is the volume of water passing a point in the penstock per second.

Principles (cont)

Weir and intake for a mini hydro scheme – the Sadap minihydro



Photo 2. Intake structure of the Sadap MHP rural electrification scheme financed through district government development funds.

Net Head (H _n)	14.5 meters
Flow (Q)	100 liters / sec
Power (P)	8 kW
Turbine Type	Cross Flow T-14
Generator Type	Synchronous
Controller Type	Electronic Load Controller (ELC)

Capacity

Hydro power stations come in a range of sizes:

- large ($>100\text{MW}$),
- medium ($1\text{-}15\text{MW}$),
- mini ($100\text{kW}\text{-}1\text{MW}$),
- micro ($5\text{kW}\text{-}100\text{kW}$),
- pico ($1\text{-}5\text{ kW}$),
- nano ($<1\text{KW}$)



The Itaipu dam – the world’s largest, located at the Paraguay-Brazil border, has an installed capacity of 12.6 GW

Capacity (cont.) - Tiko's nano-hydro at Savu Village, Naitasiri

Dam height:
6 m, total
head: 20 m,
power
output: 150
W



3. Survey of renewables (cont)

b) Wind energy

- Wind energy is the most important within the new renewables
- Supplied 95GW to global power generation in 2007 – an increase of 40% over its 2006 value
- Mature technology
- Both grid and off-grid
- Important component of remote hybrid systems

Wind energy - technology

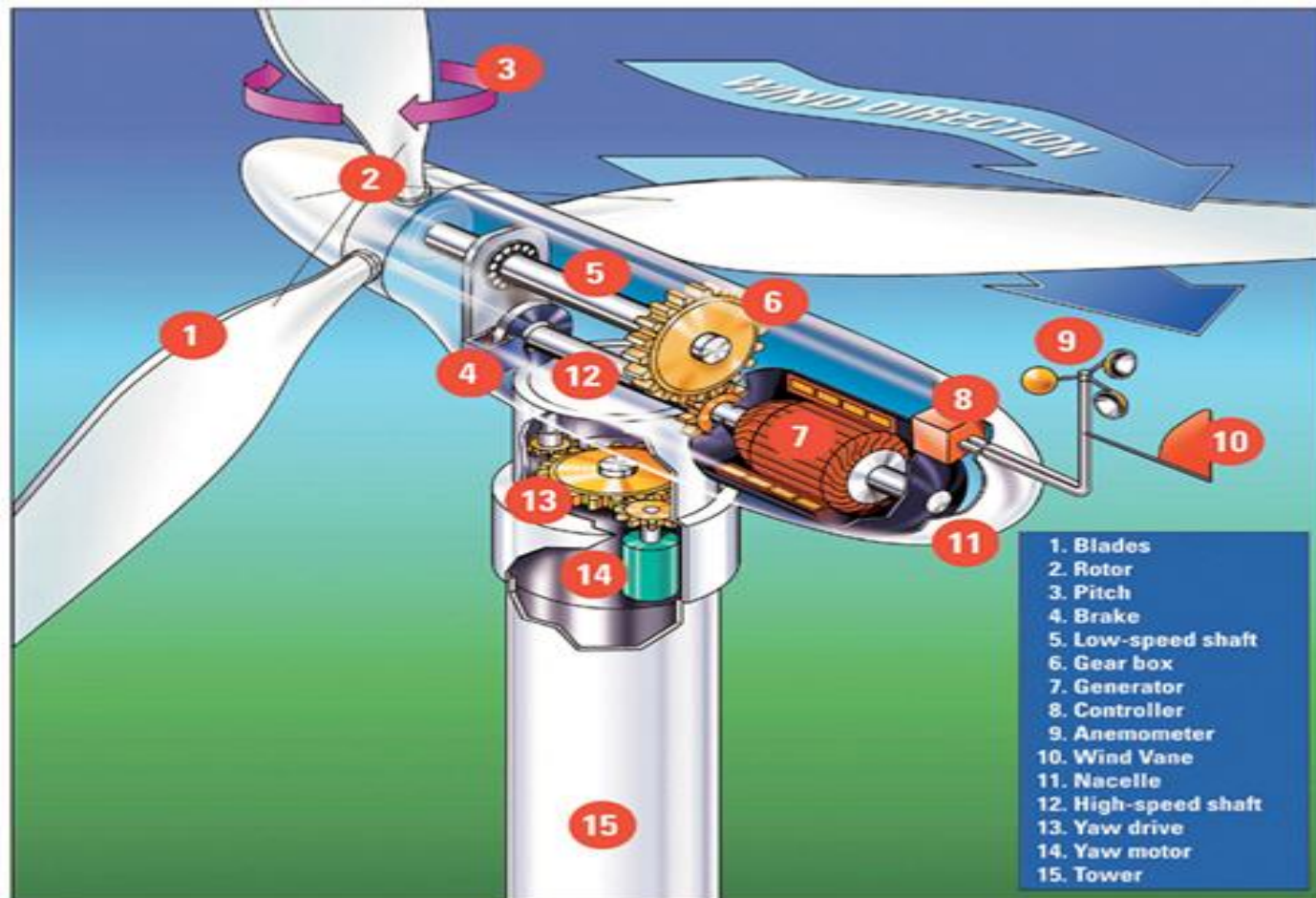
Turbine types:

- Horizontal or vertical axis
- Single, two, three or multi-bladed
- Upwind with active or passive steering
- Downwind self oriented or power steered



An example of a wind farm

Wind energy (cont)



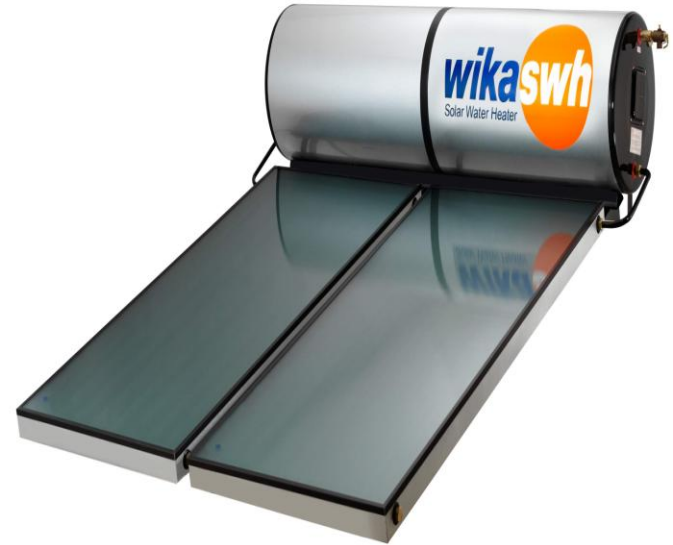
Components of a wind turbine

3. Survey of renewables (cont)

c) Solar energy

- Solar energy used as solar thermal (e.g. hot water collectors) or solar photo-voltaic (PV)
- In 2006 solar PV supplied 2.7GW to the grid world-wide
- Grid-connected PV is the fastest growing energy technology today

Solar energy (cont.)



Examples of roof-top solar PV panels and hotwater collector

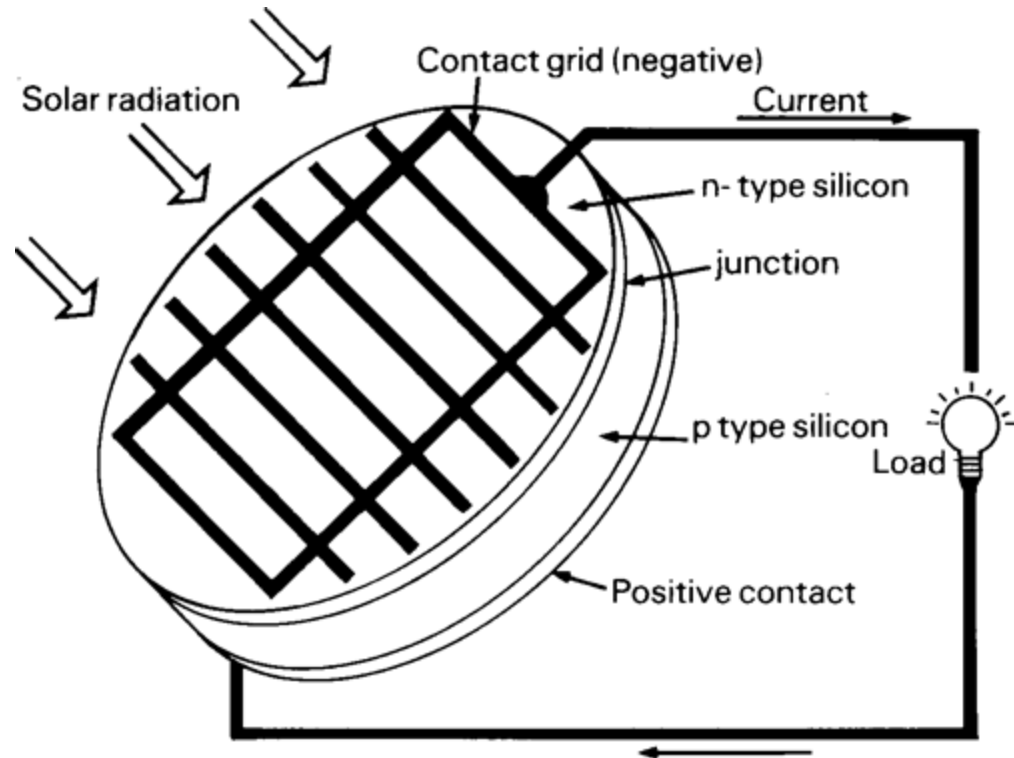
Solar energy (cont.)



A single PV solar cell – metal strips provide electrical conduction. PV panels are made up of many such cells connected in series to provide a useful voltage output

Solar energy (cont.)

Solar cells are devices that generate electricity (electron-hole pairs) when sunlight strikes them. They have inbuilt potential differences that separate the electron from the hole at a “pn junction” region and produce a current in the external circuit



3. Survey of renewables (cont)

d) Biomass energy and biofuels

- All biomass energy originates from organic matter which was formed “recently” through the process of photo-synthesis.
- Primary sources of biomass (e.g. trees, agri crops, algae etc) can be either
 - Burnt directly - **combustion**
 - Treated thermo-chemically to produce **secondary fuels** such as **syngas** through the process of **gasification**
 - Treated biochemically to produce secondary fuels such as biogas, ethanol and biodiesel
- Vegetable oils (biofuels) can be used directly as **diesel or gas turbine fuels**

Biofuels



Jatropha fruits (left) and seeds (right). Jatropha oil is widely claimed to be an ideal biofuel as it is poisonous and thus will not displace food crops for biofuel use.

Babassu nuts – oil from these nuts were used to partially power a Virgin Atlantic flight from Heathrow to Amsterdam

Biomass energy (cont)

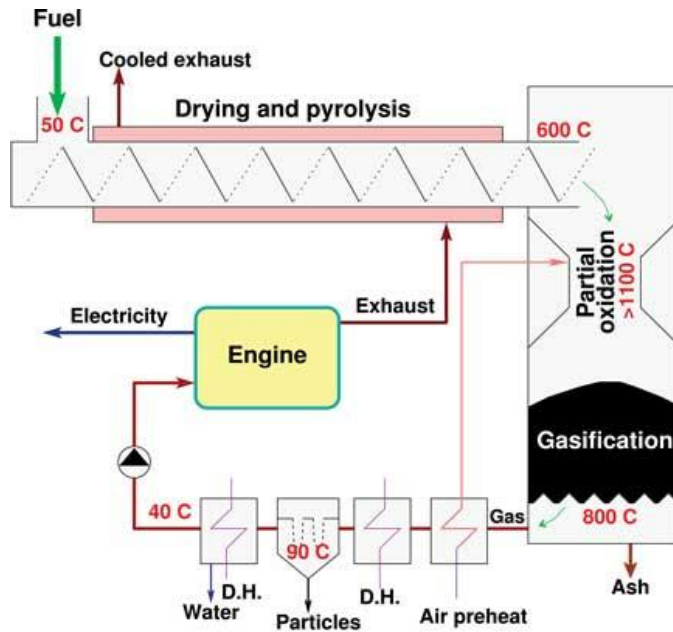


Oil palm tree (left) and kernels (right). Oil palm is being extensively cultivated in Indonesia and Malaysia to provide feedstock for the production of biodiesel.

Biomass energy (cont.)

- Biomass combustion
 - Produces heat for cooking, heating
 - Power generation via steam turbine or gas-turbine, or combined cycle power plants
- Biomass gasification produces syngas which can be used in integrated gasification power plants
- Biomass-fired power plants provided 45 GW (0.9%) of total global electricity generation in 2006

Biomass energy - gasifier

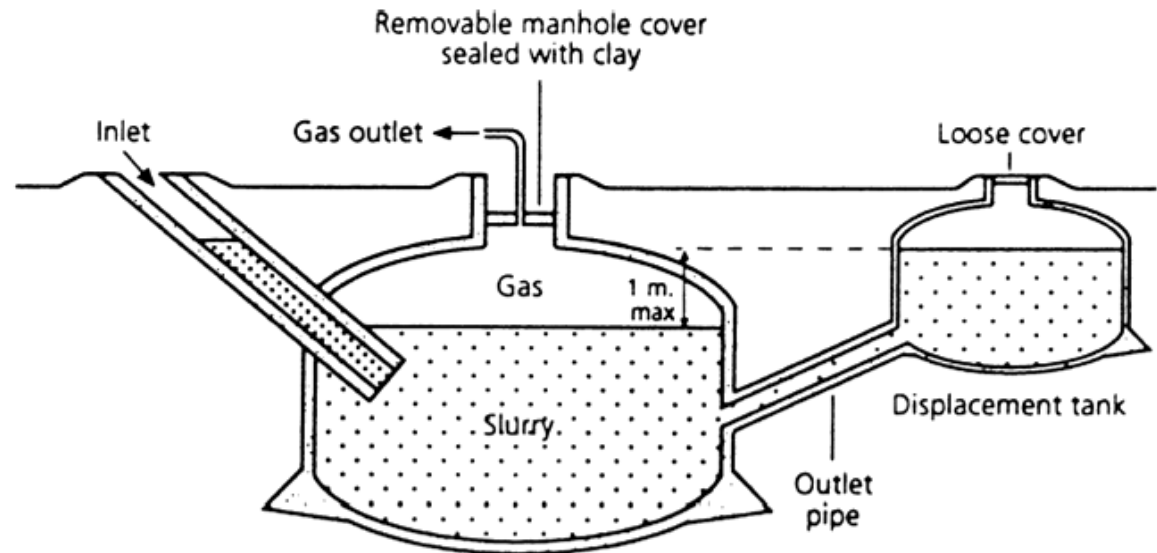


Right: a thermal gasification power plant – the Viking two-stage gasifier, built by the Biomass Gasification Group at MEK, Denmark. Left: the schematic design.

Biomass energy - Biogas

Biogas

Biogas (a mixture of methane and carbon dioxide) is produced by the action of groups of anaerobic bacteria on biomass such as animal manure in a biodigester.



Fixed-Dome Biogas Digester

Ethanol production

- Ethanol is produced by the fermentation of carbohydrates such as sugars, starches and ligno-cellulosic material (e.g. wood) by yeasts, followed by distillation

Feedstock for the fermentation process are

- Sugarcane, sugar beet - two dominant feedstocks
- USA – corn, grains, sorghum
- Starches, e.g. cassava

Biofuel (cont)

Biodiesel

- Biodiesel is an ester produced by the reaction of vegetable oils and fats (which are triglycerides, i.e. esters of glycerol) with either methanol or ethanol to produce the biodiesel and glycerol.
- e.g. coconut oil + methanol = coconut methyl ester (CME) + glycerol

Biofuels (cont)

Use of biofuels as transportation fuel

- Ethanol can be used as a 10% blend (E10) in normal petrol engines without any modification
- CME can be used as a diesel engine fuel either as a blend or unblended
- Various combinations of blended and unblended biofuels and normal, modified or flexi-vehicles now in use in Brazil, the USA, UK etc

Biofuels in Fiji

- Recently great interest in biofuels in Fiji
- Ethanol from cassava
- Coconut oil to replace diesel fuel
- But
 - Do we have enough resources?
 - How good is locally-produced biofuels for your engine?
- Need for biofuel standards

4. Requirements for a Renewable Energy Industry

We need

- Energy resources
- Human resources and know-how
- Government policy and legislation
- Other institutional mechanisms

Energy resource requirements

- Energy resources
 - ❑ To have hydro we must have water source
 - ❑ Wind turbines require wind monitoring for at least one year
 - ❑ Enough land for cassava?
 - ❑ Geothermal resources – need for detailed study
 - ❑ Wave energy – are our waves big enough?
 - ❑ Tidal power – how big are our tides?

Human resources

- Scientists and technicians
- Project managers and administrators
- Financial know-how
- Trade and industry expertise

Government policies and legislation

- National strategic plan to promote and coordinate the development of a renewable energy industry
- Legislations
- Standards framework to regulate quality of product and service

Other institutional mechanisms

- Research support
- Training institutions
- Regulatory frameworks

5. What the Fiji needs now

- Data on renewable energy resources
 - Conflicting views on the amount of hydro resources available
 - Wind energy surveys need to be done on the spot
 - How much geothermal do we really have?
 - Is there enough coconut trees to produce the copra required for CNO-biodiesel?

What Fiji needs – Feasibility studies

- Is it possible to replace fossil fuel for transportation by locally-derived biofuels?
 - Are the resources (including land resources), know-how, people, institutional frameworks available?
 - What will the environmental impacts be?
 - What will the socio-cultural impacts be?
- A complete study of financing and economics

What Fiji needs now – better standards

- We need to have standards to assess the quality of both the products (e.g. biofuels) and the services
- Fiji Department of Energy now in process of setting up biofuel standards

What Fiji needs – testing laboratories

- Labs for testing the products
 - Do they meet the minimum standards that will ensure, e.g. no engine damage?
 - Emissions testing – environmental effects
 - Long-term testing of new fuels – to check effect on engine

What Fiji needs – human resource development

- Not enough people who understand the science and technology
- Need to train administrators and project managers
- Raise basic awareness of RE potentials amongst politicians, businesses and communities
- Attract businesses and entrepreneurs to the industry

What Fiji needs – and Institute of Energy

We need a central venue where all aspects of energy, including renewable energy, can be considered, and policies drafted that will lead to effective decision-making at the highest levels

We need an Institute of Energy



Thank you for your attention!