Fiji Fuel Summary

Written by:

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Fuel Assessment Team, Fiji, January 2017

Abstract:

The following document will be your bible. You will follow this document and live by this document. This document will guide you to make informed decisions regarding fuels in Fiji and in life. Love this document. Live this document. Breathe this document.

Watch out fam because this is about to get lit. We start off with a rad page full of definitions and mad pics to let you know what a fuel is. Next we dive into the god of all sciences and look into the chemistry behind these totally cool explosions we call combustion.

Now you're like, ok cool guys but what kinds of fuel are there? Well, we got you fam, just follow us onto the next few pages where we give you a fully sick list of renewable and nonrenewable fuels so you can see what tickles your fancy.

Bet you kids are full impatient being all like ok but i want to know about Fji fuels. WELL HOLD YO HORSES here it comes! We've got you everything from what they use to where they get it from.

You're welcome, amigos.
Jan team out!

Contents:

Defining Fuel:

What is fuel?

A fuel is any substance that can be used to create energy. This can range from something as simple as a banana peel (Biomass) to something much more complicated such as petroleum.

There are two types of fuels and subsequently two types of energy: Renewable and nonrenewable. Renewable energy is a sustainable fuel source, i.e. it does not get depleted when used e.g. solar, wind etc. Nonrenewable energy is something that is depleted when used, such as coal, petroleum and gasoline.

Formal Definitions:

Cambridge dictionary:

"a substance that is used to produce heat or power, usually by burning"[1]

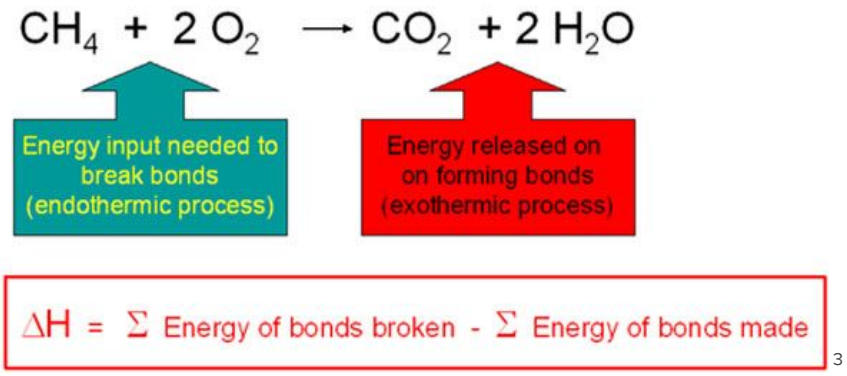
Oxford dictionary:

"Material such as coal, gas, or oil that is burned to produce heat or power"[2]

Macquarie dictionary:

"1. Combustible matter used to maintain fire, as coal, wood, oil or gas, in order to create heat or power... 3. An energy source for engines, power plants, or reactors..."

Diagrams



[3]

[1] http://dictionary.cambridge.org/dictionary/english/fuel
[2] https://en.oxforddictionaries.com/definition/fuel
[3] https://www.wou.edu/las/physci/GS361/Fossil%20fuels/methane_combustion.jpg

Basic Chemistry

Below is a basic summary of the chemistry involved so all trekkers can form an understanding of fuels and how they can be used to produce energy.

Combustion

A fuel is generally a hydrocarbon of the form: C_xH_y where C is Carbon and H is Hydrogen, and x and y are the number of Carbon and Hydrogen respectively. The hydrocarbon is then burnt in the presence of Oxygen O_2 . The products of complete combustion are Carbon Dioxide and Water. The simplest version of this is shown in the image above.

It should be noted that while complete combustion is ideal, it's not always the case. Usually incomplete combustion occurs due to lack of sufficient Oxygen and the following products can be formed: Carbon (Soot), Carbon Monoxide, some of the fuel, Carbon Dioxide and Water. Incomplete combustion results in: emissions of toxic gasses (Carbon Monoxide), non-ideal energy production and a dirty combustion chamber.

To avoid this generally we try and provide an excess of Oxygen via an Oxygen tank, which is not always accessible nor viable. Incomplete combustion will need to be taken into account when calculating the energy production of a fuel solution.

Calculations:

To calculate the total energy production, we use the change in Enthalpy (ΔH), where the triangle (Greek Symbol DELTA) means 'the change in' and the letter H means 'Enthalpy'. Each compound and element has many Enthalpy Values which can be found in a Chemistry/Chemical Engineering text book or even Wikipedia. Which value you use depends on the situation - this selection should be left to Chemistry majors/Engineers.

To calculate ΔH we need to calculate the total Enthalpy of the products, and the total Enthalpy of the reactants and subtract them. This will help us find the *difference* in Enthalpy, or the *change* in Enthalpy. It should be noted you subtract the reactants from the products as shown in the equation in the image above. [4]

[4] Any chemistry textbook

Fuel Sources

Non-renewable:

Coal

Coal is a combustible black or dark brown, sedimentary, organic rock formed from carbonised plant matter, found between rock strata (in coal seams and coal beds). Coal is also used for electricity generation.[5],[6]

Natural gas

Natural gas a fossil fuel which is found deep beneath the Earth's surface and primarily consists of methane. It is often used for heating, cooking and electrical generation.[7],[8]

Gasoline

Gasoline is a fuel derived from crude oil and petroleum liquids, through fractional distillation. It is often used in internal combustion engines, and occurs in a liquid form.[9],[10]

Diesel

Diesel is a liquid fuel consisting of a mix of hydrocarbons, derived from oil via distillation. It is used only in diesel engines (incl. generators) and is very efficient in fuel usage, however diesel is relatively expensive in cost and the engines in maintenance.[11],[12],[13]

Nuclear - Uranium-235

Nuclear energy is produced in nuclear power plants, where uranium-235 atoms undergo fission (a form of decay). This process releases energy, which boils water and is then used to turn a turbine to generate electricity.[14],[15]

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[5] https://en.wikipedia.org/wiki/Coal
[6] http://www.dbct.com.au/what-is-coal
[7] https://en.wikipedia.org/wiki/Natural_gas
[8] http://www.eia.gov/energyexplained/index.cfm/data/index.cfm?page=natural_gas_home
[9] http://www.eia.gov/energyexplained/index.cfm?page=gasoline_home
[10] https://en.wikipedia.org/wiki/Gasoline
[11] https://www.dieselnet.com/tech/fuel_diesel.php
[12] http://www.eia.gov/energyexplained/index.cfm/index.cfm?page=diesel_home
[13] http://www.deltaexpo.com/content/view/118/49/
[14] http://hyperphysics.phy-astr.gsu.edu/hbase/NucEne/U235chn.html
[15] http://www.ucsusa.org/nuclear-power/nuclear-power-technology/how-nuclear-power-works

Kerosene

Is distilled petroleum, is a combustible hydrocarbon.[16] It is generally a clear liquid, that is less dense than water. It should be noted that kerosene can be okay to use if used correctly. Installing safe-to-use kerosene systems is a viable option. [17]

Renewable:

Biomass

Biomass is a fuel produced from organic material. It uses organic waste that would otherwise be dumped in landfill, and is carbon neutral. When this is burned, it produces energy. [18]

E.g. That fire place you love so much

Biodiesel

Biodiesel is a renewable alternative for diesel. It can be made from recycled cooking oil, soybean oil, and animal fats and can be used in diesel engines with no modification. The process used to produce this is called transesterification. [19],[20]

Ethanol

Ethanol is an alcohol. It is made from organic materials such as corn, sugarcane or grasses. This is often blended with gasoline and used in vehicles. It should be noted that you will see E15 or E10 and the number after the E indicates the percentage of ethanol in the gasoline. [21]

Hydropower

Hydropower uses water to produce electric power. The water rotates the blades in the turbine causing it to transform mechanical energy into electrical energy. The amount of energy produced depends on the quantity of water flowing through the turbine and the height that the water falls. [22]

Geothermal

Geothermal energy is produced by the internal heat of the earth. This can be achieved through using the steam to power a generator. This steam is either produced by the reservoir or uses

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[16] https://en.wikipedia.org/wiki/Kerosene
[17] https://ingoeoils.co.uk/kerosene/
[18] http://www.reenergyholdings.com/renewable-energy/what-is-biomass/
[19] http://www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_biodiesel.htm
[20] http://www.biodiesel.com/biodiesel/what-is-biodiesel/
[21] https://www.fueleconomy.gov/feg/ethanol.shtml
[22] https://www.originenergy.com.au/blog/about-energy/what-is-hydropower.html

the hot fluid to boil a working fluid that then turns the turbine. It should be noted that that a working fluid is the fluid that actually does work on the turbine - causes it to turn. [23]

Solar

Solar energy involves converting the sun's radiation on the Earth to energy to generate electricity. The first method uses photovoltaic cells (solar panels), and when sun rays hit the cells, they generate an electricity. For the second method, sun rays are concentrated such that it boils water to turn a turbine, and again, generate electricity - much like nuclear energy or coal steamers.[24]

Wind

Wind energy is energy gained from the wind. The kinetic energy (motional energy) is converted to mechanical energy in turning the blades. This motion can be used to turn a turbine to generate electricity (although it can be used for other purposes as well).[25]

Secondary Energy Sources:

Electricity

Electricity is the result of flowing electric charge in a circuit or wire. This is used to power many devices, such as refrigerators, irons, lights and computers. Another form of electricity is static electricity, which is the result of an accumulation of charge. One example is lightning.

Electricity is called a secondary source because it is produced through a primary energy source, such as all the fuels listed above.[26],[27]

Hydrogen (for Hydrogen Fuel Cells)

The basic concept of hydrogen fuel cells is that hydrogen gas and oxygen gas react with each other to form water. As this reaction occurs, electrons from the oxygen and hydrogen atoms are separated and can be sent around an electric circuit (i.e. make electricity).

Although this system is essentially self-running, hydrogen gas is acquired through the electrolysis of water (separation of oxygen and hydrogen in a water molecule), which in itself requires an energy input, hence hydrogen being labelled a secondary energy source.[28],[29]

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[23] http://www.renewableenergyworld.com/geothermal-energy/tech.html
[24] http://environment.nationalgeographic.com/environment/global-warming/solar-power-profile/
[25] http://windeis.anl.gov/guide/basics/
[26] https://simple.wikipedia.org/wiki/Electricity
[27] http://www.eia.gov/energyexplained/index.cfm/data/index.cfm?page=electricity_home
[28] http://energyeducation.ca/encyclopedia/Secondary_fuel

Fuel in Fiji:

What is commonly used?

Inland Villages:

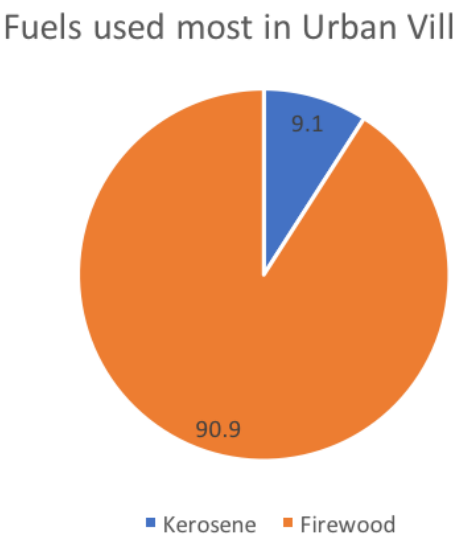
Electricity

Since these villages are inland (approximately 50 - 60 kms north of The Cottage), they are not part of the FEA's main electricity grid. The FEA will supposedly install wiring in 2017, but for now many of the villages rely on solar powered lights. They buy LED solar lights from the supermarket for $70-80. After a full day of charging (note that this is difficult to achieve in wet season) they can be used for up to 12 hrs. They do not find the lights very effective, and would rather the high quality ones from Australia and the USA (if they could afford them) instead of the low quality lights imported from China.

Cooking Fuel

Like in most Fijian villages, firewood is the preferred type of cooking fuel. However, as the firewood is often too damp to cook with, kerosene is often used due to practicality. It has not yet been said that gas is used to cook. It should be noted that many inland villages use Guava trees as firewood in the wet season as it remains dry enough all year round.

[29] http://zebu.uoregon.edu/1996/ph162/l11.html



The above image shows that 90.9% of people interviewed used Firewood the most, while 9.1% of people used Kerosene the most. It should also be noted that some villagers still don't use kerosene at all due to the cost factor. It is more expensive for inland villagers due to transportation costs.

(This information can be found under Research → 170110 Copy of Data Consolidation of Fijian Villages (DECEMBER) 01 DL .xlsx)

Coastal Villages:

Electricity

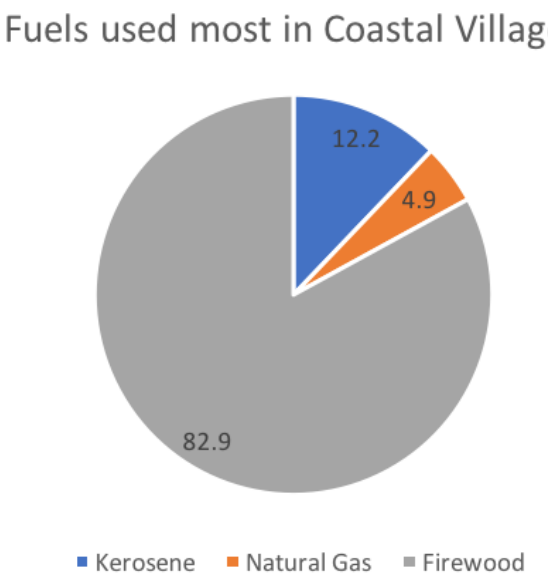
Coastal Villages have the most access to electricity as their villages are connected to the FEA's grid. However, there are numerous problems with the power provided by the FEA, and thus not all villages are connected. The main issue is the steep installation costs from the FEA (~$1000). The FEA provides a post-pay option and a pre-pay option. There is a $4.85 surcharge on the post-paid system even if they do not use any electricity that month. Many people cannot afford to pay for electricity on a regular basis, thus some villagers opt to use the pre-pay system for the few times they need electricity. For example, they can insert a pre-paid $5 voucher to their switchboard provided by the FEA.

On top of this villagers are forced to pay several extra fees for 'call-outs' and 'reconnections,' which is a problem for many people when they are often unable to pay the bill each month. The Malomalo village in particular has a problem with their post coming on time, meaning they

receive their bills late. This results in the FEA cutting off their electricity as they have not paid their bill on time, and the villagers are still forced to pay the reconnection fee.

Cooking Fuel

In order of preference, coastal villages use Firewood, Kerosene and Gasoline. Villagers prefer to you use Firewood, because it is free and gives their food a nice flavour. However, as it cannot be used in wet weather conditions, kerosene is the next cheap and easy option. Gas is seldom used in coastal villages because of its high cost.



In the above image we can see that 4.9% of people interviewed used Natural Gas the most, 12.2% of people interviewed used Kerosene the most and 82.9% of people interviewed used Firewood the most.

It should also be noted that about 30% of coastal villagers interviewed spend 60-100% of their income on fuels. (This information can be found under Research → 170110 Copy of Data Consolidation of Fijian Villages (DECEMBER) 01 DL .xlsx)

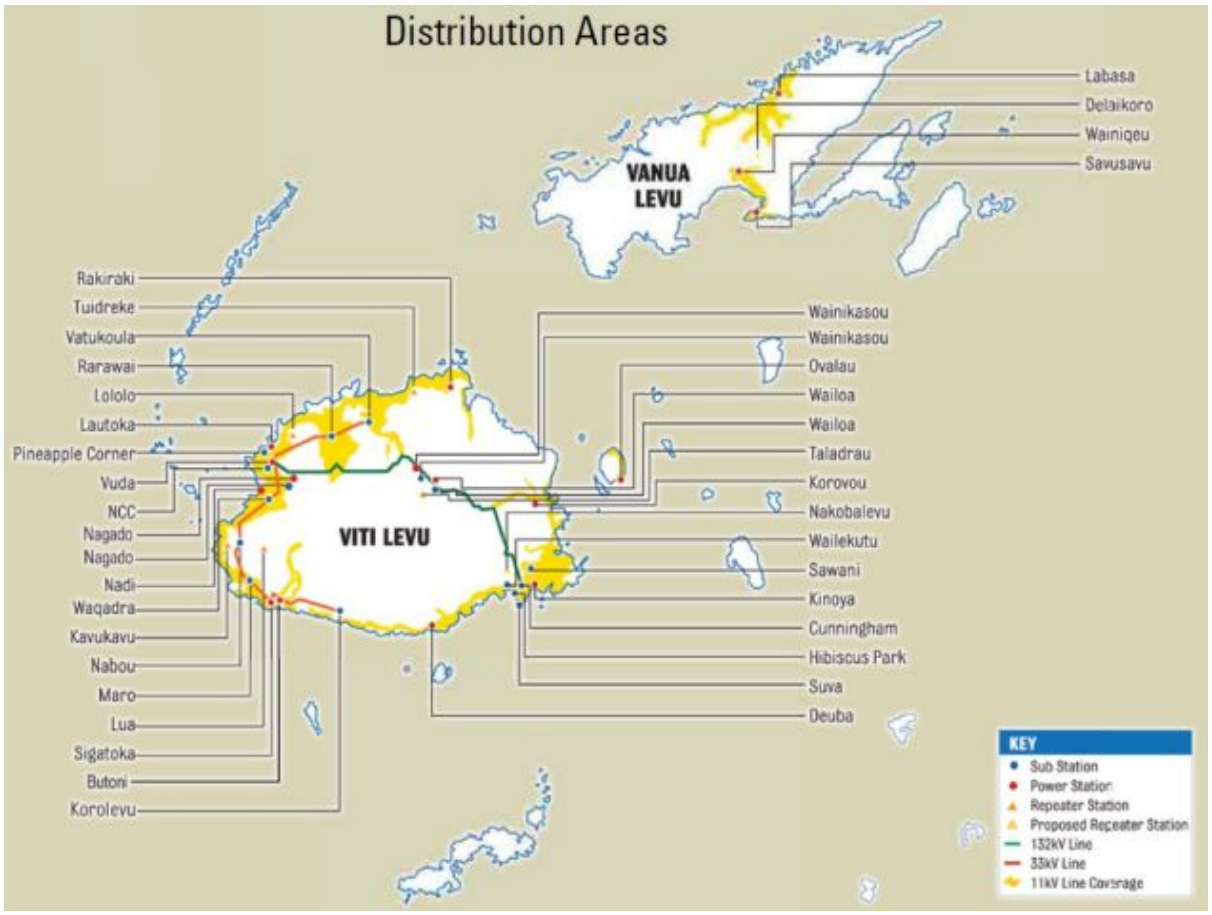
Electricity vs. cooking

Electricity:

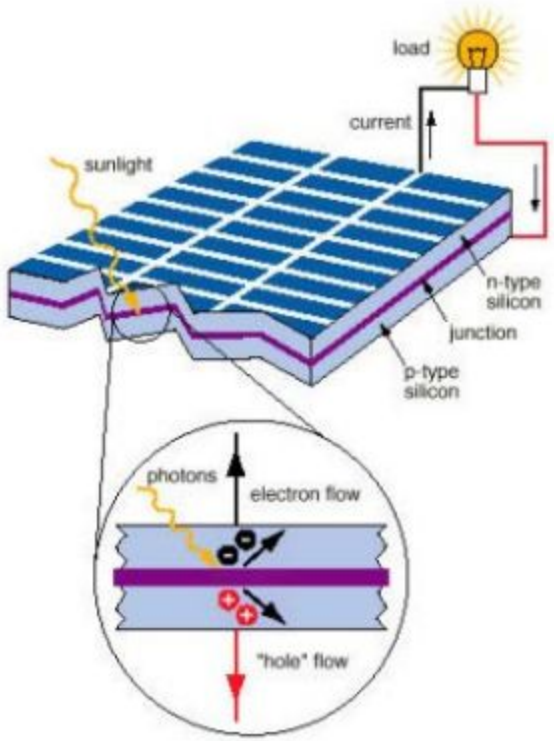
The team concluded that electricity was more of a problem in inland villages (rural):

- Electricity is non-existent in many inland villages (FEA is looking to provide electricity to several inland villages within the next 3 or 4 months, however, when villagers were asked whether they would use this over solar or vice versa, inconsistent answers were received)
- Use Pre Pay (Cash Power) system where electricity from FEA is present
- Use LED solar lights (solar panels are made in China, so not of good quality)
- Use kerosene lamps when solar lamps are unavailable
- Require electricity mainly for lights so children can study at night

As of 2010, FEA's electricity grid around Viti Levu and Vanua Levu is as follows :



Solutions such as solar panels (PV modules) or other variations of solar generated electricity inventions were studied. Photovoltaic is a technology that converts solar radiation into direct current electricity through the photovoltaic effect in semiconductors. The commercially most common technology is the silicon crystalline PV modules, as shown below.



However, as a team we realised that there were several issues associated with heading down such a path:

- Urban or coastal villages had access to electricity since they were already on the electricity grid of FEA and as such may not really need a solution such as solar power
- Villagers in urban villages were somewhat more well off than those in rural villages and even though they found electricity to be quite expensive, they could still afford it with their income
- Pursuing a solution to the electricity problem with solar power involves high risk factors for all parties involved, especially Project Everest, since the FEA is aiming to extend its electricity grid to inland villages in the next 3 to 4 months
- Liaison with several government agencies such as Department of Electricity and the Fiji Electricity Authority will be required and given their strict hierarchical structure and the ability to require permission to approve several options would be a problem
- Developing a solution for electricity may see Project Everest as a ‘middleman’ party, with major operations still being controlled as a whole by FEA and/or the Department

of Electricity

- Villagers from rural or inland areas mainly require electricity to power lights at night so their children can study, however most already used Solar LED lights or prepay systems to 'top-up' electricity

Cooking:

Some locals expressed concerns with their cooking fuels regarding:

- Expense
    - Inland villagers have to pay ~$10 to get into and out of town just to buy kerosene so a $25 a gallon purchase becomes $35
        - This is expensive for people whose only source of income is their farm
    - Other inland villagers have a service that transports it up the hill, but their kerosene is also more expensive due to transportation costs and the shopkeepers need for profit
    - For families who are coastal that only earn $200 a week, monthly payments for kerosene and gas can add up when they've also got to pay for water and electricity
- Nasal discomfort
    - Caused by the smoke from fire and kerosene
- Ocular discomfort
    - Caused by the smoke from fire and kerosene
- Inconvenience
    - Inland villagers often have to travel for up to two hours and carry home a large (20L) canister of kerosene
    - Villagers have to make an independent trip to collect and carry firewood for their family
    - Carrying a gas canister is inconvenient and difficult
    - Cooking with firewood isn't very quick
- Child safety
    - Accidental consumption of kerosene
    - Falling in/on stove/fire
    - Tripping on canisters

- Impurity
    - Some villagers have experienced the shopkeepers diluting kerosene so that it is unusable

If we could find a solution that addressed all or most of these issues that would be ideal.

We have looked into:

- Biomass
- Nazareth stoves
- Bio Briquettes
- Charcoal
- Rocket Stove
- Improved Chulas
- Gasifier Stoves

All of these can be found in the "Ideas" Folder [January → Fiji → Research → Ideas→ 2017-01-04 Efficient Cooking Stoves 01 JBL.docx]. We did very basic research into these possible avenues.

Companies

Fiji Electricity Authority (FEA) [30]

The FEA is a government-owned monopoly, providing the generation, transmission and retail of electricity to about 90% of the Fijian population on Viti Levu, Vanua Levu and Ovalau (the three largest islands of Fiji). Through the December team's research, we've found that in the local area of Sigatoka, the FEA only provides its services to on-grid locations, which occur in urban areas. However, it's been said that they are considering expanding to some upper rural (inland) regions. It has not been confirmed when.

The FEA are not in a position to help out with Project Everest, as it cannot disclose information without authorisation from higher positions. With that being said, the FEA (i.e. **William** - refer to Contacts → Contacts) was very helpful, especially regarding government operations, and the success of those initiatives. However, it is unlikely they will be helpful due to their complex internal structure.

[30] http://www.fea.com.fj/

- Contact (William)
  (+679) 990 8687

Powerlite (Fiji) Ltd [31]

Powerlite (Fiji) Limited works with a vision to provide total engineered solutions for Power and Shelter needs. They have a team of qualified and trained professionals in various fields, who provide professional advice and information on your inquires.

Their engineering team specializes in:

- System Sizing (Load)
- Supply, Installation & Maintenance services for :
  - Generators
  - Solar Systems
  - Wind Generators
  - Hydro Power
  - Building & Civil Constructions
  - Electrical
- Main Products:
  - Solar Panels
  - Wind Turbines
  - Water Turbines
- Contact:

Head Office: 19 Shalimar Street, Raiwasa

PO Box 18354, Suva, Fiji Islands.

Landline : (+679) 3384 088 or (+679) 3384095

Mob: (+679) 9922268

Fax: (+679) 3384 096

[31] http://www.powerlite.com.fj/

Clay Energy [32]

Clay Energy specialises in renewable energy (solar, hydro and wind) power systems and related products. It's based in Suva, Fiji (since 1998). They are centrally located in the South Pacific and offer products and services tailored to the region.

- Main Product:
    - We supply a complete range of renewable energy equipment from quality equipment manufacturers.
    - Products are designed for use in tropical maritime environments which experience high humidity and salt laden air.
- Main Service:
    - Remote infrastructure design
    - Installation and maintenance of renewable energy power systems
    - From the design of small village solar power systems to installation of grid connected wind turbines they can offer a solution to suit the needs of domestic, commercial, tourism and rural clients.
- Contact

Ph: (+679) 3363 880

Fax: (+679) 3363 882

Lot 13 Carpenter Street, Raiwai, Suva, Fiji

Can-AM Solar Systems Ltd [33]

They are a Canadian based company operating out of the Fiji Islands specialising in highest quality solar products.

- Main Products:
    - Solar Lantern
    - Solar Water Heater
    - Solar Fan
- Contact

18 Waimanu Rd, Suva Fiji Island

[32] http://www.clayenergy.com.fj/

[33] http://www.canadiansolar.com.fj/index.html

Email : info@canadiansolar.com.fj

Phone: (+679) 368 0678

Mobile: (+679) 860 3098 / (+679) 906 6663

Fiji Sugar Corporation [34]

The Fiji Sugar Corporation (FSC) owns and operates sugar mills for the conversion of sugarcane into biomass energy. They sell this energy to the FEA.

They have mills in Lautoka, Rarawai, Penang (Viti Levu) and Labasa (Vanua Levu).

- Contact (Head Office):

FSC Limited, Head Office, Drasa Avenue, Balawa

Private Mail Bag, Lautoka

Phone: (+679) 666 2655

Fax: (+679) 666 4685

- Contact (Information Systems Centre)

FSC Limited

P.O Box 63, Information Systems Center, Lautoka

Fax: (+679) 666 8837

Tropik Wood Industries Limited[35]

The Tropik Wood Industries Ltd (TWIL) owns and operates sawmill and chip plant, and produces wood chips. The company owns Tropik Energy Limited in Nadi which is responsible for the conversion of the sawmill and chip plant residue into biomass energy. They then sell this energy to the FEA, enabling them to provide electrical power to the coastal villages.

- Contact:
  Vakabuli Village Rd, Drasa, Lautoka
  Ph: (+679) 666 1388
  Project Everest has also gained two employees contact details (name's were not provided):

[34] http://www.fsc.com.fj/

[35] http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=13464646

- Mr. Taufia Alifereti (HR manager): talifereti@tropik.com, ph. (+679) 999 5389
- Mr. Conrad Kumar (Engineer) c.kumar@tropik.com.fj , ph. (+679) 999 5345