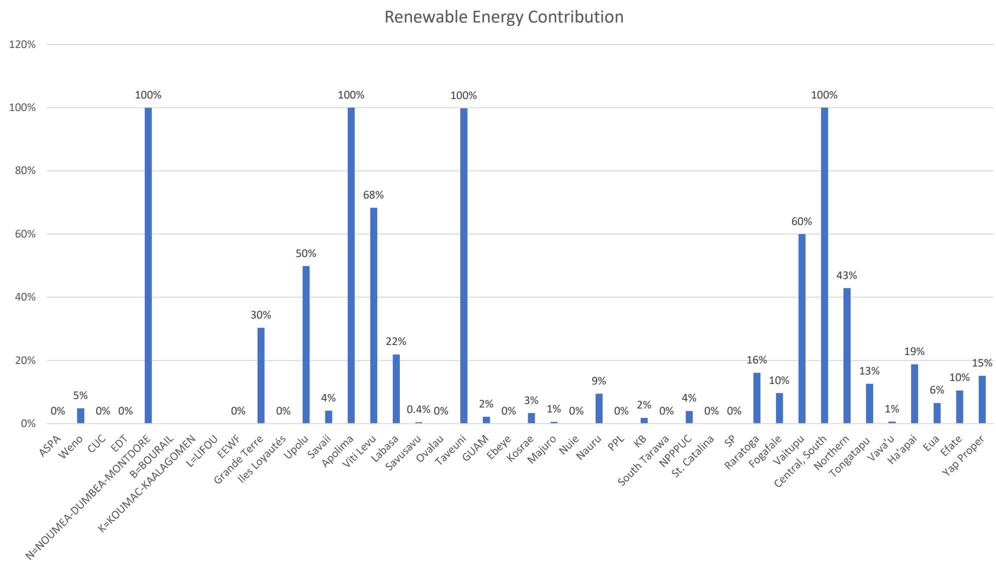
Benchmarking: Process Perspective Indicators

A Simspon

Process Perspective Indicators

Kaplan & Norton Core Processes	Description	Alternative Names for Core Processes
Innovation	The processes that create or improve products, services and the processes behind them.	• New Product Development • Renewal • Service enhancement
Operations	The day to day processes that deliver products and services based on customer orders.	• Supply chain management • Service provision • Project management • Assets management • Solutions delivery
Customer Management	The development and deepening of relationships with customers that are at every customer contact opportunity	• Customer engagement • Customer service • Account Management • Customer Relationship management
Regulatory & Social	The collection of processes that enable a firm to satisfy its regulatory, social and environmental responsibilities.	• Governance • Compliance management • Corporate social responsibility • Risk Management

Renewable Energy Contribution (% Total Energy Produced)

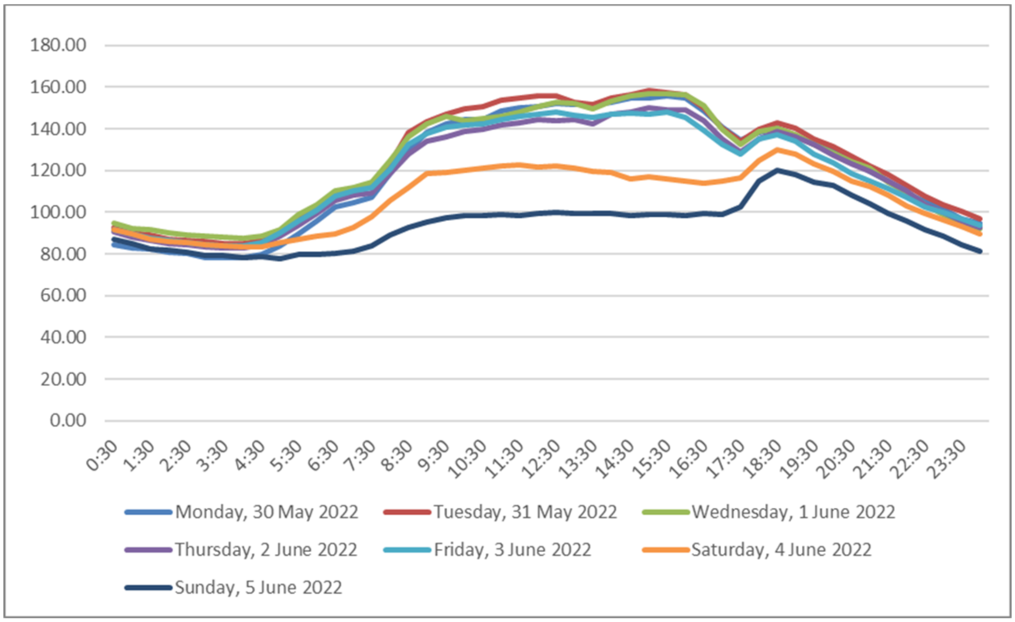


Load Factor

$$Load\ Factor\ (\%) = \frac{Gross\ Generation}{Peak\ Load\ x\ hours\ in\ period}\ x\ 100$$

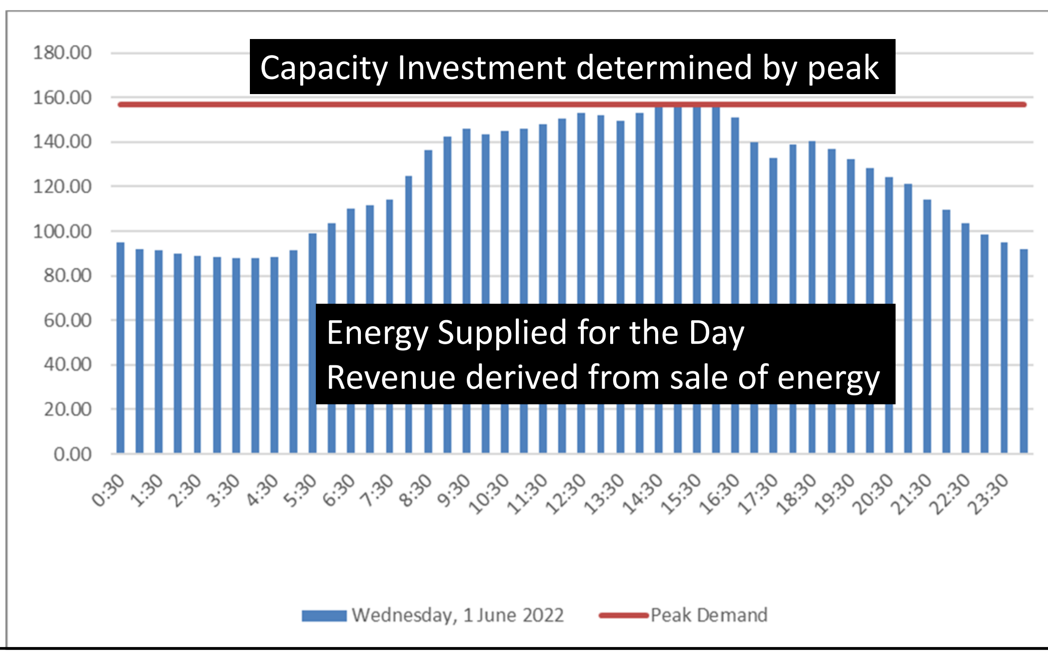
A period of 1 year = 8760 hours

EFL's Viti Levu Daily Demand Profile for a Week

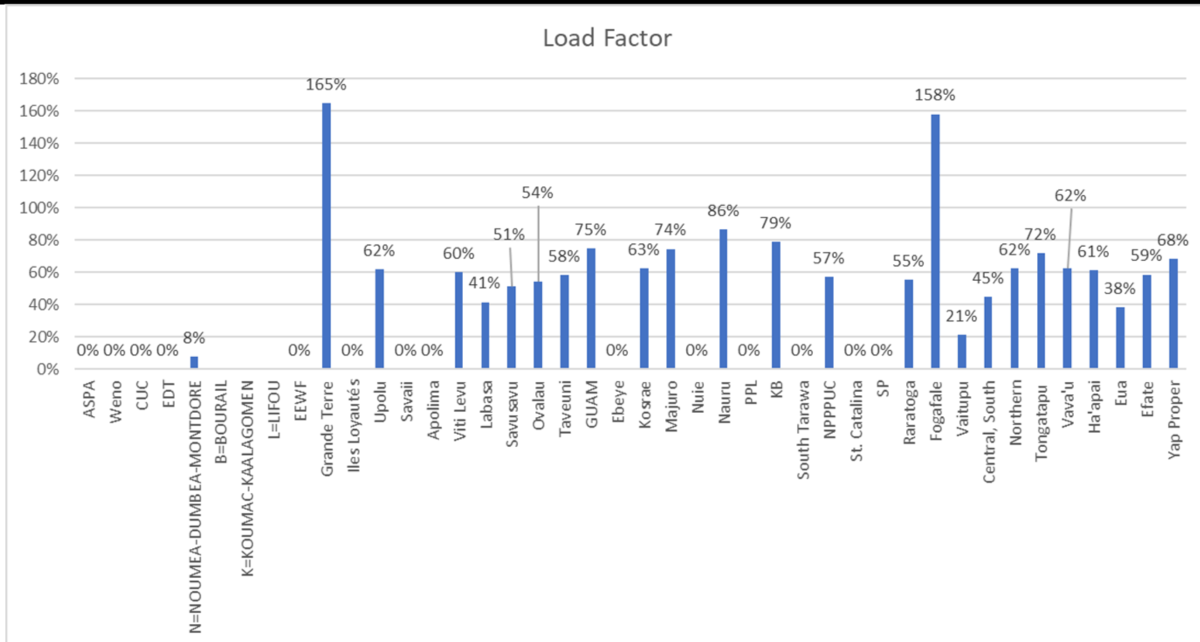


EFL's Viti Levu Daily Demand Profile for a Week

Note: EFL peak Demand for 2021 is 166.37 MW. This profile is used for illustration of load factor



Load Factor for PICs

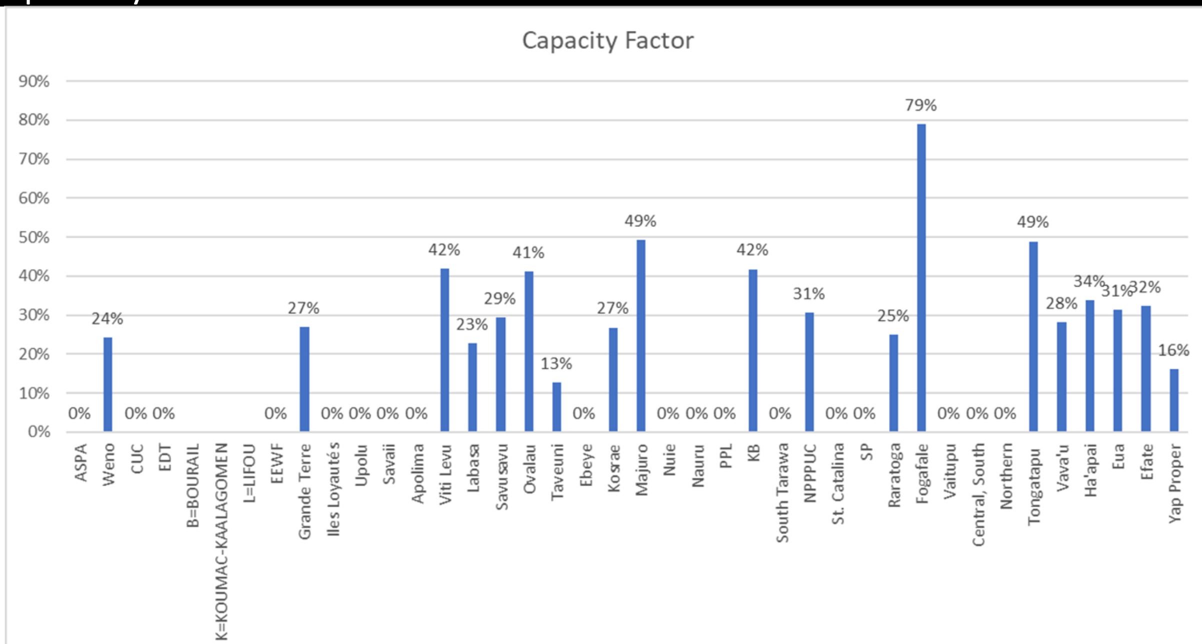


Capacity Factor

$$Capacity\ Factor\ (\%) = \frac{Gross\ Generation}{Firm\ Capacity\ x\ hours\ in\ period}\ x\ 100$$

- Firm Capacity is defined as generation capacity that is available at all times.
- Firm Capacity is provided by Diesel engines, HFO, Coal, LNG, Large Storage Hydro, Large Storage Batteries
- Non-firm capacities are run of river hydro, wind, solar PV.
- Power security policy N-1 or N-2 means there is sufficient form capacity to meet the peak demand with the loss of the largest or the two largest generating units.

Capacity Factor for PICs



Load Factor & Capacity Factor

- Two systems, A & B, each with peak demand of 10 MW and largest generator of 5 MW has a load factor of 80% and 60% respectively.
- Given a power security policy of maintaining a firm capacity of N-1 determine the minimum firm capacity required to be maintained?
- Determine the total annual energy produced for each system.
- Given the total loss + non-revenue energy used + power station auxiliary for each system is 10%, determine the total energy sales for each system?

Min. Firm Capacity = 15 MW

A = 70,080 MWh
B = 52,560 MWh

A = 63,072 MWh
B = 47,310 MWh

Availability Factor

$$Availability\ Factor\ (\%) = \frac{Total\ Installed\ Capacity\ x\ 8760 -\ Total\ Capacity\ Hours\ out\ of\ service}{Total\ Installed\ Capacity\ x\ 8760}\ x\ 100$$

1. Capacity hours out of service =
   1. Unavailability due to planned maintenance
   2. Unavailability due to forced outages
   3. Capacity that is temporarily derated
2. For VRE such as wind and solar capacity factors would be very low and may be best reported separately.

Availability Factor

Availability Factor

1. Diesel AF would be best between 90% and 95%.
2. HFO would be a little lower as it require more maintenance
3. Solar PV CF may vary between 15% and 20%
4. Wind CF between 20% and 30% and for very good sites may be up to 40%.
5. Run of River hydro would vary with the rainfall scenario for the year.

Generation Labour Productivity

$$Generation\ Labour\ Productivity\ (GWH/FTE) = \frac{Total\ Utility\ Generation\ (GWH)}{FTE\ (Gen.Employees)}$$

where

$$FTE\ Generation\ Employees\ = \frac{Paid\ hours\ Utility\ Generation\ Labour\ (hrs)}{2000\ (hrs)}$$

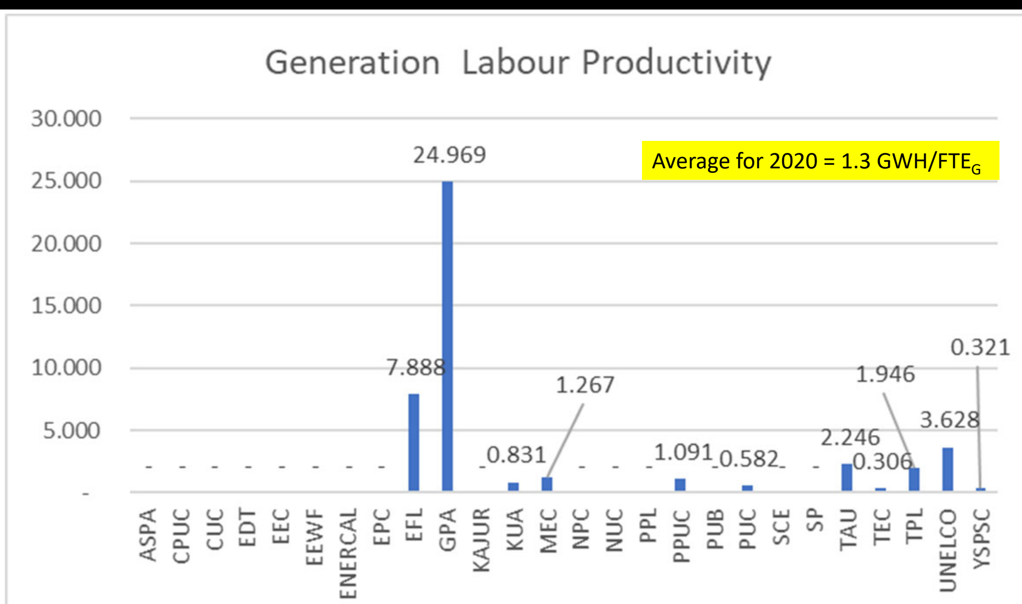
Generation Labour Productivity

Worked Hours Generation Labour	Category	Paid Hours
5000	Normal time	5,000
2000	Time & a Half	3,000
1000	Double time	2,000
Total Paid Hours		**10,000**

$$FTE\ Generation\ Employees\ = \frac{10,000\ (hrs)}{2,000\ (hrs)}$$

= 2

Generation Labour Productivity



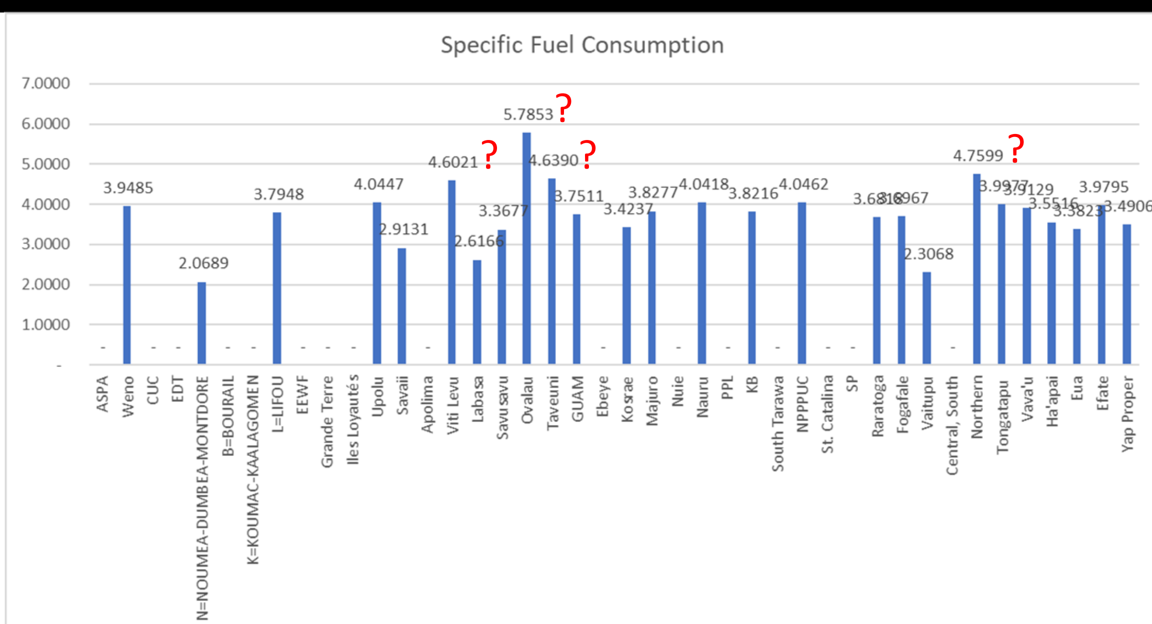
Specific Fuel Consumption

$$Specific\ Fuel\ Consumption\ = \frac{Energy\ generated\ by\ DFO\ or\ HFO\ (kWh)}{Fuel\ Used\ (litres\ or\ gallons)}$$

Or alternatively

$$Specific\ Fuel\ Consumption\ = \frac{Fuel\ Used\ (kg)}{Energy\ generated\ (kWH)}$$

Specific Fuel Consumption



Specific Fuel Consumption

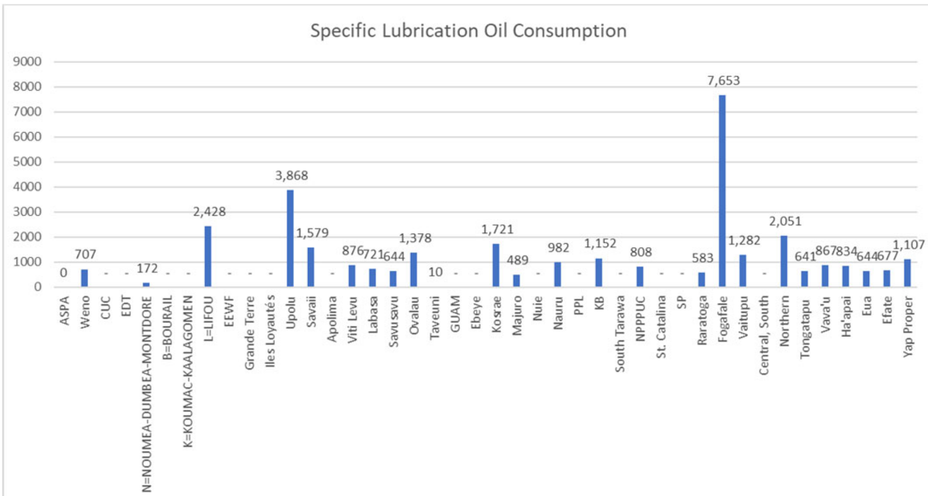
- Traditionally diesel generated energy comprise the bulk of energy production.
- This indicator becomes critical because significant costs are associated with inefficiencies.
- As renewable energy contribution increases this factor becomes less significant.

Specific Lubricating Oil Consumption

- Lower lubricating oil efficiency can be attributed to poor maintenance, e.g. due to worn piston rings or leaks in the system.
- Reasonable values are about 500–700 kWh per litre for a 1 MW engine and 1,000–1,300 kWh per litre for a 4–5 MW engine

Specific Lubricating Oil Consumption

$$\text{Lubricating Oil Consumption (kWh/L)} = \frac{\textbf{Total Fuel Oil Generation (MWh)} * 1000}{\textbf{Total Lubricants Used in Generation (L)}}$$

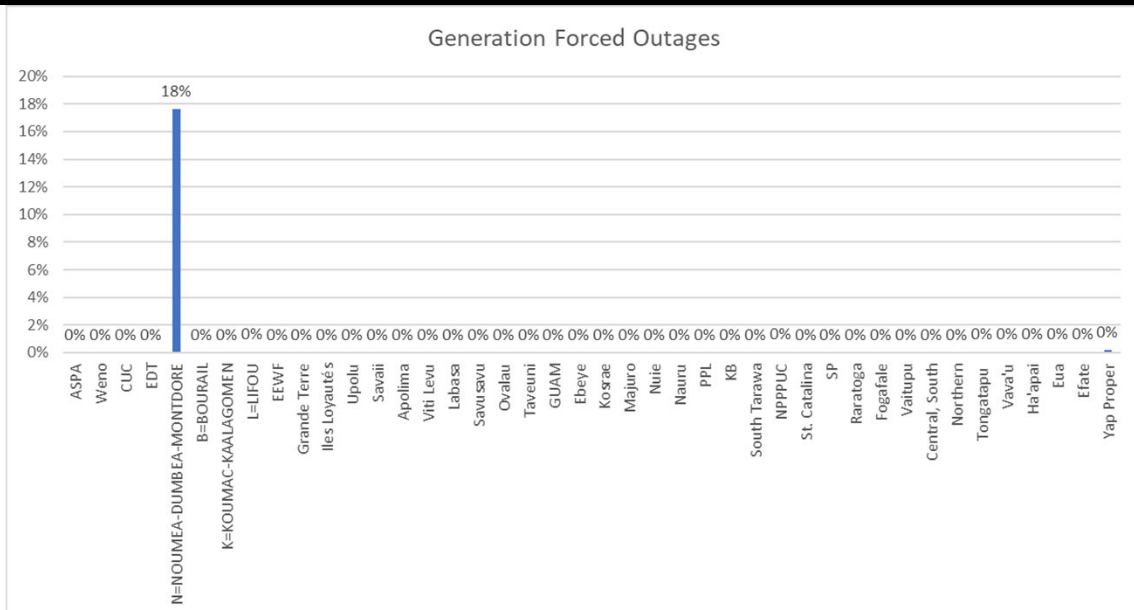


Generation Forced Outage

$$Generation\ Forced\ Outage\ = \frac{\sum Forced\ Outages\ (MWH)}{Genration\ Capacity\ (MW)x\ 8760\ (H)}$$

- A forced outage is caused by faults, operator error or a derated event on a generator.
- Determine the forced outage for a 5 MW generator that is unavailable due to a fault and takes 7 days and 5 hours to repair and make available for operations? 565 MWH
- A 10 MW generator is derated to 7 MW for 30 days due to limitation on its cooling system. Determine the forced outage unavailability? 2,163 MWH

Generation Forced Outage

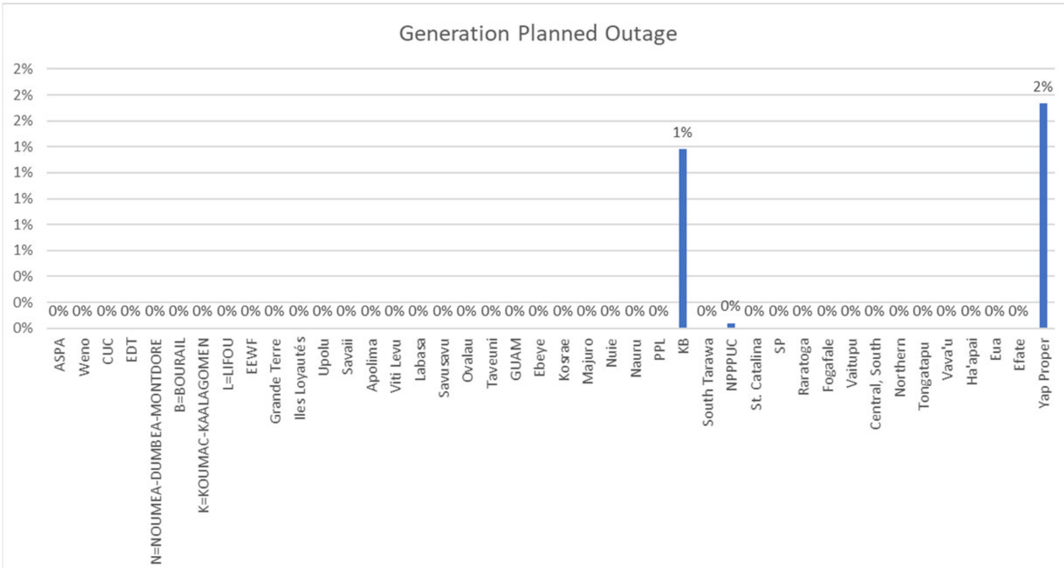


Generation Planned Outage

$$Generation\ Planned\ Outage\ = \frac{\sum Planned\ Outages\ (MWH)}{Genration\ Capacity\ (MW) x\ 8760\ (H)}$$

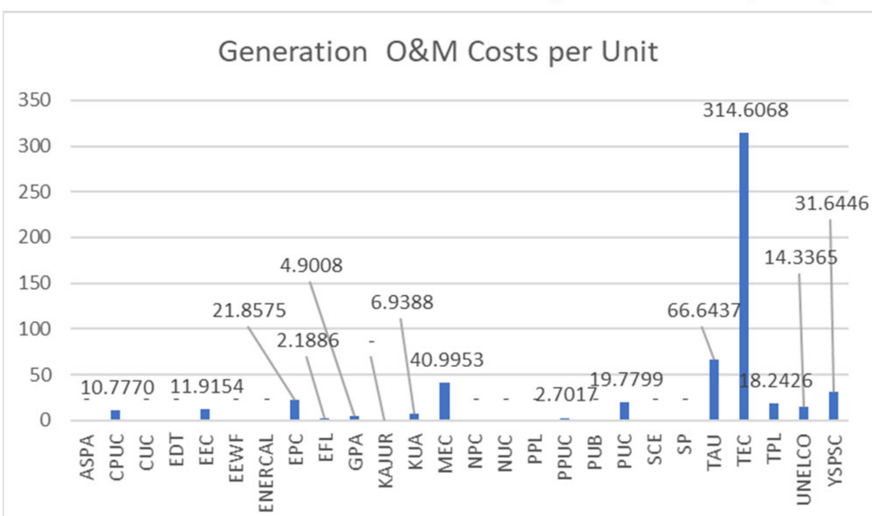
- A planned outage occurs when a generator is taken out of service for routine maintenance.

Generation Planned Outage



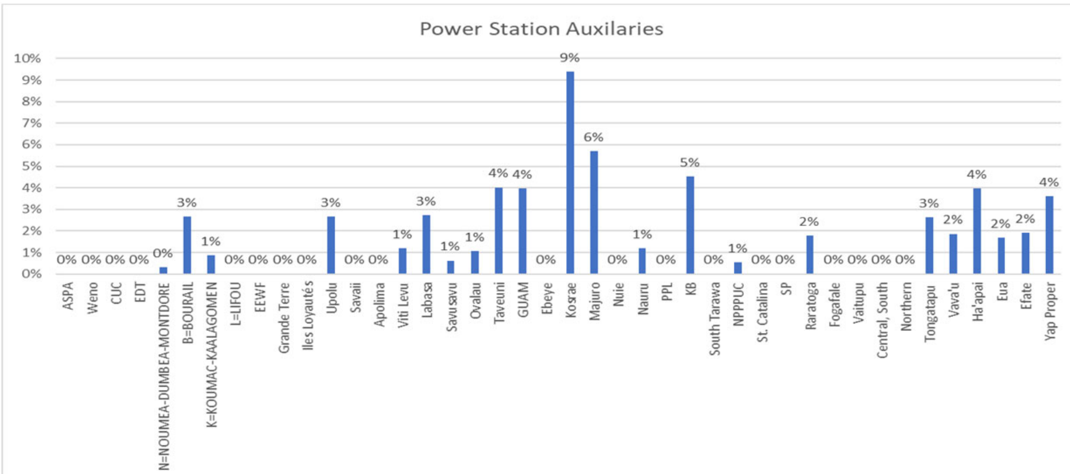
Generation O&M Expenses

$$\text{Generation O\&}M\ (USD/MWh) = \frac{\textbf{Total Generation O\&M Costs (USD)}}{\textbf{Total Utility Generation (MWh)}}$$



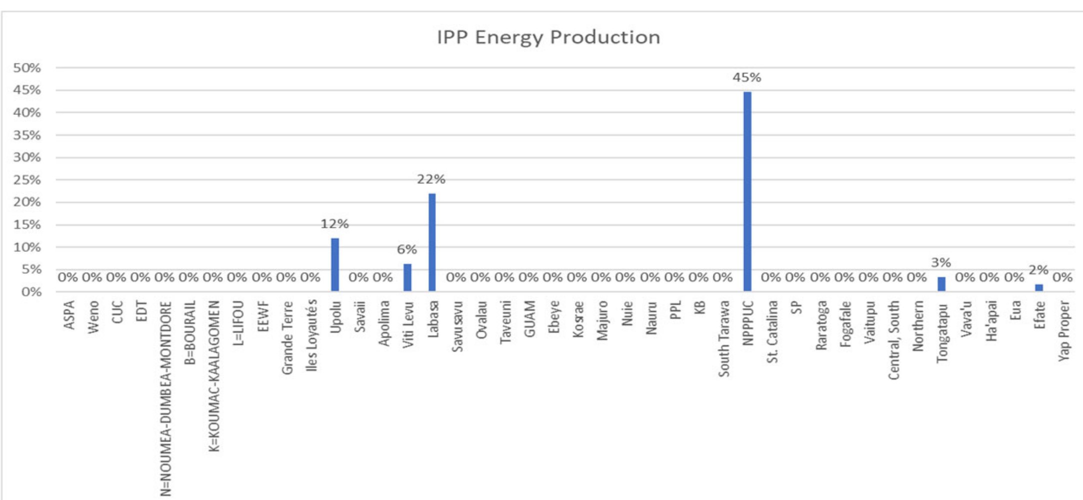
Power Station Usage

$$\text{Power Station Usage (\%)} = \frac{\textbf{Power Station Usage / Station Auxiliaries (MWh)} * 100}{\textbf{Total Utility Generation (MWh)}}$$



IPP Energy Production

$$\text{IPP Energy Generation (\%)} = \frac{\textbf{Total IPP Generation Purchased (MWh)} * 100}{\textbf{Gross Generation (MWh)}}$$



Transmission Losses

$$\text{Transmission Losses }(\%) = \frac{[\textbf{Net Generation (MWh)} - \textbf{ Electricity Delivered to Distribution Network (MWh)}] * 100}{\textbf{Net Generation (MWh)}}$$

- Only four utilities have a transmission system and one provided incorrect data while the others did not provide any data at all.

Distribution Indicators

$$\text{Transmission Losses }(\%) = \frac{[\textbf{Net Generation (MWh)} - \textbf{ Electricity Delivered to Distribution Network (MWh)}] * 100}{\textbf{Net Generation (MWh)}}$$

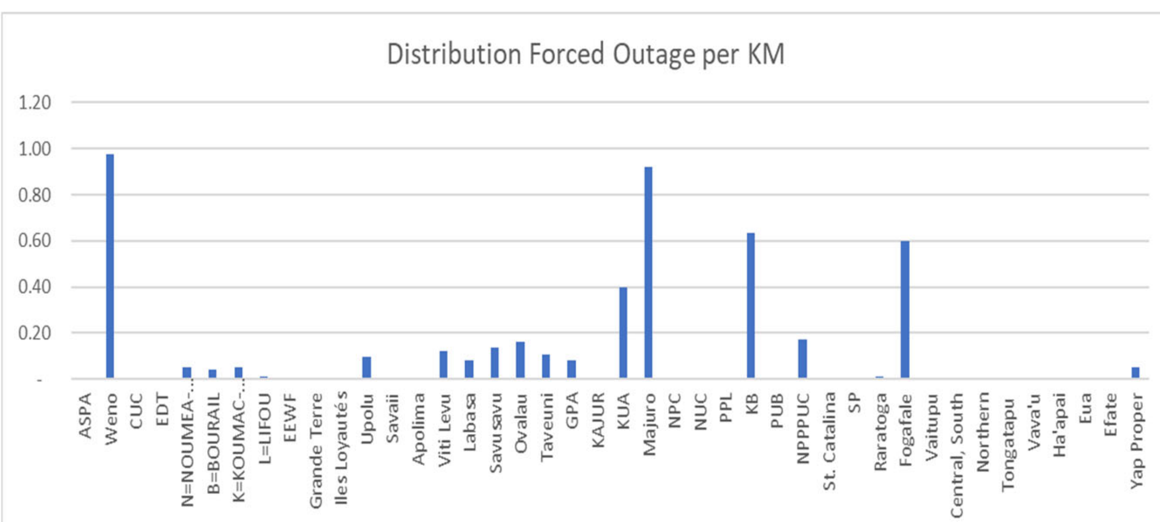
- Only four utilities have a transmission system and one provided incorrect data while the others did not provide any data at all.

Transmission Reliability

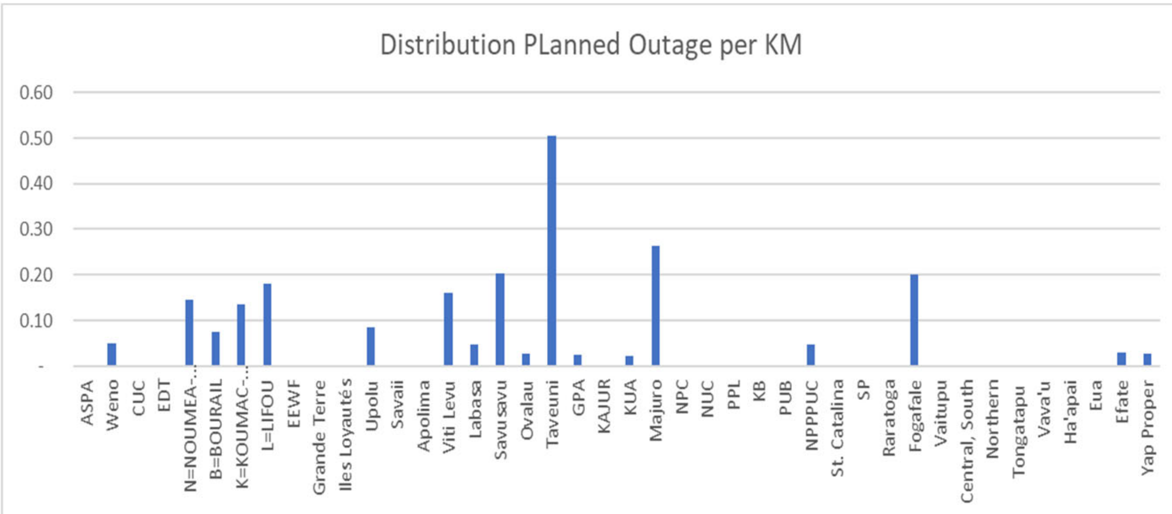
$$\text{Transmission Reliability (outage events per 100 km)} = \frac{\textbf{Number of Unplanned Transmission Outage Events (events)} * 100}{\textbf{Length of Transmission Line (km)}}$$

Transmission Grid	Events per 100 KM
Fiji – Viti Levu Interconnected System	0.68
Guam	4.06
Benchmark = 2 events per 100 KM.	

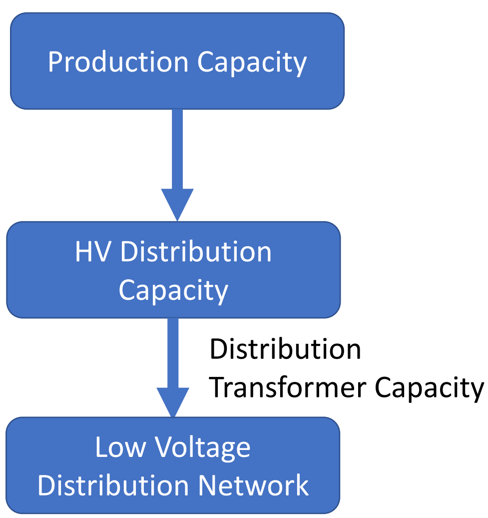
Distribution Reliability



Distribution Reliability



Distribution Transformer Utilization Factor



- Transformer distribution capacity looks at the investment in distribution transformers to transfer power for customer usage.
- Too high a TUF may indicate under investment and the risk of transformer overload.
- Too low may indicate over investment.
- Best between 30% and 40%.

Distribution Transformer Utilization Factor