PV Diesel 101

Phil Maker <philip.maker@gmail.com>

Powerwater Remote Operations/ACEP

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Abstract

An introduction to PV Diesel Systems including principles of operation for medium and high penetration systems.

Overview

This talk covers:

- Electricity, PV, Diesel, Control.
- How PV/Diesel Systems can be applied in isolated grids.

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There will be another chat about that, this is why and how not what..

> *"There had been certain difficulties during the expedition and afterwards, There was no use denying it, I had simply told the story from my own point of view, as honestly as I could" - Tenzing Norgay.*

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- See also Ackermann for Wind Diesel Hybrid Systems.

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Dill Alert: never confuse peak with average or kW and kWh!

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- **Frequency (Hz)**, typically ranging from 49 to 51Hz. (cycles per second for the boffins).
- **Voltage (V)**, typically 430V, for the hydro analogy this is height.
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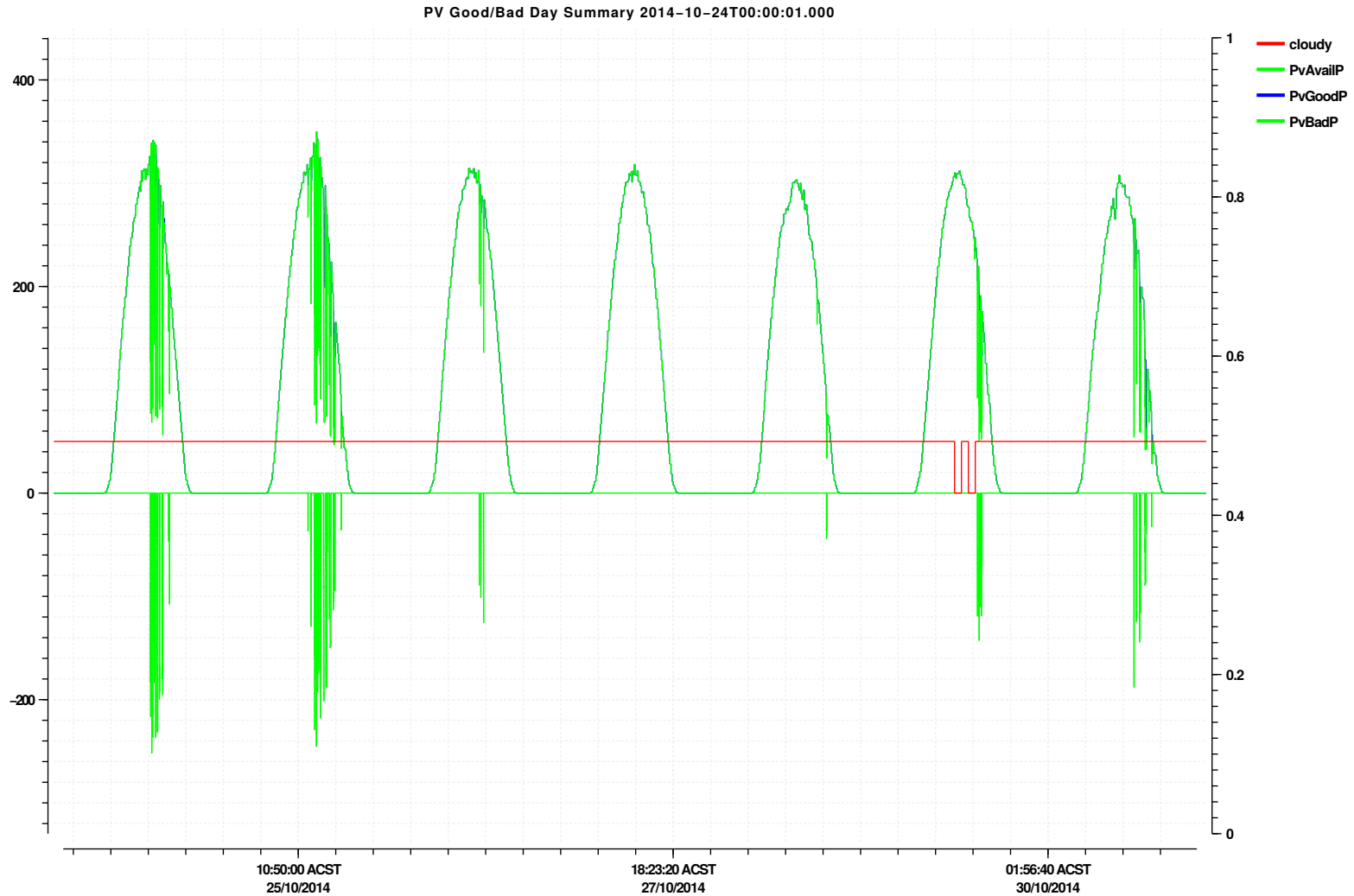
- **Reactive Power (vars)**, regulates the voltage, similar to kW it must balance:
  `GenQ = LoadQ`

Note that:

- If `(GenP or PvP > LoadP` then `F` increases.
- And vice versa
- Similarly for `Q` and `V`.

PV good days and bad days



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- **Step Load**: the capability to take a single immediate increase in load. Typically:
  `StepP` $<$ `SpinP`

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- **Setpoint control**: can be used to control output of devices but we need a mixture of Droop and Isochronous in order to balance the system.

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- Start and stop diesel in order to keep:
  `SpinP > SpinMinPPa`
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Dill Alert: Lets replace Station X with 2 x 1MW containerised sets where load varies from 500..1400 kW

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- Depend on the normal spinning reserve to handle cloud events. Typical generator start times are around 1 minute. **Dill Alert: PV varies once every minute for data sampled once every minute**
- A bad cloud event typically takes 10s, e.g.
  1. Wind speed at 1000m = 5m/s
  2. Field is 50m across.
  3. Result is obvious, i.e. PV variability depends on wind speed.
- Low Penetration is limited to 10..20% (spinning reserve).

Dill Alert: Design a power system where we keep 30kW of Spinning Reserve and try to install 60kW of PV.

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3. So control:`GenMaxP` and `PvSetP` in order to meet 1 and 2.

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- Finally: if min loading is 40% the maximum penetration is 60% sif the loads match the generators.

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- We need to minimize spill by:
  - Appropriate Generator sizing.
  - Controlling load profiles.
- Note that most of the cost of the PV in is in the mobilisation, i.e. its X+Y*K not Y*K.

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Examples are available from WA, AQ, AK, MY, ID, etc.

But its not off the shelf for larger systems.

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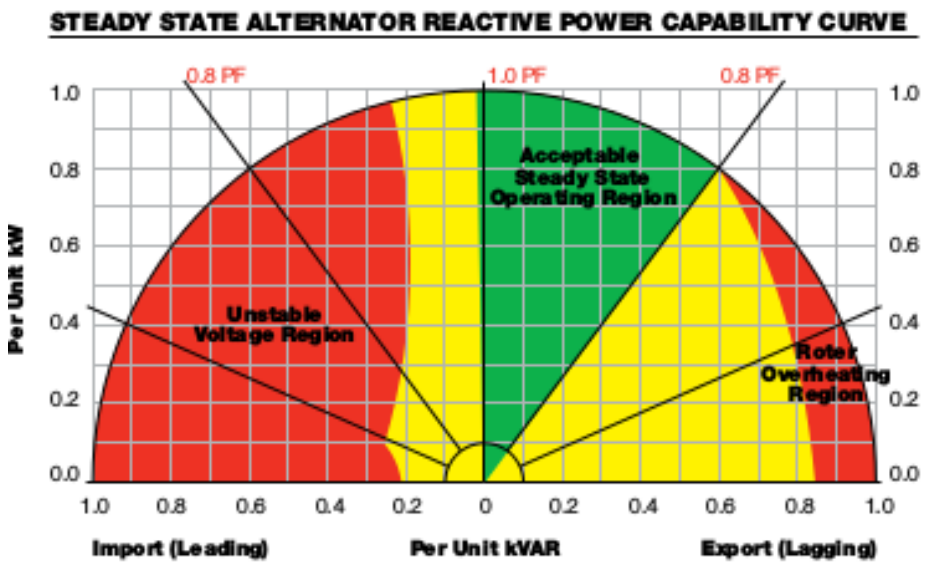

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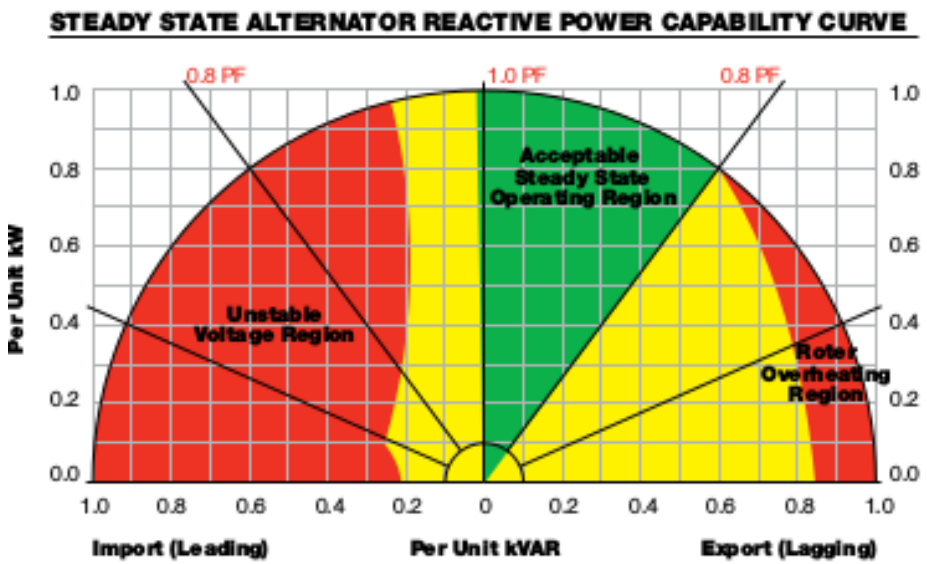
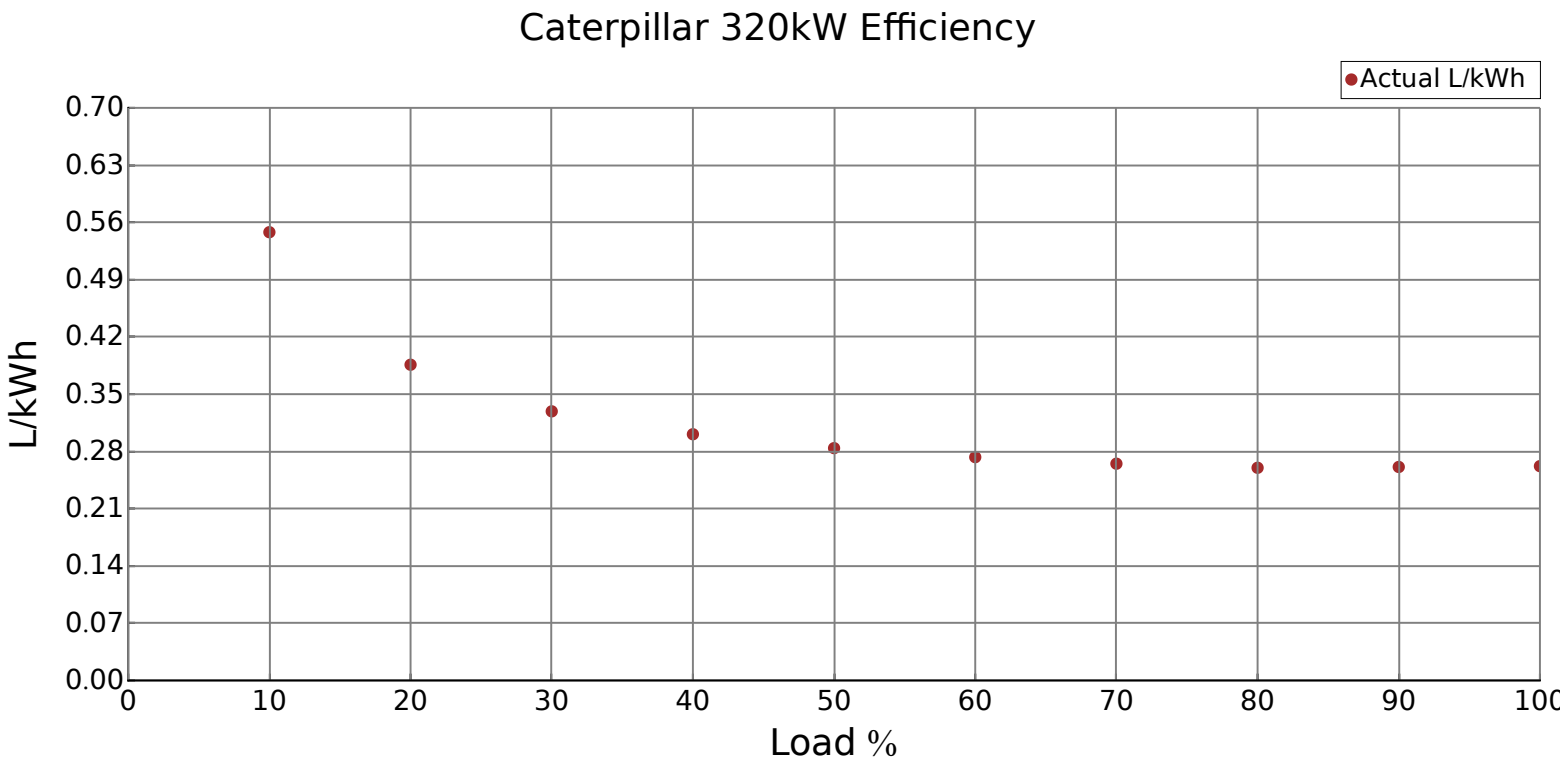


Dill Alert: At low loads my powerfactor is bad, panic

Fuel Efficiency



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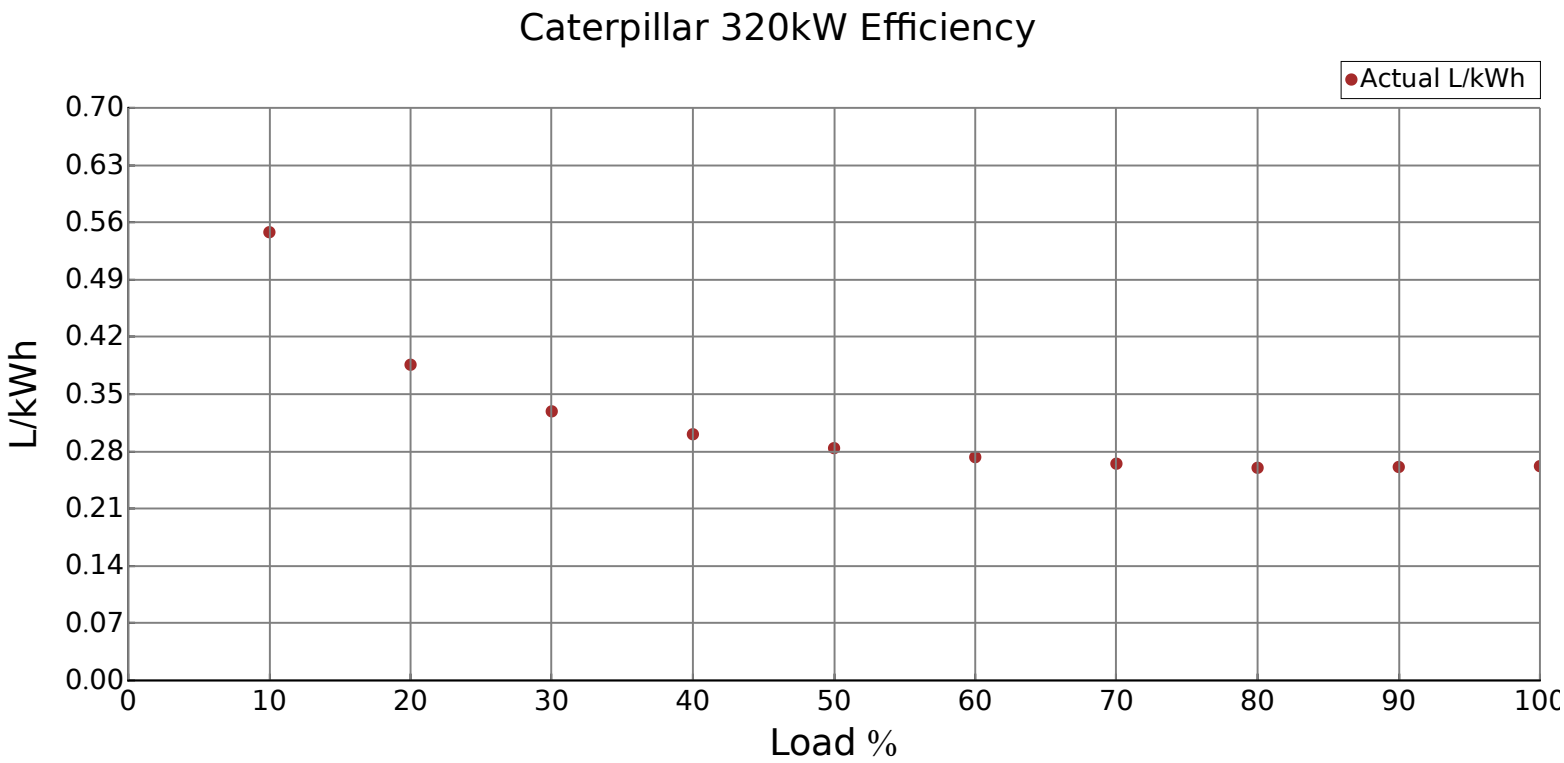
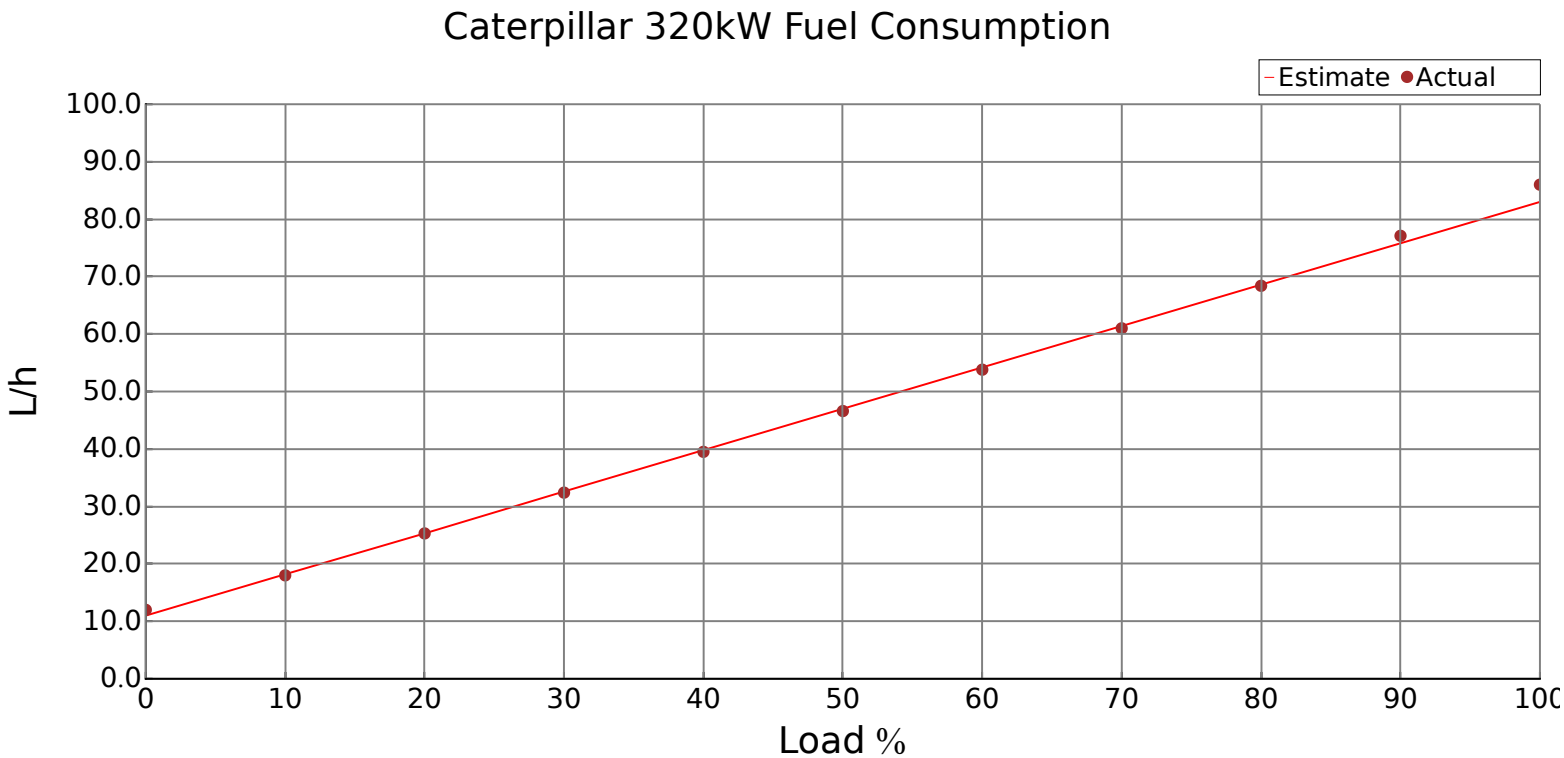


Dill Alert: So clearly we need to run diesels at around 80% load so they are efficient

Fuel Consumption



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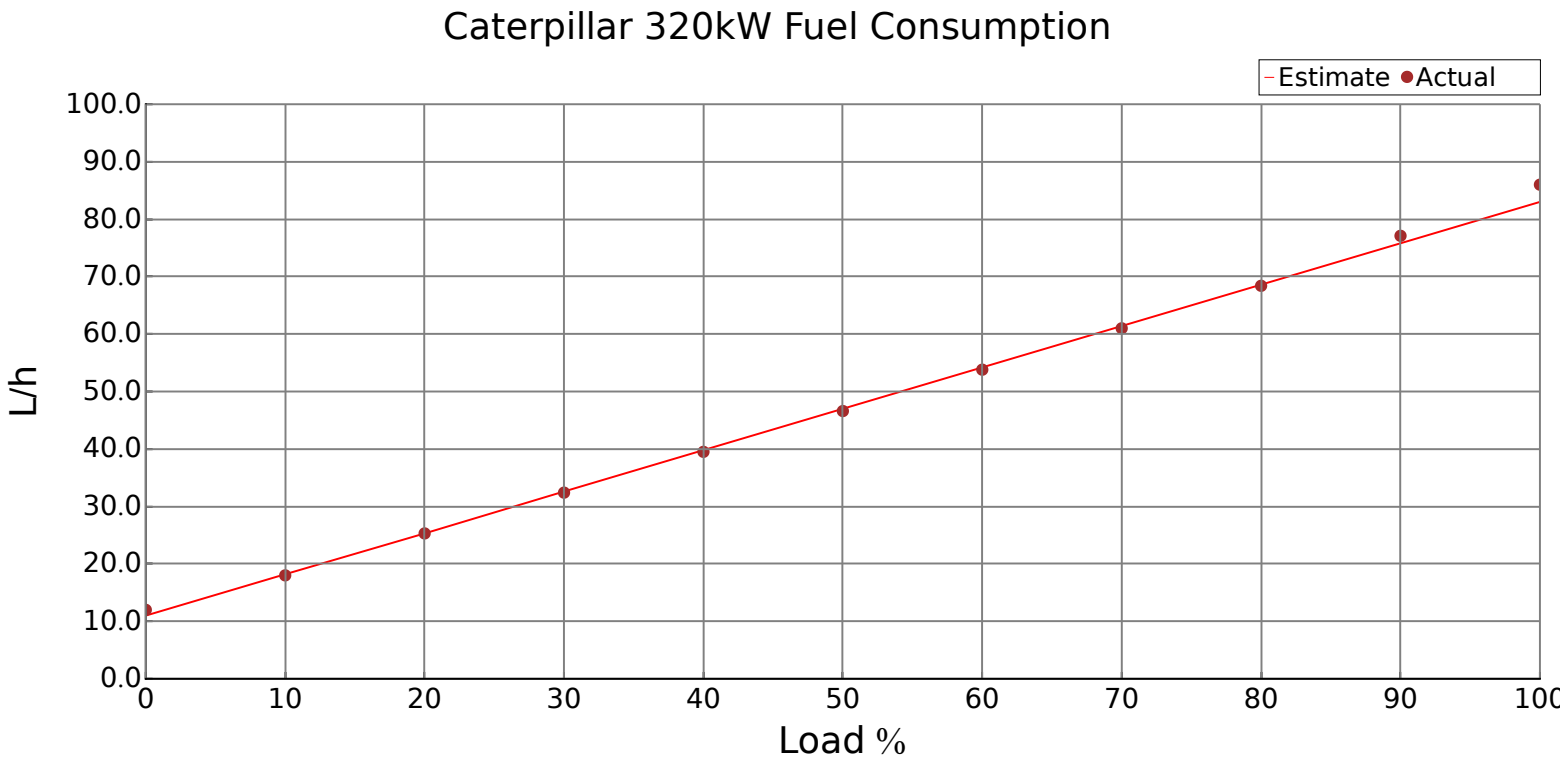

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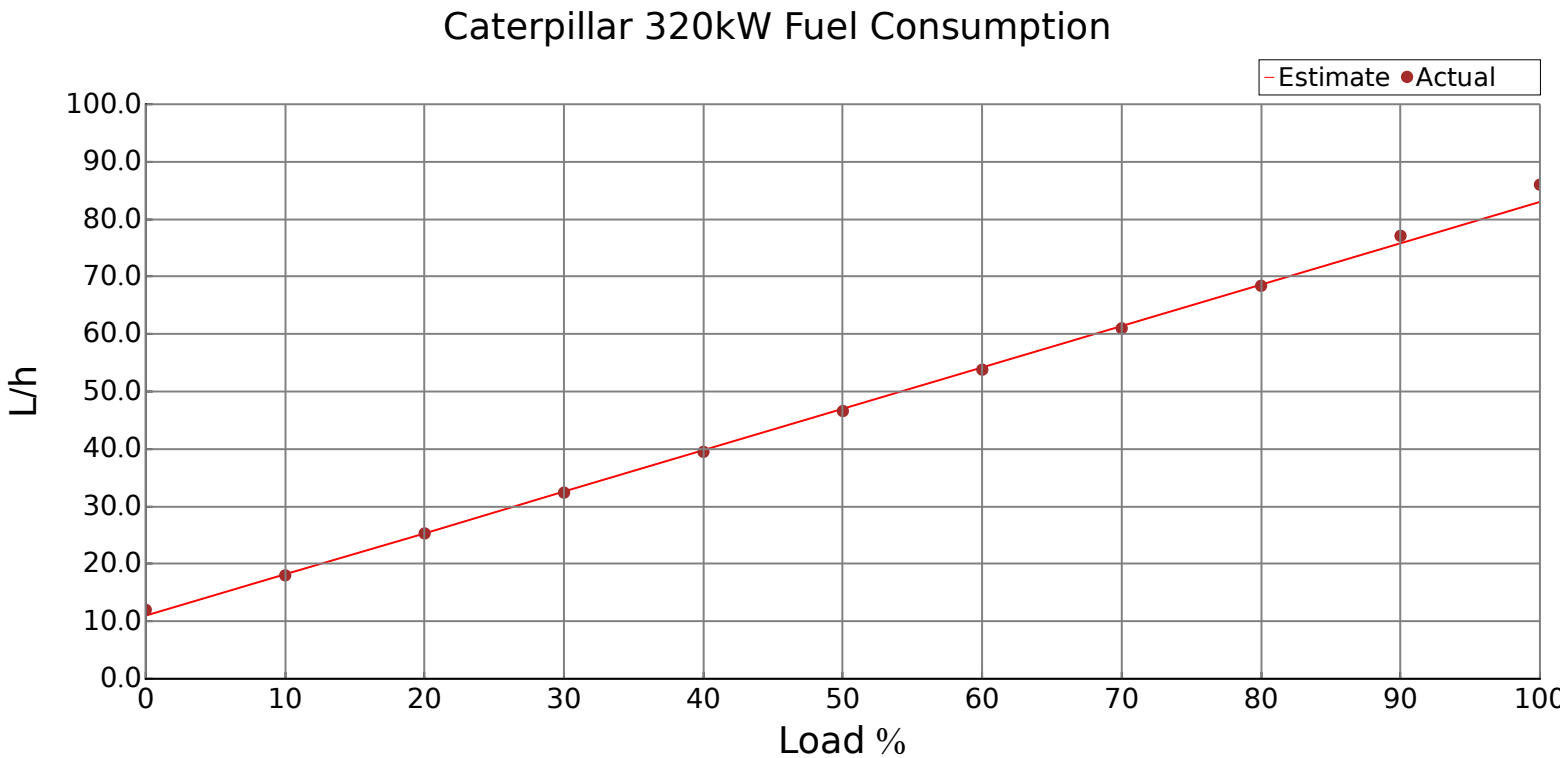

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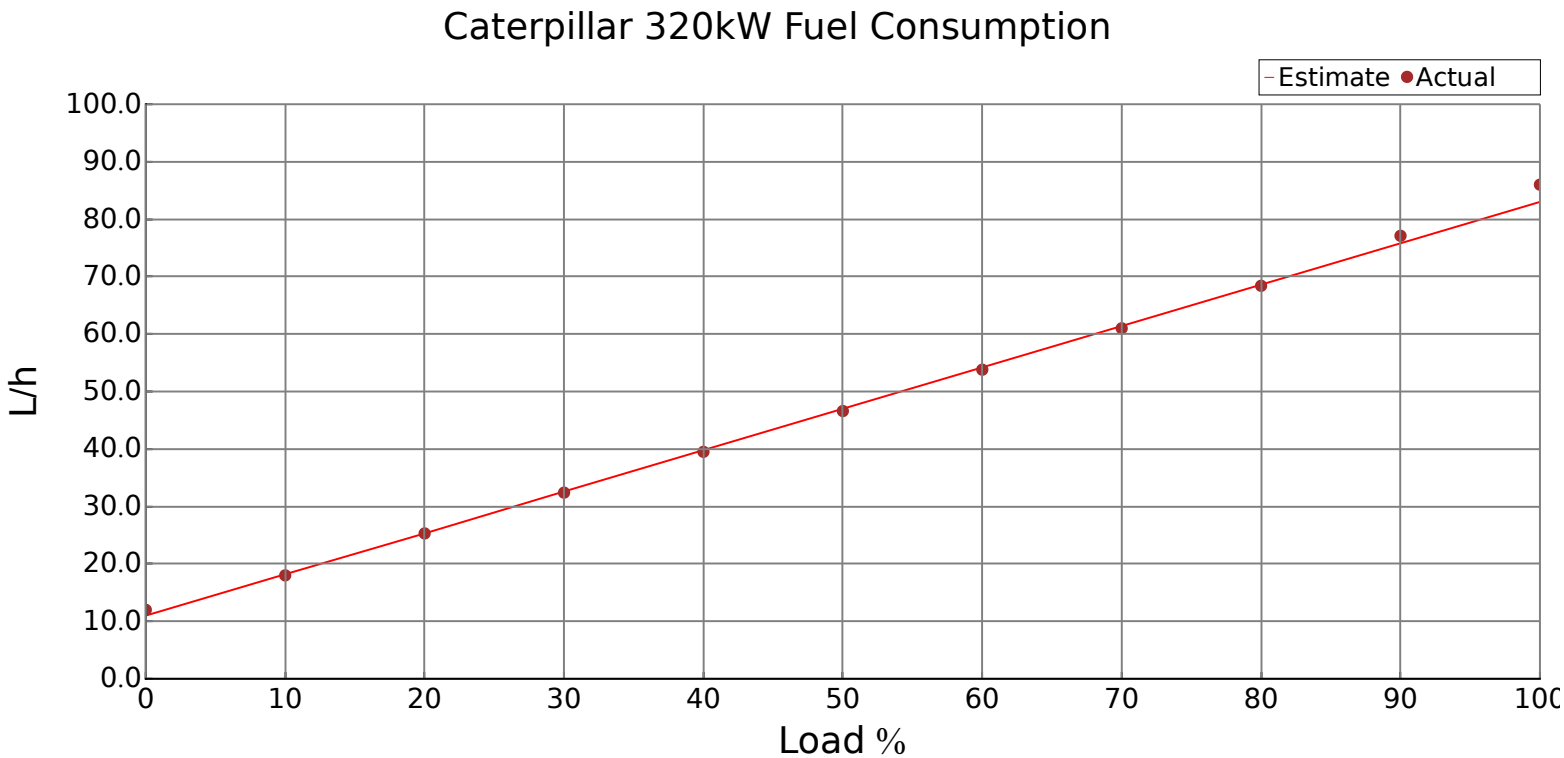

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- So there is a cost for spinning and a cost for generating.
- So every bit of PV saves fuel, running a smaller generator saves fuel.

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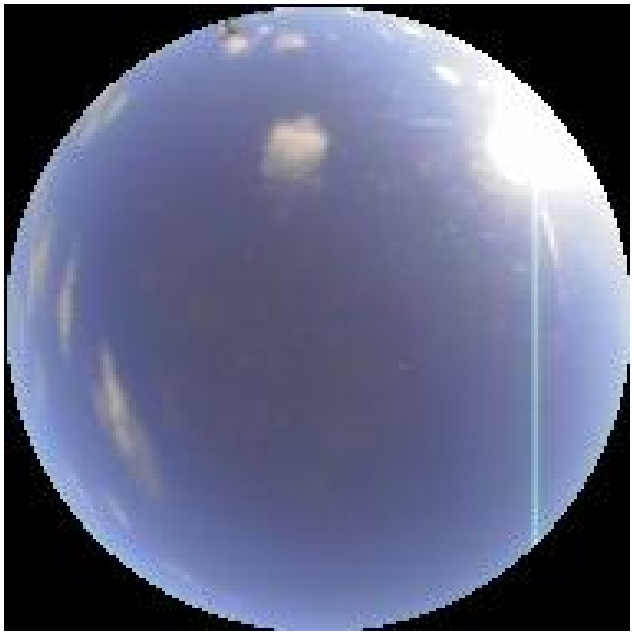

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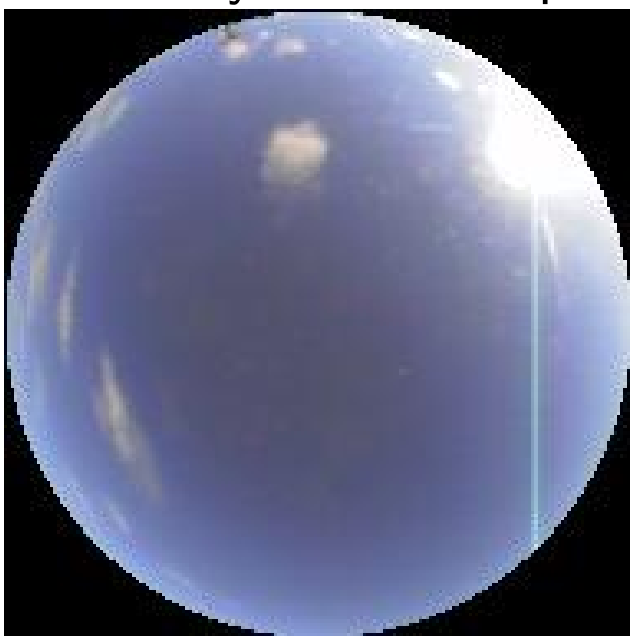

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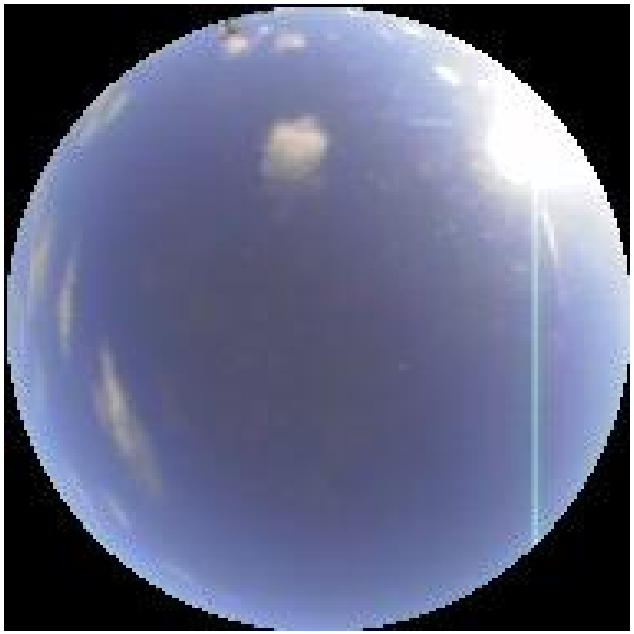

So you can run a smaller diesel: 2x320kW vs 1x320kW is around 30k$/y.

Then start the next diesel when the cloud comes.

Demand Management

Control `LoadP` so we can turn off some load, perhaps using:

Green Power Point power iff there is excess green power.

Brown Power Point we assure power but there might be an outage for 2 minutes whilst we start a diesel.

Red Power Point always on.

The key thing is we need two way control and measurement.
See Saturn South

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> *neither is survival - W. Edwards Deming*