Reciprocating Engines in Support of Grid Modernization

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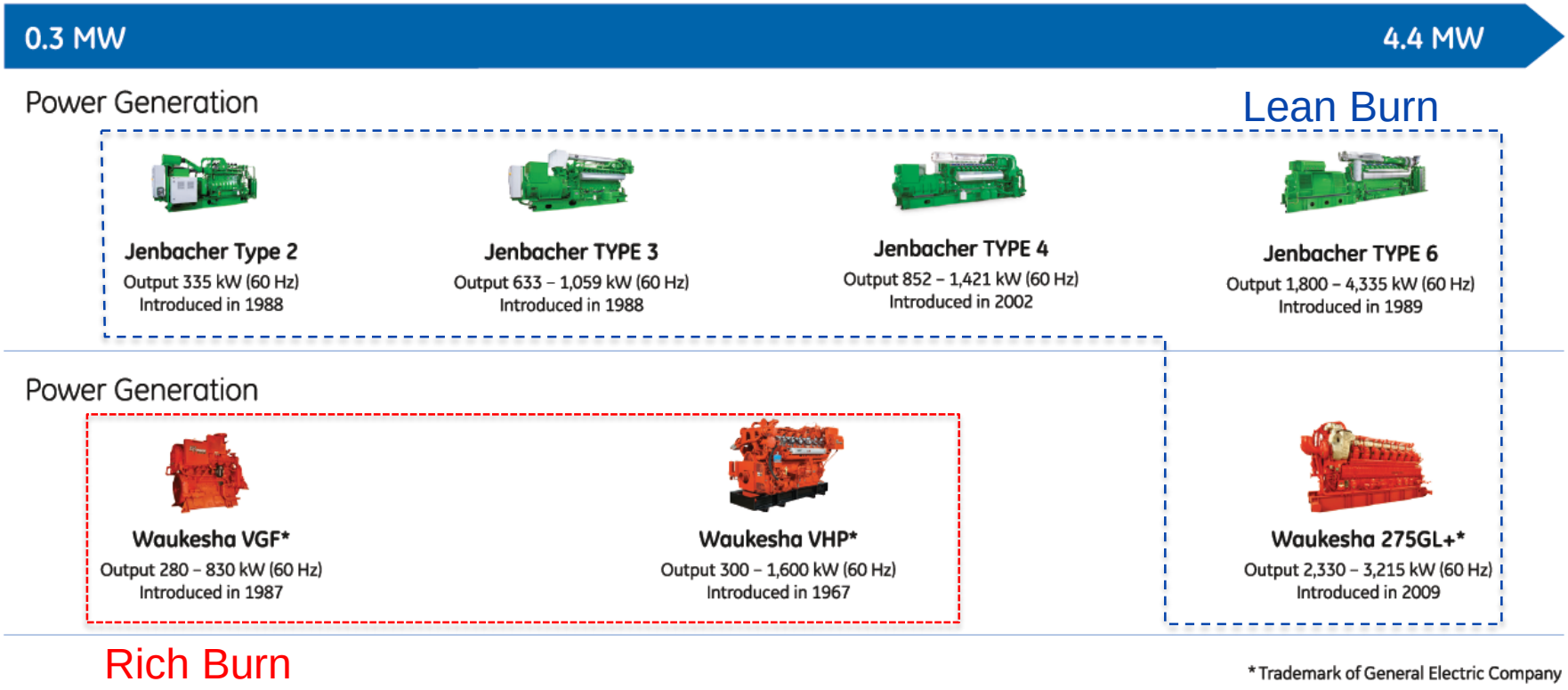
Imagination at work.

Natural Gas Reciprocating Engines

GE (Waukesha, Jenbacher), Caterpillar, Cummins, Cooper, Superior, ….

Eff ~38%, NOx <1g/hp-hr , CHP compatible

www.eren.doe.gov/deer.html

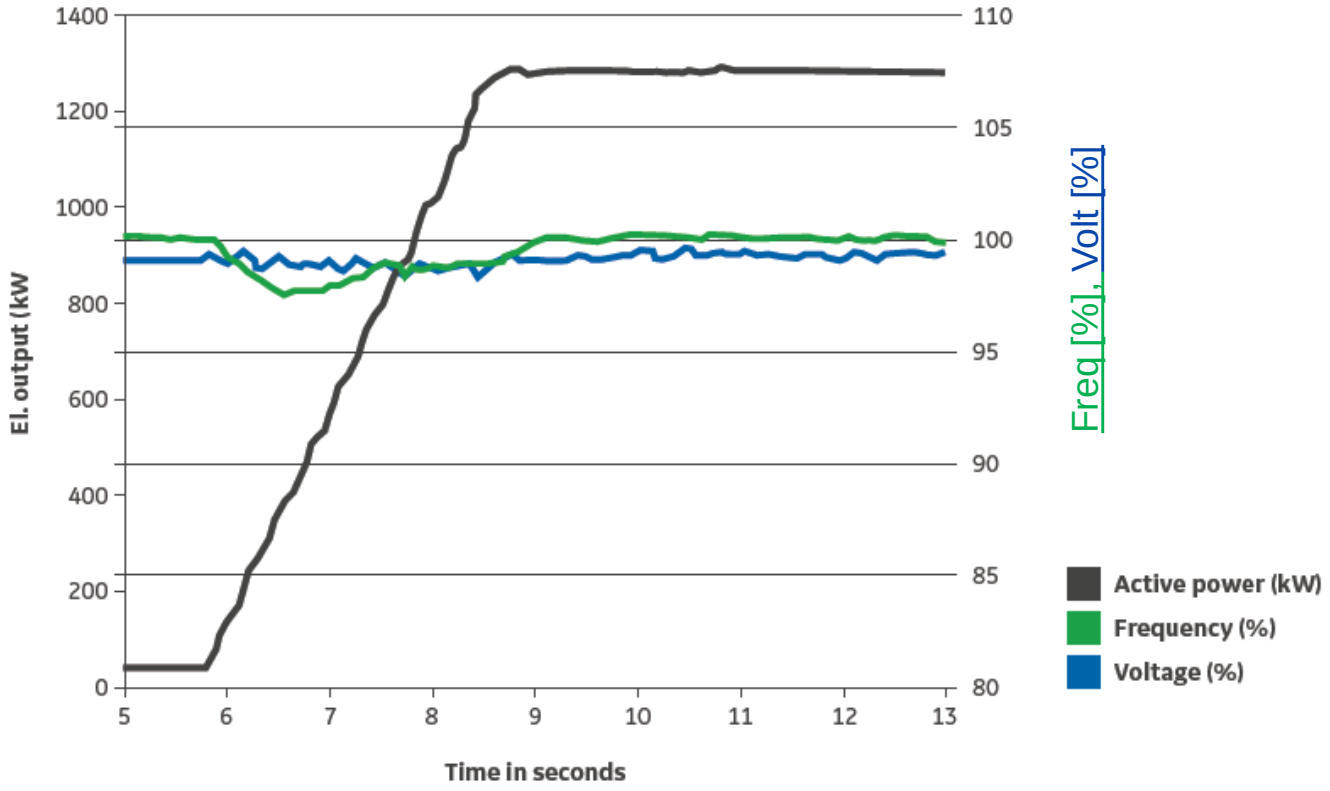


Navigant - 27 GW of NG-Generators installed by 2024

NG Recip – Rich Burn - Performance

Meets CA, TX standards w/ 3-way catalyst

Grid Independent Mode (Islanded), load ramp-up response



Grid Services - CAISO

Grid Service	Description	NG Recips
Frequency Regulation	>500kW, max <10 min, 30~60 min commitment, >25% accuracy, ramp	Yes
Spinning Reserves	>500kW, AGC w/ droop, 1 sec response, if F<59.92 Hz, then10% power in 8 sec, unit at idle for long periods	Yes, provisions for long idle ops
Non-Spin Reserves	>500kW, 10 min to ramp, 30 min commitment	Yes
Ramping Reserves	Award based on 5-min ramp capability	Yes
Demand Response	>500kW, full capacity in 40 min, duration 1~4 hours	Yes
Black Start	Start and support local load w/o grid, Volt/VAr control May start from “cold”	Yes, heaters for cold start
Voltage Reg	0.9 lag to 0.95 lead	Yes

What will Grid Services look like in 2020? Or 2025?

Areas for Improvement - technical

Faster response from lean-burn engines
- fuel injection (>5 psi NG feed)
- electrified turbo chargers
- air impingement techniques
- variable valve timing

More efficiency from NG Generators
- advanced lean burn technology (→ 50% eff?)
- better “bottoming” cycle CHP technology (→ 65% eff?)

Grid Operator needs
- models for smaller DER’s
- aggregation/disaggregation functions to 100’s of DER’s