

Solar[®] Energy Storage

Providing balance and harmony for our customers energy needs

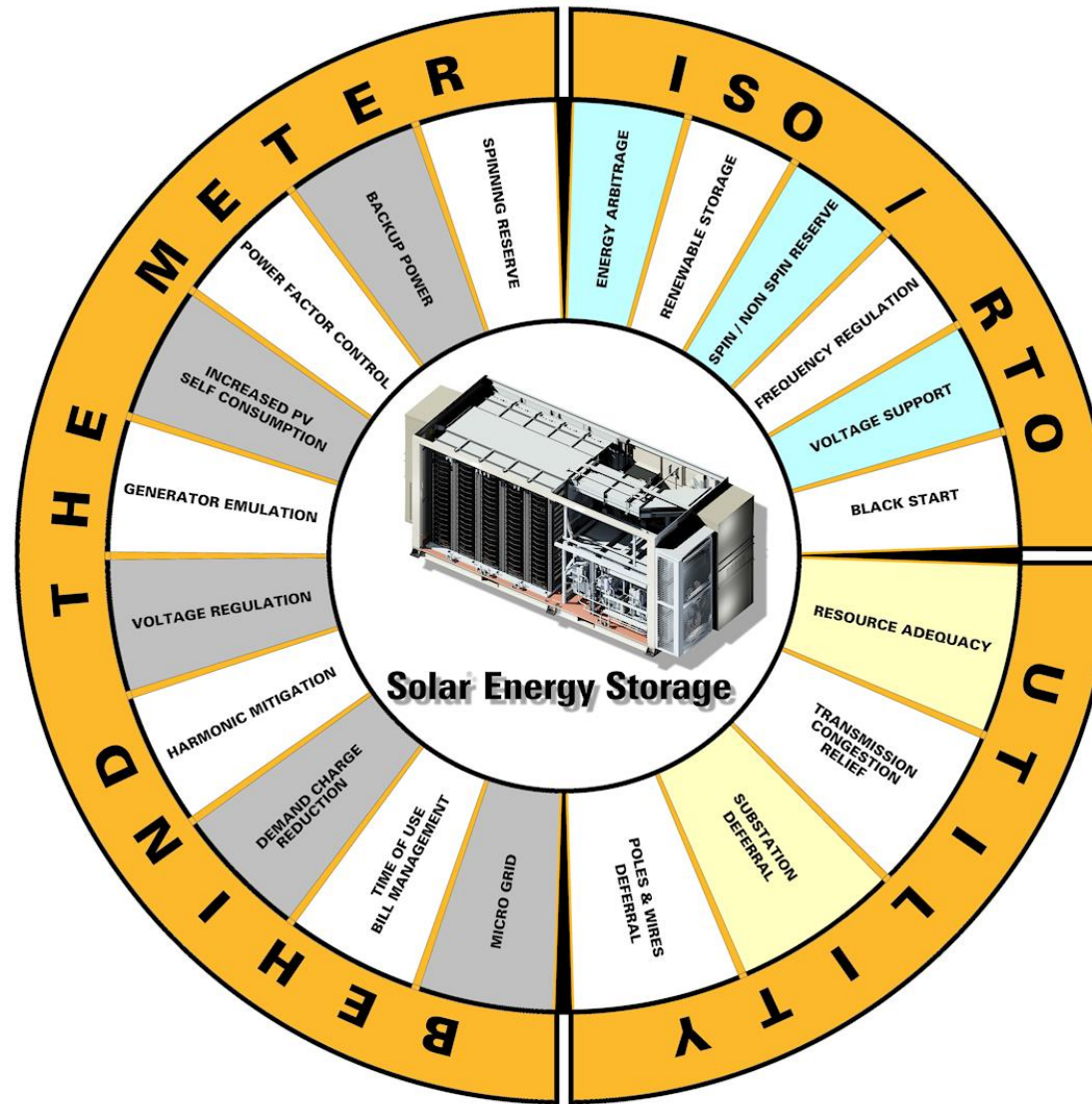


Solar[®] Turbines

A Caterpillar Company

Caterpillar: Non-Confidential

Applications for Energy Storage? – Just a Few



But first, who is Solar Turbines?

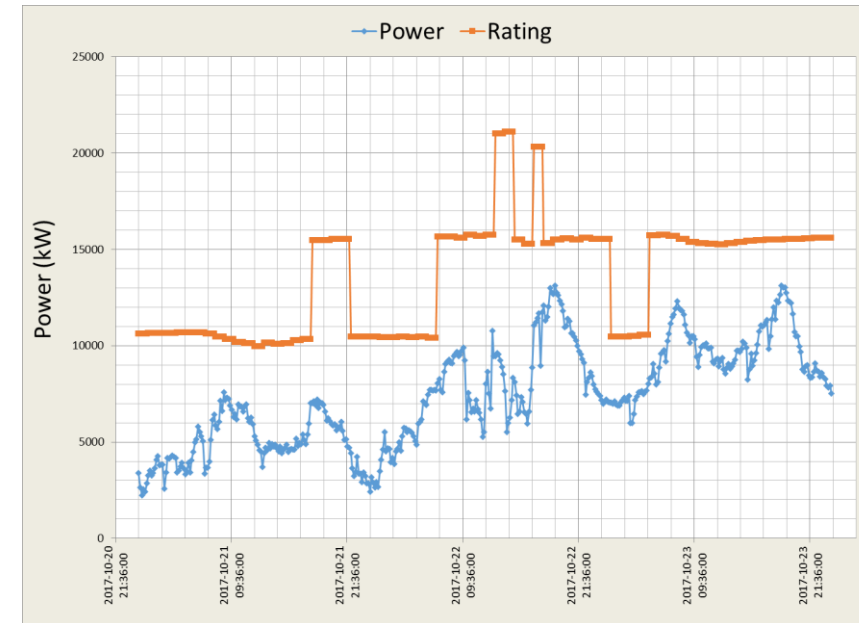
- World's Largest Manufacturer of Industrial Gas Turbines (1 to 22 MW)
- Over 15,000 Gas Turbines Sold
- Over 10,000 Gas Generators Sold
- Installations in over 100 Countries
- Direct End-to-End Sales & Service
- More than 2 Billion Fleet Operating Hours
- Global Workforce ~ 8,000 Employees
- 48 Sales & Service Locations
- 70% of Products are Exported
- Based in San Diego, California, U.S.A.
- Subsidiary of Caterpillar Inc. Since 1981

Solar[®] Energy Storage as Spinning Reserve

- Remote, Isolated Site
 - No Grid Connection
 - 10 MW Windfarm
 - 30 MW Power Plant

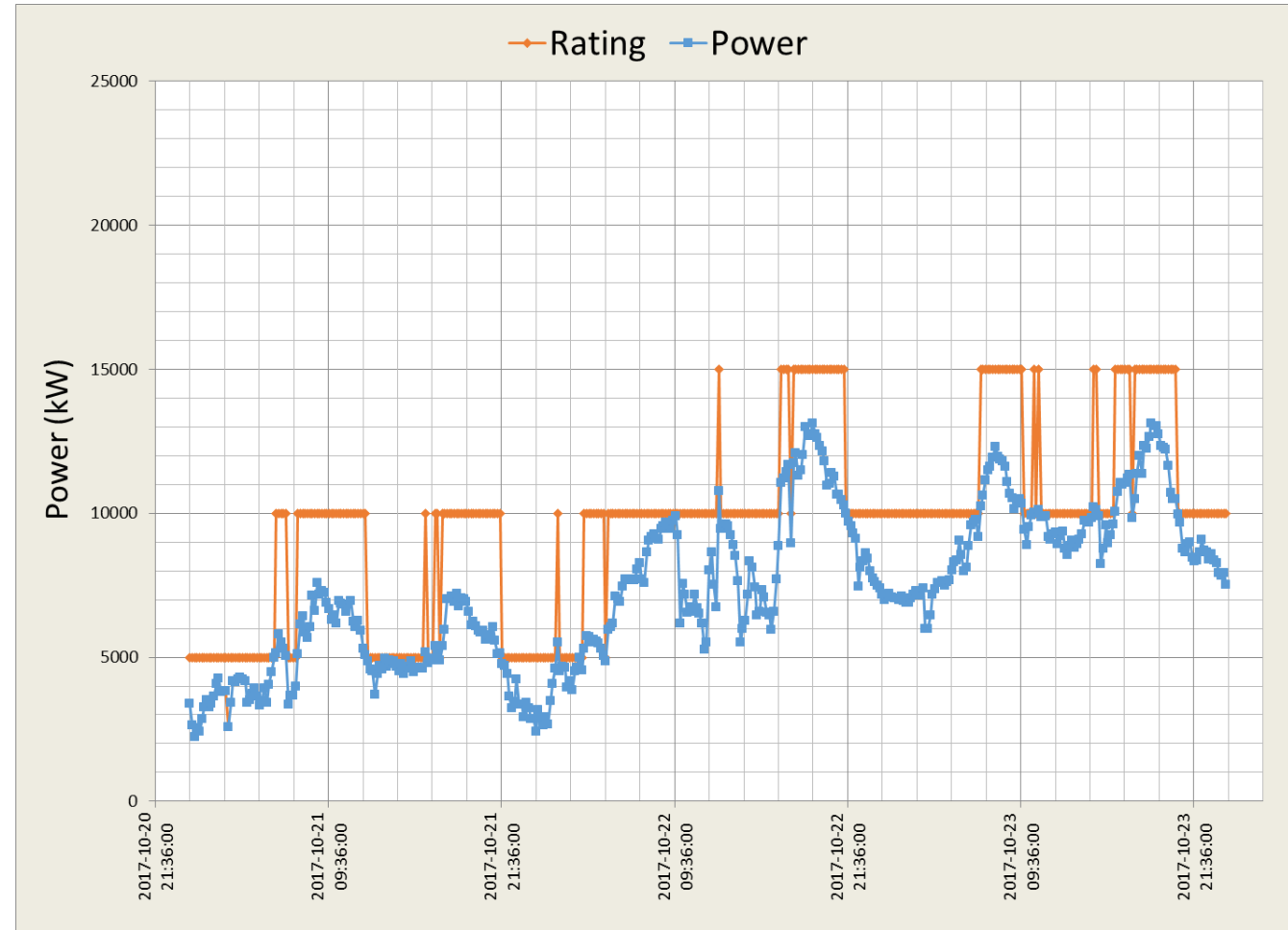
Month	Powerstation Generation [kWh]	Windfarm Generation [kWh]	Turbine Hours	Turbine Average Load [kW]	Gas Usage [TJ]	Diesel Usage [kL]	Thermal Efficiency [%]	Heat Rate [kJ/kWh]	Overall Efficiency [%]
January	6,108,866	1,333,312	2337	2613.98	95.46	0.000	23.04	15,626.47	28.07
February	5,574,192	1,211,392	2212	2519.98	88.646	0.000	22.64	15,902.93	27.56
March	6,151,126	1,059,392	2431	2530.29	99.068	1.200	22.34	16,112.77	26.19
April	6,108,189	733,808	2283	2675.51	95.202	0.800	23.09	15,590.73	25.86
May	6,693,932	1,084,896	2426	2759.25	102.68	0.400	23.47	15,341.89	27.27
June	6,973,978	595,504	2400	2905.82	104.16	3.400	24.08	14,952.55	26.13
July	6,371,804	1,828,688	2330	2734.68	98.93	0.200	23.19	15,527.04	29.84
August	6,088,905	1,808,416	2225	2736.59	93.81	0.000	23.37	15,406.71	30.31
September	5,731,254	1,244,112	2077	2759.39	88.99	0.600	23.18	15,530.95	28.21
October	5,317,863	1,388,992	1962	2710.43	82.639	1.000	23.16	15,546.73	29.20
November									
December									
Total	61,120,109	12,288,512	22,683	2694.53	949.58	7.600	23.16	15,540.84	27.82

- Power Plant Operation
 - Operates N+1 scenario
 - Average efficiency 23%



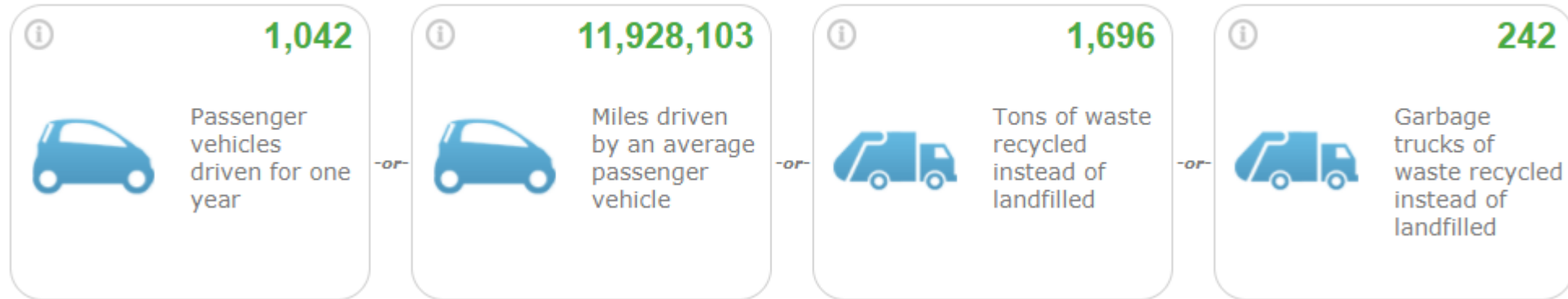
Solar[®] Energy Storage as Spinning Reserve

- Add 5MW Energy Storage
- Power Plant Operation
 - Operates Energy Storage scenario
 - Average efficiency Increases to 28%
- Save 200,000 kWh a day in fuel
 - 4,866,666 kG CO₂/year
- 5.5 year payback

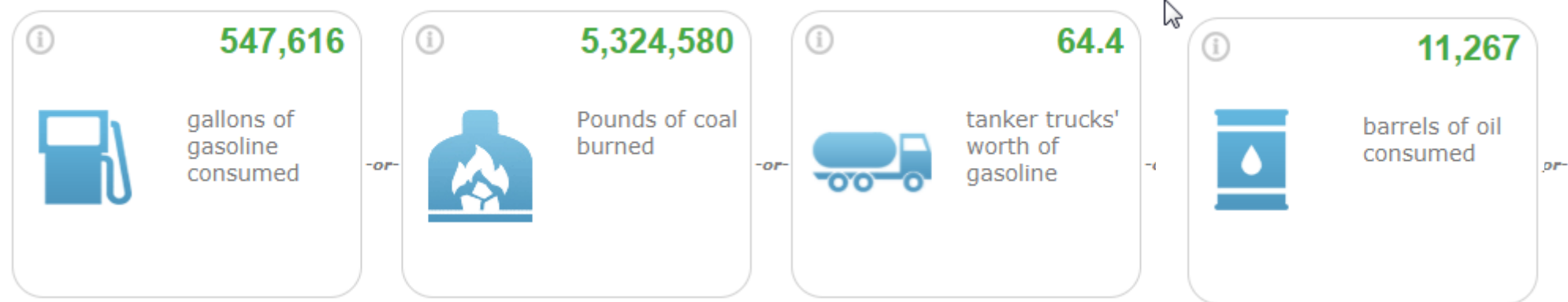


Solar[®] Energy Storage as Spinning Reserve

Greenhouse gas emissions from

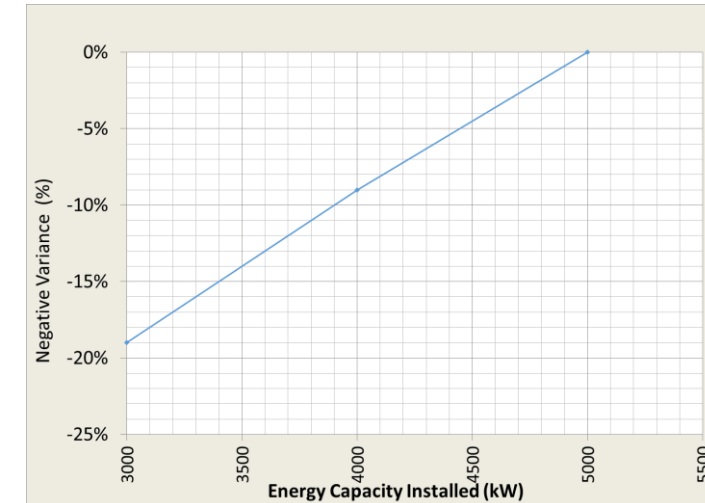
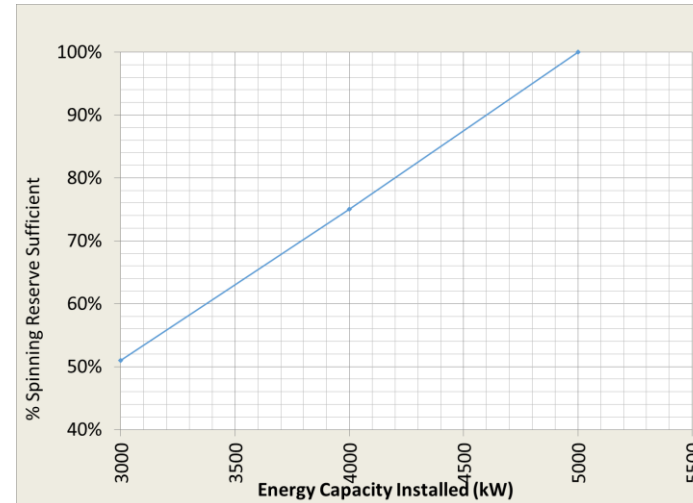
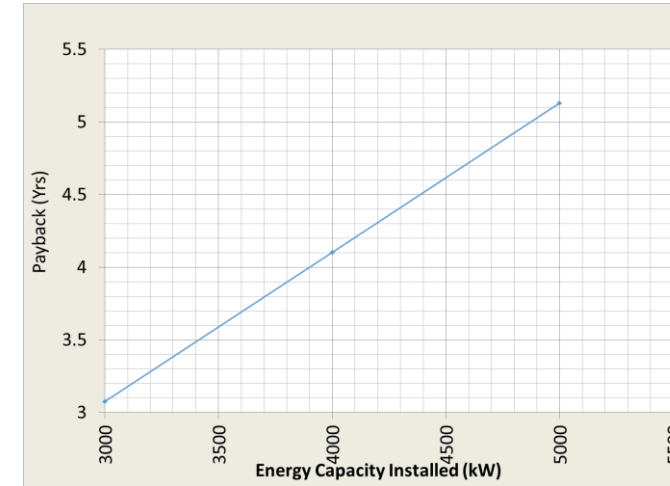


CO₂ emissions from



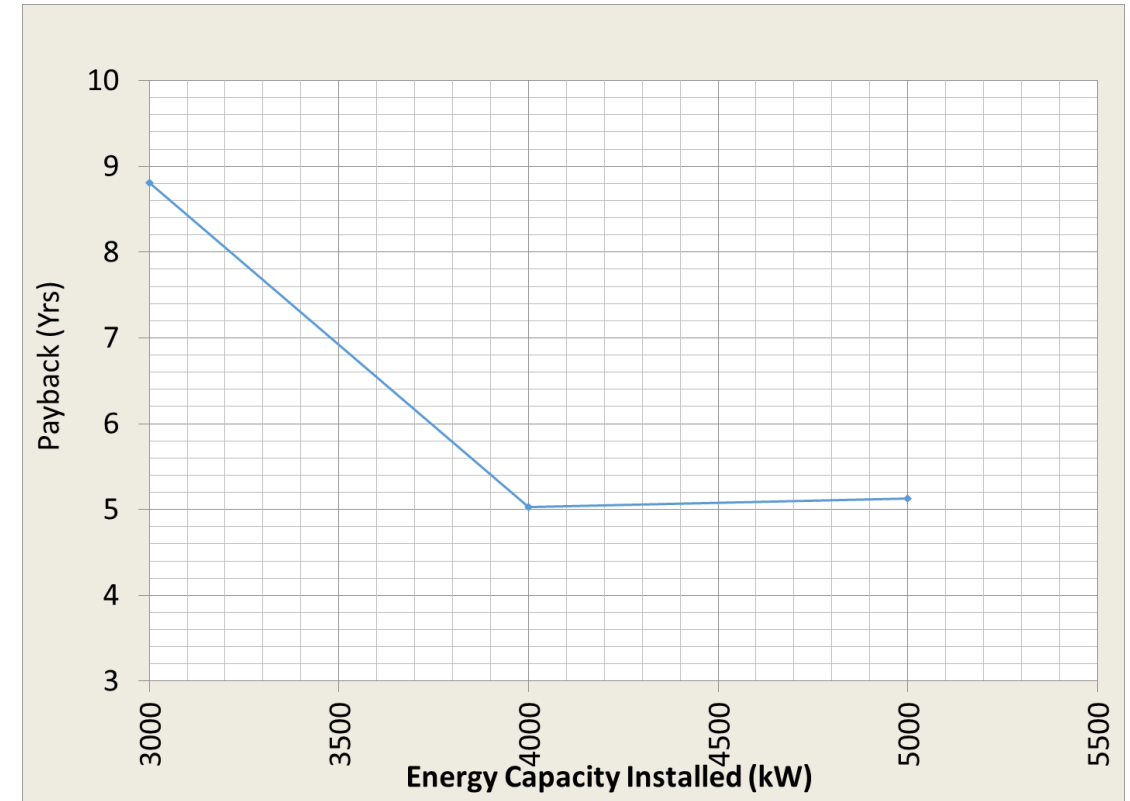
Solar[®] Energy Storage as Spinning Reserve

- Optimize Energy Storage
 - Reducing storage reduce CAPEX
 - Payback (in years) reduces
- Resiliency Reduces Also
 - How to measure it
 - % Sufficient Spinning Reserve
 - Average % Negative Variance



Solar[®] Energy Storage as Spinning Reserve

- Optimize Power Plant
 - Reducing storage reduce CAPEX
 - Increase cycling of gas turbines
- Resiliency Remains Optimum
- Keeps Payback at 5 years.
 - 2,264,080 kG of CO₂/year



Thank you





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