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Grid Scale Energy Storage

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Abstract

Grid energy storage can be used to meet New England's peak energy demands, replacing highly polluting "peaker" oil power plants. The goal of this report is to determine the most economically and technologically feasible methods of energy storage and then determine whether or not these technologies are competitive against current oil power plants. The findings of the report indicate that pumped hydro can compete with oil peakers, and sodium sulfur batteries will compete within the near future.

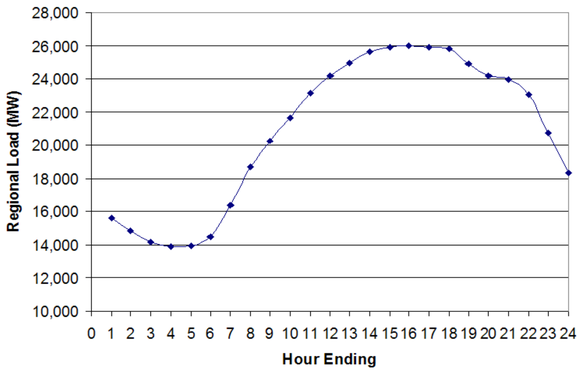

Image by Doug Hurley, Synapse Corp

The electrical load curve from New England on a typical summer day (June 9th 2008)

Objective

850MW of grid scale energy storage can be implemented on the New England to replace all 856GWh now generated by oil peaking plants

- Eliminates pollutants and emissions
- Potentially cheaper for end users
- Easily integrates PV, Wind, new energy sources
- More responsive to demand changes

Pumped Hydro

- Pumps water uphill into an upper reservoir at night to store energy, and releases the water down hill into a lower reservoir through a turbine to release energy
- 70-80% of energy is retained
- Estimated $1-2 billion for a 1GW facility
- Low maintenance costs
- Long lifespan (75-100 years)
- Zero emissions, but may alter ecosystem

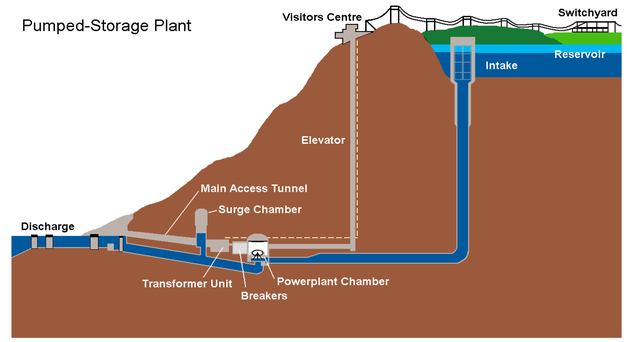

Image by David Connolly, University of Limerick

Sodium Sulfur Battery

- Durable, inexpensive to manufacture
- 15 year lifespan with little to no maintenance
- $1500/kW 89% energy recovery
- Estimated $1.5 Billion for a 1 GW facility
- Size of 470 standard cargo containers
- Up to 7 hour discharge
- 99% recyclable materials; Na and S common elements
- Zero emissions
- Selling at same price as oil generators, system pays for 93% of its cost over its lifespan by energy arbitrage
- System breaks even if NaS costs fall below$1416/kW

Peaking Oil Plants

- Burns expensive petroleum based fuels in thermal generation
- Turns on within minutes, ideal for backup or emergency power
- Produces up to 5.8GWh on a peak day
- Sells electricity at around $1.03/kWh
- 242 million tons of pollutants per year
  - 240 million tons CO_2
  - 1.6 million tons SO_2
  - 600,000 tons NO_X
  - 4,800 tons CO
  - 12,000 tons other particulates

Quantitative Results

	Efficiency	Lifetime (years)	Installation Cost ($/MW)	Selling Price ($/MWh)	Pollution (tons/yr)
Oil Thermal	40%	50	700,000	103	242,000,000
Pumped Hydro	75-80%	75-100	1,000,000 -2,000,000	103	0
Sodium Sulfur	89%	15	1,500,000	106*	0

*To break even over lifetime

Conclusions

- Pumped Hydro storage is the best option, pending geographical locations
- Extremely long lifespan makes it easy to pay back and profit
- NaS systems are not yet cost effective over lifetime
- Any storage technology will be cleaner, as their energy stems from cleaner off-peak plants such as nuclear, hydroelectric, or renewables

Background Image by OJ Byrne