

LARGE-SCALE, LONG-DURATION ENERGY STORAGE

RESPONDING TO THE URGENCY OF CLIMATE CHANGE WHILE MAINTAINING OPERATIONAL AND FINANCIAL RESILIENCE

Transforming thermal generation into low-carbon, flexible, renewable storage systems

Growing deployment of renewable energy and mandates to decarbonize electric generation are disrupting energy markets. Success of solar and wind has led to periods of over-abundance, low or negative priced energy, and curtailment of clean

generation. Pintail Power overcomes these challenges with patented hybrid technology that integrates proven thermal energy storage media with existing or new thermal generation to deliver unprecedented flexibility, efficiency and cost-effectiveness.

What if excess solar generation could be reserved (not curtailed) for steep ramps and overnight loads while increasing efficiency of essential thermal generation?

REALISTIC TRANSITION TO TARGET GOALS

Pintail Power hybrid thermal storage options fill the daily and seasonal variability gaps of wind and solar. We enable a reliable transition to aspirational clean energy targets with systems that complement batteries and can use lower carbon and renewable gas as available.

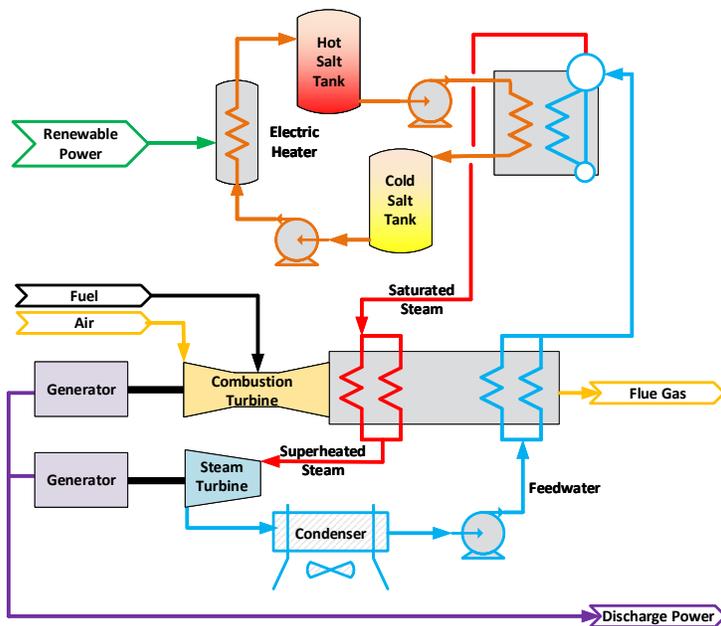
- Low cost at utility and microgrid scales
- Longer duration and smaller footprint than batteries
- More flexible siting than pumped hydro or CAES
- Minimizes need to alter customer usage behavior
- Equitable approach to supporting universal service

Immediately reduce carbon impact from existing thermal generation by 50%

Sooner is Better



Pintail Power's hybrid technology is the missing linchpin needed to dramatically increase renewable penetration on the grid.



Liquid Salt Combined Cycle™

LSCC technology integrates molten salt thermal energy storage with combustion turbine exhaust heat. Proven components from Concentrating Solar Power and process industries are added to an otherwise conventional combined cycle arrangement:

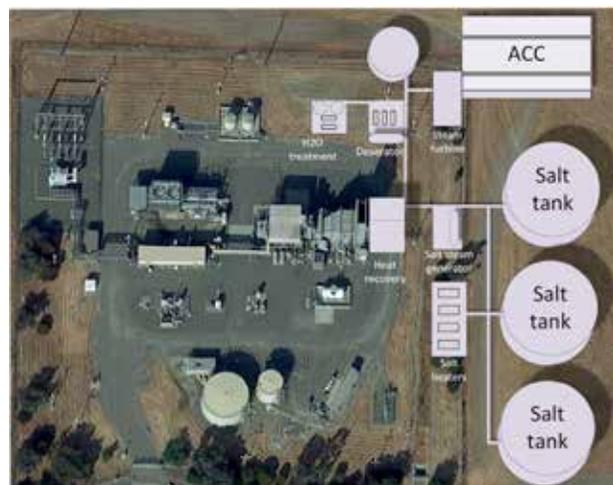
- a two-tank molten salt storage system,
- an electrical resistance heater for charging,
- and a molten salt steam generator that uses stored energy to boil water.

The patented approach increases steam flow 2.5 times, reduces the cost of thermal storage, cuts simple-cycle heat rate in half, and can be implemented at lower cost than any alternative storage technology. The salt is safe, non-toxic, non-flammable, and has no rate-of-charge or state-of-charge constraints. The system provides operational flexibility including fast startup, fast-charging, and flexible load-following.

Implementation

LSCC can be implemented at virtually any scale, from a few to many hundreds of Megawatts. The next figure illustrates how a simple cycle peaking plant could be converted to a large-scale storage facility by adding three 92-foot diameter tanks, each capable of holding more than a GWhe of energy.

In this example with an LM-6000 combustion turbine, the overall plant is rated at 91 MWe net; three tanks (2 full and 1 empty) can provide 24 hours of discharge capability



Performance

Hybrid LSCC technology works with any combustion turbine – industrial, aero-derivative, frame – from any manufacturer to efficiently decarbonize at any scale. Indicative performance is for single-pressure non-reheat, steam cycle with air cooled condenser, net of plant loads; ISO ambient, 60 Hz, natural gas fuel at Lower Heating Value. Heat rate and Electrical rate are referenced to total discharge energy per ASME PTC-53.

Combustion turbine manufacturer and model	Simple Cycle		Liquid Salt Combined Cycle				
	Power (MW)	Fuel heat rate (Btu/kWh)	Power (MW)	Fuel heat rate (Btu/kWhout)	Electrical rate (kWhin/kWhout)	Power improvement	Heat rate improvement
Siemens Trent WLE	66	8,150	113.5	4,740	0.93	72%	42%
Siemens SGT-800	57	8,502	105.0	4,602	0.76	84%	46%
GE LM6000 SPRINT	50	8,392	91.6	4,642	0.95	83%	45%
MHPS H-25	41	9,432	82.3	4,699	0.82	100%	50%
BHGE Nova LT16	16.2	9,456	33.0	4,647	0.91	104%	51%
Solar Taurus 65	6.5	10,375	13.3	4,880	0.96	104%	53%



Look for our article "Decarbonizing with Energy Storage Combined Cycles" in the December issue of POWER Magazine.

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