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April 16, 2009

California Energy Commission
Docket Unit
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: SOLARRESERVE COMMENTS ON IEPR WORKSHOP ON ENERGY STORAGE DOCKET NO. 09-IEP-1G

Enclosed for filing with the California Energy Commission is the original copy of **SOLARRESERVE COMMENTS ON IEPR WORKSHOP ON ENERGY STORAGE**, (09-IEP-1G).

Sincerely,

Scott Galati
Counsel to SolarReserve

SOLARRESERVE

CALIFORNIA ENERGY COMMISSION - DOCKET 09-IEP-1G

Comments on 2009 IEPR Workshop on Energy Storage Technologies 4-16-09

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SOLARRESERVE INTRODUCTION

ABOUT SOLARRESERVE

- SolarReserve is a developer and owner of large-scale concentrated solar power (CSP) projects for sale of electricity to utilities
- SolarReserve is a well capitalized solar energy development company based in Santa Monica, California

TECHNOLOGY

- SolarReserve utilizes thermal storage technology allowing us to meet and follow utility peak demand requirements of electricity
- The technology was developed by United Technologies Corporation (UTC), a diversified US-based technology company and demonstrated at Solar Two in Barstow, CA

FINANCIAL BACKING

- SolarReserve is Backed by a Consortium of Major Financial Partners: *U.S. Renewables Group (USRG); Good Energies ,Citi – Sustainable Development Investments (SDI) , Credit Suisse Customized Fund Investment Group ("CFIG") , Argonaut Private Equity, The PCG Clean Energy and Technology Fund, Nimes Capital, LLC*

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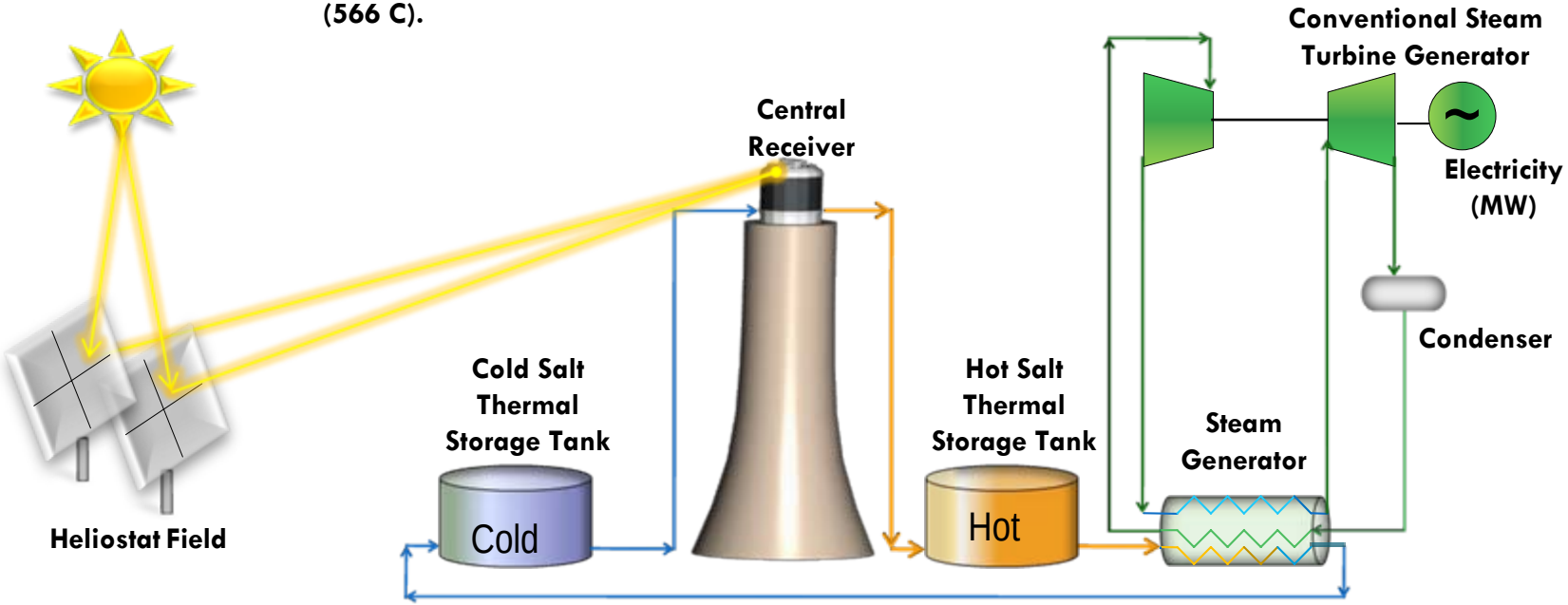
SOLARRESERVE PROCESS DIAGRAM

1. Sunlight is concentrated and directed from a large field of heliostats to a receiver on a tall tower.
2. Molten salt from the cold salt tank is pumped through the receiver where it is heated to 1050 F (566 C).
3. The heated salt from the receiver is stored in the hot salt tank.
4. Molten salt is pumped from the hot salt tank through a steam generator that creates steam, which drives a steam turbine, generating electricity.
5. Cold salt at 525°F (288 °C) flows back to the cold salt tank.



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BENEFITS OF INTEGRAL THERMAL STORAGE IN A SOLAR PROJECT

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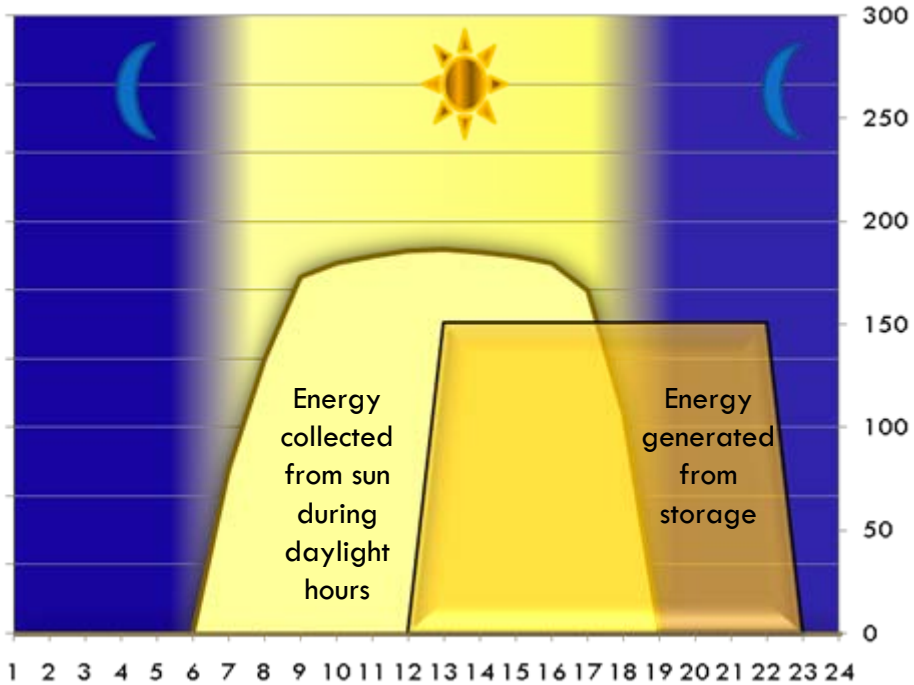
Isolation of Electricity Generation from Energy Collection

Operating Stability

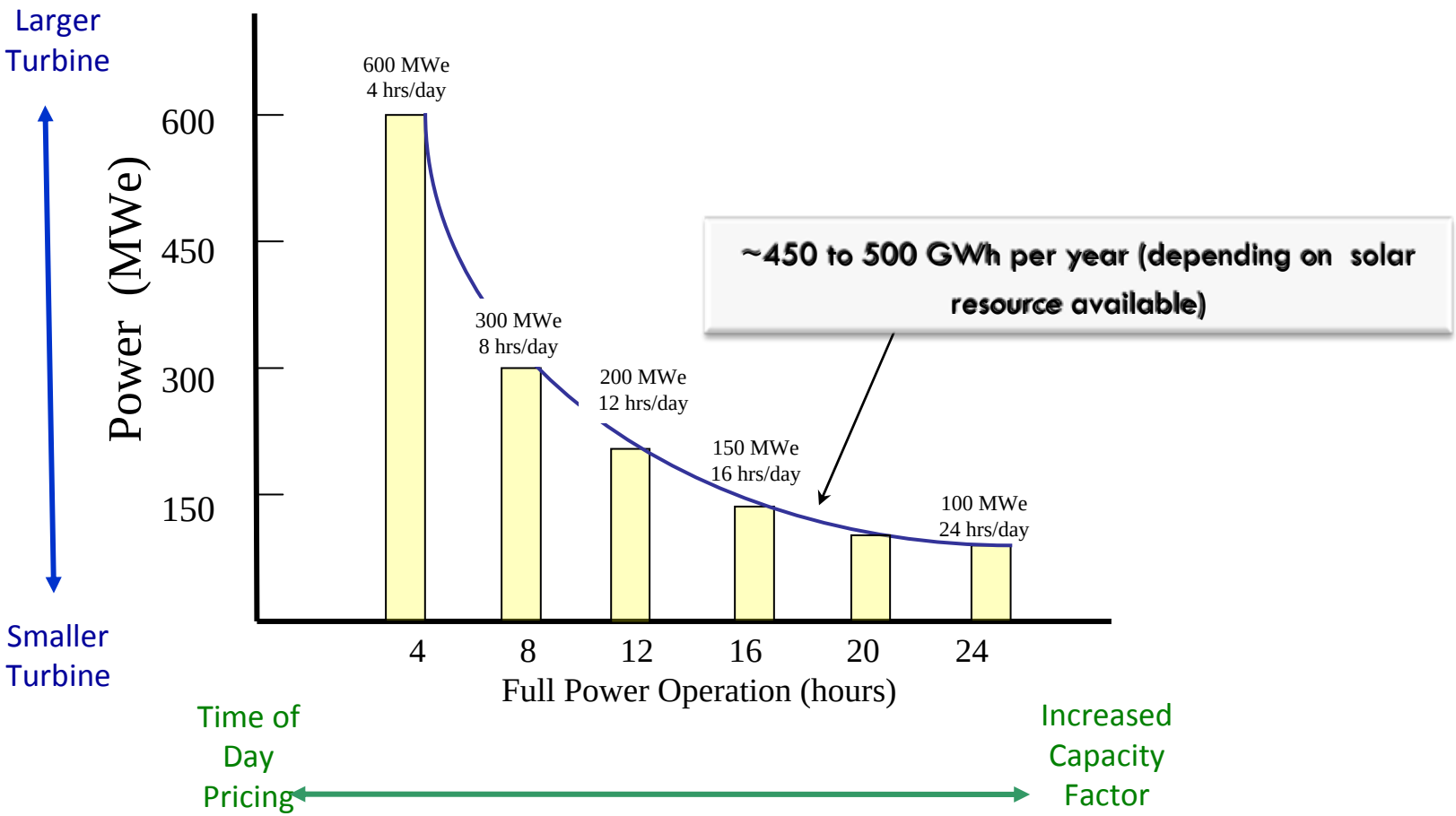
Dispatchability

Load Following

Ability to Operate Into Evening Peak After Sun Goes Down



FLEXIBILITY TO CUSTOMIZE STEAM TURBINE OUTPUT AND OPERATING PROFILE TO MEET NEEDS OF MARKET



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BENEFITS OF CENTRAL TOWER TECHNOLOGY

- By focusing all of the sun's energy onto a central point, the heat transfer fluid can be heated and stored at high temperatures.
  - *Higher temperatures translate to more efficient steam cycles*
  - *Thermal storage at higher temperatures is more cost effective through reduced storage volume for a given amount of energy*
- Systems have a cost advantage by being able to benefit from economies of scale, reducing the cost to generate

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TECHNOLOGY VALIDATION AT SOLAR TWO (DOE DEMONSTRATION PROJECT)

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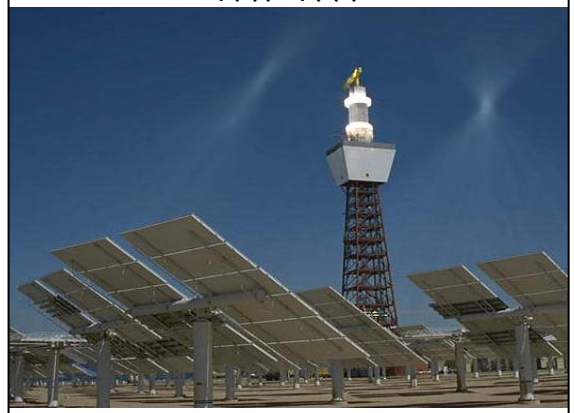
- Molten Salt Operations Characterized
- Demonstrated electric power 24 hr/day
- Exceeded Performance Targets
- Receiver Performance Exceeded Prediction (88% Efficiency)
- Pump Performance-Demonstrated Full-Flow at Design Pressures

10 MWe Pilot Plant
1997-1999



- 300 ft tall tower; 1926 heliostats
- 42 MWt receiver; 10 MWe turbine
- 3 hours molten salt storage

"Over the three-year operating lifetime, daily operation of Solar Two became relatively routine, with various performance records broken on a fairly regular basis."

DOE SunLab Brochure, March 2000)

PICTURES OF SOLAR TWO (BARSTOW, CA)

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OTHER SOLAR CONCEPTS BEING STUDIED BY MARKET

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- New lower freezing point heat transfer fluids
- Phase change materials
- Thermo-chemical storage
- Sand sifter
- Nano particles and nano tubes
- Graphite monoliths

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OTHER DEPLOYABLE TECHNOLOGIES

- Steam in pressure vessels
- Compressed air – in tanks in underground caverns
- Pumped storage – using water
- Concrete monoliths
- Other Solids: ceramics, alumina, iron oxides, etc.
- Molten nitrate salts:
  - Single-Tank Thermocline
  - Two-Tank System

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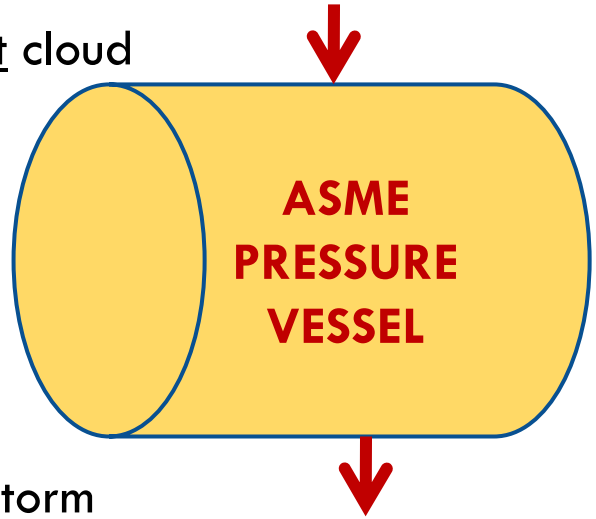
STORING STEAM IN LARGE PRESSURE VESSELS

- Can provide some operating stability through short cloud transients.

- Requires an ASME code stamped pressure vessel.

- Cannot support large scale:
  - Firm Dispatch (utility dispatch and curtail)
  - Dispatch through the night or through a long storm
  - Load Following – to fill in on wind transmission lines
  - Load Multiplying- for peaker duty
  - Cannot efficiently collect energy at various temperatures on hazy days or near sunset.



Primarily useful to provide short term operating stability through short cloud transients.

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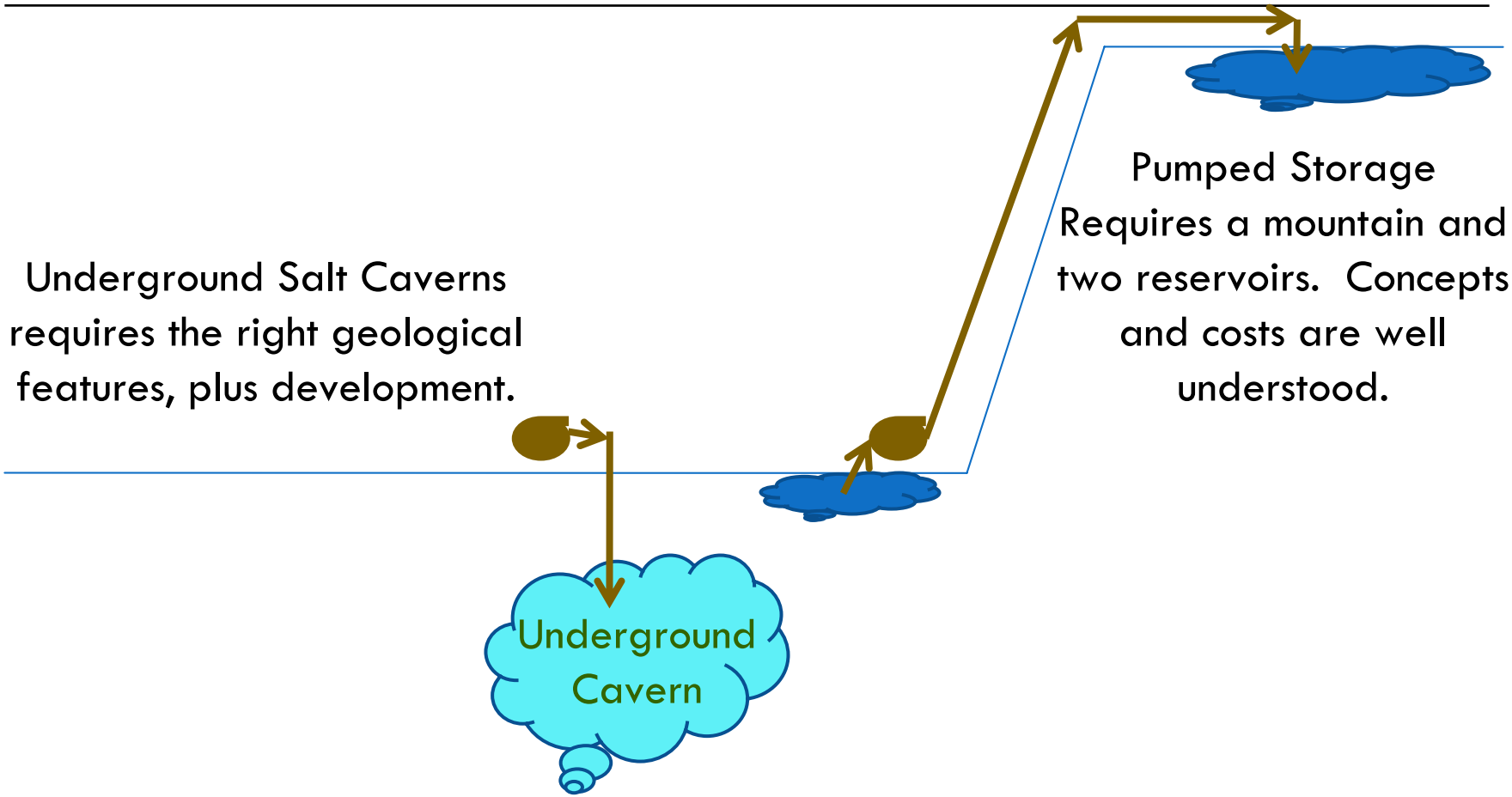
PUMPED STORAGE AND PRESSURIZED CAVERNS

Underground Salt Caverns requires the right geological features, plus development.



Pumped Storage Requires a mountain and two reservoirs. Concepts and costs are well understood.

Both Pumped Hydro and Compressed Air in Caverns work. Both require extensive offsite development.

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SOLID MEDIA: CONCRETE, CERAMIC, ALUMINA MANGANESE OXIDE, IRON, ETC.

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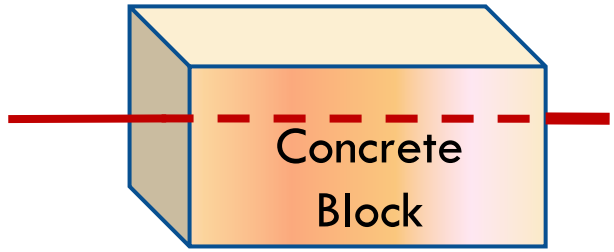
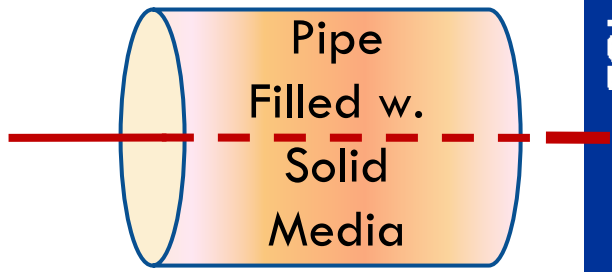
- Concrete blocks and Solid Media containers might be paired with heated air, CO_2 or liquid heat transfer fluids.



- Concrete can be inexpensive, but there is concern about concrete separating from the HTF tube after many thermal cycles. Tests underway at DLR look promising.

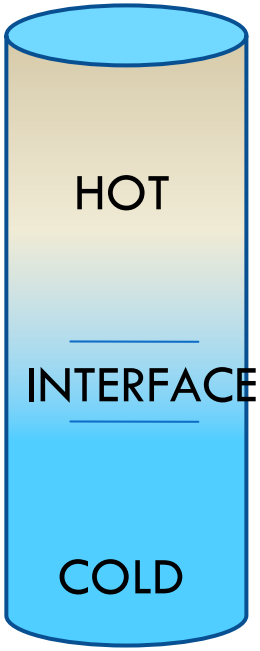


- Cost is still a question for other solid media.

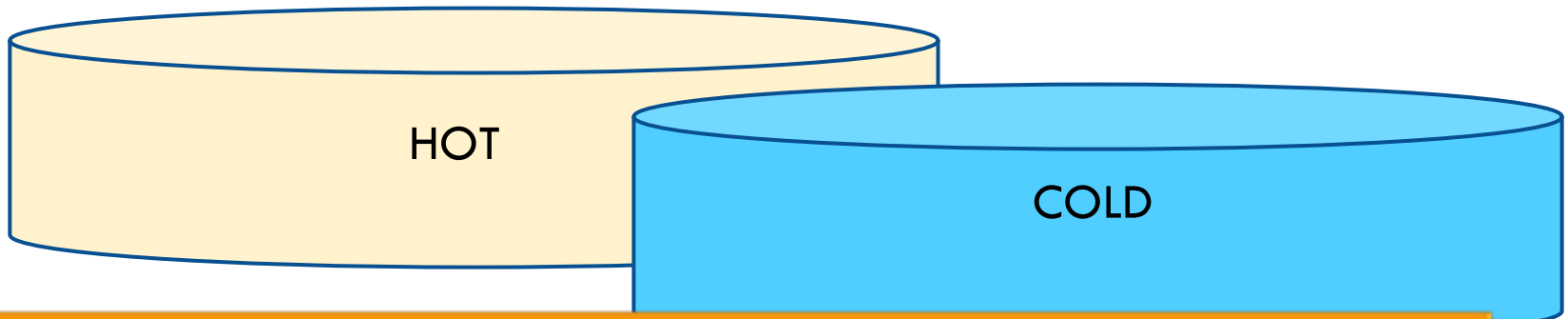
- These systems cannot efficiently utilize heat at various temperatures.

Single Tank Systems (Steam, Ceramic & Concrete) Cannot Capture Heat at Low Temperatures w/o Degrading the Hot Side Temperature.

THERMOCLINE THERMAL STORAGE SYSTEMS



- Thermoclines promise cost savings by using one tank instead of two.
- They can work well in small and moderate sizes
- Work best with tall, narrow cylinders (to keep the interface zone from growing to fill the entire volume. Tall and narrow is more expensive than short and wide.
- Does not scale to commercial sized plants which might use 50 to 75 million pounds of salt.
- A two tank system might use two tanks each ~40' tall by ~150' in dia.



Thermoclines' cost advantage does not scale.

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BENEFITS OF TWO-TANK STORAGE SYSTEMS

- Firm Dispatch – Enabling Utility Dispatch & Curtail
- Grid Stability – Stable Output thru Cloud Transients
- Magnified Peaking Capacity
- Increased Annual Capacity Factor
- Low Insolation Collection – for Hazy Days
- Equipment Elimination
- Eliminates Startup Boiler
- Eliminates Supplemental Firing for Superheat

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THERMAL STORAGE AS AN "ADD-ON" TO A CSP TROUGH SYSTEM

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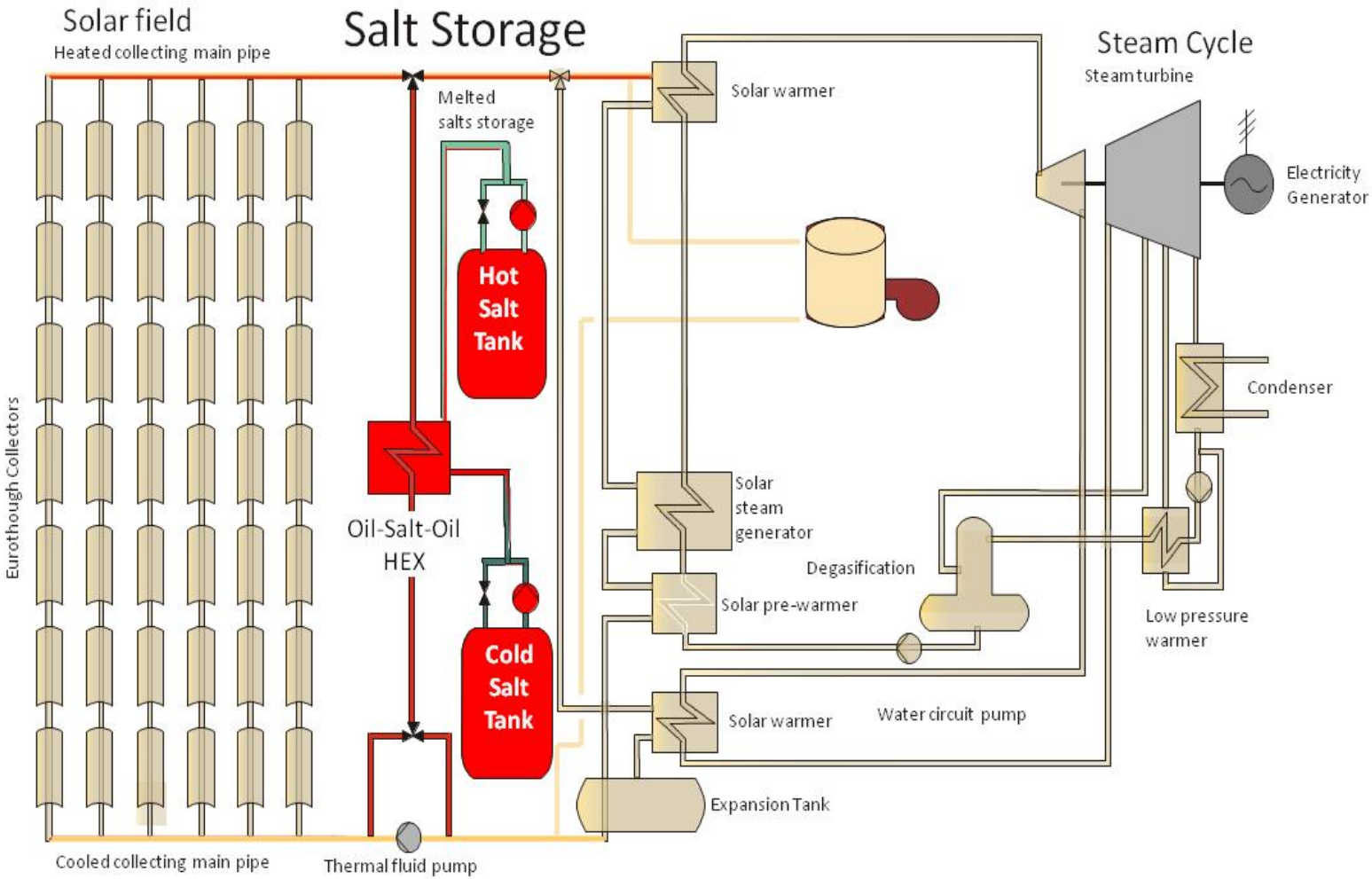

Addition of heat exchangers to cycle reduces efficiency and cost-effectiveness of storage in this application.

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REMOVING BARRIERS TO WIDER DEPLOYMENT OF TECHNOLOGIES WITH THERMAL STORAGE

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Suggestions:

- Establish permitting priority for projects equipped with thermal storage
- Provide enhanced RPS benefits for projects equipped with thermal storage
- Encourage the CPUC to consider valuation premiums for projects with thermal storage in utility procurement processes

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Thank You

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