Liquid-Phase Pathway

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Liquid Pathway Challenges

**Major Risk Factors:**
- Salt materials compatibility and corrosion control
  - Salt piping, valves and flanges
- Salt tank cost and durability
- Sodium safety and acceptance
- Salt vapors?
- Sodium materials compatibility at > 650°C?

*Concentrating Solar Power Gen3 Demonstration Roadmap, NREL/TP-5500-67464, 2017*
Liquid Pathway Strategy

- Leverage experience in liquid heat transfer fluid (HTF) and thermal storage media
  - Modest operating pressure
  - Known correlations for heat transfer performance
  - Known pumping and transfer methods
  - Ecosystem of industrial suppliers and developers working with molten salts
- Consider the superior heat transfer properties of liquid metal sodium as a receiver fluid
  - Relevant CSP industry experience from Vast Solar, John Cockerill
  - Extensive safety and handling data from industrial and nuclear sector usage
- Coordinate with ongoing industry-, federal-, and international-funded R&D to overcome challenges
- Develop Risk Registry to identify, track, and manage risk
- Establish Advisory Committee to guide AHP decision process
Liquid Pathway Project Team

Salt-HTF Work

- Sandia
  - B&P (integration)
  - Construction contractors
  - Vac Process Engr (Primary HX)
  - Dan Barth (Piping & valves Consultant)
- NREL
  - EPRI (TAC)
  - JT Thorpe (insulation)
  - Nooter/Eriksen ( Receivers)
  - Solar Dynamics (Tank consultant)
- Job Industrial (Salt tanks)
- ICL ( Salts)
- Hatch (Salt Melter)

U.S. DOE

ARENA Australia

ASTRI

Sodium-HTF Work

- ANU
  - Techno-economics, sodium handling, sodium receiver
- CSIRO
  - Sodium receiver and subsystem design
- QUT
  - Sodium material compatibility
- UniSA
  - Material properties, salt storage, other TES
- Flinders U.
  - Material properties
Break to other panelists
Molten-Salt Storage Tanks: Design Summary

- **Refractory-lined, carbon steel tanks**
  - Liner design patterned after Dead Sea Magnesium electrolysis vats
  - Liner design is identical for both hot and cold tanks
  - Tank wall design temperature is approximately 60°C

- **Mortar made from same material as the hot face brick for compatibility with liner and salt.**

- **Mortar ability to prevent salt penetration remains a risk**
Receiver Down Selection Decision

Analytic Hierarchy Process (AHP) used to systematically compare benefits and risks of the two design approaches:

- **Benefit**
  - Sodium Design
  - Salt Design

- **Risk**
  - Sodium Design
  - Salt Design

- Maximize efficiency and performance
- Maximize long-term reliability and availability
- Minimize the risk to people and the environment

Sodium case has 11% lower LCOE, and higher Benefit/Risk ratio (Sodium = 1.19, Salt = 0.86)
Commercial-Scale Liquid Pathway System Design

Advantages of the 2 x 50-MWe Sodium/Salt design:
- Better optical efficiency
- Ability to utilize smaller, lower-cost towers
- Smaller-diameter salt tanks
- Better match to nascent sCO$_2$ power cycle capacity
- Adaptability to fringe-of-grid and small-grid markets
- Easier financing and shorter construction times
- Faster learning-by-doing cost reduction
- Larger “power park” facilities allow for shared staff and support infrastructure as well as operational redundancy
Risk Status and Future Opportunities

Risk Focus:
• Tank liner durability
• Salt vapor impacts

Future Work and Opportunities
• Chloride-salt tank test
• Internal insulation for molten-nitrate salt tanks
• Molten-chloride salt handling in Gen IV nuclear systems, e.g., TerraPower
• Sodium/Salt CSP systems, e.g., Vast Solar
Commercial System Design
Project Final Report and Journal Publications


