

# Solar Thermal Materials Research

University of California, Riverside

Terrafore, Inc

Jet Propulsion Laboratory (JPL)

Rocketdyne, Inc.

Our team comprised of *University, Industry and National Laboratory Partners*

## Academia

- **University of California, Riverside**
  - Prof. Reza Abbasachian,
  - Prof. Chris Dames,
  - Prof. Javier Garay,
  - Corey Hardin, graduate student Laboratory
  - Mehrnoush Zare, graduate student

## Industry

- **Terrafore (Riverside company)**
  - Rajan Kasetty, CEO
  - Anoop Mathur, CTO
- **Hamilton Sundstrand Rocketdyne (Fortune 40 company)**

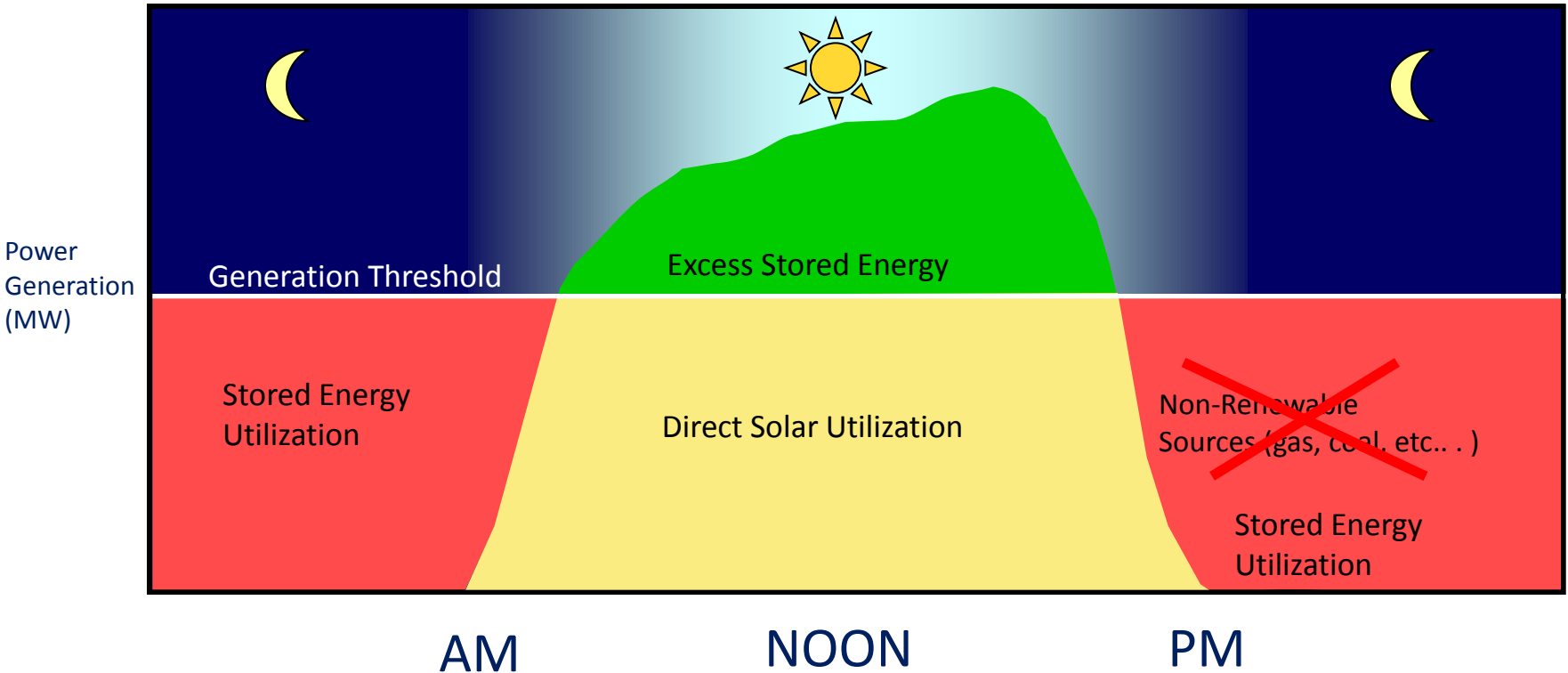
## National Lab

- **Jet Propulsion Laboratory**

**Funded by US Department of Energy (DOE)**

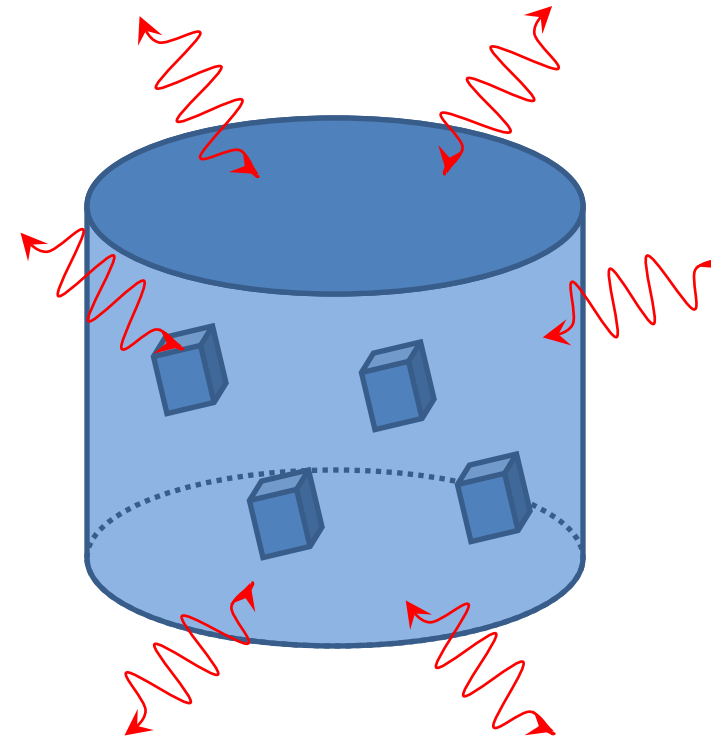


- Solar thermal energy is the term used for collecting thermal energy from the sun for functional use.
  - Heat can be used for power generation
- **Plant Sizes 200 kW to 100's of MW** Specific Plant styles : Power Tower, Trough, Linear Fresnel,
- **Urban and Remote Locations**
  - **Our contribution will improve thermal energy storage**



- Solar-Thermal with Storage Allows:
  - Generation of electricity *when we want and not just when the sun shines*. Utilities call this *dispatchability*.

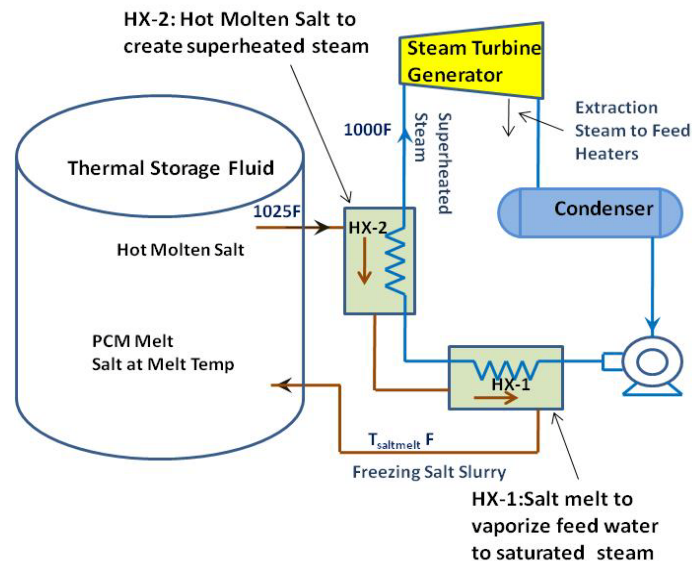
- There are different ways to store thermal energy:
  - Sensible heat: heat that can be stored in material (solid, liquid, etc.)
  - Phase change heat or latent heat: heat absorbed or released when material melts and solidifies.



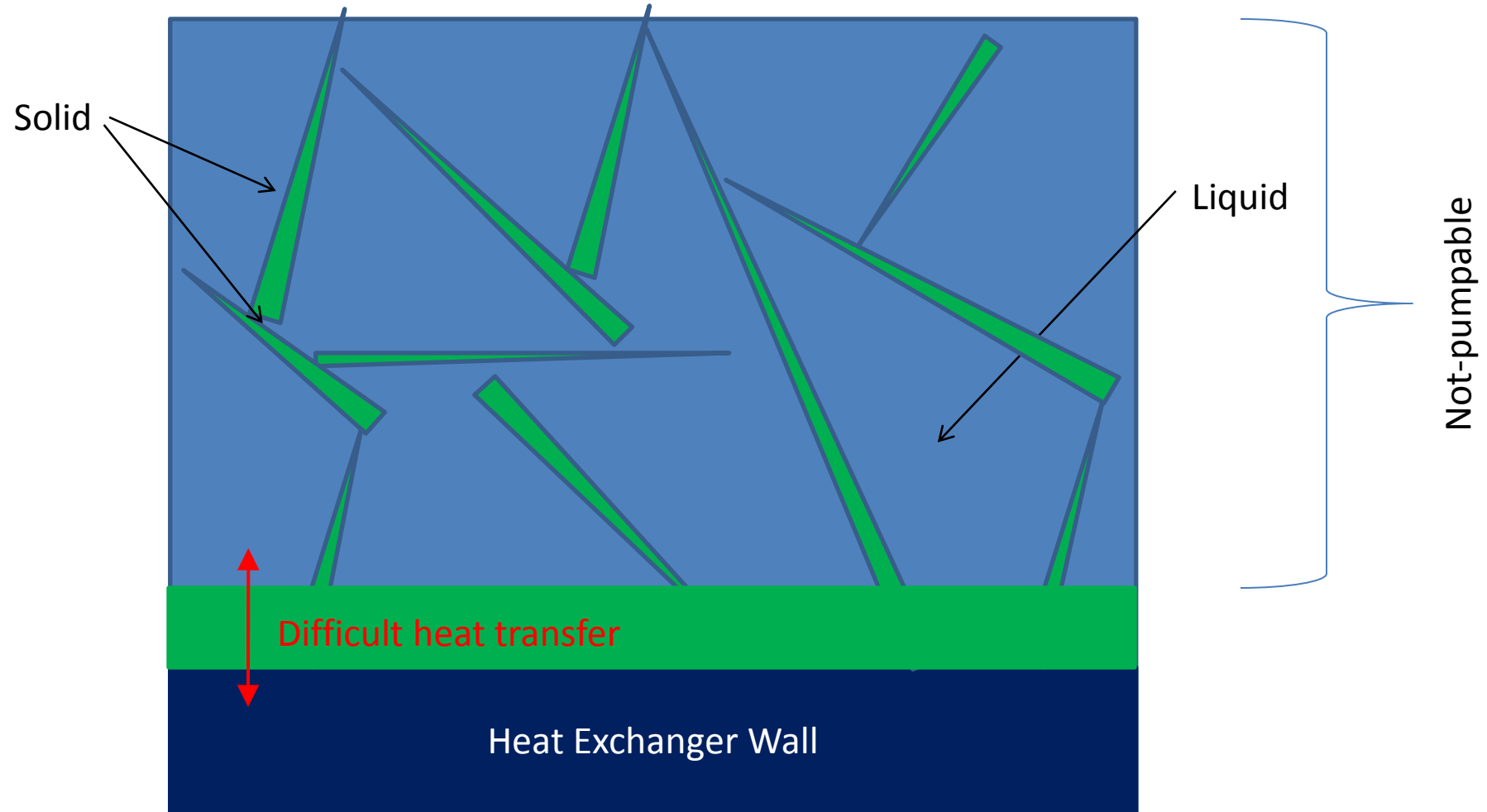
- State of the art Solar-Thermal *uses only Sensible heat*
- We will use *both Sensible & phase change heat*

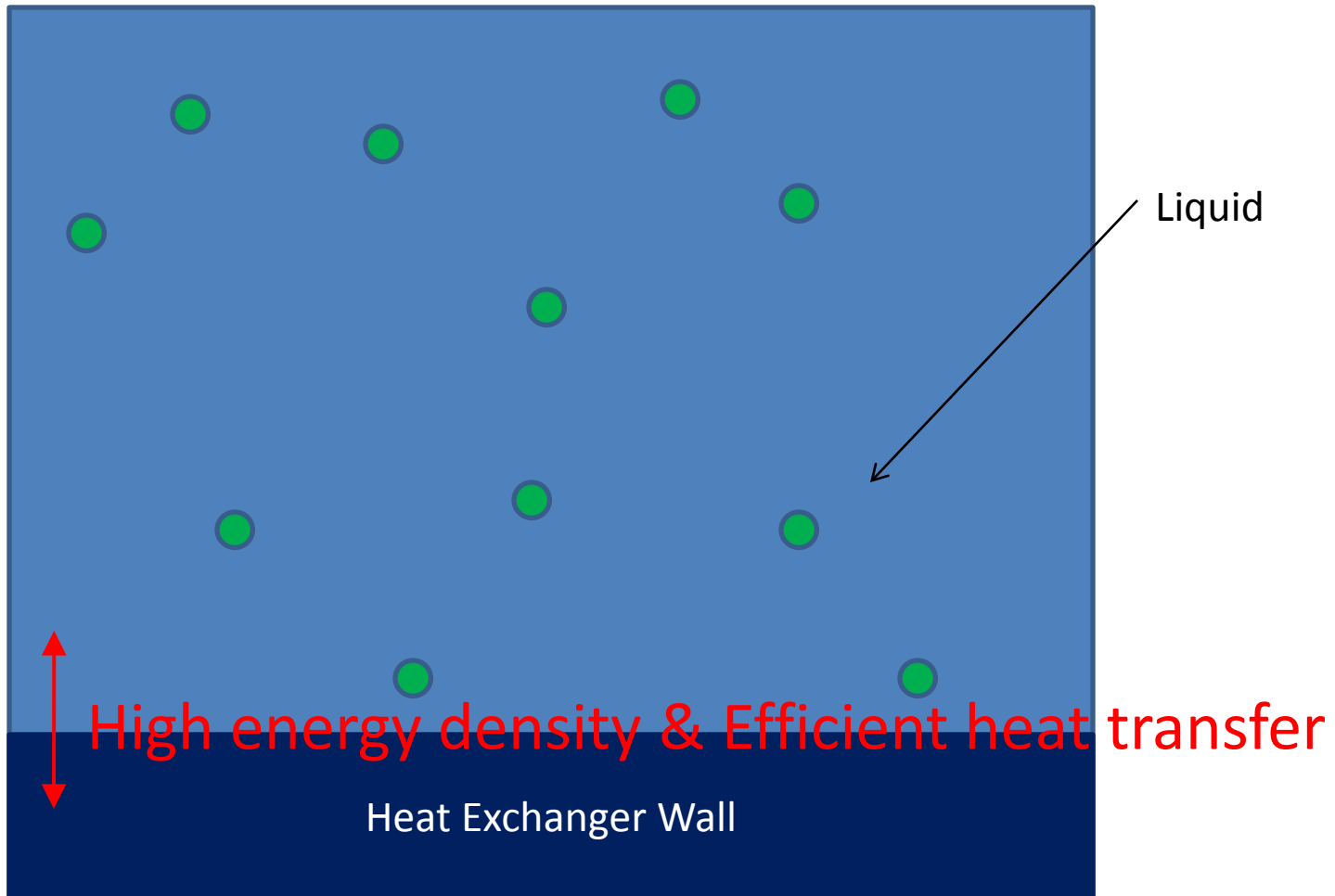
- Thermal Energy Storage in Phase Change Material (PCM) can potentially result in:
  - 30% reduction in amount of storage material needed
  - 60% reduction in container size
  - 2% to 3% improvement in overall system efficiency
  - Flexibility to operate with different steam cycles → Small to large scale power plants
  - Increased temperature operation range: Flexibility to store energy when collection temperature less than optimal

- 1) **PCM material challenges:** Design proper energy storage material
  - Deliver sufficient *phase change heat* to be useful
  - Be 'pumpable' in two-phase state
  
- 2) **Heat transfer challenges:** Retrieving stored thermal energy
  - Efficient heat transfer from material to heat exchanger



- An ideal PCM will have the following properties:
  - High heat of fusion providing *high energy density* ( $\text{kJ/kg}$  and  $\text{kJ/m}^3$ )
  - High chemical and thermal cycling stability
  - Low specific cost
  - Low toxicity
  - Low corrosivity
  - Withstand >5000 phase change cycles
  - Have phase change in proper range to accommodate a very wide variety of CSP applications (275-350 °C)

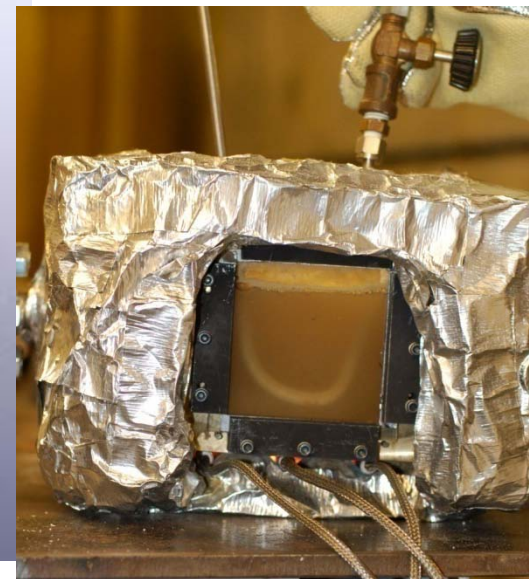
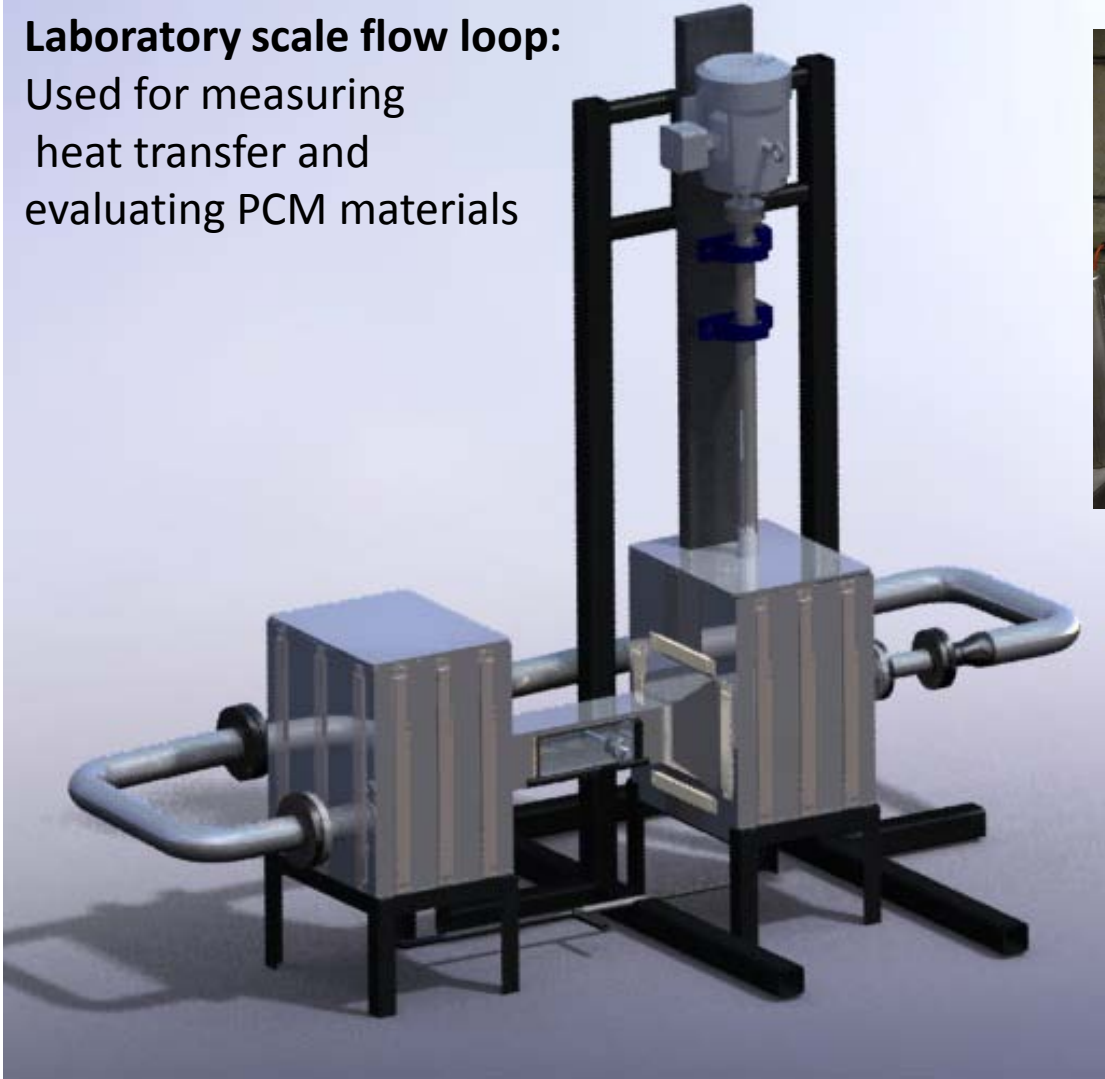




- These materials will deliver high energy density necessary

## Laboratory scale flow loop:

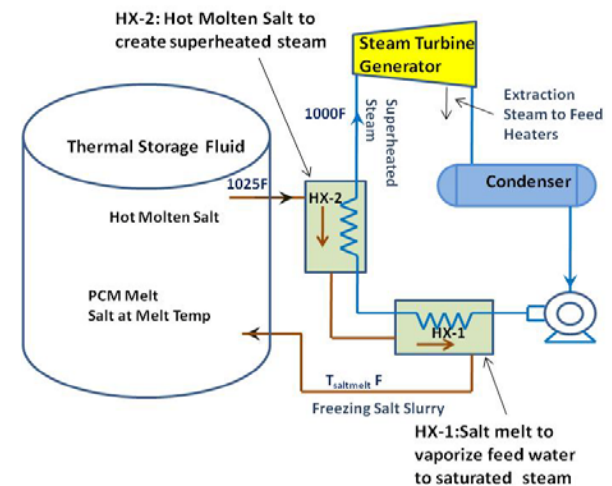
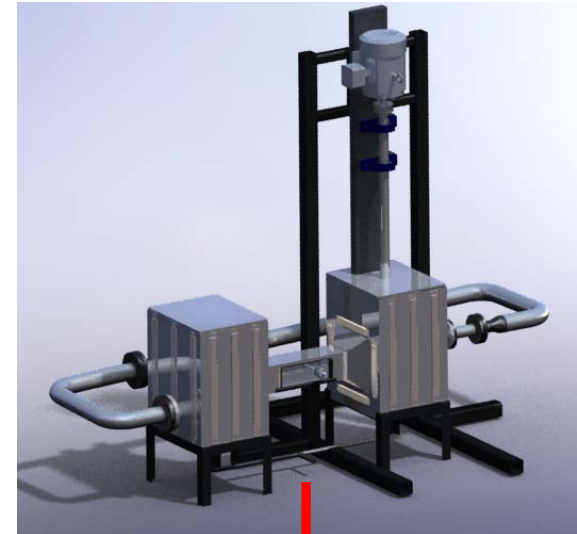
Used for measuring heat transfer and evaluating PCM materials



**PHASE 1** Design and Characterize Phase Change Materials & Heat Transfer  
(Year 1)

**PHASE 2** Design and Build a Laboratory scale Prototype and optimize PCM  
(Year 2)

**PHASE 3** Validate PCM-based TES on Engineering Prototype  
(Year 3)



- The team is comprised of terrafore, UCR, JPL and HSR
- We are working on a 3 phase DOE funded project
- Main contribution will be in more efficient thermal energy storage utilizing phase change materials

Thank you for listening!