HIGH DENSITY THERMAL STORAGE WORKSHOP

BREAKOUT REPORT

THERMOPHYSICAL STORAGE

www.arpa-e.energy.gov

TOP APPLICATIONS

TOP 5

- Solar thermal power plants
- Distributed solar thermal (small scale)
- Building cooling/heating
- Waste heat (industrial)
- Vehicle as the system

ADDITIONAL

- Temp regulated transportation and packaging
- Server / data centers and other IT
- Protection (thermal, moisture control, etc.)
- Other indirect protection/efficiency uses

TOP NEEDS

TOP 3

- Engineered materials
- Containment and packaging
- System design/architecture for power capability
    - Heat exchanger solutions

ADDITIONAL

- Advance fundamental understanding and design capabilities to account for
    - Dynamic effects (duty cycle / lifetime)
    - Uncertainty

MATERIALS INNOVATIONS/PHENOMENA TO INVESTIGATE

Engineered nanomaterials

- Carbon nanomaterials
  - As fillers for increased thermal transport
  - As active physi-sorption materials
- Metal organic frameworks
- Heterogeneous nanostructures
  - Core-shell inorganic nanoparticles
- Nanoscale phase transitions
  - Tunable
  - Isomerization as a transition
- As nucleation sites
- Scaling / mnfc / cost are among core issues

MATERIALS INNOVATIONS/PHENOMENA TO INVESTIGATE

Phase change materials

- PCMs for latent storage
  - Combine with nanotubes
  - Add physical thermal transport structures (e.g. heat pipes)
  - Use as thermal insulation
  - Combine with novel carriers/architectures
  - In fluids/slurries

MATERIALS INNOVATIONS/PHENOMENA TO INVESTIGATE

Engineered Phase Transitions

- PCMs with tunable transition temperatures
- Can we engineer various properties of material around the critical temperature
- Combine magnetic particles with ice and use magnetic transition to increase latent heat
- Control nucleation
    - Heterogeneous → Homogeneous

MATERIALS INNOVATIONS/PHENOMENA TO INVESTIGATE

Other ideas

- Use thermal energy to drive charge separation
- Supercritical
  - Can we leverage underground containment
  - Non-water systems may allow for reduced pressures

CONTAINMENT INNOVATIONS/PHENOMENA TO INVESTIGATE

- Vacuum insulation panels
  - Switchable
    - With thermal diodes or heat pipes
- Phase change materials as insulation
- Aerogels
- MOFs
- Magneto-hydrodynamic pumps for salt systems
- Layered nanomaterials
- Electro/magneto- hydrodynamic fluids
- Using engineered wetting transitions
- Controllable emissivity using bandgap engineering
- Other electronic triggers for thermal conductivity

GENERAL PROGRAMMATIC SUGGESTIONS

- Targets should be application-specific!!
- Cost
  - Cost need not be a specific target, but should incorporate rules to suggest viability
    - Abundance
    - Scalability
  - Or else cost could be compared to electrical storage cost*efficiency
- May want to consider code-driven secondary factors i.e. fire safety
- May want to account for scale

GENERAL PROGRAMMATIC SUGGESTIONS

- Program should focus on key focus areas:
  - Engineered materials
  - Containment and packaging
  - System design/architecture for power capability

- Program should focus on proof-of-concept through to scaling-ready