

Alternative Applications for Thermal Storage



The goal of this breakout session is to identify and characterize additional areas of impact on the US Energy landscape and beyond

1. Identify additional areas of impact on the US
 - Non-obvious direct applications for thermal storage?
 - Can thermal storage be used to overcome a critical barrier to deployment or impact of other energy technologies?

2. Characterize for each possible application:
 - What scale and scope of impact is achievable?
 - Why is this not being done already today?
 - What specific targets within a high impact r&d program would address this area of impact?

Alternative Applications for Thermal Storage



Agenda for the breakout session

1. Introduction (15 minutes)
2. Alternate application brainstorm (20 minutes)
3. Compile ideas and select top areas of impact (20 minutes)
4. Characterize top areas and recommend programmatic elements (30 minutes)
5. Sum up and generate report-out (15 minutes)

Examples: Vehicle A/C



The opportunity:

- 7-10+ billion gallons of gasoline used every year for vehicle A/C
 - Roughly 10% of US imported crude oil
- A/C load can increase vehicle fuel consumption by as much as
 - 35% for typical ICE vehicle
 - 100+% for strong HEV
- A/C can reduce EV range by as much as 35%



Examples: Vehicle A/C



The challenge:

- Peak A/C load ~ $3 \text{ kW}_e / 9 \text{ kW}_t$
- Regular A/C load ~ $1 \text{ kW}_e / 3 \text{ kW}_t$

- 40% of all vehicle trips are under 10 minutes
- 85% of all vehicle trips are under 30 minutes

- So to displace A/C for 85% of trips would require between 5.4 -16 MJ of thermal storage → **16 - 48 kg of ice**

10 Min Trips

30 Min Trips

High A/C	1.5 kWh _t (5.4 MJ)	4.5 kWh _t (16 MJ)
Reg A/C	0.5 kWh _t (1.8 MJ)	1.5 kWh _t (5.4 MJ)

Primary Obstacles:

- Energy density
- Controllability
- Rate
- Cost

Data from NREL



Examples: Other Vehicle Applications?



Additional impacts in vehicles

- Thermal protection/management for vehicles
 - Cold start mitigation for ICE or EV
 - Zebra battery is suitable for EV but operates at 250 °C
- Cabin heating in electric vehicles is not free!
 - Avoid heating load on battery, which also kills range
- Other ideas?



Examples: Agile loads for grid support



Could thermal storage be used as a massive controllable and distributed load for grid stabilization?

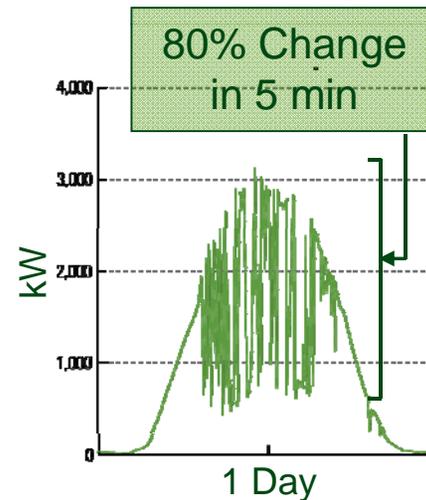
Example: Refrigerator/Freezers

- US has
 - ~100 Million Primary Refrigerators
 - ~30 Million Secondary Refrigerators
- If 5% of each refrigerator/freezer's volume was dedicated to H2O phase change..
 - **Total up to ~150 GWh of controllable load**

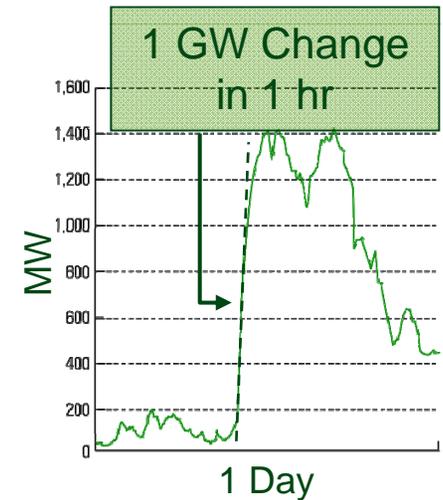
Renewables Today



Solar PV in AZ (TEP)



Wind in OR (BPA)



Problem:
Minutes-to-Hours Changes in Power

Other areas to consider



1. Critical thermal management/protection needs
2. Temperature controlled shipping/transport
3. Carbon capture applications
4. Oil and gas exploration/production/transport (e.g. LNG?)
5. Electricity generation / power plants
6. Additional and high-value non energy-specific applications