LOW TEMPERATURE BREAKOUT

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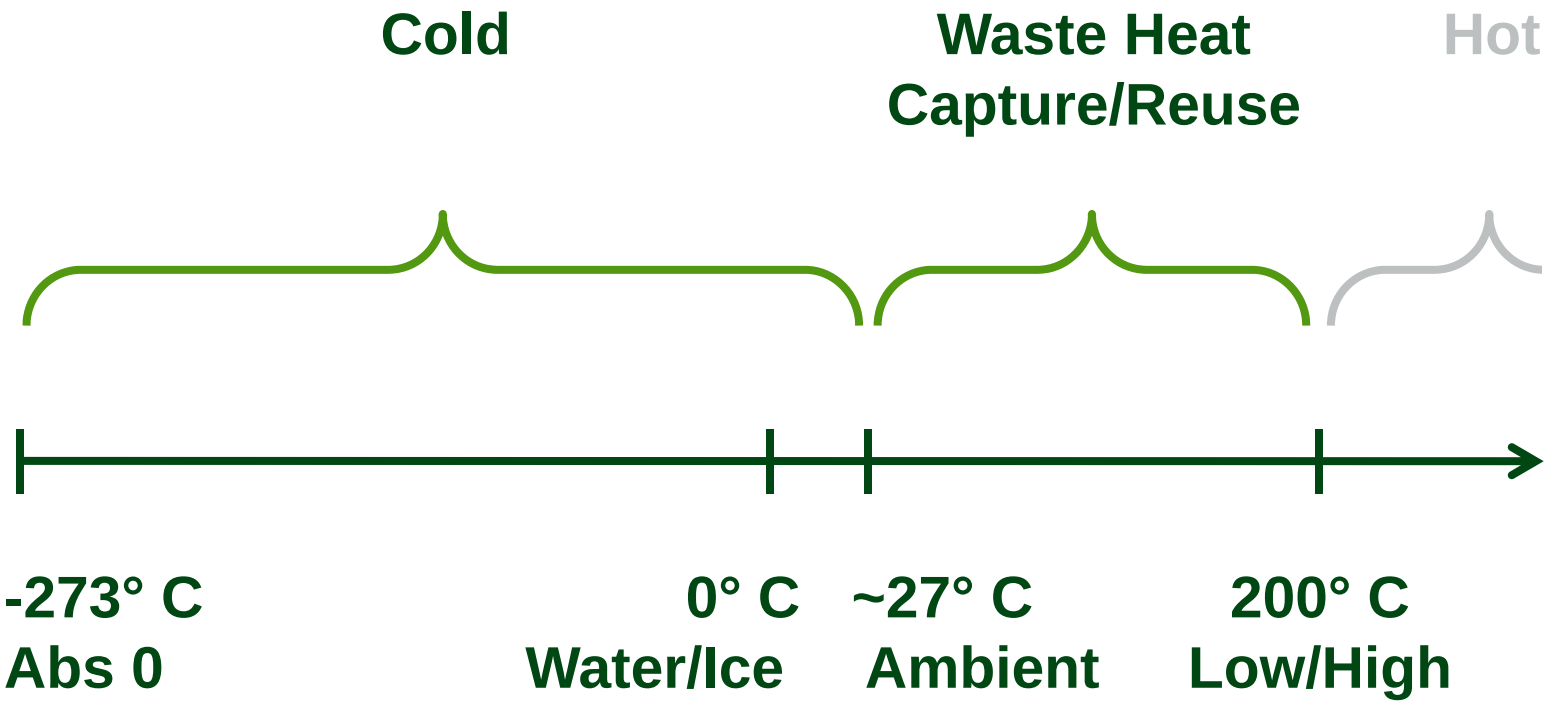
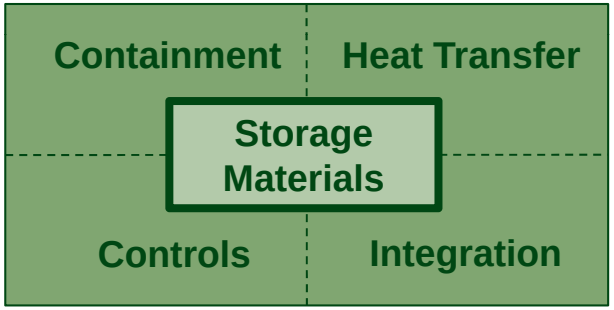
2 REGIMES


Cold
Waste Heat Capture/Reuse
Hot
-273° C
Abs 0
0° C
Water/Ice
~27° C
Ambient
200° C
Low/High

BASIC THERMAL STORAGE CONSIDERATIONS

Key Metrics of Performance	Example Units	Material Property	System Property
Storage Energy Density	MJ /kg, MJ /L	✔	✔
Transfer Power Density	MJ /kg•hr, MJ /L•hr	✔	✔
Operating Temperature	ºC	✔	✔
Cycle Life	# Cycles	✔	✔
Self-Discharge Rate	% /hour		✔
Roundtrip Efficiency	%		✔
Cost	$/MJ	✔	✔

Thermal Storage System



- Several important metrics to consider
- Both materials and system level considerations are important
- Properties may be complex or coupled, for instance:
  - e.g. power capability may change as heat is extracted and reactions proceed
  - e.g. power capability may degrade after several cycles

PRIMARY APPLICATIONS OVERVIEW

Buildings

Impact Objective: Dramatically reduce building energy consumption by storing and redeploying heat or cold to match building loads to optimize time of electricity use, maybe utilizing solar thermal heating for buildings.

Vehicles

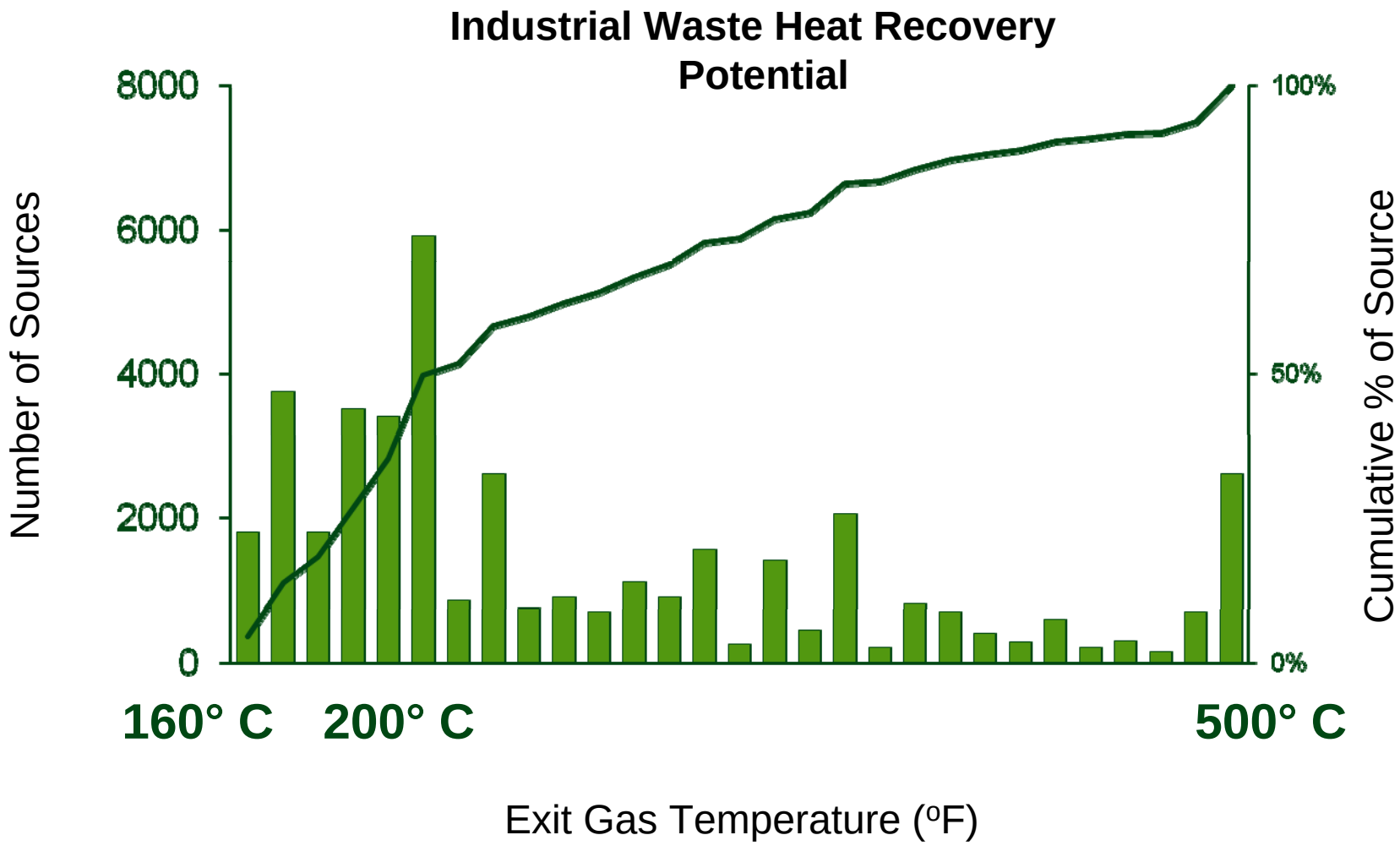
Impact Objective: Dramatically reduce electric vehicle energy consumption by storing and redeploying heat or cold to match load & optimize time of electricity use

Industrial waste heat capture and storage

Impact Objective: Dramatically reduce industrial energy consumption by storing and redeploying waste heat for processing and manufacturing

Operational Mode(s)	Current Solution(s)	R&D Needs
Buildings: diurnal load shifting	water tanks, ice, embedded building materials, etc.	• Energy density • Power density • Longer storage time and less loss • Thermal cycling stress • Reaction reversibility • Cost
Buildings: seasonal load shifting	soil, sand, water, concrete, etc.	
Buildings: thermal storage coupled to CHP	water, oil, organic phase change materials, etc.	
Vehicles: diurnal load shifting	Insulation, thermal mass	
Industrial waste heat capture and storage	non-water Rankine cycles, thermoelectric materials etc.	

SCALE


Industrial Waste Heat Recovery Potential
8000
6000
4000
2000
0
Number of Sources
100%
50%
0%
Cumulative % of Source
160° C
200° C
500° C
Exit Gas Temperature (ºF)

QUESTIONS

1. What are the highest value and highest impact uses for low temperature storage?

QUESTIONS

2. Given the low value of low grade heat, should we focus on getting the most out of storage in low cost materials or is it better to up-convert and store at a higher temperature?

QUESTIONS

3. How much energy density reduction is acceptable going from storage material to an integrated system, including the heat charging and discharging?

What containment or system innovations could allow us to get more out of existing low-temp storage materials?

How can energy density be increased from 0.5 MJ/kg to 5 MJ/kg without increasing the cost significantly?

QUESTIONS

4. What low temperature chemical reactions can potentially be used for thermal storage?

QUESTIONS

5. What should be the target cost per kWh_t for low temperature systems?

Should the cost be broken into storage cost ($/$kWh_t$) and charge/discharge cost ($/$kW_t$)?

QUESTIONS

6. Can long term (> months) be economically viable given low number of cycles for these systems?

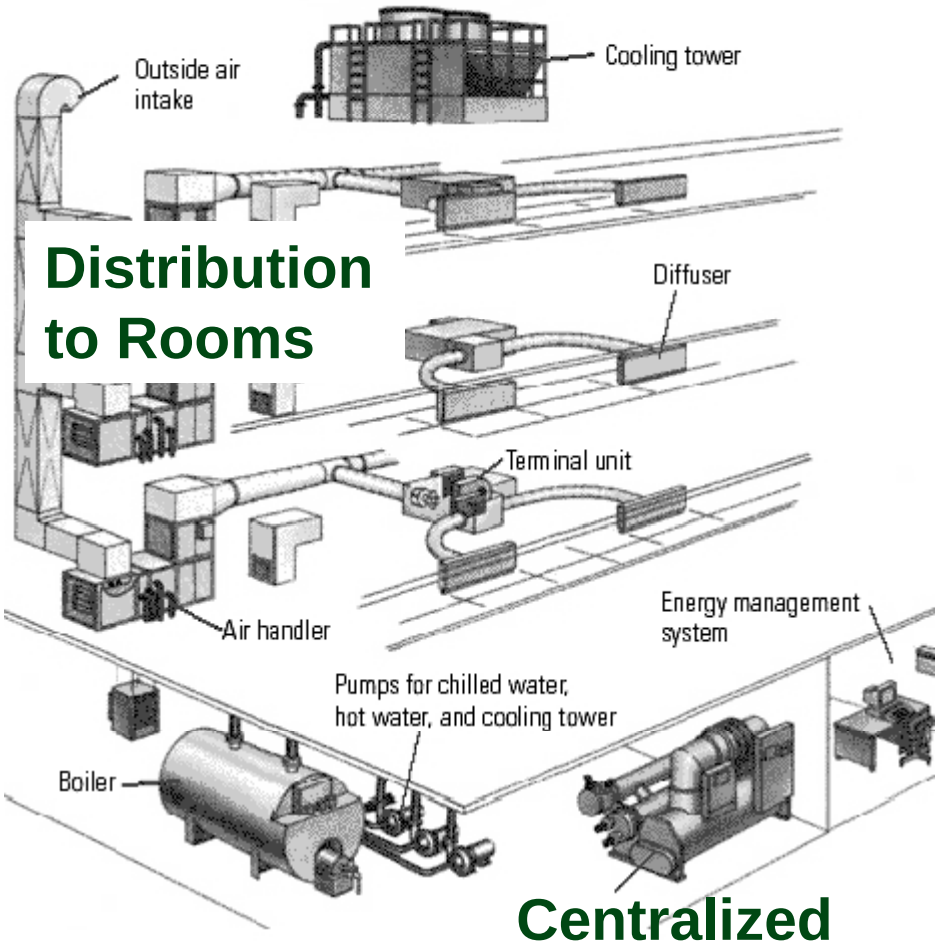
QUESTIONS

7. What innovations can be made to give existing products a dual-purpose function as a thermal storage medium (e.g. storage medium also provides the structural support for buildings)?

QUESTIONS

8. Beyond ice storage, what innovations can be pursued for space cooling applications?

What specs would enable room-level distributed cold storage for AC load peak shaving?



QUESTIONS

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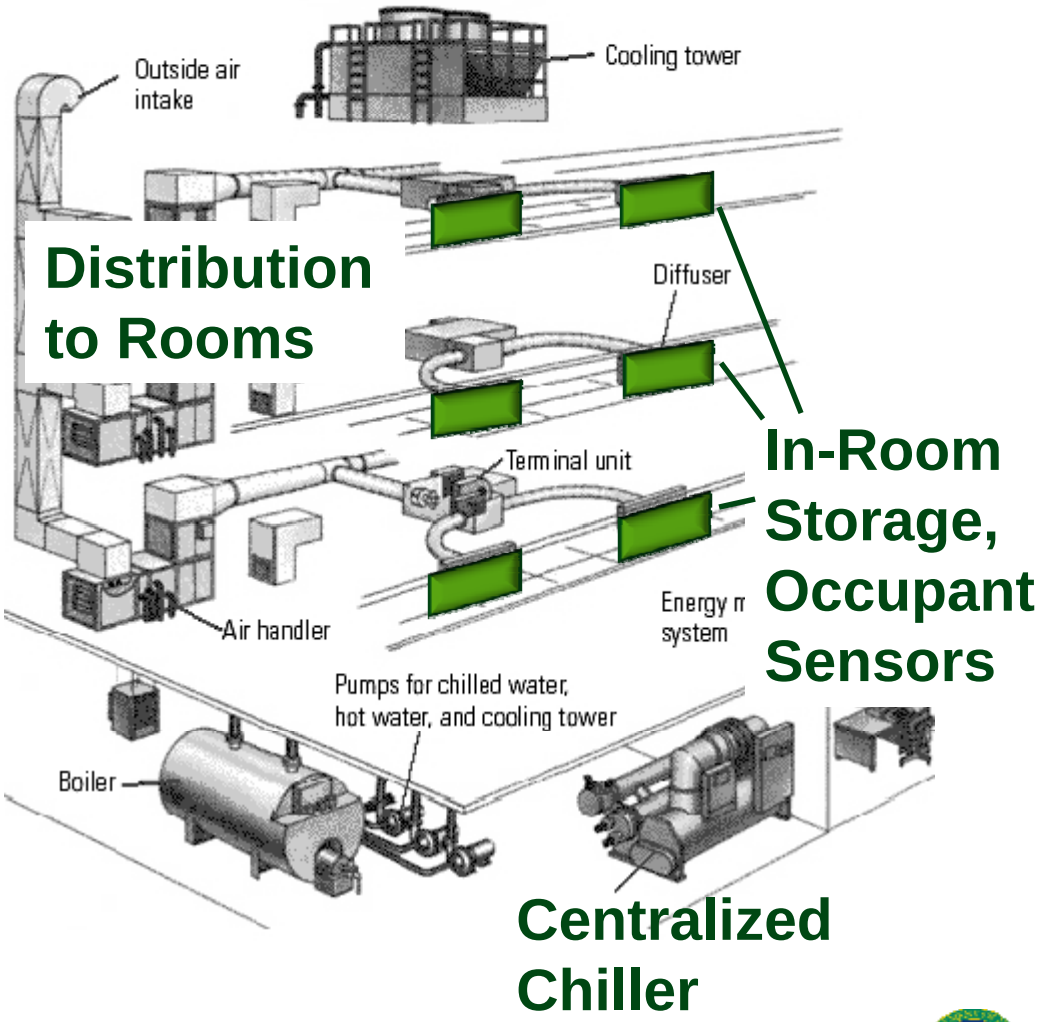

QUESTIONS

9. What will a high impact research and development program look like for a low temperature system?

What is the composition of an ideal research team?

Is it enough to specify:

- **Cost metrics ($/kWh$_{th}$ $/W$_{th}$)**
- **Energy density metrics (MJ/kg MJ/m^3)**
- **Cycle life**
- **Roundtrip efficiency**
- **Storage times**

What should the metrics be? What targets should we be challenging researchers to achieve?

POLL

What are the highest value and highest impact uses for low temperature storage?