HIGH DENSITY THERMAL STORAGE WORKSHOP

BREAKOUT REPORT

THERMOCHEMICAL STORAGE

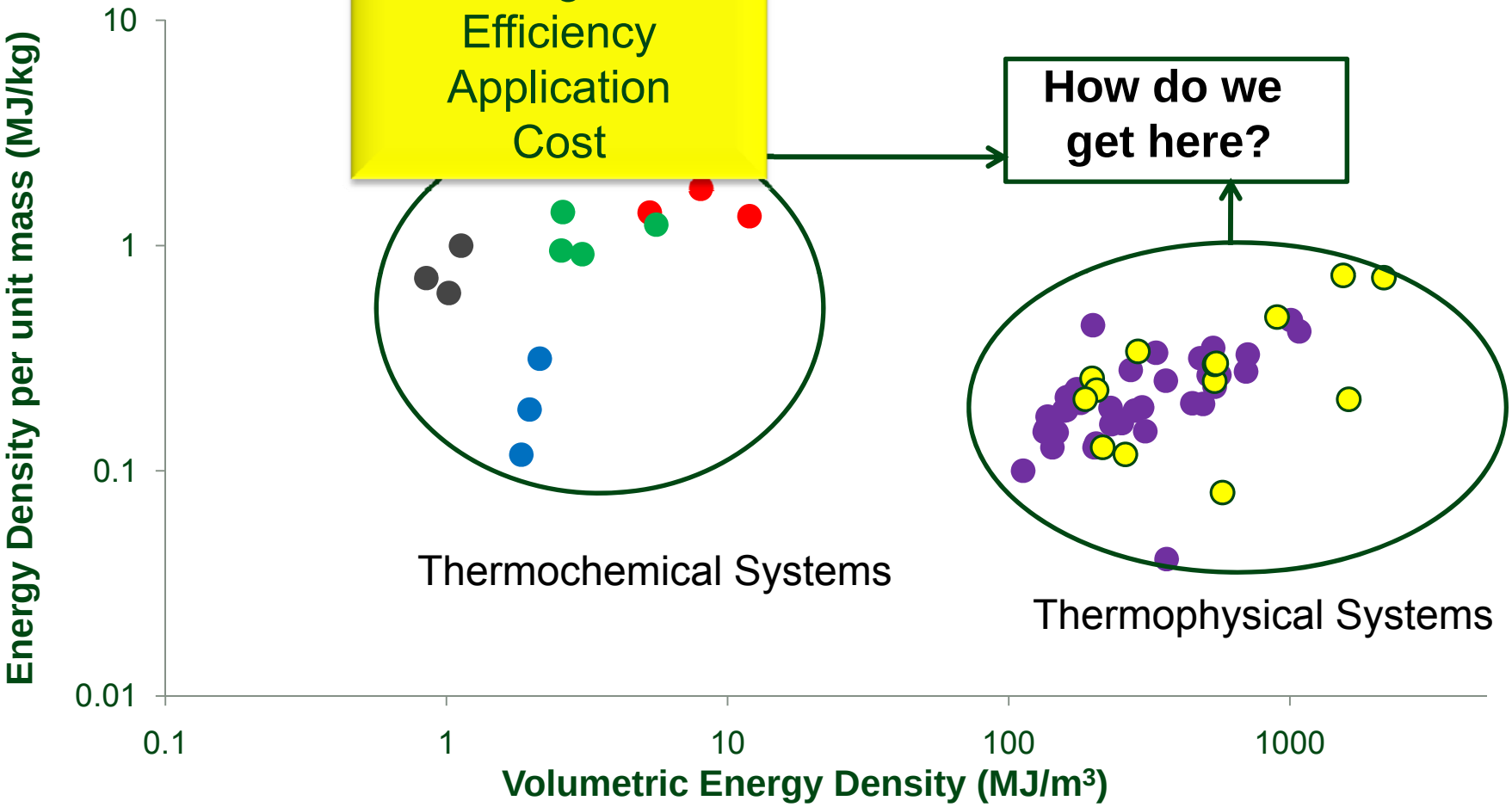
www.arpa-e.energy.gov

MOST USEFUL APPLICATIONS AND THE BOTTLENECKS

- Large-scale high-temperature (>350 degrees C) heating
  - Produce electricity or fuels (or other higher value products)
  - Efficiency matters when the heat isn't free
- Moderate temperatures for processing & manufacturing
  - 200 degrees C
- Cooling
- Capturing waste heat
- Datacenters

SEVERAL AXES MISSING

Temperature
Discharge Rate
Efficiency
Application
Cost



- Metal Carbonates
- Metal Hydroxides
- Gas Phase Organic Reactions
- Salt Ammoniates
- Phase Change Materials
- Sensible Storage

NEW THERMOCHEMICAL APPROACHES

- Using hydrides for storage
  - Large ΔH, but reversibility, cost is holding it back (catalyst)
  - Can you use the hydrogen as fuel?
- Ionic liquids
  - Gas storage and a reactant
- Microphase separation (high temp)
  - Sensible heat + energy of mixing
- High entropy reactions
  - Depolymerization
  - Rotational degrees of freedom

NEW THERMOCHEMICAL APPROACHES

- Metal-organic frameworks
- Condensed phase reactions
- Supersaturated solution of salts to generate a metastable state
- Design chemistries that will get around reactor design issues
  - Size, complexity, heat/mass transfer, efficiencies
- One reaction system improves efficiency and reduces process complexity
- Disproportionation reactions
- Gases are okay for very high ΔH
- Leverage advances in porous materials and nanoscience
  - Few advances in basic chemistry for TES

NON-THERMAL APPROACHES

- These approaches are good for fast discharge
- Pressure swing applied to metastable states
- Magnetocaloric effects for large entropy changes
- Thermal/electrical battery
- Photochemical, electrical potential, etc. as a trigger

CATALYTIC APPROACHES

- "Thermo-flow" battery
  - Fixed catalyst, flow liquid over
- Membrane-catalyst hybrids
- Reversible polymerization for high entropy materials

IDEAL TEAM

- Reactor engineers, designers
- Heat transfer specialists
- Chemists, materials scientists