HIGH DENSITY THERMAL STORAGE WORKSHOP

BREAKOUT REPORT

THERMAL STORAGE FOR NUCLEAR ENERGY

www.arpa-e.energy.gov

1. How do we quantify the need/value in integrating thermal storage with nuclear?

- Need a utility and vendor to develop a benefits estimate for good realism (Northern Midwest and Southwest, perhaps)
  - Couples with renewables like wind and solar
  - Or a highly variable baseload
- Regional issues include timescale, regional availability of resources like water, and competition like peaking
- Projections for other competitive intermediate technologies will matter – What are other folks paying for peaking power (see MISO or PJM)
- Gigawatt-hour, gigawatt-day, gigawatt-year issues

2. What are the biggest barriers to integrating thermal storage with nuclear energy?

- For *present*, you would need a utility interested in making changes to what may be a high capacity factor plant – has to be even more reliable than the plant, can't be allowed to trip the reactor
- It's not high temperature heat – current advanced light water reactor designs are limited to less than 300 C, and the waste heat is really low. You would have to consider taking off intermediate steam heat.
- Going to a Gen IV system, gets you into the 500-800 C range
- Siting questions – putting outside the exclusionary boundary. May need to take it a km away. Dependent on what you are storing.
- Licensing and regulatory questions will inevitable have to be addressed.
- Issues with pore space ownership

3. What system(s)/materials are best suited for this application? What will be cost of storage for diurnal, weekly and seasonal charging and discharging?

- Depends on temperatures and pressures that you are dealing with, and also scale since nuclear is typically bigger
- For any of these technology options, you can't afford to build something at the gigawatt-day scale – a lot of heat.

4. What is the total capacity potential for deployment of thermal storage with nuclear?

- In the high tens to hundreds of gigawatt-years
- It can be taken as a fraction of your nuclear capacity

5. What advances in heat exchanger or power conversion technology would enable economic utilization of nuclear heat?

- Supercritical CO2 brayton cycle
- The heat exchanger is a critical component
  - Heatric (UK company) is an example, but it has fabrication issues
  - Other fluids could be considered, but these interplay with the materials bonding issues
  - What is the lifetime of diffusion bonded? We do not have cycle data. Also need high ductility.
  - Diffusion bonded numerical modeling could point to potential improvements. Also need some experimental data.
- Are there alternatives for high temperature heat transfer? Steel mills used checkerbrick – a direct coupled heat transfer approach – $C_p dT$ type storage

6. What are the implications of an attached thermal energy storage system on the safety licensing of the reactor?

- For instance, could the thermal energy storage be a source of emergency power?
  - *NO, otherwise would have to qualify as a piece of safety equipment.*
- What incidents with the thermal energy storage system might propagate into the reactor operation?
  - The thermal storage system must be as reliable or more reliable than the nuclear plant
  - Need to verify that there is no feedback into an accident issue.
  - Induced seismicity would also have to be considered with underground storage

7. What will a very high impact research and development program look like for nuclear energy storage system assuming a funding of < $5M per project? What will be the composition of an ideal research team?

- LWRs
  - Steam accumulator, with a high heat capacity solid inside
  - Something that changes the game at 250 C would couple beautifully
- HTR (500-800 C, could be gas or sodium)
  - Now matches solar temperatures
  - Or process heat
- What about a new SMR? Could DoD be a risk taker? Use this for an installation?
- Something that could be proven in the fossil environment (or perhaps thermal solar) then migrated to nuclear could be a potential development path
- Supercritical CO2 Brayton cycle
- High temperature seals

QUESTIONS?