CHANGING WHAT'S POSSIBLE

Day 2: Manufacturing

Chicago Room readout

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What techniques should ARPA-E consider

- Sub micron scale, finer features for enhanced heat transfer, which other parts of DOE has one. What can be leveraged?
- Small features have been there for many years. Different techniques for different scales like roll to roll with Embossing
- Tubes will be as long as New Jersey. 3D printing is great for R&D, for making things for a power plant, you need miles and miles of machinery.
- For a 600 MW plant, an air cooled condenser takes 1.5 years to build at an installed cost of $30 – 40 M.
- The first ACC was installed in Germany in 1928, not much of the design has changed, just the configuration.
- What is the next increment towards mass manufacturing? The opportunity with dry cooling is to close the gap between where we are and 100%.
- Consensus on diminishing returns for higher effectiveness.
- 3 to 5 year paybacks are required for technologies to be adopted.
- Hard to put a value on water. Value is different than cost, when you have to pay for it, that is when it affects decisions.
- Permitting is why people are going towards dry cooling not because the costs are high for water.
- ACC does not burn down, insurance company loves it, it's easy to recycle. An ACC in a very wet region was installed, and a lot of money on it.

3D printing and modular systems

- 3D printing will find each role. Taking a modular approach is a good step. Modular design allows you to do 3D printing.. then you modularize it.
- What components do you think is feasible.
- Inner components of the system will use 3D printing as the shape complexity drives you through this route.
- Each time, the cost increases dramatically for modularization
- Shipping dimensions limits the modularization.
- Onsite manufacturing/assembly is very expensive due to union labor and lack of skilled labor.
- Metrics need to be developed around the MFG process.

Materials and other cost considerations

- Is 80% material cost reasonable?
- Need to make 2-miles a day of fin tube, you will not get a bank loan easily.
- The ACC is not the only area where we need to consider MFG. E.g. absorption and radiative cooling.
- There needs to be fundamental materials research.
  - Example: Fundamental limit of Lithium Bromide Ammonia system. Does not go well with aluminum. Need to do more research on materials. Steel coated aluminum.
- Can put some additives to reduce crystallization.
- Wet cooling towers are used for commercial LiBr-Ammonia systems.
- The 2.0 COP target is very challenging
- Reliability is very important.

Market adoption and scale up

- Advanced manufacturing targets making complex geometry designs available, but not necessarily at lower cost per the (N+1)-th unit. Performance should go up, otherwise why do it?
- It does not matter if one makes six 100-MW systems or three 200-MW systems, the material costs are dominating.
- Process industries, data center cooling, commercial HVAC, chemical industry are in line with this. Steam condensing is a smaller universe. You don't do that in HVAC and datacenters. There are many other industries.
- This opens the question of using other fluids.
- Getting new technology into a plant is very arduous. Many of the technologies in development for plants are also developing for these other markets.
- What scales are we talking about? E.g. pulp. What demo size would be good for other markets
- For oxygen tonnages, we're looking at 500 ton per day for specialty gases. In power gen you have 10,000 tons per day. Midscale for power gen is 50-100 ton per day. The smallest system will be 200 to 250 MW gets you into the large scale.
- A 100 MW heat rejection system is typical for a small building HVAC application. This is also the size of the unit in the Water Research Center in Atlanta.
- To manufacture a polymer based heat exchanger, Is that possible now? Need for high conductivity polymers? Other ways to manufacture them? (E.g. "Cooled Poly" having 20 W/m-K)
- Once the scale develops, then it is very difficult to fix on a polymer.
- For polymer Heat exchangers, how is that compatible with the manufacturing approaches discussed?
- All heat exchangers are sucking in pollen, dust, etc. The system must be cleanable. (e.g. pressure washed). The ACCs are cleaned with 1300 psi washers. An operator just moves across the system and washes it 1 or 2x per year. It must withstand being treated with 1300 psi water. Must also withstand Hail Storm. All debris gets sucked in, e.g. napkins.
- 11 or 12 fins per inch are restriction due to cleaning.