Breakout-2 – Group C – McPherson

Chris Atkinson - Facilitator

Gokul Vishwanathan – Note taker

1: Reactors with minimal human intervention – Sensors, Controls and Monitoring

- Sensors: Monitor complete structures in real time. Reduce cost due to lower personnel needs. Self-regulating systems – integral in the physics of the design.
- Current SOA: Miniaturization without optimization for SMRs.
- Design for inherent safety but sensors are needed as supervisory control units. Model based controls can be next level.
- Interaction of the reactor with grid and Balance of Plant (BOP) with different value streams aside electricity.
- Time constants of load and reactor need to be taken into consideration – load following can be provided by physics and not instrumentation (e.g. LANL heat pipe technology).
- No knowledge of sensors that suit 700 C for 10 years with telematics – development area. Debate on whether sensors external to the core are needed or not. Need for temp. and flow sensors with information transmission to central control.

2: Application: Load following, <$0.10/kWh

- Debate whether integrating storage with reactor is better than load following. Utilities may need a varied portfolio and hence better to have both value streams.
- A need for the reactor to work with renewables was identified.
- Debate on value vs. price. For example, $0.1/kWh nuclear reactor with risks may not be attractive as $0.12/kWh without risk.
- Value stacking needs to be considered. Electricity plus heat, avoided T&D costs, off-grid applications, Data centers (2% of electricity is spent in data centers - niche market
- Energy storage industry has found about 11 value functions it offers. Can we find something similar?
  - Example of value: Coal drying in Wyoming using reactor improves the value of dry coal.

2: Application: Load following, <$0.10/kWh

- Enabling technology can be 3-D printing. 3-D printing is costly but can accomplish the manufacturing in less time, which adds value for nuclear industry.
- Qualification of advanced and new materials and processes for 3-D printing. 3-D printing of components may be an area of investigation.

3: Optimization with Scale

- Key optimization is in developing a topical report for zero EPZ. Need for a risk informed EPZ. Development of a topical report: source term based, transportation limit based.
- Trade studies are needed to identify designs (currently miniaturization is taking place without optimization).
- Need sensors that can survive in molten salt environment – chemical environment.

4: Polling: $30 M and 3 year ARPA-E program

- Self-regulating systems. Reduction of active systems. Concepts include: natural vs. forced circulation, thermal hydraulics, core physics, management of activity swings, and controlling reactivity during transients.
- Sensors and monitoring: Independent of control. Sensors include: Temperature, flow, pressure, position, vibration health monitoring and neutron detectors (make sure you are not reinventing the wheel –work with other agencies). Need for robust wireless self-powered sensors.
- Unexplored design space. Shrinking without optimization is ongoing. Optimization of designs at 10 MW scale is needed
- $30 M - impossible to demonstrate a reactor but feasible to integrate a machine. Demonstrate a machine without fuel (heating elements). Heat removal and shutdown demo. Sun-scale or full-scale demonstration.

4: Polling: $30 M and 3 year ARPA-E program

- Solid-state system needs. Solid state shutdown systems. Solid state shielding systems.
- Complexity of heat exchanger to divert heat for process and some for electric power conversion. New HX designs.
- Topical report and zero EPZ. Demonstrations to support topical reports. Experimental EPZ demonstration. Can fund multiple topical reports and demo to public.
- Not knowing the status of EPZ – Focus on sensors and monitoring.
- Design, scoping and optimization studies to find common themes.
- Advanced Materials – high temp and corrosion resistant. Water-less cooling and designs.

4: Polling: $30 M and 3 year ARPA-E program

- Final points:
  - Coordinate with existing DOE programs.
  - Develop and investigate a design methodology? The design space is complex, multi-dimensional and far from existing designs and implementations.
  - Can ARPA-E fund the development of an integrated design, which is not technology specific? Design, build, test and demonstrate range of technologies including materials, sensors, controls and load following.