Hybrid Energy Systems Program

Federal POC: Martha Shields, NE-52

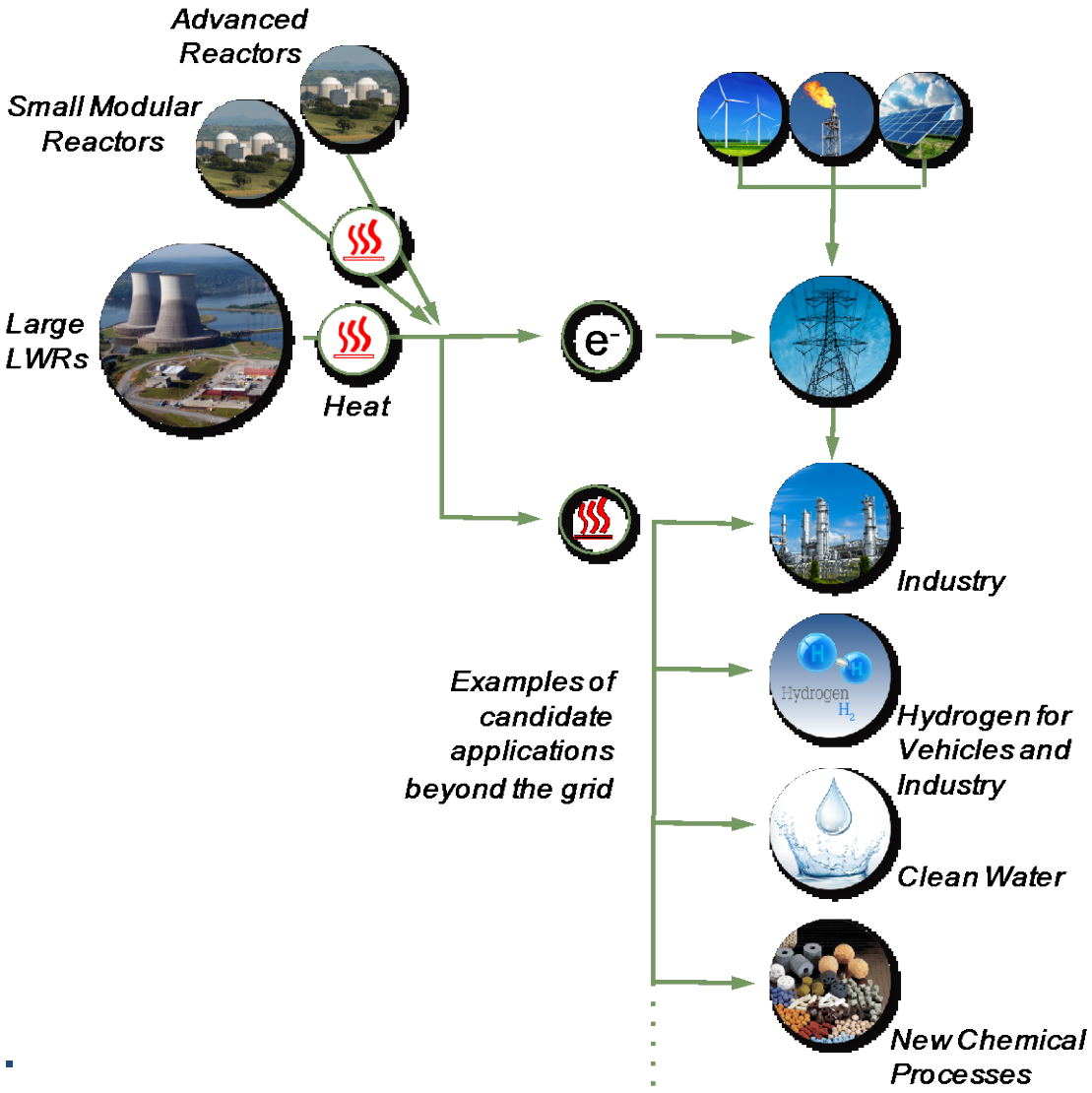
Technical POC: Shannon Bragg-Sitton, N-R HES Program Lead, Idaho National Laboratory

For reference, see: N-R HES 2016 Technology Development Program Plan, https://www.osti.gov/scitech/servlets/purl/1333006

U.S. DEPARTMENT OF ENERGY

Energy System Flexibility

- Goal: A sustainable and balanced energy portfolio for reliable, robust electricity at stable, affordable prices
- Proposed solution: An energy system dynamically integrated with other fuel sources and industrial applications
- Contributions from nuclear fission will extend beyond electricity generation
  - **Hybrid Energy Systems (HES)** maximize flexibility and economic performance while ensuring reliability and robustness/resilience.



HES Program Scope

Focused R&D in HES design, optimization, and testing for promising hybrid system architectures, coupled with development of technology options, will enable more efficient, environmentally sustainable energy systems

- Modeling and Simulation: Tool Development & Associated Analysis
  - Assess technical and economic viability
  - Determine optimal system design and energy dispatch.
  - FY-18 Focus has been: Pilot case studies for specific plants and regions with utility partners.
- Demonstration/Experimental Systems (electrically heated)
  - Demonstrate hardware interfaces, control systems, dynamic operation, etc.
  - FY-18 Focus has been:
    - Design review for PWR-emulation loop.
    - Design/build thermal energy distribution system (TEDS) to connect PWR loop & hydrogen electrolysis

NE 2.1: Studies of Component/System Degradation

Characterization of dynamic energy system behavior

- Modeling & hardware-in-the-loop (HIL) testing
- Objective:
  - Capture real-time, dynamic response behavior
  - Determine impact of thermal cycling on components and subsystems as it relates to component and system robustness, resiliency, response rates, etc.

NE 2.2: Cyber-Informed System Design for N-R HES

Grid Operations by Regional Transmission Organizations / Independent System Operators (RTO/ISO)

Enhanced Data Communications Protocol

w/ consideration for cybersecurity impacts

Front-end-controllers and control theory for optimal energy dispatch in tightly coupled integrated energy systems operations.

Cyber-informed engineering should be incorporated into the respective levels of data transmission and management, human monitoring and control performance, control signal processing, and device level control actions. Studies should include control hardware in-the-loop (CHIP).

NE 2.3: Systems Controls for N-R HES

Develop predictive load and supply forecasting (e.g. using predictive “agent-based” models)

- System control technology/approach development
- Objective:
  - Optimize energy dispatch in real time for integrated energy systems

Expected Outcomes with NEUP

- Engagement of university researchers having diverse expertise will bring new solutions to HES design, optimization, and demonstration
- NEUP modeling and simulation scope is intended to develop tools and techniques that can solve longer-term questions associated with hybrid energy systems design, design optimization, and operational optimization
- Results and outputs will enhance ongoing HES modeling and simulation work
  - Support longer-term needs, but could be integrated with the broader laboratory toolset as soon as they are available
  - Will be used as a component of follow-on system design and testing / to refine Hardware-In-the-Loop system design
- Requirements:
  - Analysis/evaluation approaches must be compatible with the laboratory developed toolset (RAVEN, Modelica) to allow for future integration
  - Deliverables should include modeling and simulation components that are ready for integration into the overall HES model architecture

Questions?