



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear-Renewable Hybrid Energy System FY18 CINR Scope

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**For reference, see: N-R HES 1016 Technology Development Program Plan,
<https://www.osti.gov/scitech/servlets/purl/1333006>**



N-R HES Program Overview

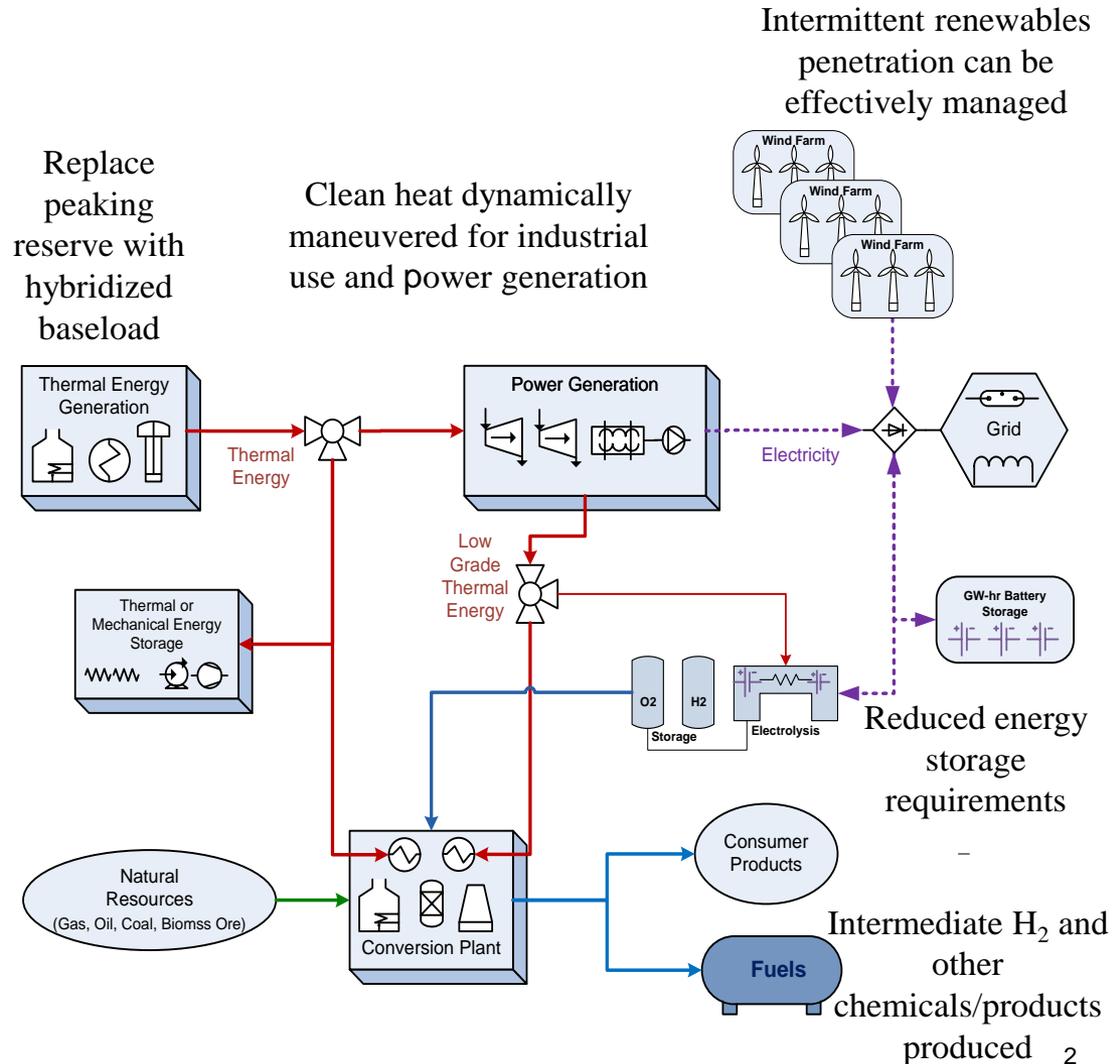
Nuclear Energy

■ **N-R HES are cooperatively- controlled systems that dynamically apportion thermal and/or electrical energy to provide responsive generation to the power grid**

■ **Anticipated benefits include:**

- Dispatchable, flexible electricity provided to the grid
- Synchronous electromechanical inertia for the grid
- Reduced industrial sector carbon footprint
- Stabilized energy costs

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





Expected Outcomes from NEUP Collaborations

- **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**
 - 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
 - Key contribution areas support longer-term needs, but could be integrated with the broader laboratory toolset as soon as they are available
- **Scope related to technology feasibility will provide early demonstration of low TRL technologies that could improve the technical and/or economic performance of N-R HES**
 - Proposed scope targets areas that are currently in the conceptual stage and must be demonstrated at the bench scale prior to integration with an HES
 - May include both bench-scale experiments and corresponding model development



N-R HES Modeling & Simulation

- **The N-R HES program is seeking contributions that will result in development of additional modeling and simulation tools and approaches to support the development of advanced nuclear-renewable hybrid energy systems. Tools must be able to link with Modelica component models and RAVEN optimization tools under development by the DOE national laboratory team.**
- **Proposals are sought in the following areas:**
 - Development of additional detailed component models to support integrated system evaluation within the HES modeling and simulation framework and within specific regions. Could include energy storage systems, industrial processes, etc., translating mathematical models into compatible Modelica models.
 - Evaluation of the economic potential and advantage of new process design with heat storage over baseload electricity production.
 - Characterization of dynamic energy system behavior to determine impact of thermal cycling of components and subsystems on component and system robustness, resiliency, response rates, etc.



Support for N-R HES System Demonstration

- **The N-R HES program is interested in demonstrating low TRL system components and/or subsystems at reduced scale to show technical feasibility, economic potential of integration, etc.**
- **Proposals are requested in the following areas:**
 - Scaled studies of energy storage concepts, e.g. a scaled down demonstration of thermal energy storage concepts that could later be integrated in the INL Dynamic Energy Transport And Integration Laboratory (DETAIL) for integrated systems testing.
 - Efficient temperature amplification technologies, such as chemical heat pumps, that can allow conventional LWRs and near term SMRs to support a wider range of industrial applications. Options could include upgrading of “waste heat” or primary heat from the systems. Concepts should give consideration to operational, regulatory, and safety constraints associated with an operating nuclear plant.