Nuclear Energy University Programs
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CT-2:
Integrated Energy Systems Design and Modeling
Federal POC – Rebecca Onuschak
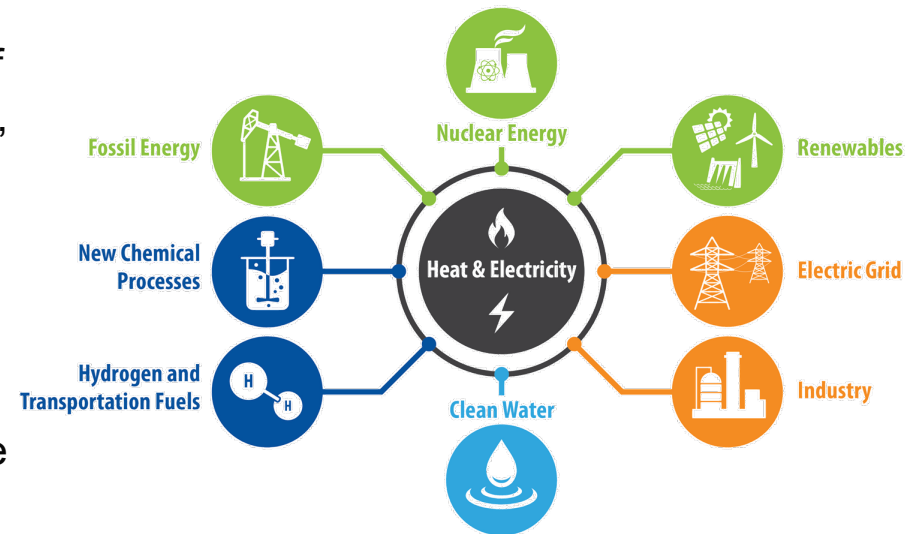Technical POC – Shannon Bragg-Sitton

Integrated Energy Systems Program Overview

Mission: Maximize energy utilization, generator profitability, and grid reliability and resilience through novel systems integration and process design, using nuclear energy resources across all energy sectors in coordination with other generators on the grid.

Goals: The IES program develops tools and technologies that will lead to demonstration of multiple integrated energy systems that have a clear path toward commercialization. Timelines follow the associated reactor concepts and designs (current fleet now, SMRs 1-5 yrs, non-LWR 5-15 years).

Strategic R&D Areas:

- *System Simulation*. Develop and exercise an ecosystem for modeling, analysis, optimization of IES that can accommodate various reactor types, renewable technologies, and energy users.

  - ➢ *Economic Analysis.* Establish a reference capability to validate current practices in valuing nuclear energy in the energy market (electric and non-electric).

- *Experimental Evaluation*. Establish and operate a fully-functional and diverse non-nuclear facility for model validation and initial technology demonstration.

Fossil Energy · **Nuclear Energy** · **Renewables** · **New Chemical Processes** · **Heat & Electricity** · **Electric Grid** · **Hydrogen and Transportation Fuels** · **Clean Water** · **Industry**

IES
Integrated Energy Systems

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- Work scopes of interest for FY21 applications focus on concepts and technologies to use advanced (non-water cooled) reactors in IES, advanced performance optimization techniques, and IES cybersecurity.

- Advanced reactor IES development areas of interest:
  - Feasibility, concept development and/or optimization of systems that take advantage of advanced reactor thermal energy input or other novel reactor features.
  - Process design as it pertains to nuclear system integration (e.g., potential for radiation-assisted processes, modification of the process design to better match the nuclear system); and/or
  - Interface design (e.g., advanced heat exchangers, requirement for design of intermediate loops, impact to balance of plant, control systems) for prioritized coupled processes.

- Topics not of interest:
  - Novel reactor designs
  - End use technology development, except modifications to allow use in a nuclear IES

    ✘ Improved efficiency of end-use (e.g. hydrogen production or desalination) is not a topic of interest

    ✔ Converting process parameters to better match parameters of an advanced reactor IES concept (e.g. changing process temperature) is a topic of interest

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- IES performance optimization include areas of interest:
  - Algorithms for real time, online optimization of IES dispatch for economic performance, with an emphasis on resolving the specific challenges of integrating nuclear power systems and their operations into such environments
  - Real time update of IES control system predictive capability
  - Large-scale data assimilation in real time.

- Topics not of interest:
  - Demand forecasting for the electric grid or non-electric IES processes, except as part of a feasibility or optimization study. For example:

    ✖ Electric grid demand models and forecasting tools are not of interest as primary proposal subjects

    ✓ Electric grid demand models and forecasting tools may be of interest as part of an IES feasibility or optimization study, if existing models are not available to support the proposed method(s) or concept(s).

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- IES cybersecurity areas of interest:
  - IES-specific cyber-informed engineering approaches, architectures and/or design concepts.
  - Cost-effective approaches to ensuring the security of these complex energy systems that require significant data exchange and control interactions among multiple coupled energy producers and users.
  - Concepts for ensuring cybersecurity in the context of multiple regulatory, safety and security frameworks.

- Topics not of interest:
  - General industrial cybersecurity techniques that do not address the specific types of challenges described above.

    ✘ Technologies to detect, prevent or respond to industrial control systems cyber-intrusion are not of interest

    ✔ Cyber-informed engineering approaches that incorporate requirements and techniques of the nuclear sector and another IES sector are of interest.

    ✔ Architectures and/or technologies that segment nuclear and non-nuclear IES subsystems to simplify design, licensing and management are of interest.

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Other things to consider:

- Even if not submitting a cybersecurity-specific application, cyber-informed engineering should be considered in system design, dispatch optimization, and system control.

- Computational models should be capable of integrating with the Modelica and RAVEN-based ecosystem for modeling and analysis that is used by the lab team for IES.

- Systems of interest could be applicable to fixed installations or could be modular and transportable in their design.

- Principal investigators are encouraged to investigate the potential markets and market competitiveness of proposed solutions within large-scale centralized grid or islanded micro-grids that may be applicable to SMR or micro-reactor technologies.