U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

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Light Water Reactor Sustainability (LWRS)
FY 2021 CINR Webinar: IRP-RC-3

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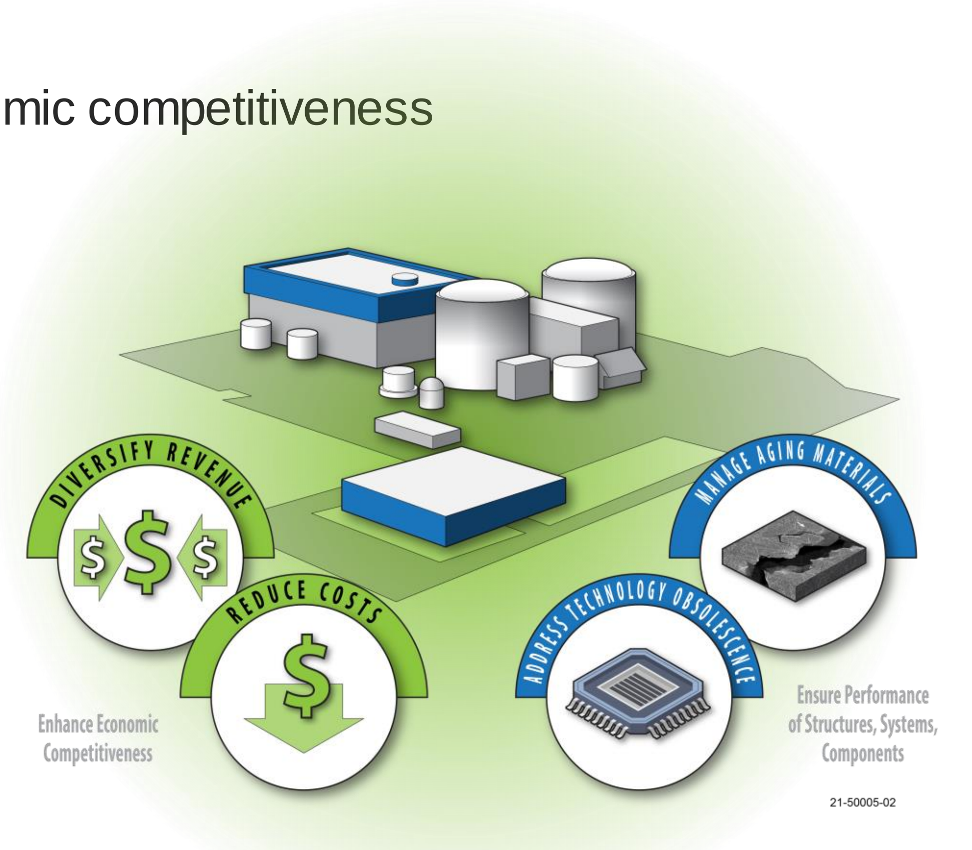
Light Water Reactor Sustainability

- **Goal**
  - Enhance the safe, efficient, and economical performance of our nation's nuclear fleet and extend the operating lifetimes of this reliable source of electricity

- **Objectives**
  - Enable long term operation of the existing nuclear power plants
  - Deploy innovative approaches to improve economics and economic competitiveness of LWRs in the near term and in future energy markets.
  - Sustain safety, improve reliability, enhance economics

- **Focus Areas**
  - Plant Modernization Research and Development
  - Flexible Plant Operation and Generation
  - Risk-Informed Systems Analysis
  - Materials Research
  - Physical Security



Research Pathways

Plant Modernization	Enable plant efficiency improvements through a strategy for long-term modernization
Flexible Plant Operation & Generation	Enable diversification and increase revenue of light water reactors by deploying systems to extract electrical and thermal energy to produce non-electrical products
Risk Informed System Analysis	Develop significantly improved safety analysis methods and tools to optimize the safety, reliability, and economics of plants
Materials Research	Understand and predict long-term behavior of materials in nuclear power plants, including detecting and characterizing aging mechanisms
Physical Security	Develop and provide technologies and the technical bases to optimize physical security postures to maintain protection and improve efficiencies

CINR Workscope: IRP-RC-3

“Research projects that accelerate the development of control systems, data collection, processing and system diagnostics, and computational tools that enable existing LWR power plants to be efficiently and safely integrated with process applications and that allow nuclear power plants to provide ancillary services to the grid.”

Motivation and Background:

- Nuclear power plants are considering more flexible approaches to plant operation
- Technologies new to the commercial nuclear power industry
- Requires new operating concepts, supporting technologies, risk assessment tools

Application Details:

- ELIGIBLE TO LEAD: UNIVERSITIES ONLY
- UP TO 5 YEARS AND $4,000,000
- A consortium; Additional university collaborator, multiple university and non-university partners

CINR Workscope: IRP-RC-3

1.) *Controls systems that are capable of rapidly apportioning thermal and electrical power to support electricity grid technical services while optimizing plant revenue through energy arbitrage.*

- Design and testing of new operator task panels with human factors that ensure reliable human performance and efficient hybrid operations.

- Development of IEEE-2030 standards and protocol for grid-to-plant data links that enable nuclear plant operators to directly communicate with regional transmission and balancing authorities, thus allowing the nuclear plant to participate in capacity markets by providing spinning or non-spinning reserves or frequency regulation.

CINR Workscope: IRP-RC-3

2.) General or plant specific LWR simulators or other computational tools that can be used to help design, test, and optimize dynamic thermal energy extraction and delivery and electricity dispatch.

- Full-scope simulators that can be used to optimize thermal energy extraction within the operating basis of the nuclear plant license.
- Reduced order models of the integrated systems that can be used to accelerate the development of human factors
- Computational models that are tied to actual physical unit operations that represent new energy delivery components that can credibly support probabilistic risk assessments (PRAs) addressing the risks of potential upsets in operating conditions and loss of load situations that are introduced by specific integrated plant designs and hybrid operation conditions.

CINR Workscope: IRP-RC-3

3.) Extension of legacy probabilistic tools to include new initiating events introduced by new grid-to-plant process controls and plant-to-hybrid process controls coupling.

- Hybrid plants that flexibly apportion power to the grid and thermal energy and power to a hydrogen production plant

- Hybrid operations that store thermal energy for power arbitrage on the grid- where power dynamics of power transmission are included in potential loss of load events

- Modes of heat rejection relevant to rapid transients in the new heat extraction and delivery system; for example, failure of control values, sudden disruption in the heat transport line to the external thermal energy application, or a rapid change is heat demand by the external application

CINR Workscope: IRP-RC-3

4.) Development and demonstration of operating concepts using smart valve flow controllers, smart instrumentation, data links, and data analytics for hybrid plant operations.

- Approaches that combine analog instruments and controls with digital instruments and controls for rapid thermal and electrical power dispatch to an external user

- Design and testing of smart valves and valve alignments in thermal flow loops with multiple parallel outputs/inputs for plants that serve multiple processes for systems that enable rapid thermal extraction and dispatch based on operator-supervised automatic control systems

- Data management and analytics that enable operators to track system state conditions and that can be used to automatically adjust process conditions with human cognition and supervision

- Instrumentation and data analytics that perform component health monitoring

- Approaches that provide inherent cyber security and systems reliability based on total state awareness .

Questions?

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