National Academies of Science

Perspectives on New Nuclear for NAS Study on “Laying the Foundation for New and Advanced Reactors in the United States”

July 19, 2021

Marilyn C. Kray
Vice President, Nuclear Strategy & Development

Exelon Generation®

View of Transitioning Power Grid and Generation Assets

Original

- Nuclear and fossil baseload
- "Shoulder" fossil units
- Peaker units
- Minimal renewables
- Nuclear generation dedicated to electricity
- Regulated market with obligation to serve
- Generating assets typically owned by single entity in a region

Current/Future

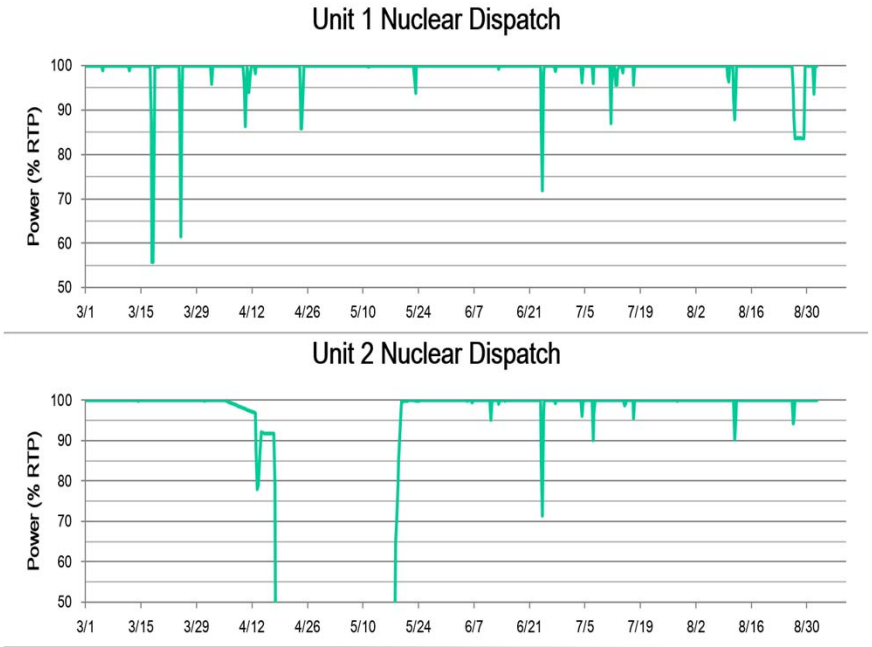
- Flexible generators
- Order of dispatch dependent on market
- Significant renewables
- Increased distributed generation
- Expanded services beyond electricity
- Deregulated energy markets
- Multiple generation asset owners
- Variety of nuclear generation sizes

Flexibility Options for Nuclear Baseload Providers

- Maintain nuclear power and dump steam
- Ramp down nuclear power (Advanced Nuclear Dispatch)
- Divert steam to another process
- Supply electricity to a dedicated load
  - Hydrogen production
  - Data centers
  - Cryptocurrency mining
  - Behind the meter issues
    - FERC tariff applicability
    - External hazards to nuclear plant
    - Impact on security plan, emergency plan
    - "Green" pedigree of generation source
- Store nuclear energy or electricity
  - Pumped storage
  - Batteries

Resource: EPRI Report "Nuclear Beyond Electricity-Landscape of Opportunities Initial Survey and Near Term Actions" issued March 15, 2021, Product ID 3002020437

Advanced Nuclear Dispatch (AND)



- Initiated in 2016 to respond to real-time market signals to relieve elevated congestion levels and optimize station output
- Elevated congestion levels driven by:
  - Local transmission outages
  - Low load conditions
  - High levels of wind generation
- Unit load changes are requested from Generation Dispatch, but Unit Shift Manager has ultimate authority on whether to respond
- Ramp rates established to avoid excessive wear on equipment
- Extensive procedural guides and training developed
- Established modeling aids to project probability of dispatch
- Resulted in cost savings as compared to scenario without AND

Hydrogen Demonstration Project

Objective

- Install a 1MW Polymer Electrolyte Membrane (PEM) electrolyzer and supporting infrastructure at an Exelon nuclear power plant
- Provide economic supply of in-house hydrogen consumption at the plant
- Simulate a scale-up operation of a larger electrolyzer participation in power markets

Timeline and budget

- Conditional award: 10/01/2019
- Removal of condition: 07/30/2021
- Project End Date: 04/01/2023
- Total Project Forecast: $13.8M

Questions, challenges

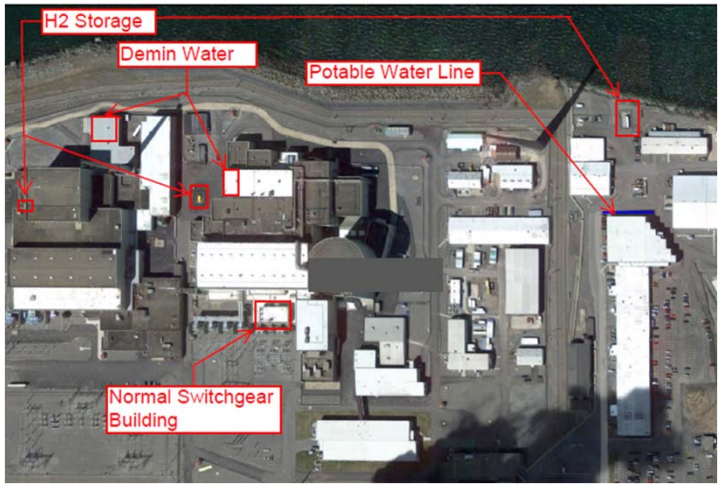
- Site Selection
  - What are the criteria for site selection?
- Regulatory
  - What are the relevant regulations that affect nuclear hydrogen production?
- Market-related
  - What is the effective electricity price that the electrolyzer pays?

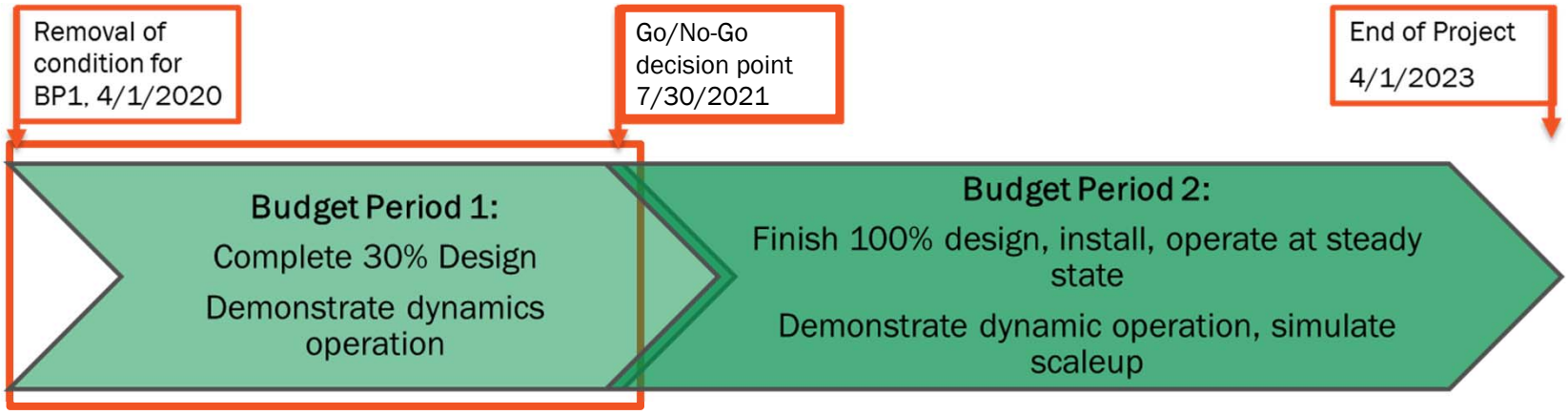
Partners/Sponsors

- DOE-FCTO funding
- Exelon Corporation
- Nel Hydrogen
- Idaho National Laboratory
- National Renewable Energy Laboratory
- Argonne National Laboratory

Project timeline and next steps

	Key Milestones & Deliverables
Year 1 (BP1)	• Site selection, 30% engineering design • Simulation using prototype electrolyzer
Year 2 (BP2)	• 100% engineering design, decision to install • Complete manufacture, test of electrolyzer.
Year 3 (BP2)	• Start of steady state operation of electrolyzer • Simulation of scale-up electrolyzer operation • Demonstration of dynamic operation on site





Advanced reactors expand on the flexibility attributes of the current large, light water reactor fleet

Advanced Reactors

GOVERNMENT RESPONSE

- Federal legislation
- DOE funding and GAIN initiative
- NRC funding and actions

INDUSTRY RESPONSE

- Increased activity by technology developers
- Availability of venture capital funding
- Coordination of industry initiatives

Current drivers present a platform for action related to Advanced Reactors, thus prompting actions by both government and industry

Advanced Reactor Key Considerations

Wide field of developers

- Sizes range from startups to large corporations
- Experience levels range from new to original equipment manufacturers

Benefits of Advanced Reactors

- Lower overall cost
- Reduced construction risk due to modularization
- Enhanced safety features
- Ability to produce more than electricity
- Greater agility on grid
- Flexible operations to level fluctuation of renewables

Challenges with Advanced Reactors

- Immature designs do not yet enable accurate cost estimates
- Regulatory approval timeline uncertain, especially for advanced designs
- Funding streams for developers to finalize designs

Exelon Activities with Advanced Reactors

- Motivation for advanced reactor strategy
  - Influence future designs by providing operational perspectives
  - Ensure available technology alternatives for the future
  - Create business opportunities to provide operational services to new entrants in nuclear ownership
  - Communicate our long-term commitment to nuclear to employees and external stakeholders
  - Uphold our role as an industry leader
- Engaging with multiple reactor developers
- Leading industry forums

Exelon sees advanced reactors as critical for decarbonization and as the enabling foundation for the deployment of renewables

Areas of Continued Effort

- Economic Modeling
  - Market forecasts and generation dispatch profiles needed for states to meet established decarbonization goals
- Technical
  - Specific needs to address new materials, fuels, moderators and coolants being prompted by reactor developers and being addressed primarily through DOE-funded programs
- Regulatory
  - Continued work by NRC and industry to address non-light water technologies and incorporate risk-informed approaches
- Policy
  - Needed to preserve existing fleet to sustain the human resource pipeline and the manufacturing capabilities
  - Market structure needed to reward generation that “volunteers” to down power in response to renewable availability