A Future of Nuclear Energy:
The Nuclear Renaissance, the Role of INL, and Potential in the Northwest

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Northwest Power and Conservation Council Meeting
09 June 2010
The Nuclear Renaissance: Factors Driving Renewed US Interest in Nuclear Energy

• Electrical Generation Supply/Demand
• Global Warming, Greenhouse Gas Emissions
• Technology Advances
• Regulatory Process Improvements
• Legislative Opportunities (e.g. Energy Policy Act 2005, carbon emissions pricing, etc.)
Facts regarding nuclear energy in the US

- Baseload power is necessary to meet electricity demand and nuclear and hydroelectric power are the only low-carbon options that serve this function.

- Three decades of outstanding performance by any measure – safety, reliability, availability, and the lowest production costs.

- Reactors are safe because of redundant systems, automatic shutdown systems and multiple layers of separation...

- ...and because of industry’s commitment to comprehensive safety procedures and a stringent federal regulator.

- Thirty new reactors are under consideration and more will be needed.

- 104 reactors supply 20% of electricity, and operate in 31 states.

- 70% of emissions-free electricity is nuclear, displacing the equivalent of annual CO₂ from U.S. cars.

- Nuclear generation reached a new high of 808.97 million megawatt hours (91% capacity factor) in 2008.

- Over last decade, the equivalent of 23 1,000 MW plants have been added to the grid through efficiency improvements, up-rates, use of higher burn-up fuel.

- Production costs are lower than any other primary energy including coal and natural gas (less than 2 cents/kilowatt-hour).
Designs competing for US market: Generation III+

- Standardized designs based on modularization producing shorter construction and licensing schedules
- Cost savings from modularization
- Passive or redundant systems to enhance safety
Proposed locations for new nuclear plants

Map showing various proposed locations for new nuclear plants across the United States. Each location is marked with a specific design or number of units. The map includes notes on designs and units, with symbols indicating different types of plants. The map includes a key explaining the symbols used, such as ABWR, AP1000, EPR, ESBWR, and USAPWR. It also notes whether the review is suspended or partially suspended.
Integrated Small Modular Reactors

An option to large scale nuclear power plants:

- Reduced financial risk for entry into nuclear power generation
- Better fit to electrical grid infrastructure in many places
- Factory manufacturing; easier to ship components
- Scalable
- Potentially adaptable to non-electricity applications
- Potential safety advantage
- Most electrical generation plants are < 500 Me
- Opportunity for innovation
- Improved water management?
- Adapt Gen-III+ and Gen-IV technology

Vendors:

- **Westinghouse International**
  - International Reactor Innovative and Secure (IRIS)
  - 335 MWe

- **Babcock & Wilcox**
  - mPower
  - 125 MWe

- **NuScale Power, Inc.**
  - (based in Corvallis, OR)
  - NuScale
  - 45 MWe

Source, R. Black, DOE 2009 ANS Conference
## Estimated Costs for Deploying New Plants

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<th>Source</th>
<th>Capital Cost $/kW</th>
<th>LCOE ¢/kWh</th>
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### Nuclear Science and Technology at INL

#### Focus Areas
- Nuclear Reactors
- Nuclear Safety
- Advanced Nuclear Fuel
- Nuclear Fuel Cycle
- Radioisotope Power

#### Major Programs and Facilities
- LWR Sustainability
- Advanced Fuel Cycle Development
- Next Generation Nuclear Plant
- ATR National Scientific User Facility
- Space Nuclear Power Systems

#### Enabling Expertise
- Human Factors, Instrumentation and Control
- Advanced Modeling and Simulation
- Nuclear Fuels and Materials
- Hydrogen Production and Use
Light Water Reactor Sustainability

Continued reliance on existing US nuclear plants

- Present 60 year licenses mean current plants shut down starting 2030
- Steep reduction in generation if current fleet operations are not sustained
- Integrated aspects of program:
  - Nuclear Materials Aging and Degradation
  - Advanced LWR Fuel Development
  - Risk-Informed Safety Margin Characterization
  - Advanced Instrumentation and Control Technologies
  - Test and deploy technologies reducing water consumption for nuclear and other energy systems

Extending operation of existing reactors will avoid ~12 billion metric tons CO₂ and provide enough electricity for 70 million homes during an additional 20 years of operations.
Next Generation Nuclear Plant

Building a next generation reactor in the US

- Addressing barriers to development of advanced reactor technology for process heat, electricity, and hydrogen
- Different industrial processes are best utilized with heat from high temperature gas reactors

NGNP will enable commercialization of High Temperature Gas-Cooled Reactor technology to provide process heat and electricity production
Advanced Fuel Cycle Development

Why close the fuel cycle?

- Resource extension to ensure sustainability
- Waste management to reduce radiotoxic threat
- Repository environmental effects, size, and regulation
- Opportunity for global materials management with favorable economics
- Focus on underlying science enables optimal solutions
Nuclear Energy for the Northwest?

• Columbia Generating Station pursuing 20-yr licensing extension (to 2043)

• New nuclear facilities presently under consideration in Idaho (site near Hammet for a plant, new enrichment facility in Idaho Falls); each facility generates ~ 500 high-salary permanent jobs for operation, plus ~ 2500+ construction jobs for ~ 5 year period

• Potential for deployment of small modular reactors

• Southeast of US likely to see “first-wave” of new construction, giving a gauge for success (in cost and schedule) for potential development in Northwest

• Public acceptance in Northwest likely very dependent upon addressing water issues, additional ratepayer costs, and carbon emission pricing