A Future of Nuclear Energy:

The Nuclear Renaissance, the Role of INL, and Potential in the Northwest

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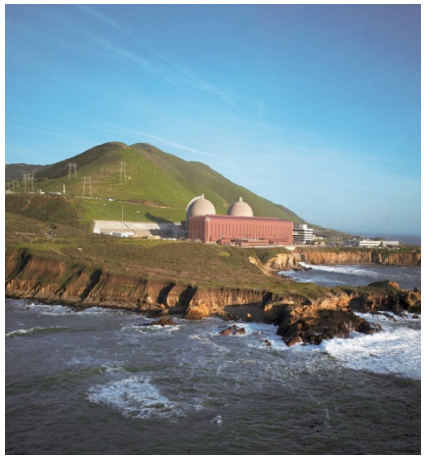
The Nuclear Renaissance: Factors Driving Renewed US Interest in Nuclear Energy

- *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

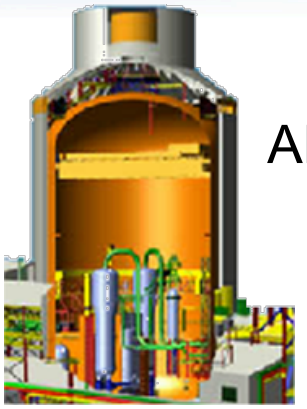
- *Baseload* power is necessary to meet electricity demand and nuclear and hydroelectric power are the only low-carbon options that serve this function
- Three decades of outstanding performance by any measure – safety, reliability, availability, and the lowest production costs
- Reactors are safe because 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 CO_2 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)

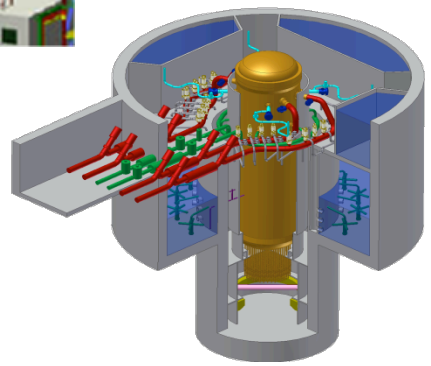
Designs competing for US market: Generation III+

- Standardized designs based on modularization producing shorter construction and licensing schedules
- Cost savings from modularization
- Passive or redundant systems to enhance safety

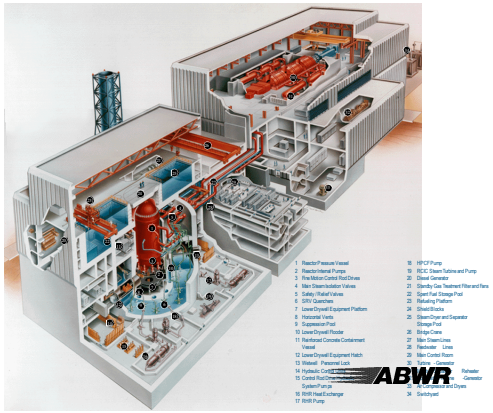


AP-1000

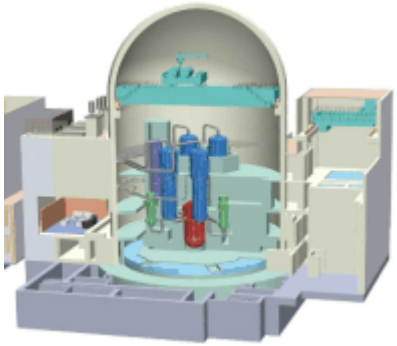
ESBWR



ABWR

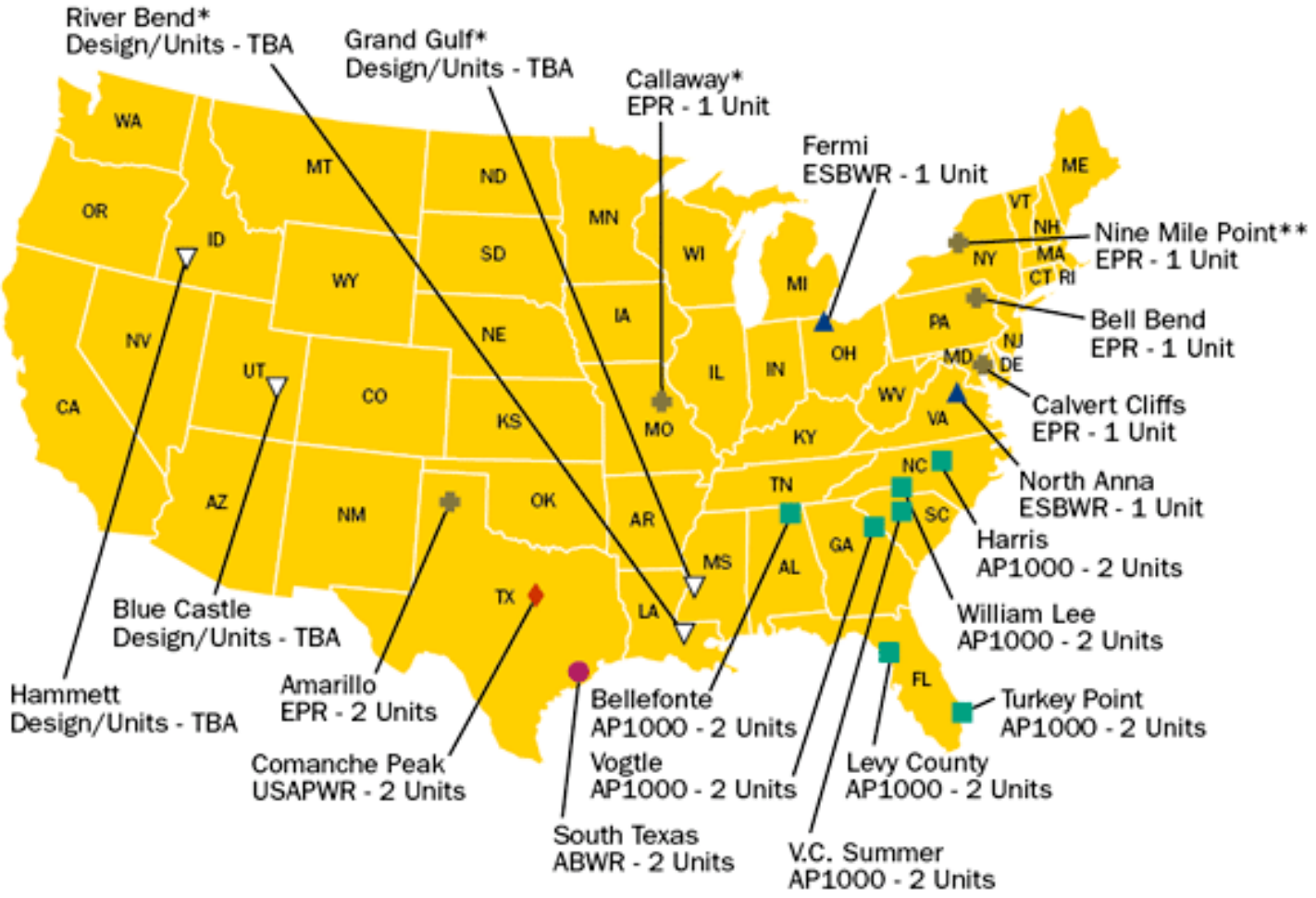


US APWR



EPR

Proposed locations for new nuclear plants



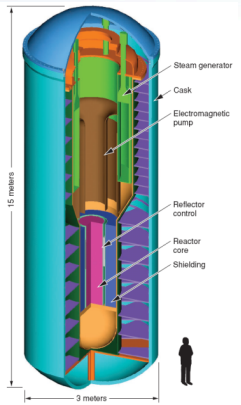
*Review Suspended

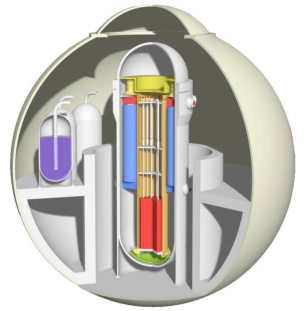
**Review Partially Suspended

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 < 500Me
- 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

	Capital Cost $/kW	LCOE ¢/kWh
MIT (2003)	2000–2500	5–6
University of Chicago (Aug 2004)	1853	5–8
Standard & Poor's (May 2007)	4000	9–10
Keystone Study (Jun 2007, updated)	3600–4000	9–14
Moody's (Oct 2007)	5000–6000	
California Energy Comm (Dec 2007)	2950	9–12

Nuclear Science and Technology at INL

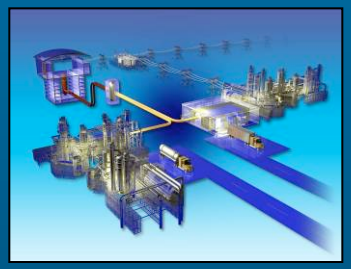
Focus Areas

Nuclear Reactors	Nuclear Safety	Advanced Nuclear Fuel	Nuclear Fuel Cycle	Radioisotope Power

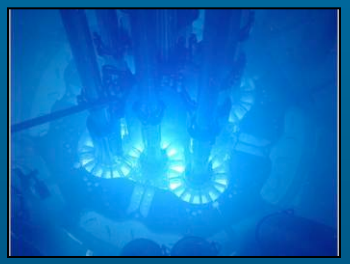
Major Programs and Facilities

LWR Sustainability

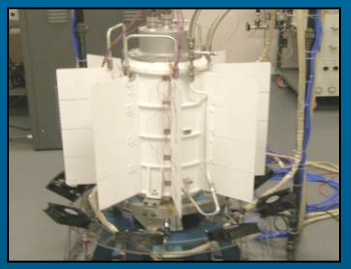
Advanced Fuel Cycle Development



Next Generation Nuclear Plant



ATR National Scientific User Facility



Space Nuclear Power Systems

Enabling Expertise

Human Factors, Instrumentation and Control

Advanced Modeling and Simulation

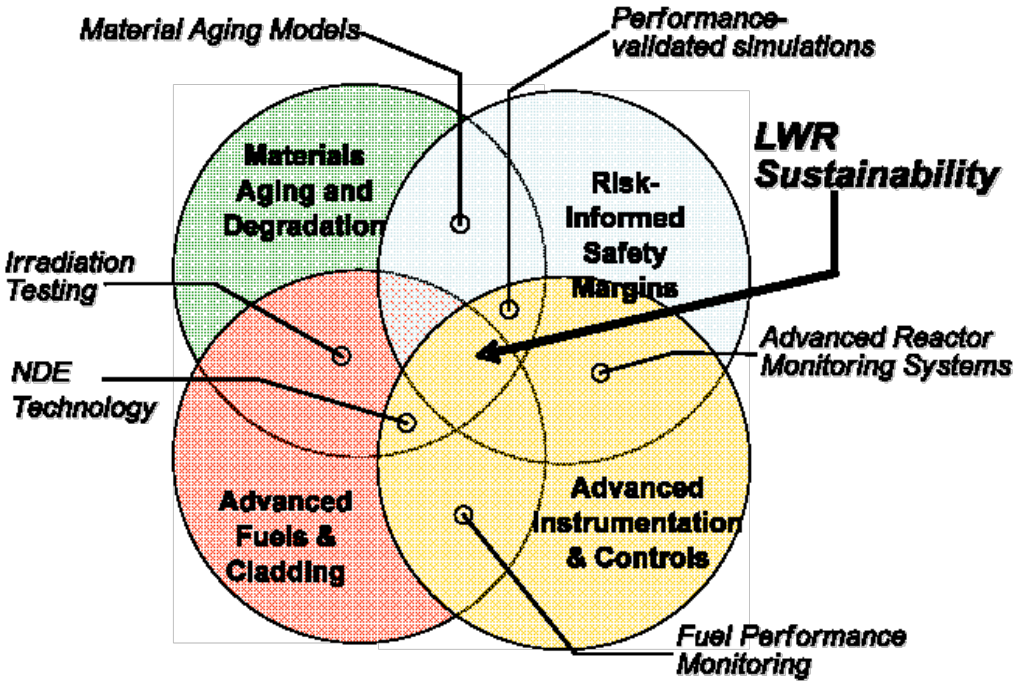
Nuclear Fuels and Materials

Hydrogen Production and Use

Light Water Reactor Sustainability

Continued reliance on existing US nuclear plants

- Present 60 year licenses means 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

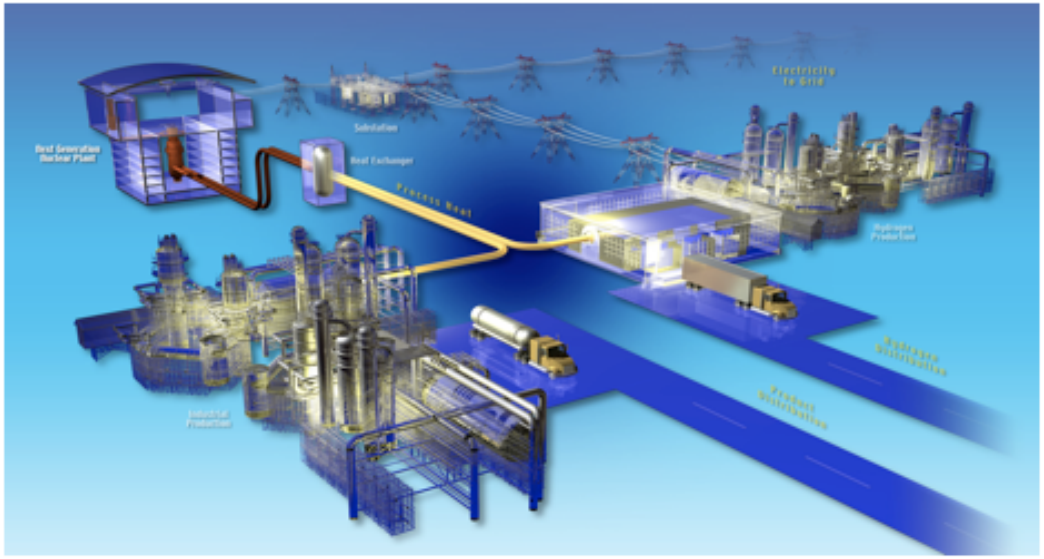


Extending operation of existing reactors will avoid ~12 billion metric tons CO_2 and provide enough electricity for 70 million homes during an additional 20 years of operations.

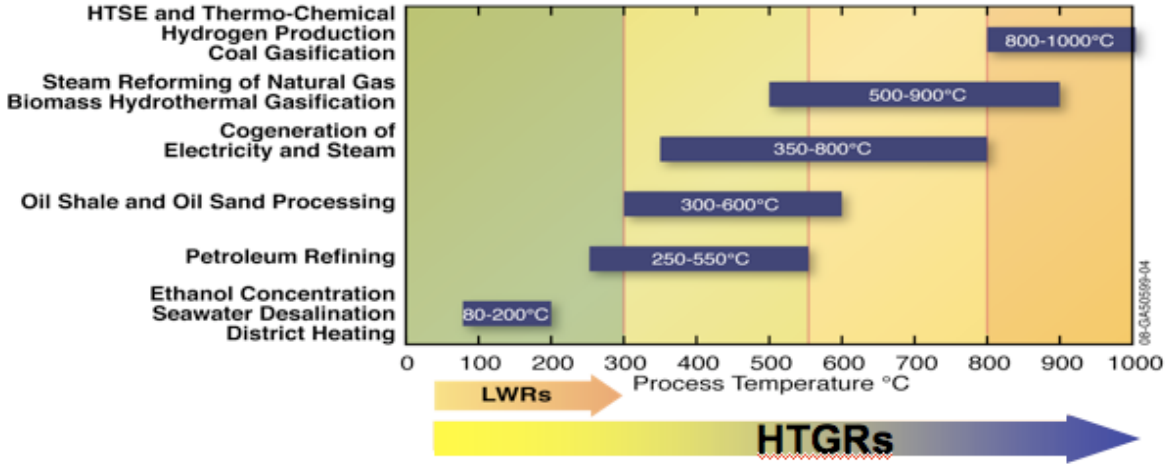
Next Generation Nuclear Plant

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



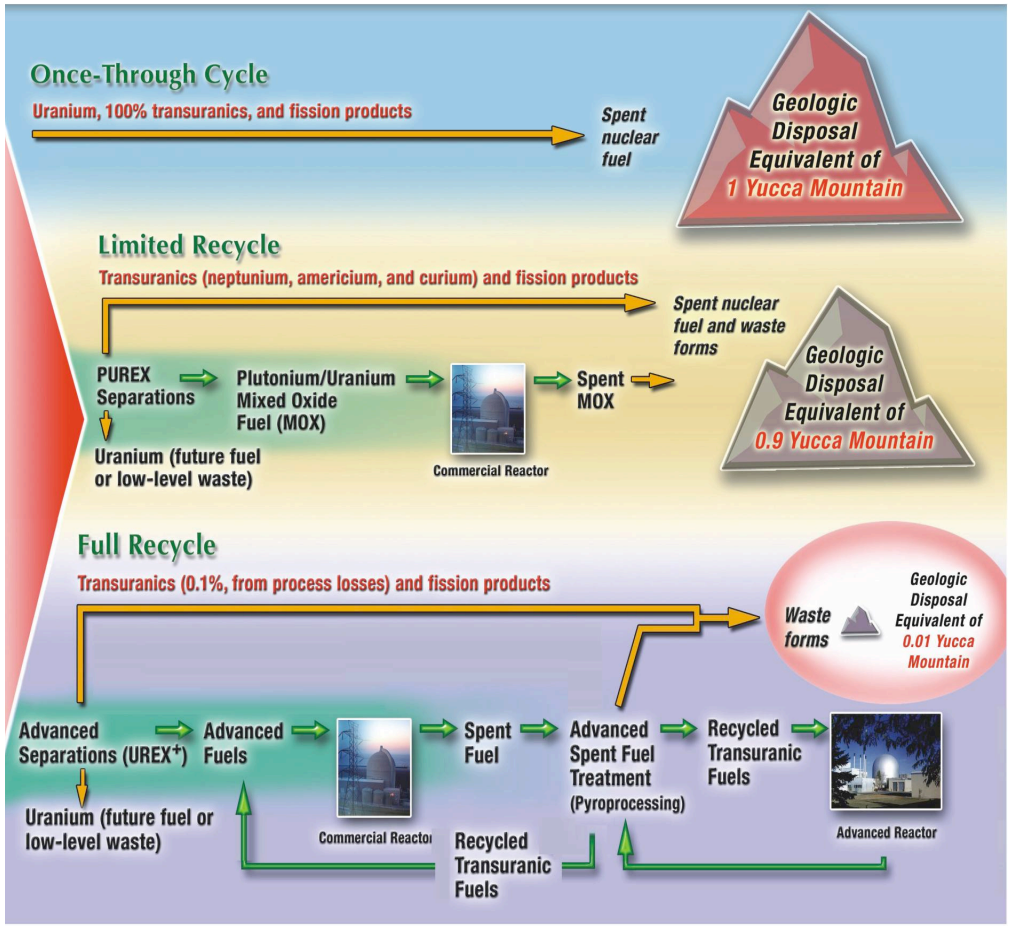
- **NGNP will enable commercialization of High Temperature Gas-Cooled Reactor technology to provide process heat and electricity production**



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