

Development of the Next Generation of Nuclear Energy Plants

**United States Energy Association
Washington, DC**

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Idaho National Laboratory***

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DOE's System of National Laboratories

Science and engineering capabilities to meet national and global challenges

National Labs do what industry and universities *can't, won't or shouldn't do*



INL — The National Nuclear Energy Laboratory

Idaho National Laboratory — Our Present

LABORATORY

Battelle
Laboratory Expertise



Nuclear Operations



the babcock & wilcox company

Infrastructure
Management



Washington Division

Industry Connection



National
University
Consortia

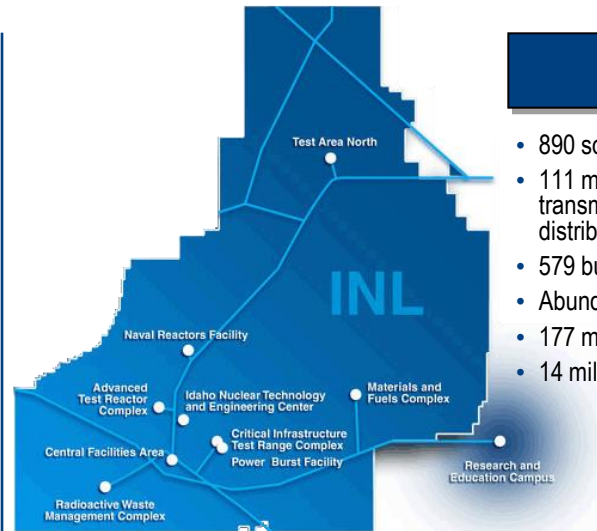


Massachusetts
Institute of
Technology



University of Idaho

SITE



- 890 square miles
- 111 miles of electrical transmission and distribution lines
- 579 buildings
- Abundant water
- 177 miles of paved roads
- 14 miles of railroad lines



Idaho National Laboratory

4300 Employees
Business Volume \$800M



1675 Employees
Business Volume \$365M

Naval Reactors
Facility

1450 Employees



850 Employees
Business Volume \$124M

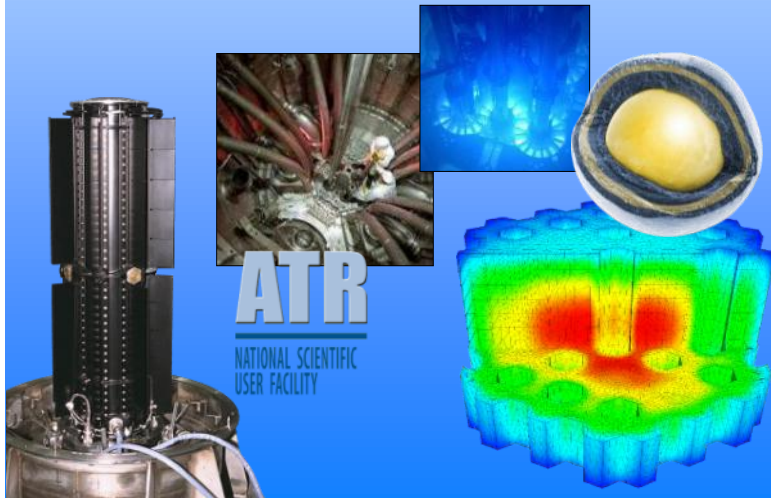
Idaho National Laboratory — The National Nuclear Energy Laboratory

Research Programs of National Importance

Nuclear Energy

- ▶ Fuel Cycle R&D
- ▶ Light Water Reactor Sustainability R&D
- ▶ Next Generation Nuclear Plant (NGNP)
- ▶ ATR National Scientific User Facility
- ▶ Space Nuclear

U.S. National Nuclear Energy Laboratory and an International leader



National & Homeland Security

- ▶ Supervisory Control and Data Acquisition (SCADA) Work
- ▶ Grid Reliability and Security
- ▶ Cyber Security
- ▶ Wireless Communications
- ▶ Nuclear Nonproliferation
- ▶ Armor, Explosive Blast Protection

A leader in critical infrastructure protection and homeland security



Energy & Environment

- ▶ Hybrid Energy Systems
- ▶ Clean Energy and Water
- ▶ Bio-fuels and Synfuels
- ▶ Battery Technology
- ▶ Non-traditional Hydrocarbon use

A leader in developing solutions to energy, resources and infrastructure challenges in the State, Region and Nation



Delivering technologies that benefit our communities, state, region and country

Nuclear Energy Today and in the Near Future



United States

- 20% of our electricity
- Number one source of emission-free electricity
- 104 reactors in operation
- 13 license applications for 22 reactors currently under review by the NRC



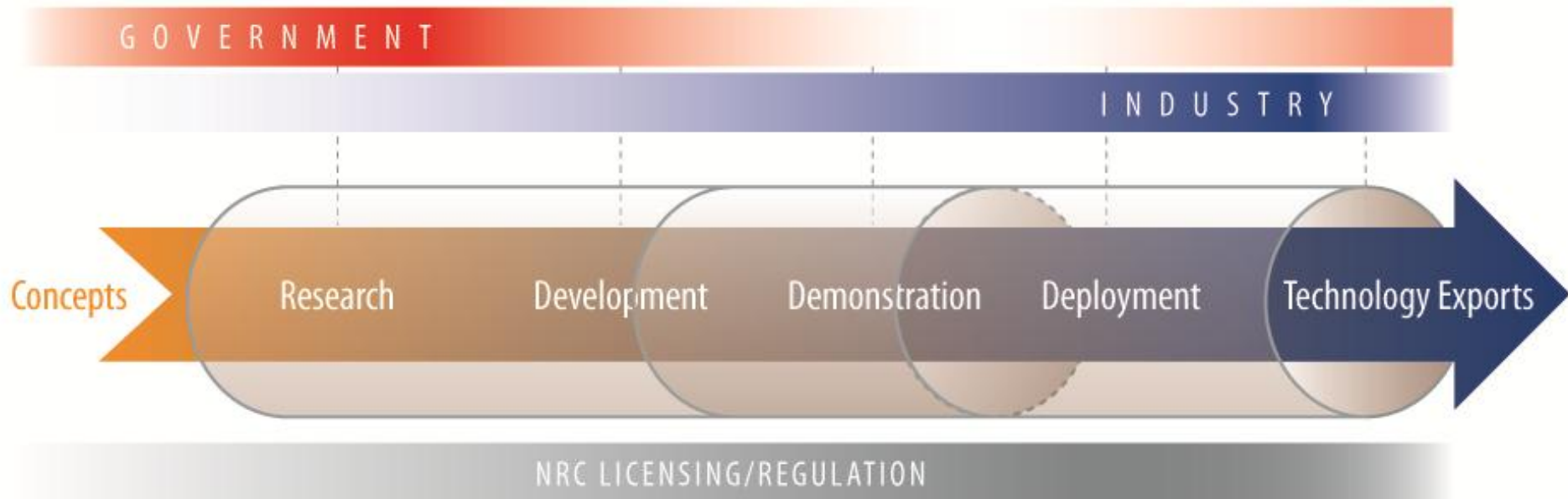
International

- 16 countries rely on nuclear to supply at least one-quarter of their total electricity
- 333 reactors in operation outside the U.S.



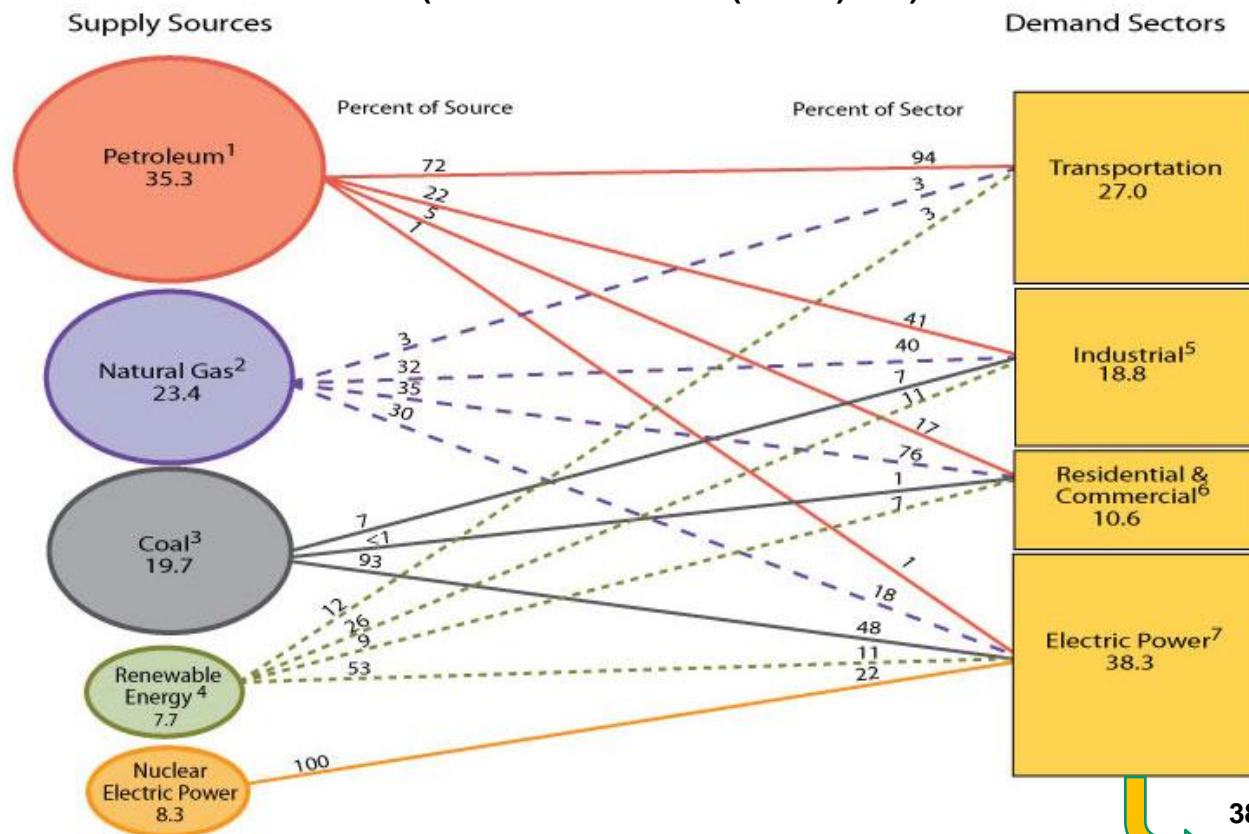
437 reactors in 30 countries generating 15% of the world's electricity — 55 new reactors under construction worldwide

Innovations in Nuclear Energy Technology

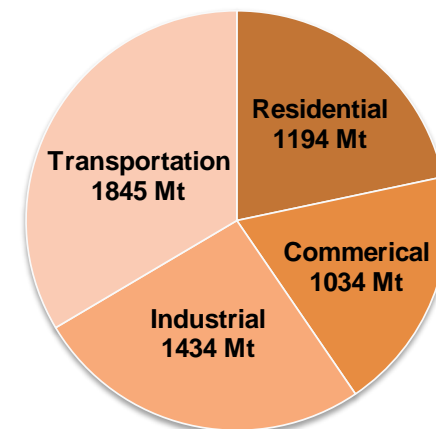


Energy Production and Consumption in U.S.

U.S. Primary Energy Flow by Source and Sector, 2009 (Quad -- Quadrillion (1x10¹⁵) Btu)



U.S. Greenhouse Gas Emissions by Sector, 2009 (Million metric tons, CO₂ equivalent AEO 2010, May 2010)



5507 Mt Total

**38% to Residential
37% to Commercial
25% to Industrial
<1% to Transportation**

¹Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."

²Excludes supplemental gaseous fuels.

³Includes less than 0.1 quadrillion Btu of coal coke net exports.

⁴Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.

⁵Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.

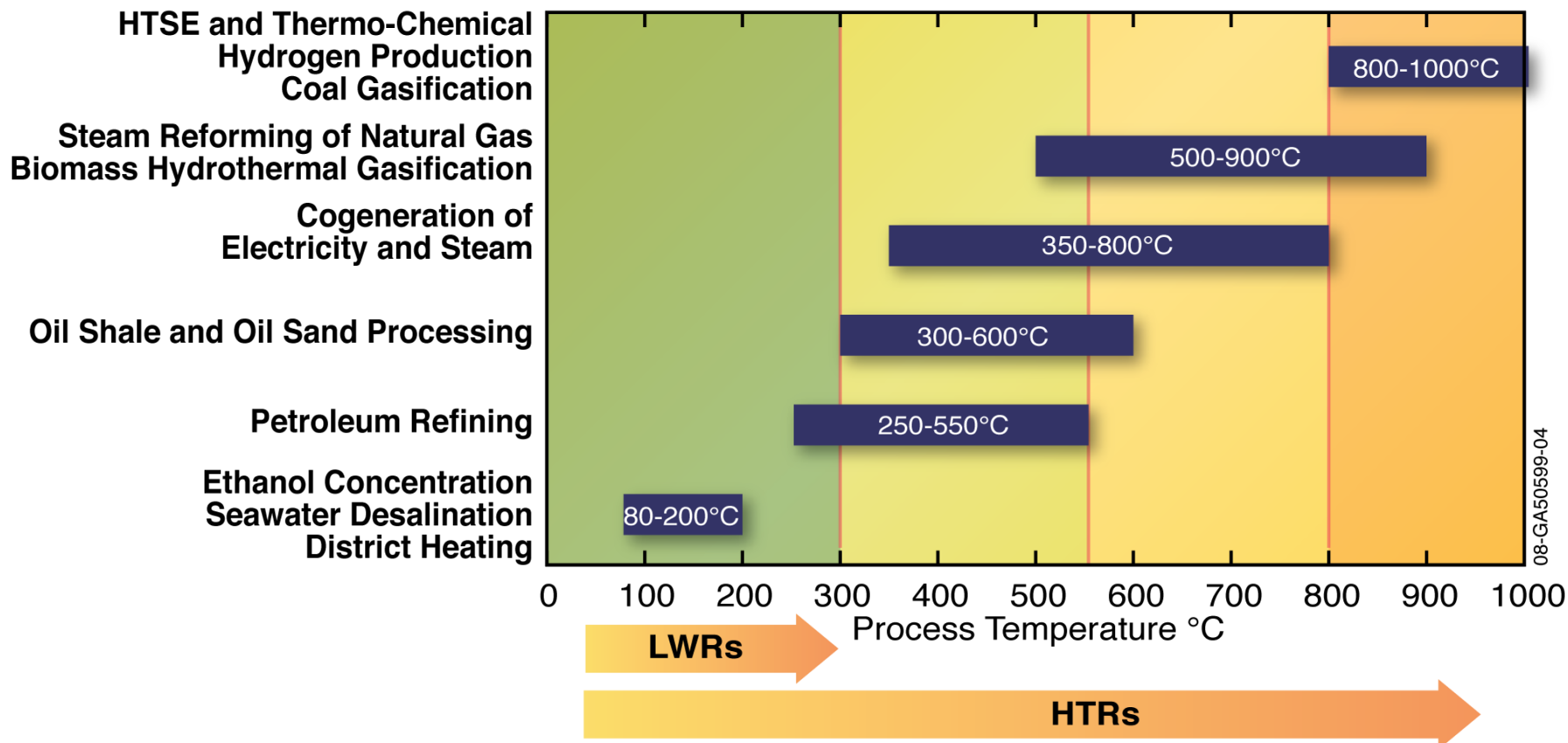
⁶Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.

⁷Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal total due to independent rounding.

Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Tables 1.3, 2.1b-2.1f, 10.3, and 10.4.

Innovation in Nuclear Energy – Beyond Electricity – Applications of HTRs



High Temperature Reactors can provide energy production that supports the spectrum of industrial applications including the petrochemical and petroleum industries

The Opportunity — Integrating Nuclear High Temperature Process Heat with Industrial Applications

Existing Plants – Assuming 25% penetration of process heat & power market - - 2.7 quads*



Fertilizers/Ammonia
(23 plants in U.S.—NH₃ production)

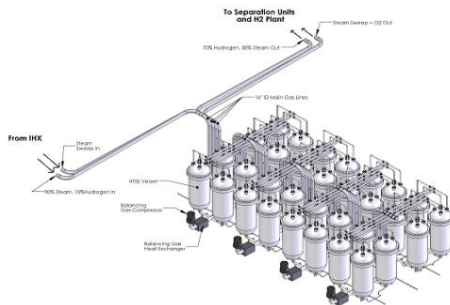


Petrochemical
(170 plants in U.S.)



Petroleum Refining
(137 plants in U.S.)

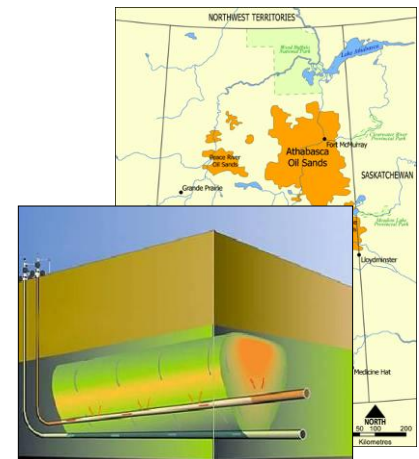
Growing and New Markets – Potential for 9.3 quads of HTGR Process Heat & Power



Hydrogen Production



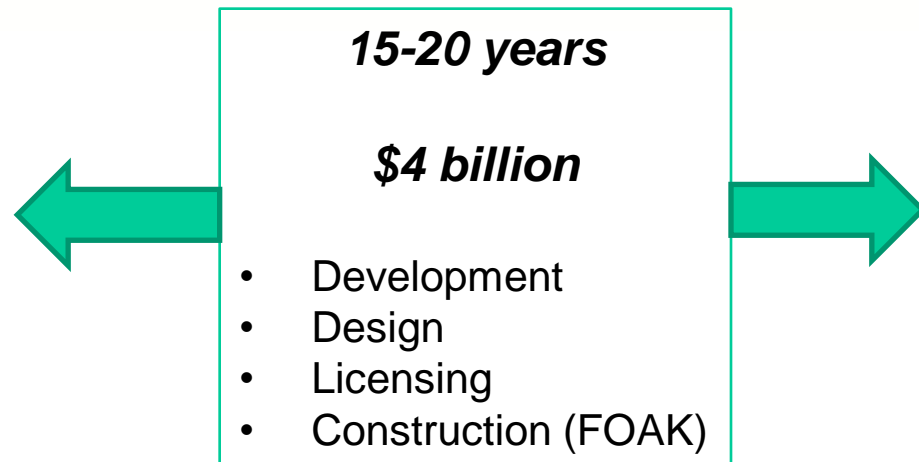
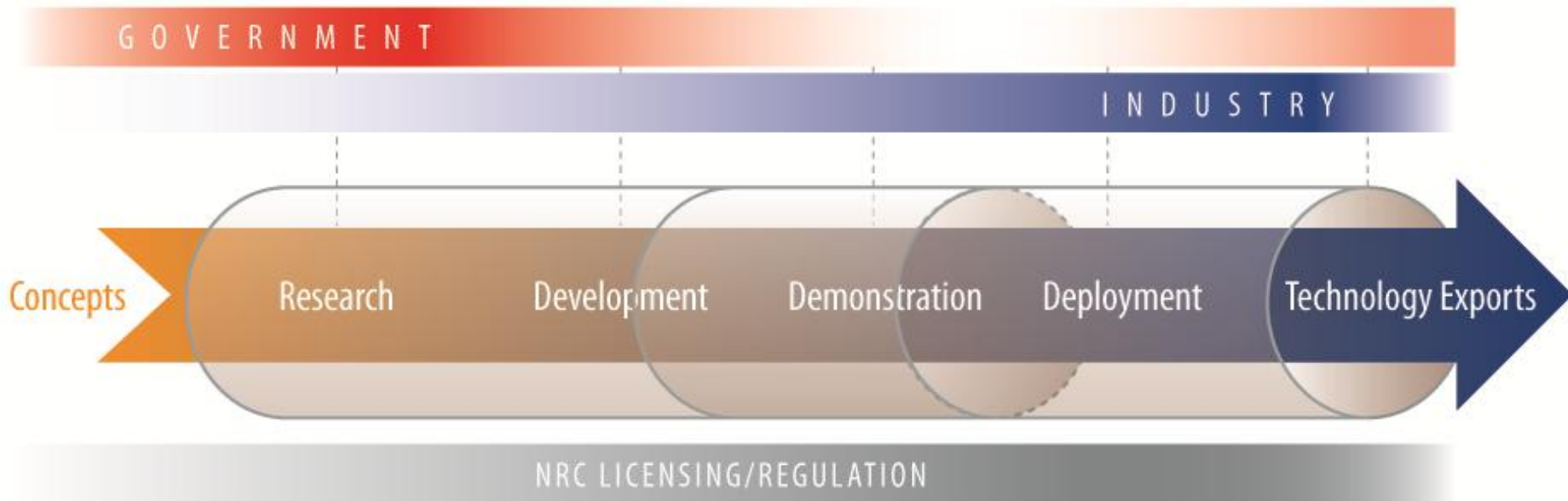
Coal-to-Liquids (24 – 100,000 bpd new plants)



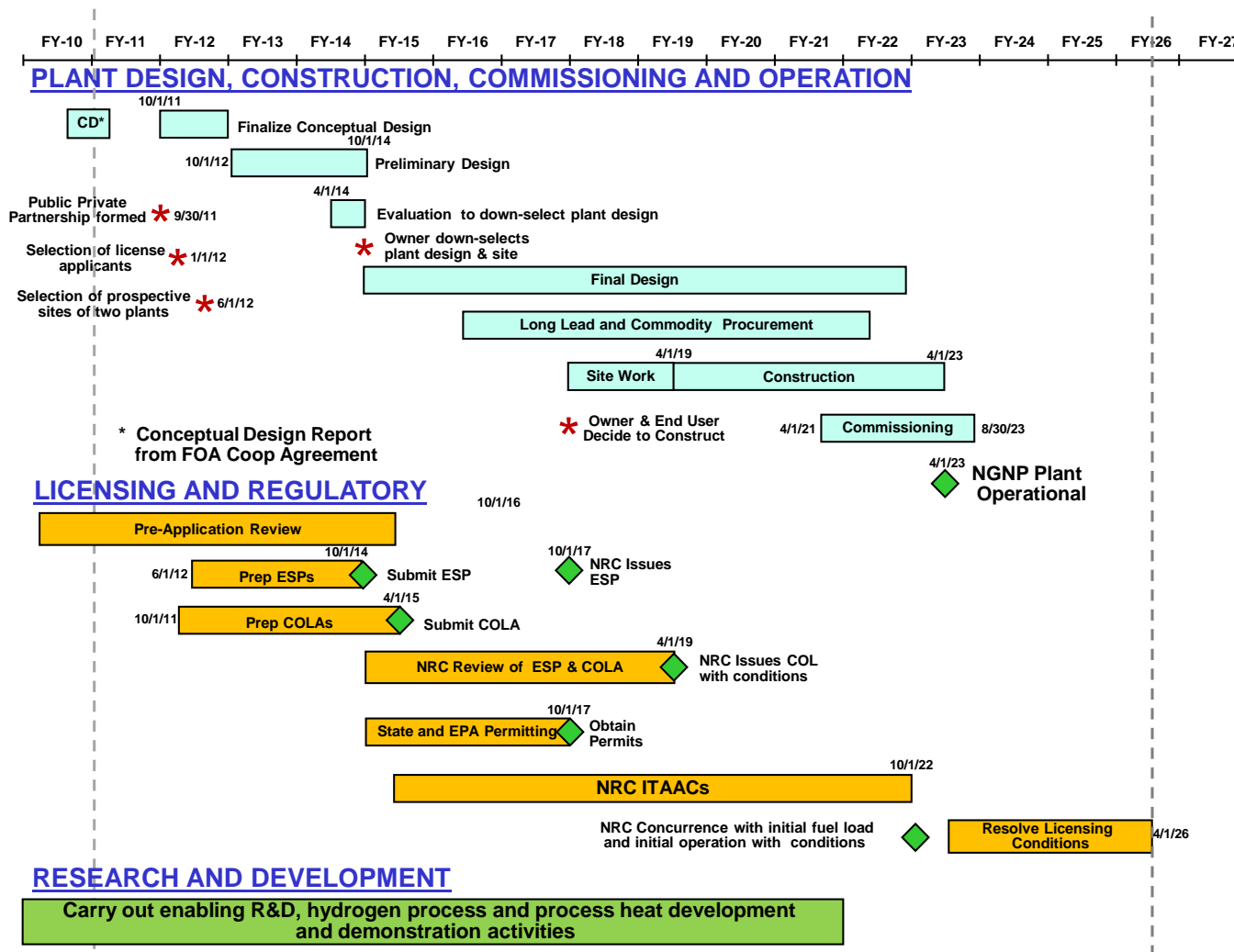
Oil Sands/Shale

* Quad = 1×10^{15} Btu (293×10^6 MW_{th}) annual energy consumption

Developing and Deploying the High Temperature Gas-Cooled Reactor



Development Initial Deployment



Meeting America's Energy Challenge — Context

- **Infrastructures for production and distribution of large amounts of energy are expensive and time consuming to change.**
- **Today advocates for particular technologies often overstate the benefits and understate the costs. Opponents of particular technologies do the opposite.**
- **Lack of coherent national energy policies and complementary industry strategies has led to considerable uncertainties regarding energy infrastructure investment**
- **Policy and business decisions have led to the U.S. Government and industry no longer being the leaders in developing, demonstrating and deploying nuclear energy technology. A concerted effort is needed to reverse this course.**



Innovations in Nuclear Energy

- **Essential to realizing clean, affordable and reliable energy production**
- **Expensive and require a long term commitment**
- **Government and industry must partner to achieve substantive innovation in nuclear energy**



A Multi-Decade Nuclear Energy Strategy – the Obligations

- **Nuclear energy development and deployment involves a complex and intimate relationship between government and industry.**
- **Industry's obligations**
 - Make well-considered investments in energy production and use
 - Support technology development that ensures the long term future for nuclear energy and other energy technologies
- **Government's obligations**
 - Stabilize energy policy to allow rational long-term energy-related business decisions
 - Assist industry in making considerable investments required to construct new nuclear energy facilities
 - Share financial risk with industry to develop and license advances in nuclear energy technology that support the national interests



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