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Idaho National Engineering and Environmental Laboratory

Nuclear Energy's Role in Responding to the Energy Challenges of the 21st Century

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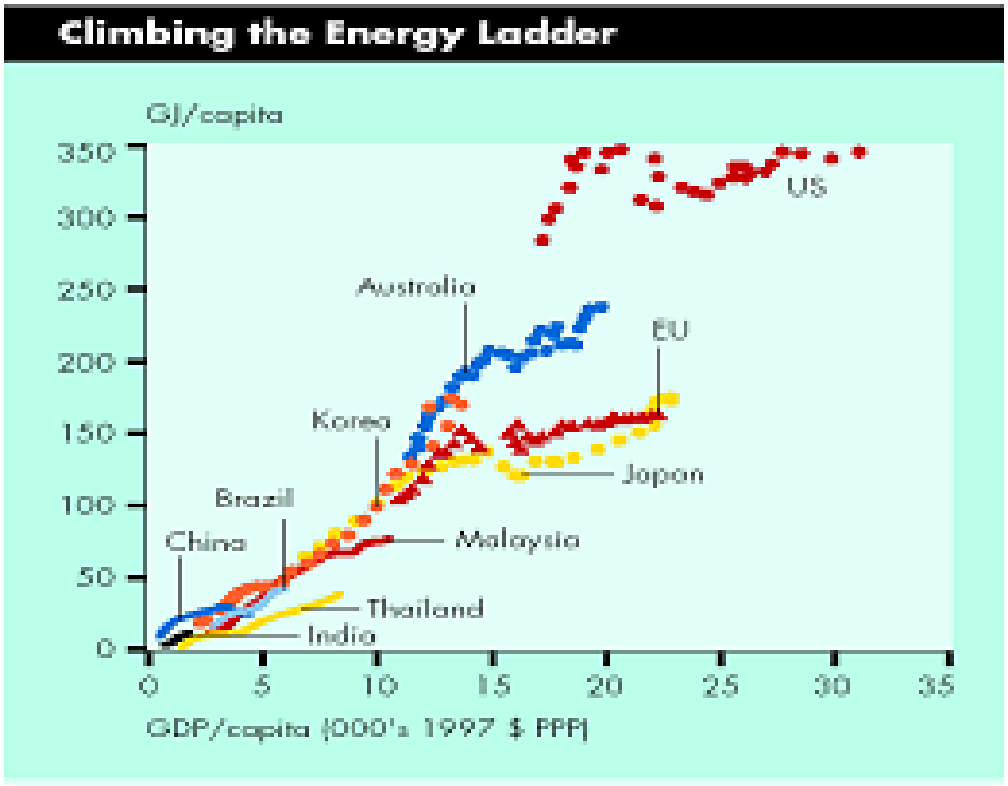
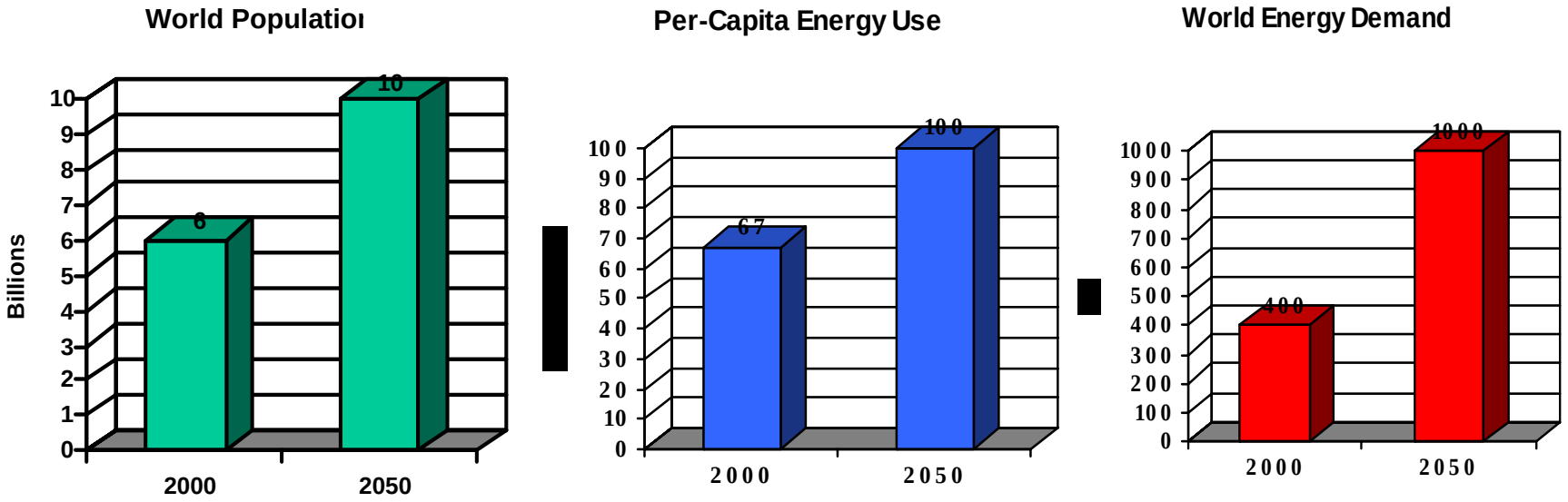
Energy is the Fuel of National Prosperity



Source: Royal Dutch Shell, "Exploring the Future - Energy Needs, Choices and Possibilities

World Energy Demand is Forecast to Grow Substantially in the First Half of the 21st Century

- *As Population Grows and Developing Countries Attempt to Increase Their Standard of Living. . . . .*



- *. . . We Will Face Increasing Competition For Limited Energy Resources*
- *The Impact on Energy Supply Stability May Be Great*

Notes: Present U.S. energy use - 300 GJ/person; developing world avg.. ~20 GJ/person

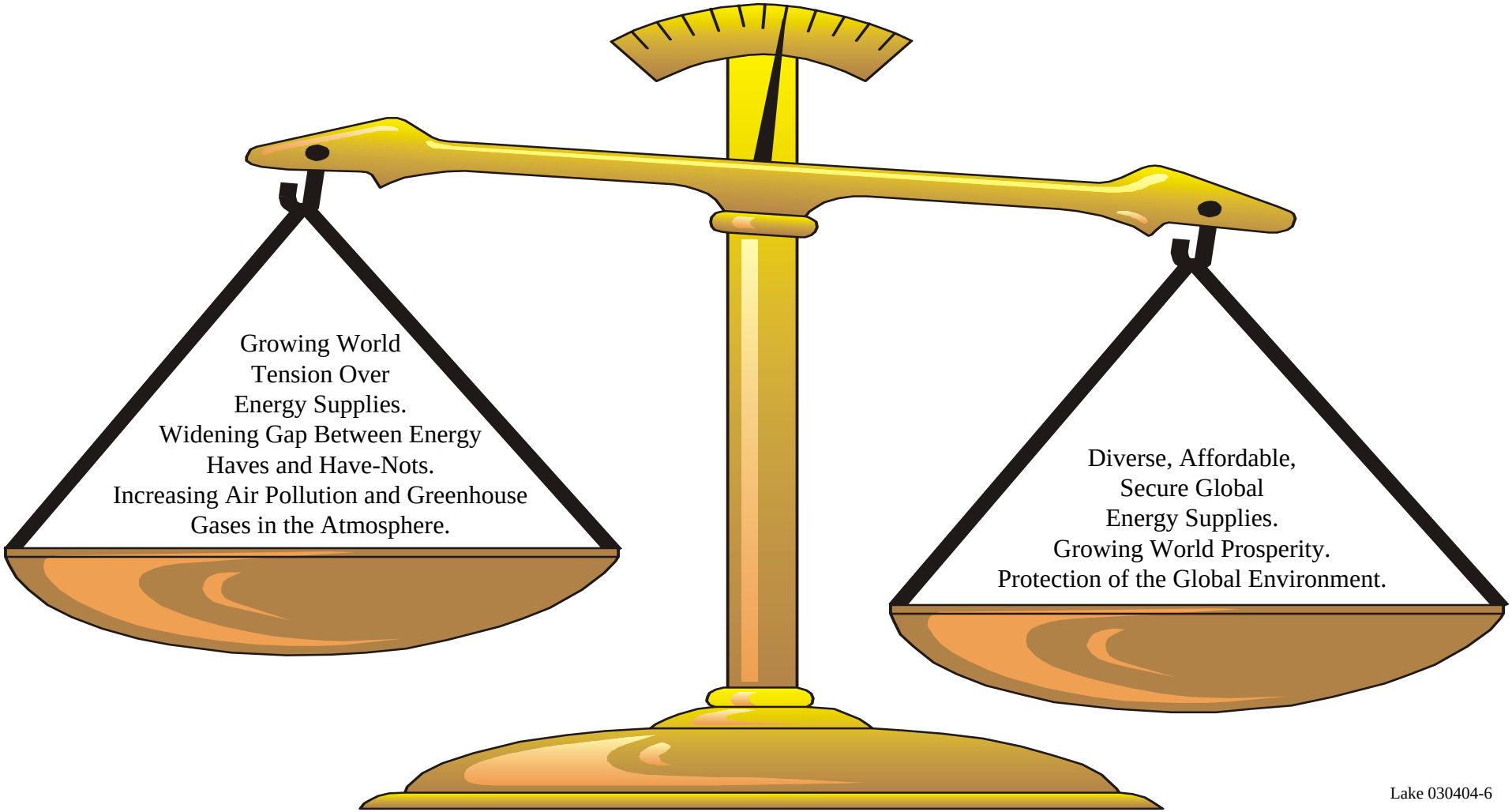
Energy Choices and Energy Challenges

- *Fossil Fuels (Coal, Oil, Natural Gas) Supply More Than 85 % of US Energy*
  - *Air Pollution and Greenhouse Gas Emissions*
  - *Natural Gas Prices 2-3X Higher Than in the 1990s*
  - *Growing US Reliance on Imported Oil and Gas*
  - *Security of Supplies and Impact on the US Economy*
- *Hydropower Supplies 6% of US Electricity*
  - *Available Resources are Already Used so Growth Potential is Limited*
  - *Growing Environmental Concerns*
- *Renewable Energy (Wind, Solar, Biofuels)*
  - *Very High Cost*
  - *Infrastructure Issues (High Land Use, Intermittent Generation, Energy Storage Requirements)*
- *Nuclear Power Supplies 20% of US Electricity*
  - *High Capital Cost*
  - *Public Perceptions of Safety*
  - *Substainability (Fuel Supply and Nuclear Waste Management)*
  - *Proliferation Resistance and Physical Protection*

Energy Security and Environmental Quality are Strong Drivers for Increased Use of Nuclear Energy

- *Economic Growth and Prosperity are Tied to Abundant, Affordable, and Secure Energy Supplies*
- *Preservation of the Environment and Avoidance of Adverse Human Health Impacts Increasingly Demand Clean Energy Supplies*
- *Depleting Fossil Fuel Supplies and Rising Fossil Energy Prices Motivate Nations Toward Energy Supply Diversity*
- *U.S. Must:*
  - *Reduce Reliance on Foreign Oil Supplies in the Transportation Sector*
  - *Avoid Becoming too Reliant on Foreign Gas in the Heating Sector*
  - *Maintain Diversity of Supply in the Electricity Sector*
- *The Major World Economies in the U.S., Europe, and Asia Have a Responsibility to Lead in the Development and Deployment of Sustainable, Secure, and Clean Energy Supplies (. . .Nuclear Energy)*

What will be the Legacy of United States Energy Leadership?



The National Energy Policy Recommends:

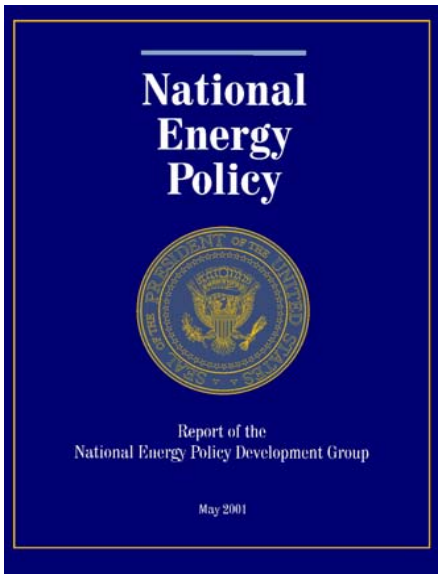
"The expansion of nuclear energy in the U.S.", and to

"Develop the next generation technology – including hydrogen," and that

"The U.S. should consider technologies…to develop reprocessing and fuel treatment…that are cleaner, more efficient, less waste-intensive, and more proliferation-resistant"

– Vice President Cheney, and the Secretaries of State, Energy, Transportation, Interior, Commerce, Treasury and Agriculture, and heads of EPA and OMB, among others

May 2001

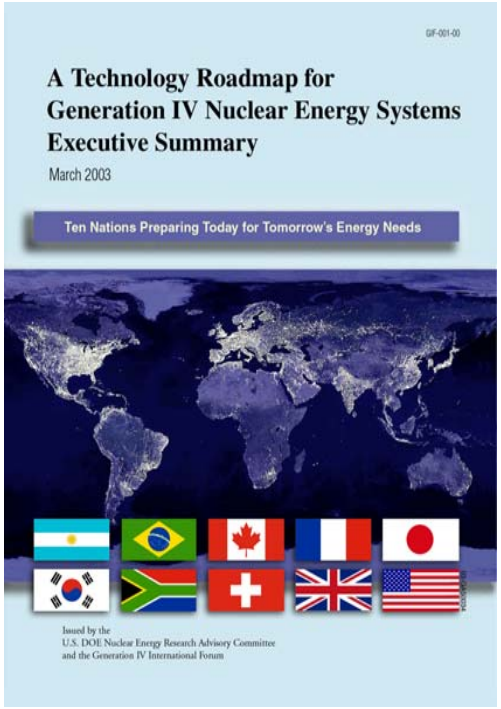


http://energy.gov/HQPress/releases01/maypr/national_energy_policy.pdf

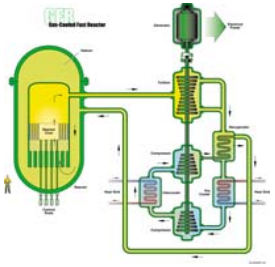
Generation IV Technology Goals

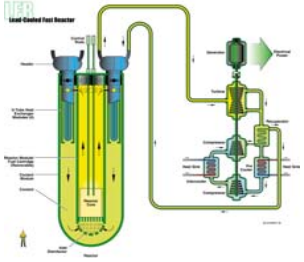
- Generation IV Program Goals are Aimed at Developing Advanced Nuclear Systems that are Deployable by 2030 or Earlier and:
  - Have Adequate Fuel Resources and Reserves for Many Years and a Sustainable Fuel Cycle
  - Are Economically Competitive With Other Energy Alternatives
  - Are Even Safer and More Reliable Than Current Technology
  - Are Exceptionally Proliferation Resistant and Have Additional Protection Against External Threats

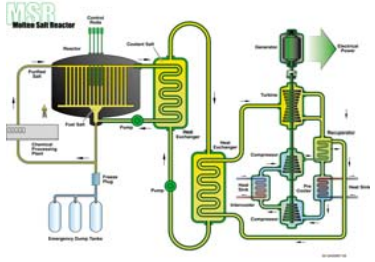
March 2003

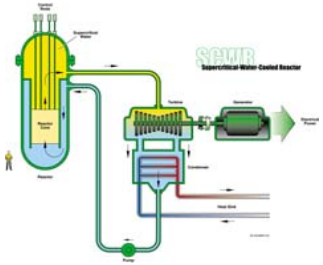


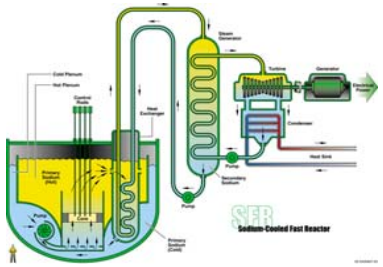
http://gif.inel.gov/roadmap

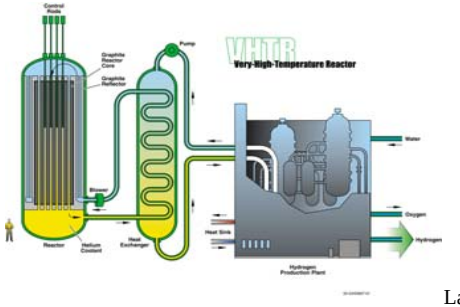






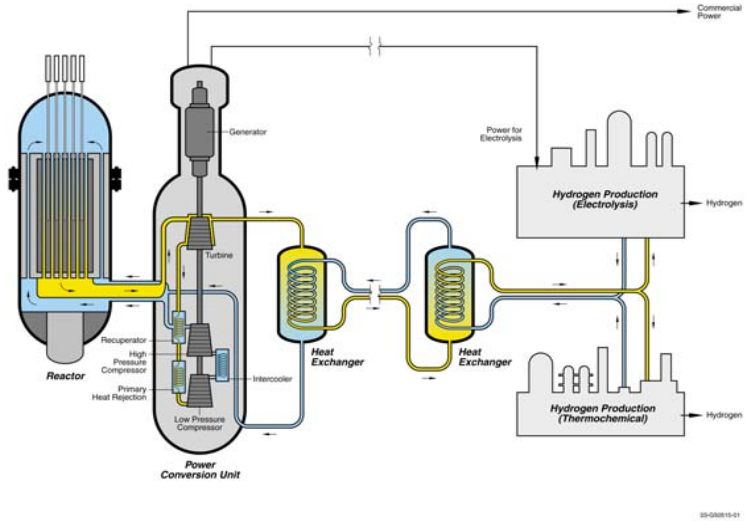






The Very-High-Temperature Reactor Illustrates the Approach to Achieving the Generation IV Goals

- Greatly Simplified Modular Design Lowers Capital Cost
- High Outlet Temperature Improves Thermal Efficiency
- Hydrogen Production Potential Opens New Markets
- Strong High Temperature Graphite-Ceramic Core Materials Improve Safety
- Passively Safe to Loss of Coolant Accident
- Efficient Plutonium "Burner"
- Deep-Burn, Once-Through Fuel Cycle with Graphite-Ceramic Fuel is Highly Proliferation Resistant
- Below-Grade Siting Improves Physical Protection Against External Forces



- 150-300 MWe Modular Design
- High-Temperature Graphite Core
- Strong Graphite-Ceramic Coated-Particle Fuel
- 1000°C Helium Coolant Outlet Temperature

Advanced Fuel Cycle Goals

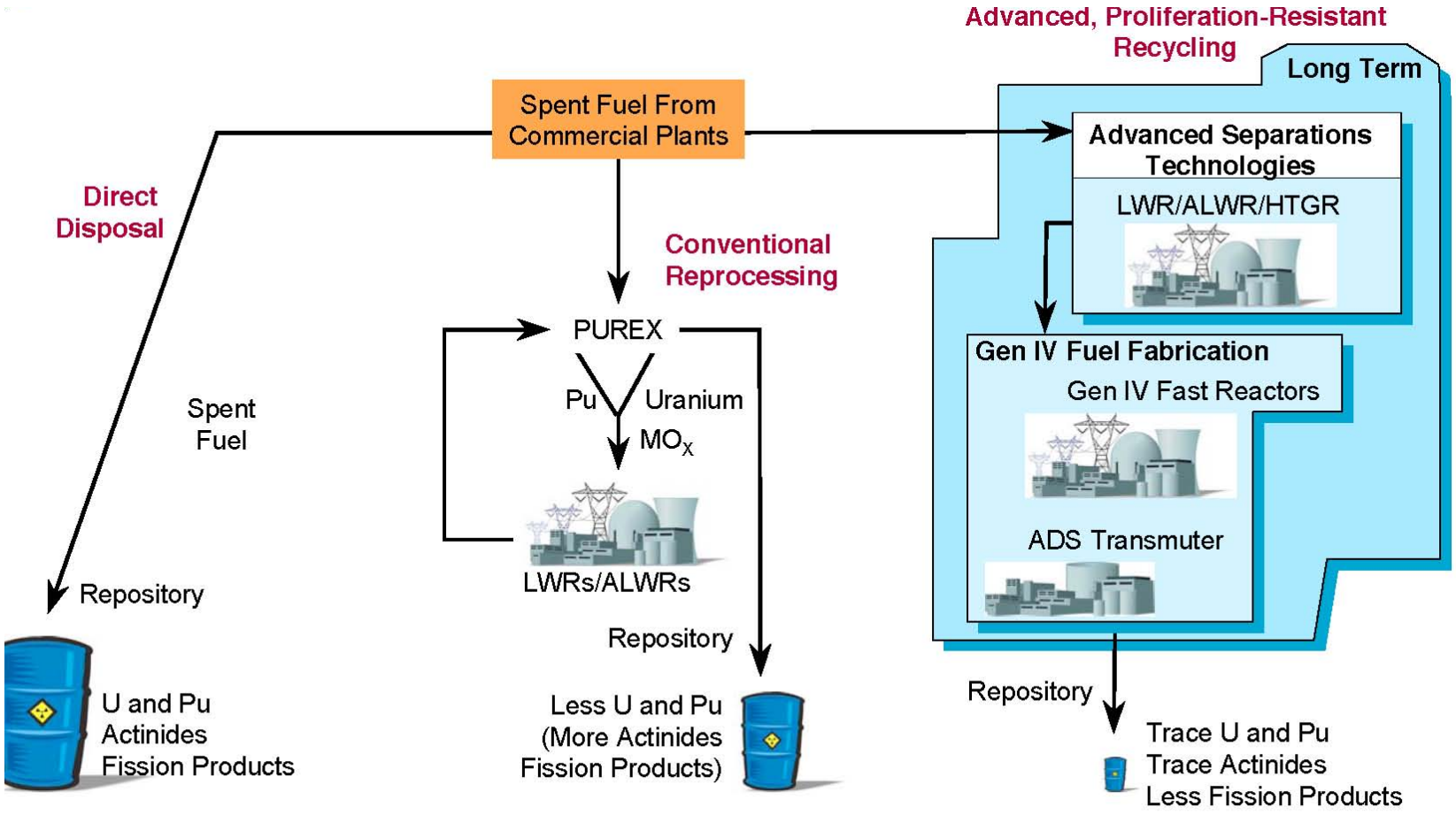
The goal of the DOE NE AFCI is to develop fuel cycle technology that:

- Enables recovery of the energy value from commercial spent nuclear fuel,
- Reduces the cost of geologic disposal of commercial spent nuclear fuel,
- Reduces the inventories of civilian plutonium in the U.S.,
- Reduces the toxicity and lifetime of high-level nuclear waste bound for geologic disposal, and
- Enables more effective use of the currently proposed geologic repository so that it will serve the needs of the U.S. through the 21st century

January 2003

http://www.nuclear.gov/AFCI_RptCong2003.pdf

Advanced Fuel Cycle

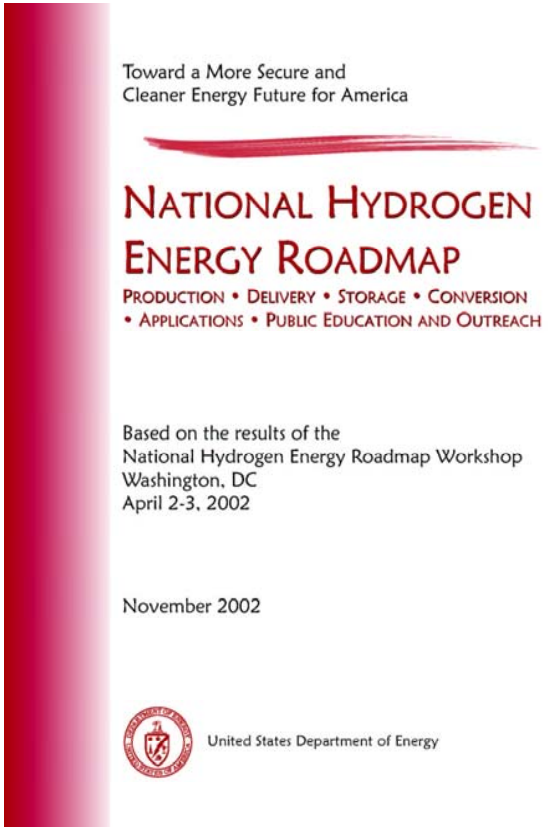


Hydrogen is the key to energy security

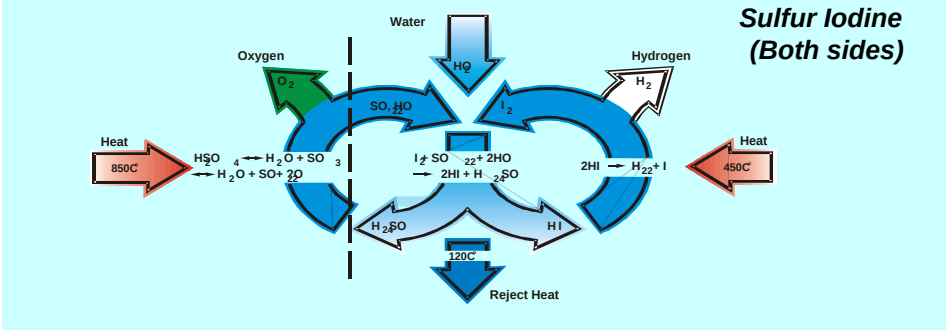
President Bush's Freedom Fuel Initiative *"with a new national commitment, our scientists and engineers, will overcome obstacles to taking these [fuel cell] cars from laboratory to showroom, so that the first car driven by a child born today could be powered by hydrogen and pollution-free"*

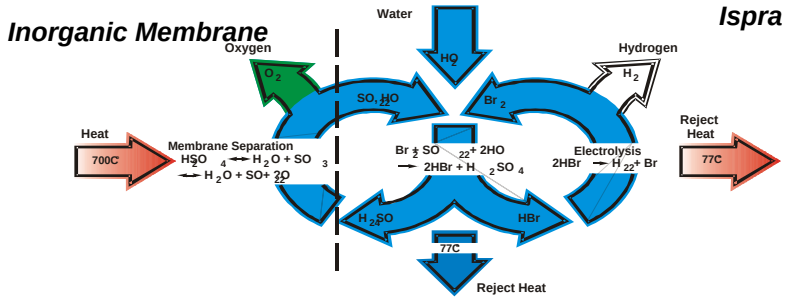
George W. Bush, State of the Union Speech, January 2003

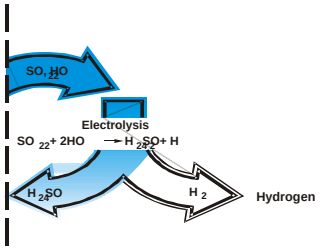
- Displaces imported oil
- Emissions-Free Transportation Fuel
- National Hydrogen Energy Roadmap identifies major hydrogen production technologies
  - Steam Reforming of Natural Gas (with Carbon Sequestration)
  - Water "Cracking" using Nuclear Heat
    - Thermochemical
    - Thermoelectrical
  - Coal Gasification (with Carbon Sequestration)
  - Other Renewables and Bioproducts

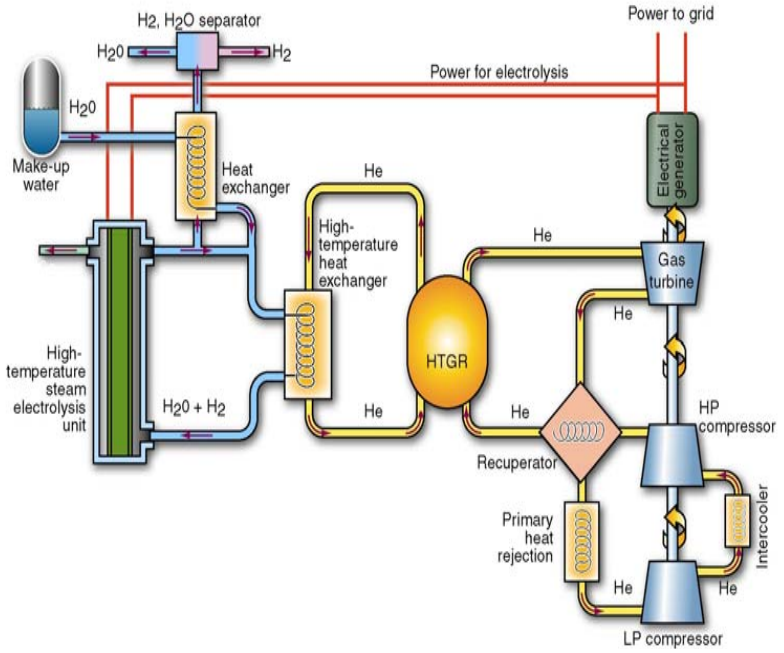


Nuclear Hydrogen Production Technologies









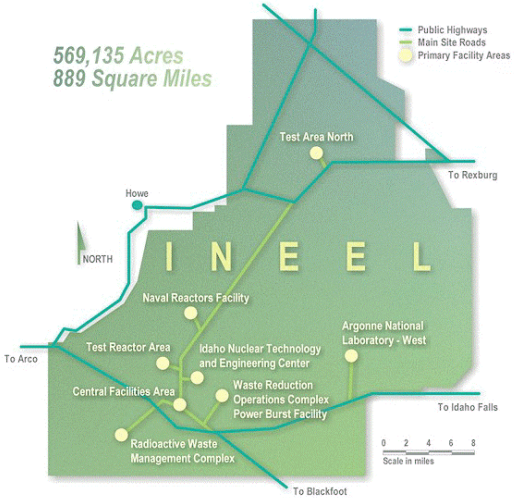
Thermo-Chemical Water Splitting

High Temperature Electrolysis

Designation of INEEL as a DOE NE LAB

"First, INEEL will be the central command center for the federal government's Generation IV nuclear systems research."

Second, an "Idaho Advanced Fuel Cycle Technology Initiative will be the focal point for developing and demonstrating separation technologies for treating and reducing spent nuclear fuel and high level waste."

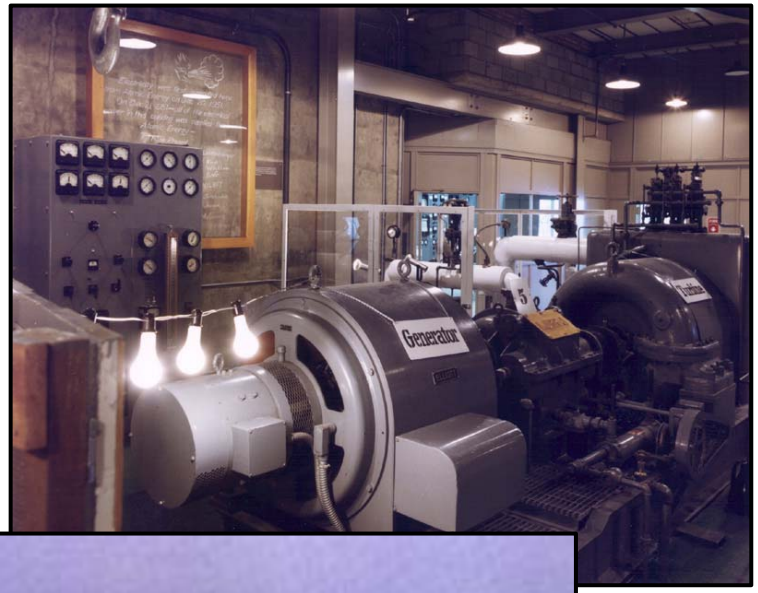


– Spencer Abraham

July 15, 2002

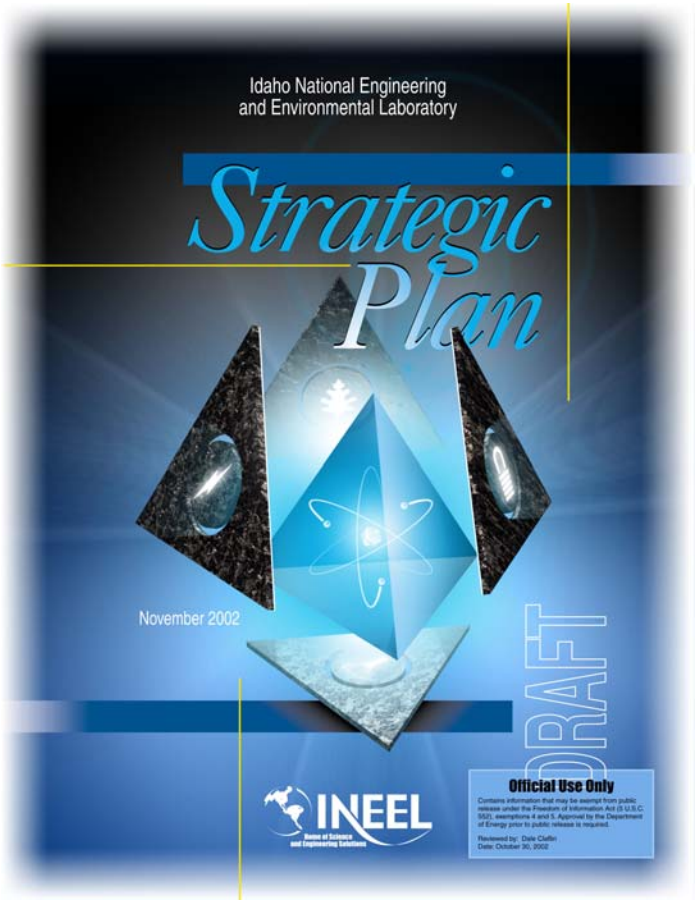
A Proud Heritage of Nuclear Excellence

- World's First Generation of Electricity from Nuclear Power
- First Materials Test Reactor
- First Breeder Reactor
- First Naval Propulsion Reactor
- 52 Research, Development, Testing, and Demonstration Reactors
- Worldwide Nuclear Safety Basis (LOFT/RELAP5)



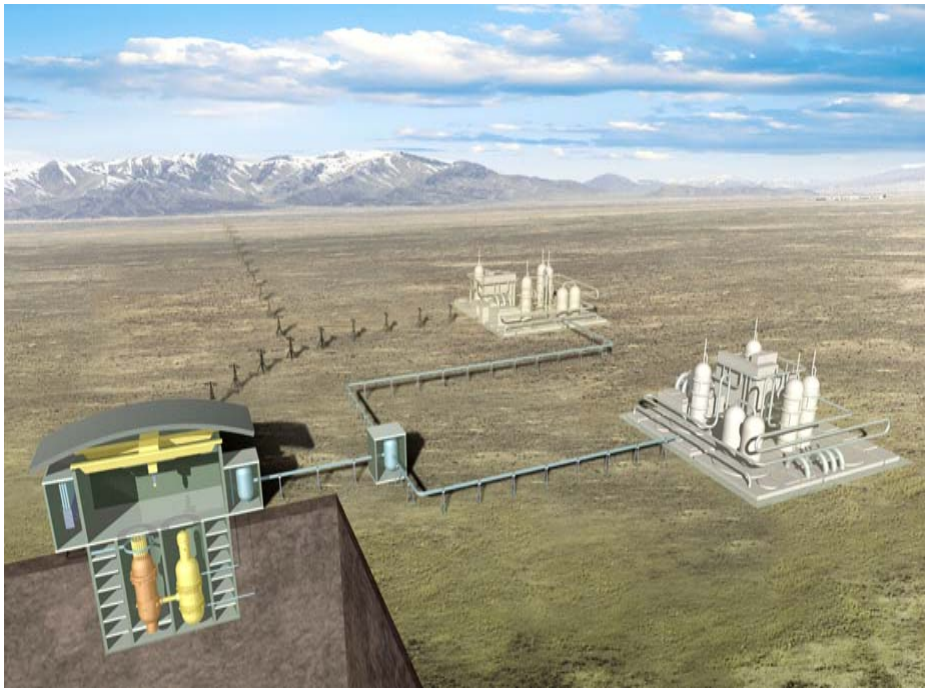
The INEEL Strategic Vision is to be the leading contributor to our Nation's Energy Security and Environmental Quality by developing advanced, sustainable, safe and economic nuclear energy and fuel cycle technologies

- *Leadership of the Generation IV Advanced Reactor Systems R&D*
  - *Systems Analysis and Integration*
  - *Very High Temperature Reactor*
  - *Gas-Cooled Fast Reactor*
  - *Supercritical Water-Cooled Reactor*
- *Advanced Fuel Cycle Systems Analysis, Separations R&D and Engineering Demonstration*
- *Advanced Fuel Development and Irradiation Testing in the Advanced Test Reactor*
- *Leadership and Host Site for the Advanced Reactor Hydrogen Co-Generation Demonstration (NGNP)*
- *System Ground Test for the Nuclear Space Initiative*
- *Fast Neutron Research Reactor*



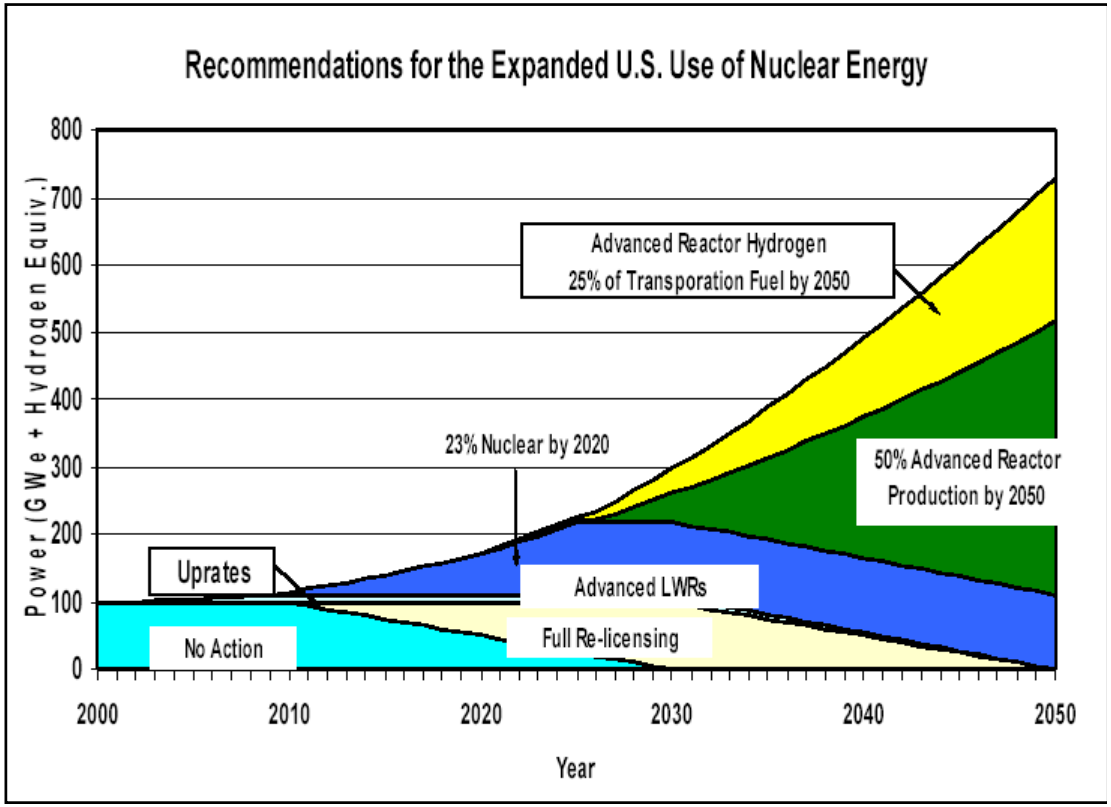
The Next Generation Nuclear Plant is the Leading Generation IV Technology for Near-Term Demonstration in Idaho

- NGNP Mission is High-Efficiency Electricity and Hydrogen Production
  - Improved Economics
    - Reduced Capital Cost
    - Expanded Product Markets
  - Naturally Safe/High Temperature Capability
  - Sustainable
    - Energy Security and Zero Emissions
    - Plutonium Burnup Capability
    - Deep-Burn or Closed Fuel Cycle
  - Secure and Robust



The Potential for Nuclear Energy in the First Half of the 21st Century is Tremendous

- 50% of U.S. electricity produced by nuclear power by 2050
- 25% of U.S. transportation fuel produced by nuclear energy (nuclear-produced hydrogen) by 2050
- Demonstrate a closed fuel cycle system by 2020
- Demonstrate a global nuclear energy system consisting of intrinsic and extrinsic safeguards that reduces proliferation risk.



ARGONNE NATIONAL LABORATORY

Lawrence Livermore National Laboratory

INEEL Idaho National Engineering and Environmental Laboratory

Los Alamos NATIONAL LABORATORY

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Sandia National Laboratories

Nuclear Energy has an opportunity to contribute to a more secure and prosperous tomorrow