

U.S. Energy Perspective

Global 2011 — Tsuruga Session



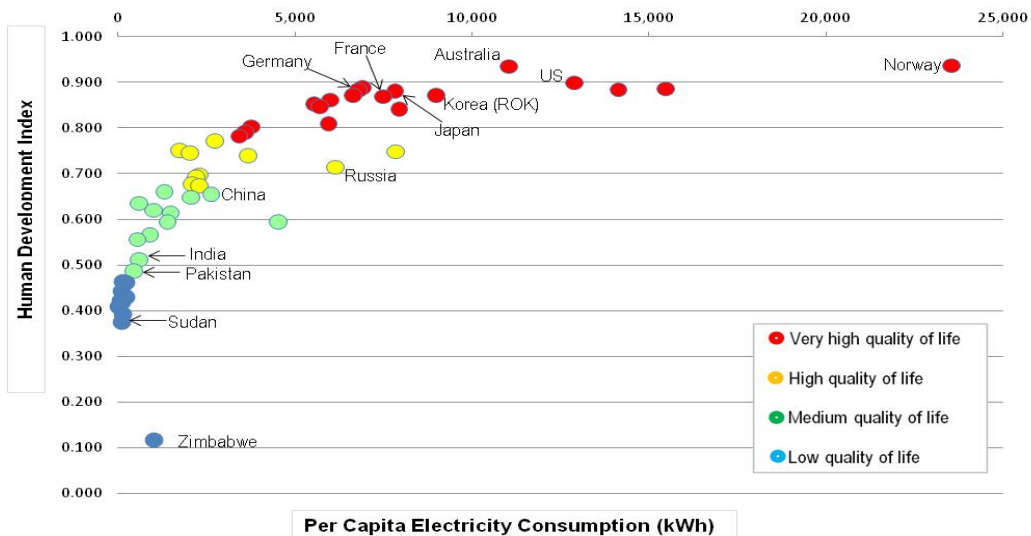
David Hill
 Deputy Laboratory Director
 Science and Technology
 Idaho National Laboratory

December 16, 2011



Energy is Essential to Achieving a High Quality of Life

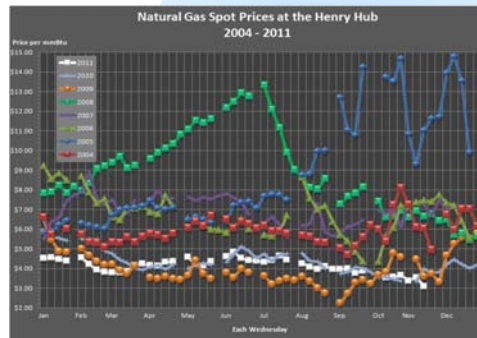
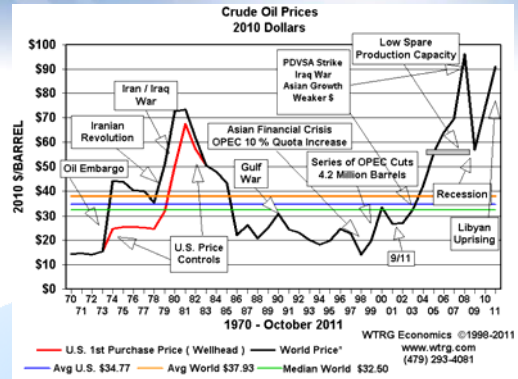
Correlation Between Human Development Index and Per Capita Electricity Consumption, 2009



Human Development Index - Human Development Report 2010, United Nations (2009 data)
 Per Capita Electricity Consumption (kWh) - Key World Energy Statistics, International Energy Agency (2009 data)

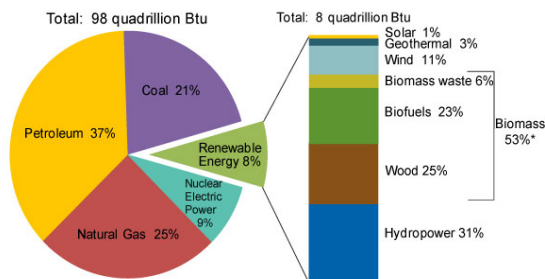
The Energy Challenge...

- Volatile prices for oil and natural gas
- Energy security (U.S. imports about half of its petroleum supplies)
- Increased risk of climate change with burning of fossil fuels



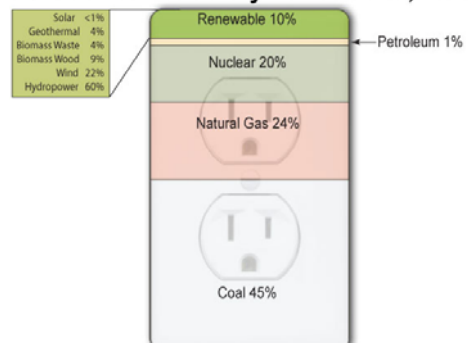
The U.S. Has Many Options for Energy and Electricity Supply

U.S. Primary Energy Consumption by Energy Source, 2010



Note: Sum of biomass components does not equal 53% due to independent rounding.
Source: U.S. Energy Information Administration, *Annual Energy Review 2010*.

Sources of Electricity Generation, 2010

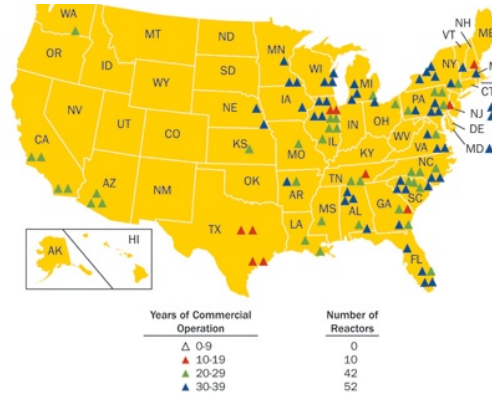


Source: U.S. Energy Information Administration, *Monthly Energy Review* (June 2011). Percentages based on Table 7.2a, preliminary 2010 data.

Nuclear Energy is an Important Part of U.S. Energy and Electricity Supply

- The U.S. is the world's largest producer of nuclear power, accounting for more than 30% of worldwide nuclear generation of electricity
- The country's 104 nuclear reactors produced 807 billion kWh in 2010, over 20% of total electrical output (8.8% of energy supply)
- Virtually all plants operating today are expected to operate for at least 60 years

104 Currently Licensed Operating Nuclear Reactors



Source: U.S. Nuclear Regulatory Commission

“Nuclear power is an important part of our own energy future, along with renewable sources like wind, solar, natural gas, and clean coal...”

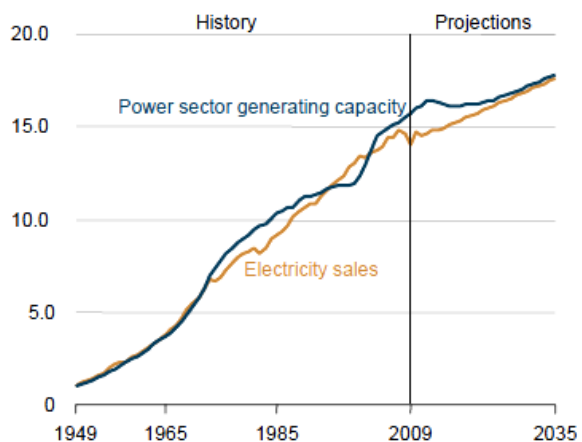
President Obama
March 17, 2011

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U.S. Expects Use of Both Energy and Nuclear Energy to Grow

- Energy consumption grows by 0.7% per year over the next 25 years
- Electricity demand grows by 31 percent between now and 2035
- Nuclear energy is expected to grow in generation by about 9% and fall slightly from 8.8% of total primary energy use to 8%
- Policies that put a price on carbon would prompt significantly more growth in nuclear energy in the U.S. (about 29 GW)

Growth in Electricity Generating Capacity in U.S., 1949 - 2035

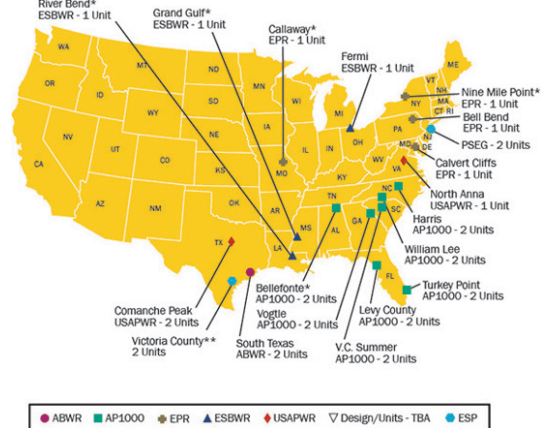


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U.S. Moving Forward with New Plants but at a Slower Pace

- **Based on its many benefits, U.S. industry is pursuing building new plants:**
 - Reliable, affordable, low emissions electricity, necessary for grid stability
 - Can contribute beyond electricity by providing process heat for petrochemical industry
 - Engine of high quality jobs
- **Economic recession has impacted both use and investment in energy technologies**
- **Government policies, including R&D investment, loan guarantees have helped pave the way for new nuclear plants**
- **4-6 new nuclear units may come on line by 2020**
- **Lower gas prices since 2009 have put the economic viability of some of these projects in doubt**

Locations with Applications to Build New Plants



Challenges to expanded use of nuclear energy are largely economic and what to do with the waste.

Addressing Barriers to Use of Nuclear Energy

- **Nearer-term financial challenges**
 - Cost of the first few new plants will exceed sponsor's balance sheet (\$6B - \$8B+/unit)
 - U.S. awarded \$8B for the first two loan guarantees last year to Southern Company and to AREVA for an enrichment plant
- **Long term, the principal challenge is what to do with the waste**
 - Management of back end of the fuel cycle is a government responsibility
 - Administration is seeking new options for improved management of nuclear waste
 - Blue Ribbon Commission formed last year recently issued their draft recommendations, to be finalized by early next year



Vogtle Units 3&4 are expected to be placed in service in 2016 and 2017, respectively

Energy Policy Act of 2005 addressed financial, regulatory and technical barriers to use of nuclear energy through research, development and demonstration, tax policy and other incentives.

Impact of Fukushima in U.S. —Two Tests

A Test of Technology



Pool Storage



Dry Storage

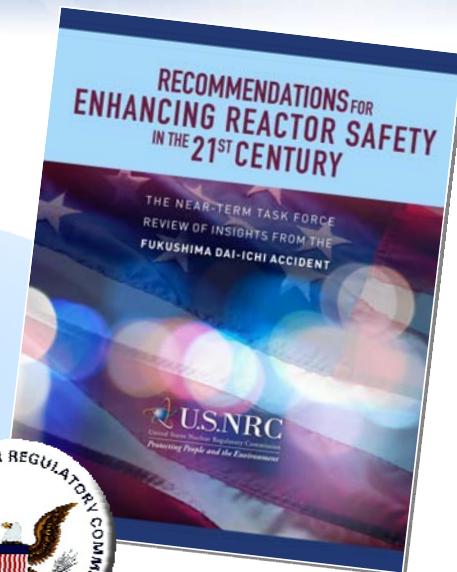
A Test of Public Judgment about Costs, Risks and Environmental Impacts of Our Energy Choices



Vogtle Units 3 and 4 will be the first new generation nuclear plants in the United States

U.S. Regulator Actions

- Clarifying the regulatory framework
- Ensuring protection
- Enhancing mitigation
- Strengthening emergency preparedness
- Improving the efficiency of nuclear regulatory commission programs



U.S. Industry Actions

- Joint Leadership Model — Institute of Nuclear Power Operations, Electric Power Research Institute and Nuclear Energy Institute
- Improve nuclear safety by learning and applying lessons from Fukushima

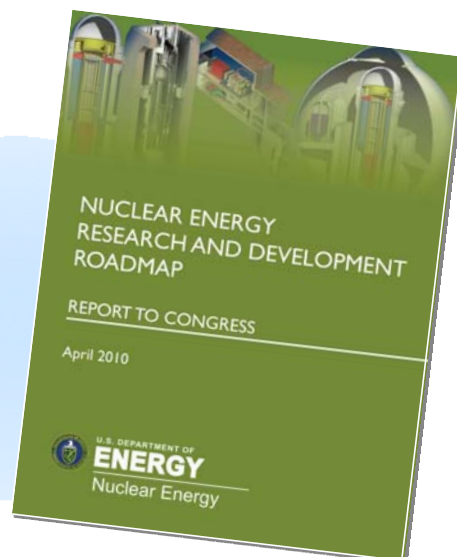


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U.S. Government Perspective on Reactor and Fuel Cycle Programs

Research and Development Objectives

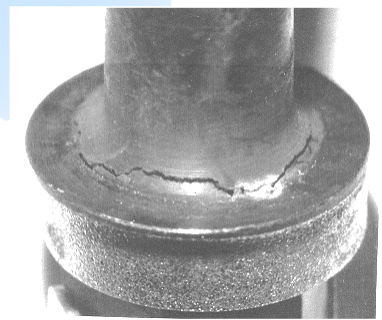
- Department of Energy, Office of Nuclear Energy organizes its R&D activities along four main R&D objectives that address challenges to expanded use of nuclear power:
 - Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors
 - Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals
 - Develop sustainable nuclear fuel cycles
 - Understanding and minimize risks of nuclear proliferation and terrorism



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R&D Supporting Safe, Reliable Long-Term Operation of Today's Reactors

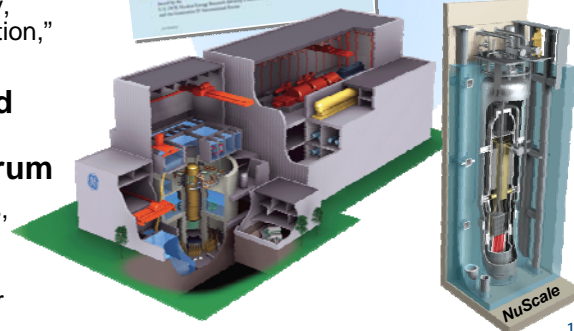
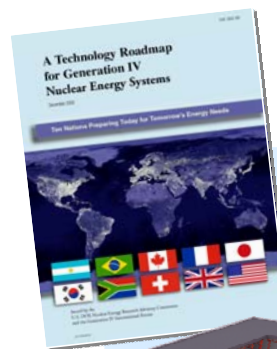
- Cost shared partnership between industry and government, about \$25M/year invested by DOE
- Technical leadership through Idaho National Laboratory and the Electric Power Research Institute, assisted by national laboratories, universities, and international partners
- Enable existing nuclear power plants to safely provide clean and affordable electricity beyond current license periods
- Develop fundamental scientific basis to allow continued safe long-term operation of existing LWRs
- Develop technical and operational improvements that contribute to long-term economic viability of existing nuclear power plants



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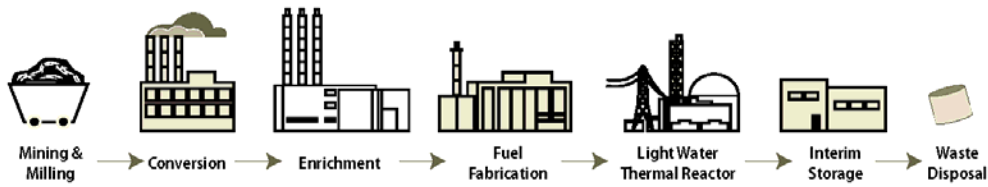
R&D on Advanced Reactor Technologies

- **Developing Advanced Reactor Technologies**
 - Generation IV technologies are those that represent improvements in waste intensity, performance, economics and sustainability, and proliferation-resistance/physical protection
 - U.S. interest in high-temperature gas cooled reactor and sodium fast reactor
 - US industry is considering business case for small modular reactors (modularity, smaller capital outlay, "factory fabrication," lower water usage)
- **U.S. collaboration on advanced technologies through the Generation IV International Forum**
 - International collective of 13 countries, agree to collaborate on R&D
 - Collaborating to make Generation IV systems deployable by 2030 or earlier



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Developing Sustainable Fuel Cycles

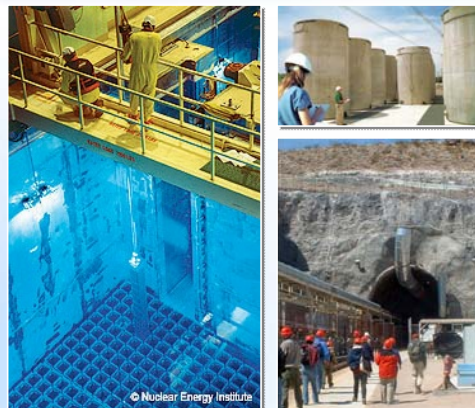


- U.S. presently uses an open fuel cycle, but has been researching more advanced fuel cycles including those that recover and reuse constituents from the “spent fuel” in thermal and fast reactor systems
- U.S. fuel cycle research includes an emphasis on accident tolerant fuels for Light Water Reactors and R&D on long term storage of used fuel
- The U.S. terminated the Yucca Mountain repository program in 2009 in order to develop a new approach to management of used fuel
- A Presidential Blue Ribbon Commission is providing the policy and planning framework that will help guide management of used nuclear fuel and fuel cycle research and development
- The BRC’s work is still underway, but through its draft recommendations, it affirmed the need for R&D on advanced fuel cycles

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Blue Ribbon Commission Recommendations

- **Blue Ribbon Commission issued draft report on July 29, 2011**
 - An approach to siting and developing waste management and disposal facilities that is adaptive, staged, consent based, transparent, and standards and science based
 - New, single-purposed organization to develop/implement integrated program
 - Assured access by the nuclear waste program to the balance of the NWF and revenues generated by annual payments
 - Prompt efforts to develop one or more permanent deep geological facilities for safe disposal of SNF and HLW
 - Prompt efforts to develop one or more consolidated interim storage facilities as part of an integrated plan for the back end



- Stable, long-term support for RD&D on advanced reactor and fuel cycle technologies that have the potential to offer substantial benefits
- International leadership to address global nonproliferation concerns and improve safety and security of nuclear facilities and materials worldwide

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Final Thoughts

- **U.S. is committed to continued development of nuclear energy as a secure resource for energy**
- **U.S. continues to invest in nuclear energy research and development**
 - Light water reactor sustainability
 - Advanced Generation IV reactors, including small modular reactors
 - Back end of the nuclear fuel cycle (waste disposition)
- **U.S. is always interested in cooperation with traditional partners**



Condolences and Admiration

