



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Overview of Nuclear Reactor Technologies Portfolio

for

45th IAEA TWG-FR Meeting
Argonne National Laboratory
June 20 – 22, 2012

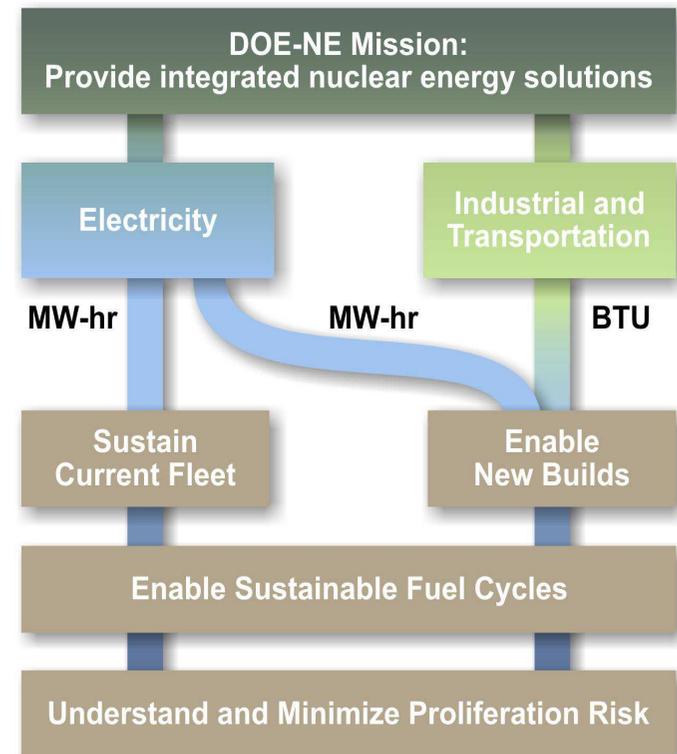
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June 20, 2012

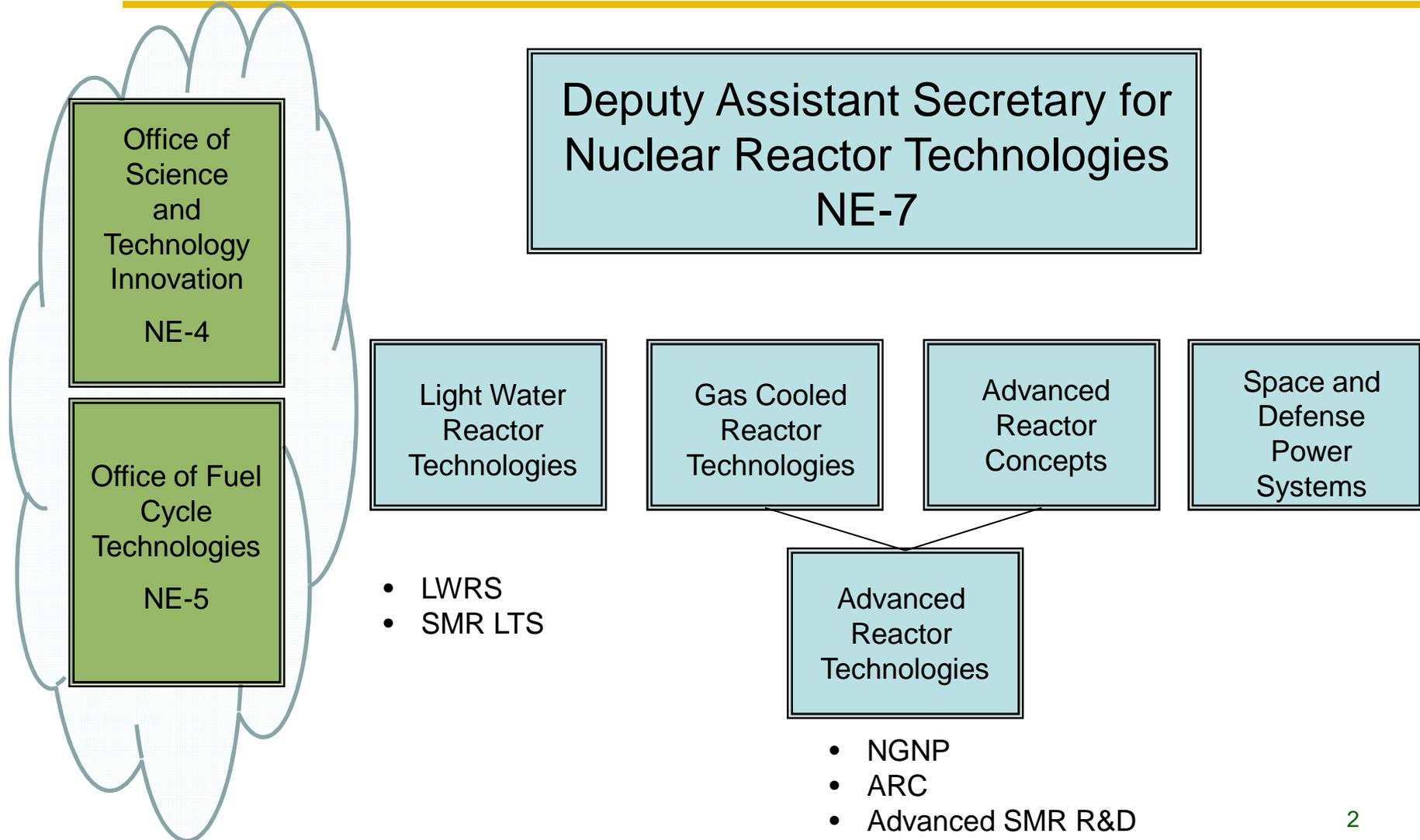


- **Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors**
- **Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals**
- **Develop sustainable nuclear fuel cycles**
- **Develop capabilities to reduce the risks of nuclear proliferation and terrorism**





Organization Chart





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Reactor Concepts Research, Development, and Demonstration

Budget Summary

\$ in thousands

Program Element	FY 2012 Enacted	FY 2013 Request
Small Modular Reactor Advanced Concepts R&D	28,001	18,479
Next Generation Nuclear Plant (NGNP)	40,000	21,557
Light Water Reactor Sustainability	25,000	21,661
Advanced Reactor Concepts	21,870	12,377
Total:	114,871	73,674

- **Mission**

- Develop new and advanced reactor designs and technologies that advance the state of reactor technology to improve competitiveness and help advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs

- **FY 2013 Planned Accomplishments**

- Conduct R&D to support advanced SMR designs
- Perform targeted fuels and materials R&D activities to support NGNP
- Research technologies that support safe and economical long-term operation of the existing nuclear fleet
- Conduct R&D on Advanced Reactor Concepts



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Light Water Reactor Sustainability

- **Five LWRs research pathways to provide technical basis to extend current fleet beyond 60 years with improved performance and safety:**
 - Nuclear Materials Aging and Degradation
 - Risk-Informed Safety Margin Characterization
 - Advanced Instrumentation, Information, and Control Systems Technologies
 - Systems Analysis and Emerging Issues
 - Advanced LWR Nuclear Fuel Development
 - Accident tolerant fuels





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SMR Licensing Technical Support

■ Accelerate commercialization of SMR technologies

- U.S.-based SMR designs (nominally 300 MWe or less per unit)
- Open to LWR and Advanced SMR designs

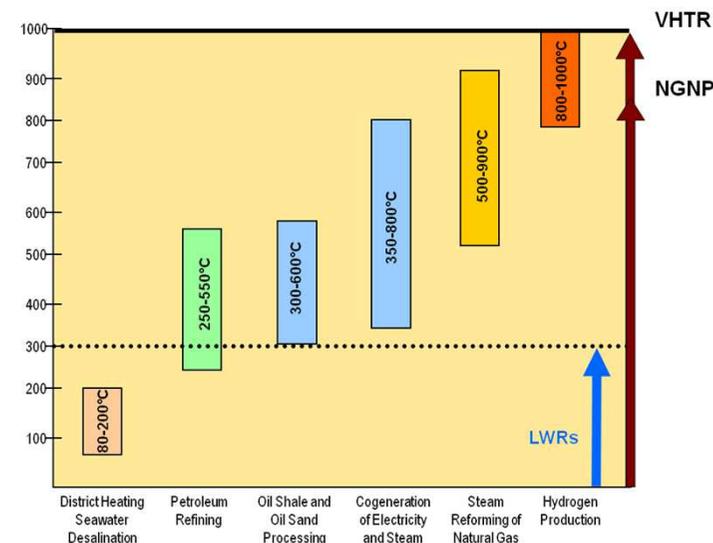
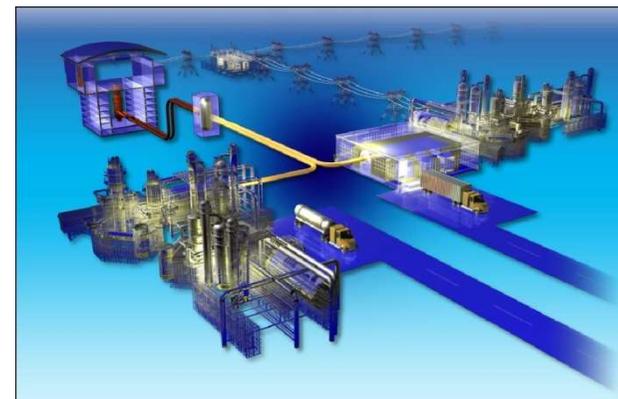
■ Cost-Shared Industry Partnership Program

- Five-year program, totaling \$452M (DOE contribution)
- First-of-a kind engineering, design certification application and licensing support
 - *Construction costs not included*
- Goal is to have electricity on the grid by 2022



Next Generation Nuclear Plant

- **Demonstrate high-temperature gas-cooled reactor (HTGR) technology to produce electricity and high temperature process heat**
- **Provide process heat for industrial processes needing temperatures 700-900° C**
 - Collaborate with NRC to establish a licensing framework for HTGRs
 - Partner with industry to commercialize HTGR technology
 - Collaborate with national laboratories, universities, and international community to perform R&D to reduce technical risk
- **R&D focus areas:**
 - Fuel qualification
 - Materials (High Temperature Metals and Graphite)
 - Design and Safety Methods
 - Licensing Support





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Advanced Reactor Concepts

■ New innovative technologies

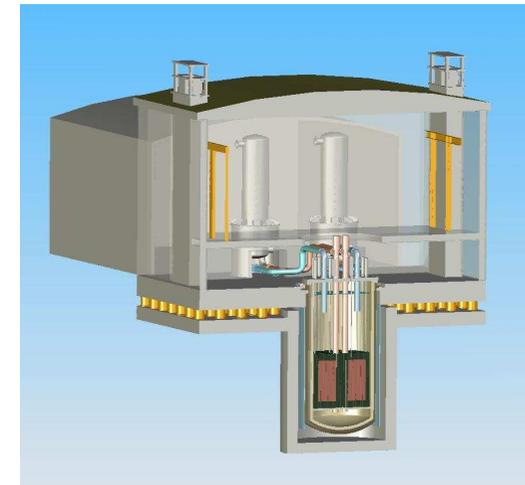
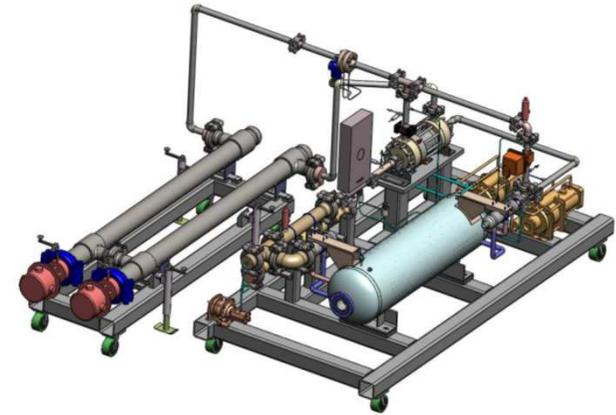
- GEN IV based designs
- Deployment 20+ years

■ R&D focus

- Sodium Fast Reactors
- Fluoride Salt High Temperature Reactors
- Supercritical CO₂ Brayton Cycle Advanced Energy Conversion Technology

■ Broader applications

- Process heat applications
- Improved economic competitiveness
- Transportable/mobile
- Waste management
- Long-lived cores
- Address environmental challenges





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Advanced SMR R&D Program

Seeking Industry Input and Collaboration

- **DOE recognizes the need to invest in Advanced SMR R&D**
 - Deployment of Advanced SMRs would follow the near-term SMR deployment path as they mature
- **DOE is seeking greater interaction with industry and other stakeholders on the development of its R&D program**
- **Established a Technical Review Panel (TRP) in 2012**
 - Reviews advanced reactor concepts and help identify R&D needs
 - TRP members include experts from industry, national labs, and academia
 - Issued Request for Information (RFI) for industry to voluntarily submit information on reactor concepts
 - Results of the TRP review will be used to help inform DOE's R&D program

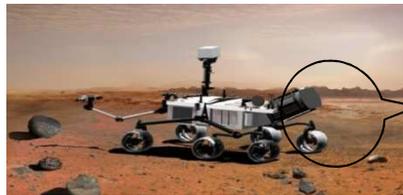




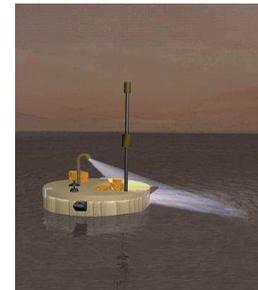
Space and Defense Power Systems

■ Multi-Mission Thermoelectric Generator (MMRTG)

- Fueled with Pu^{238} ; 110 We
- Used on the Mars Science Laboratory rover "Curiosity"
- Launched Nov. 2011, Mars landing – August 2012



Mars Science Laboratory



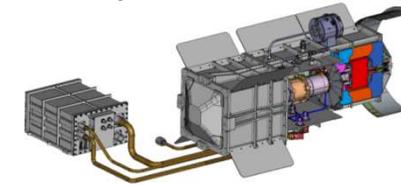
Titan Mare Explorer



Comet Hopper

■ Advanced Stirling Radioisotope Generator (ASRG)

- Fueled with Pu^{238}
- Uses Stirling converter to produce about 130 We
- Over 4x more efficient than RTGs
- Could be used on the Discovery 12 mission



■ Nuclear Thermal Propulsion

- Nuclear fission reactor heats H_2 to produce thrust for inter-planetary travel



■ Fission Surface Power System

- 40 kWe fission reactor for use on the Moon, Mars or near earth object





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Fukushima Impacts on DOE/NE Research

- **Focusing efforts in many programs on safety and accident tolerance**
 - LWRS and Office of Science and Technology Innovation programs
- **Continuing programs to develop inherently safe advanced reactors**
 - NNGP, ARC, and Advanced SMR
- **Forming new programs to look at advanced fuels and other technologies to improve accident tolerance**
- **Working with international community to analyze the accident to improve our modeling capability and develop lessons learned**



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Final Blue Ribbon Commission Report: Key Recommendations (January 26, 2012)

- 1. A new consent-based approach to siting**
- 2. A new organization to implement the waste management program**
- 3. Access to utility waste disposal fees for their intended purpose**
- 4. Prompt efforts to develop a new geologic disposal facility**
- 5. Prompt efforts to develop one or more consolidated storage facilities**
- 6. Early preparation for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities**
- 7. Support for advances in nuclear energy technology and for workforce development**
- 8. Active U.S. leadership in international efforts to address safety, nonproliferation, and security concerns**



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Summary

- **NE-7 has a broad R&D portfolio**
- **DOE and the Administration continue to support nuclear energy to address carbon emissions and energy security goals**
 - *Invest in keeping existing fleet operating safely*
 - *Move technology to commercialization through targeted R&D*
 - *Cutting edge R&D to support advanced concepts*
- **Respond to the Fukushima lessons learned**
- **From a longer term perspective**
 - *Maintain unique capabilities to support future policy decisions*
 - *Engage universities to generate new ideas and develop the workforce of the future*