



U.S. DEPARTMENT OF
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Nuclear Energy

Activities to Support Advanced Reactor Development

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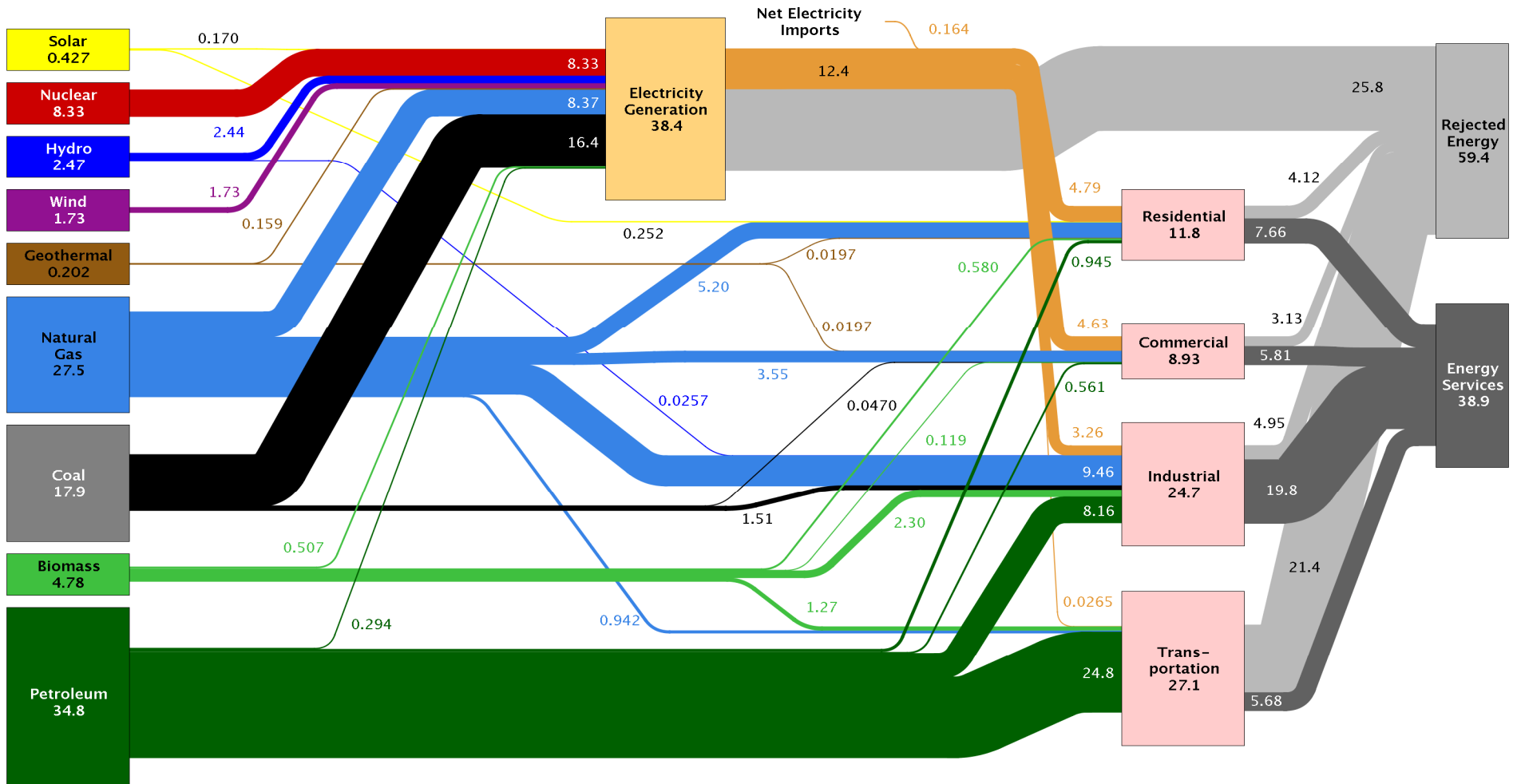
- **Mission:** Perform research to advance the state of reactor technology to improve its economic competitiveness and safety and advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs

- **Objectives:**
 - Develop technologies that can enable new concepts and designs to achieve greater levels of safety and resilience, flexibility of use, sustainability and construction or operational affordability.
 - Collaborate with industry to identify and conduct essential research to reduce technical risk associated with advanced reactor technologies.
 - Sustain essential technical expertise and capabilities within national laboratories, universities, and industry to perform needed research.
 - Collaborate with NRC and Standards Developing Organizations (SDO's) to address gaps in codes and standards to support advanced reactor designs



Nuclear Energy Important Role US Electrical Generation

Estimated U.S. Energy Use in 2014: ~98.3 Quads





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ART Technical Focus Areas

■ Fast Reactor Technologies:

- Mechanisms Engineering Test Laboratory (METL) for testing of small and intermediate scale components in liquid sodium
- Modernization of codes and knowledge preservation

■ High Temperature Reactor Technologies:

- Coated particle fuel development and nuclear grade graphite qualification
- High Temperature Test Facility at Oregon State University

■ Advanced Reactor Generic Technologies:

- Address design needs for advanced materials, including ASME code cases, energy conversion, decay heat removal systems and modeling methods

■ Advanced Reactor Regulatory Framework:

- Work with NRC to finalize advanced reactor design criteria and develop associated implementation guides

■ Advanced Reactor System Studies

- Hybrid Energy Studies with Energy Efficiency and Renewable Energy
- Advanced Test / Demonstration Reactor Planning Study



Industry-Led R&D Collaborations

■ Technical Review Panel (TRP) Process to inform R&D decisions

- Facilitates greater engagement between DOE and industry.
- During 2012 and 2014 Technical Review Panel (TRP) identified R&D needs for viable advanced reactor concepts to inform DOE-NE R&D investment decisions.
- Funding Opportunity Announcements used to make industry led R&D awards.

■ Four awards were made in 2013 for a government cost share of \$3.5M.

- General Electric (SFR) - Electromagnetic Pumps
- General Atomics (GFR) - Silicon Carbide Bonding
- Gen4 Energy (LFR) - Lead Bismuth Natural Circulation
- Westinghouse (SFR) - Modeling and Validation of Sodium Plugging for Heat Exchangers

■ Five awards selections in 2014 for a government cost share of \$13M.

- AREVA (SFR/LFR) - Thermal hydraulic simulations for liquid metal fast reactors
- General Electric (SFR) – Probabilistic risk assessment methodologies
- General Atomics (GFR) - Fabrication and testing Silicon Carbide structures
- NGNP Alliance (HTGR) – Decay heat removal testing
- Westinghouse – (SFR) Thermo-acoustic sensors



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FY2015 Industry Collaboration

■ The FY15 Omnibus Spending Bill included the following:

\$12,500,000 is for the further development of two performance based advanced reactor concepts, of which \$7,500,000 is for industry-only competition of two performance-based advanced reactor concepts and \$5,000,000 is for the national laboratories selected to work with the awardees to perform the work required by the awardees to meet the goals of the awards.

■ Advanced Reactor Technology (2015) Funding Opportunity Announcement

- Released July 31, 2015, with proposals due October 5, 2015
- Complete selection process and make awards in CY15
- Looking to support a broad scope including such areas as R&D, design analysis, scale testing or licensing support to further development in the areas of safety, operations, and economics,
- Designed to support multi-year funding (up to \$100M, with 20% cost-share)



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Advanced Test/Demo Reactor Planning Study

■ **FY15 Omnibus Spending Bill**

“\$7,000,000 is for an advanced test/demonstration reactor planning study by the national laboratories, industry, and other relevant stakeholders of such a reactor in the U.S. The study will evaluate advanced reactor technology options, capabilities, and requirements within the context of national needs and public policy to support innovation in nuclear energy.”

■ **Nuclear Energy Advisory Council (NEAC) providing study advice.**

■ **The objective of the study is to provide transparent, and defensible options to address need for, and technology of, a test and or demonstration reactor(s) to be built to support innovation and long term commercialization.**

■ **Recent Steps**

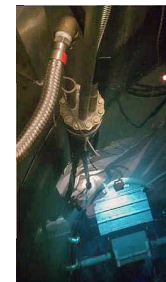
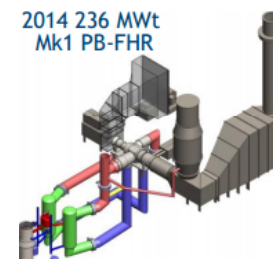
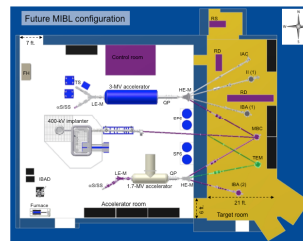
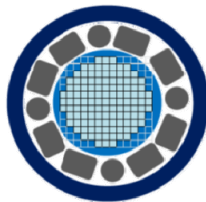
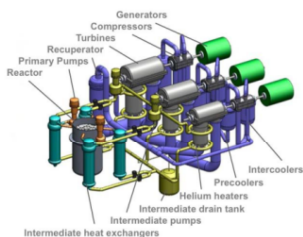
- Workshop held in April with stakeholders to develop criteria and metrics
- Began the Technology Assessment evaluation in June

■ **Revised schedule provides draft report in April 2016.**



DOE Programs with Universities

- **DOE funds specific projects under the Nuclear Energy University Program (NEUP)**
 - *Several projects each year are for R&D on advanced reactor related topics*
 - *Funded 18 projects (\$13.6M) in FY13*
 - *Funded 14 projects (\$10.4M) in FY14*
 - *Funded 13 projects (\$9.5M) in FY15*
- **Integrated Research Projects are more extensive projects in support of advanced nuclear technologies**
 - High-Temperature Salt-Cooled Reactor for Power and Process Heat (2011, MIT, Wisconsin, UC Berkeley, \$7.5M)
 - High Fidelity Ion Beam Simulation of High Dose Neutron Irradiation (2013, University of Michigan, \$5M)
 - Integrated Approach to FHR Technology and Design Challenges (2014, MIT, \$5M and Georgia Tech, \$5M)





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International Collaborations

R&D work conducted with international partners through:

■ **Multi-lateral collaborations**

- Generation-IV SFR and VHTR System Arrangements
- IAEA and OECD coordinated research projects

■ **Bilateral collaborations on diverse topics with**

- China
- Russia
- France
- Japan
- Korea