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Basic Science Investment Improves U.S. Global Competitiveness

Federal investment in scientific discovery and technology is vital to maintaining U.S. economic leadership globally and in growing key emerging sectors such as clean energy

Overview

Basic science is the foundation of innovation and involves "theoretical or experimental investigative research to advance knowledge without a specifically known or immediately practical application. It is the quest for new knowledge and the exploration of the unknown."[1] Such studies fuel the future of research and development (R&D), demonstration, and deployment of new energy technologies. Promotion of early stage exploration activities can unlock the discovery of new materials and processes, contributing to breakthroughs in various industries, including the capture of energy from renewable resources.

The U.S. Department of Energy has long been a sponsor of research to strengthen U.S. competitiveness in innovative energy technologies. In recent years, however, the agency has faced increased competition for funding. Since the mid-1990s, energy investments have accounted for only 1 percent of the government's R&D budget. By comparison, defense has received almost half of federal research monies nearly every year, and health has consumed 20 to 25 percent.[2] If the U.S. is to maintain its leadership role in the clean energy arena, enhanced federal investment in the sector is critical.

Stages of Innovation

The introduction of advanced ideas, devices, or processes drives the emergence and creation of market sectors and supports the U.S. economy. The three stages of progression for discovery and invention are:

- **Basic science and early stage R&D.** Fundamental exploration to acquire new knowledge of materials and processes leading to novel theories and products.
- **Applied research.** Establishment of state-of-the-art concepts and prototype advancements, and exploration of the feasibility of scaling up these modern commodities.
- **Technology maturation and deployment.** Evaluation of materials, components, and efficiencies to optimize performance, demonstrate concepts, and support market adoption.

Advancements in basic science set the stage for U.S. leadership

The DOE's Basic Energy Sciences program supports developing technologies and commercial-sector improvements by offering funding opportunities and creating state-of-the-art facilities. The initiative has led to a range of discoveries, from materials that decrease solar panel costs to next-generation battery designs.

The department also supports affiliated test centers, such as the **national laboratories**, **energy frontier research centers**, and **energy innovation hubs**. These workspaces move discoveries from theory through applied study and set the stage for product maturation and deployment, encouraging development of our country's renewable markets and a presence in the worldwide clean energy economy.[3]

National laboratories provide expertise and resources

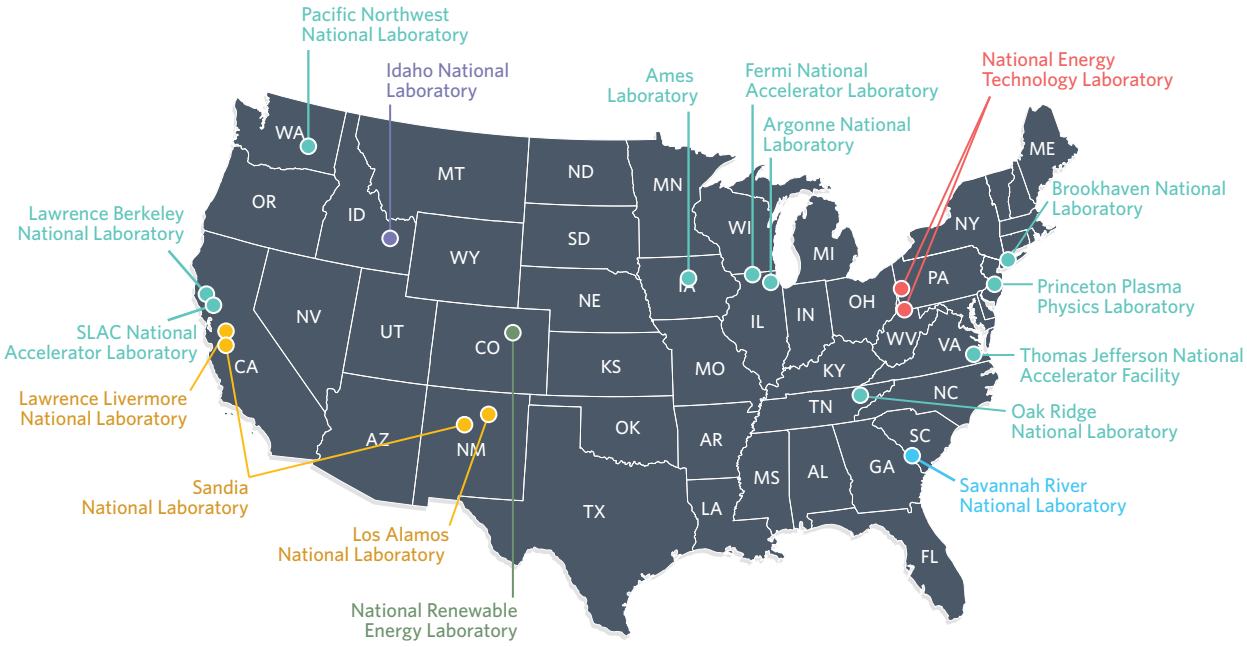
The national laboratories have led scientific advancement for more than 60 years, offering multidisciplinary capabilities for the country's research priorities. The national laboratory system originated to support World War II efforts. Those specialized labs were consolidated under the DOE's predecessor, the Atomic Energy Commission, for non-nuclear studies in 1960.

The current system comprises 17 laboratories used by 29,000 scientists across the country. The labs engage academic, corporate, and other partners to execute large-scale, complex investigations. These public-private partnerships can lead to clean, reliable, and affordable energy technologies.[4] Collaboration with the national labs provides scientists with unique access to cutting-edge equipment and technical experts, facilitating discovery and innovation.

In 2013, the national labs won 31 of the R&D 100 Awards, presented annually by *R&D Magazine* in recognition of exceptional products or processes introduced into the marketplace. More than 800 of the research awards, known as the "Oscars of Invention," have been won by the national labs since the competition began in 1962.[5]

Department of Energy National Laboratories

Facilities support basic science and innovation across the country



- Office of Science laboratory
- Office of Energy Efficiency and Renewable Energy laboratory
- Office of Environmental Management laboratory
- National Nuclear Security Administration laboratory
- Office of Nuclear Energy, Science, and Technology laboratory
- Office of Fossil Energy laboratory

Source: U.S. Department of Energy

Government investment spurred electric vehicle battery improvements

The DOE's early exploration of lithium-ion batteries led to groundbreaking technology improvements and commercial production. In the late 1990s, work on batteries by scientists at Argonne National Laboratory in Illinois was the foundation of applied experimentation by DOE's Vehicle Technologies Office. The results were licensed to General Motors in 2010 and are used in the Chevrolet Volt.[*]

From discovery through maturation and deployment, the department enabled new ideas to come to fruition, positioning the United States as a developer and manufacturer in the clean vehicle market. In 2014, the country is expected to have produced almost a third of total electric vehicles manufactured worldwide. [†]Advancements made in conjunction with the DOE have driven more than 50 percent of the growth of the U.S. economy during the past half-century.[‡]

A Chevrolet Volt battery undergoes testing at Argonne National Laboratory.

[*] Argonne National Laboratory, "Argonne Battery Technology Helps Power Chevy Volt," August 2013, http://www.anl.gov/sites/anl.gov/files/ESMS_BatteryStorage_Fact%20Sheet_September%202013.pdf.

[†] David Undercoffler, "Electric-Vehicle Production Worldwide Forecast to Surge 67% in 2014," *Los Angeles Times*, Feb. 4, 2014, http://articles.latimes.com/2014/feb/04/autos/la-fi-hy-autos-electric-vehicle-global-production-forecast-2014-20140204.

[‡] U.S. Department of Energy, "Lab Game-Changers in Our Past and Future," March 20, 2012, http://energy.gov/articles/lab-game-changers-our-past-and-future.

Energy frontier research centers foster discovery

The DOE helps to bridge the gaps between basic science, early stage R&D, and technological deployment through its support for 46 energy frontier research centers. These workshops accelerate development of leading-edge products by facilitating collaboration among universities, national laboratories, nonprofit organizations, and private companies.[6] In June 2014, the DOE awarded $100 million to the centers to fast-track discoveries and advances in energy production, storage, and use.[7]

Contributions of U.S. DOE Energy Frontier Research Centers from 2009 to 2014

Quantity	Product
5,400	Peer-reviewed scientific articles
280	U.S. patent applications
180	Foreign patent applications
100	Unpatented invention disclosures
70	Licenses

Energy innovation hubs promote technology development

The energy innovation hubs, established in 2010, are cooperative centers that, through a combination of basic and applied science and engineering expertise, address the technological barriers in the energy sector.[8] They pair national experts with state-of-the-art equipment and facilities to accelerate the pace of scientific discovery and enable commercialization. They also assist with public-private alliances. The four hubs currently funded by DOE are:

- **The Fuels From Sunlight Energy Innovation Hub** (the Joint Center for Artificial Photosynthesis), headed by the California Institute of Technology, which explores advanced solar-fuel processes that turn sunlight and water into transportation fuel.[9]
- **The Critical Materials Institute,** led by Ames National Laboratory, which studies materials that are essential for manufacturing clean energy products, such as hybrid and electric vehicles, wind turbines, and photovoltaic cells.[10]
- **The Joint Center for Energy Storage Research** at Argonne National Laboratory, which advances battery capabilities to increase reliability and storage potential while lowering costs.[11]
- **The Consortium for Advanced Simulation of Light Water Reactors**, managed by Oak Ridge National Laboratory, which focuses on nuclear modeling and simulation to enhance the safety, reliability, and economics of commercial nuclear reactors.[12]

Basic research spurs innovation

Financing of scientific analysis leads to lower-cost technology, increased adoption, and a higher quality of life for Americans. These investments produce new products and services that create jobs, improve efficiency, and reduce emissions. As the global marketplace for clean energy technologies continues to expand, funding for this early exploration is essential. The United States needs to prioritize investment in energy R&D, as it has done for the health and defense industries, to ensure sustained market competitiveness for the country's scientists, developers, and manufacturers.

For more information on the role these programs play in supporting the basic science and early stage R&D, see the following links:

- **Department of Energy Office of Science—Basic Energy Sciences**
- **Department of Energy—Energy Innovation Hubs**
- **Department of Energy Office of Science—Energy Frontier Research Centers**
- **Department of Energy National Laboratories**

Endnotes

1 International Council for Science, "The Value of Basic Scientific Research," December 2004, http://www.icsu.org/publications/icsu-position-statements/value-scientific-research.

2 J.J. Dooley, "U.S. Federal Investments in Energy R&D: 1961-2008," U.S. Department of Energy, http://www.wired.com/images_blogs/wiredscience/2009/08/federal-investment-in-energy-rd-2008.pdf.

3 U.S. Department of Energy Office of Science, "Basic Energy Sciences Summary Report," February 2014, http://science.energy.gov/~/media/bes/pdf/reports/files/BES2014SR_rpt.pdf.

4 U.S. Department of Energy, "About the National Labs," http://energy.gov/about-national-labs.

5 U.S. Department of Energy, "National Lab Projects Win R&D 100 Awards," July 22, 2014, http://energy.gov/articles/national-lab-projects-win-rd-100-awards.

6 U.S. Department of Energy, Office of Science, "Energy Frontier Research Centers Fact Sheet," June 6, 2014, http://science.energy.gov/~/media/bes/efrc/pdf/efrc/EFRC_Fact_Sheet_06-06-2014.pdf.

7 U.S. Department of Energy, "DOE Awards $100 Million for Innovative Energy Research," June 18, 2014, http://energy.gov/articles/doe-awards-100-million-innovative-energy-research.

8 U.S. Department of Energy, "Hubs," http://energy.gov/science-innovation/innovation/hubs.

9 U.S. Department of Energy, "DOE Energy Innovation Hubs," March 25, 2013, http://science.energy.gov/bes/research/doe-energy-innovation-hubs/.

10 Critical Materials Institute, "CMI Factsheet," December 2013, https://cmi.ameslab.gov/sites/default/files/two-page-description-of-CMI.pdf.

11 Joint Center for Energy Storage Research, "The National Mission," 2013, http://www.jcesr.org/research/the-national-need/.

12 Consortium for Advanced Simulation of Light Water Reactors (CASL), "About CASL," http://www.casl.gov/introduction.shtml.

For further information, please visit:

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