U.S. DEPARTMENT OF ENERGY | Office of Science

Mission Agency Perspective on Assessing Research Value and Impact

Presentation to the Government-University-Industry Research Roundtable

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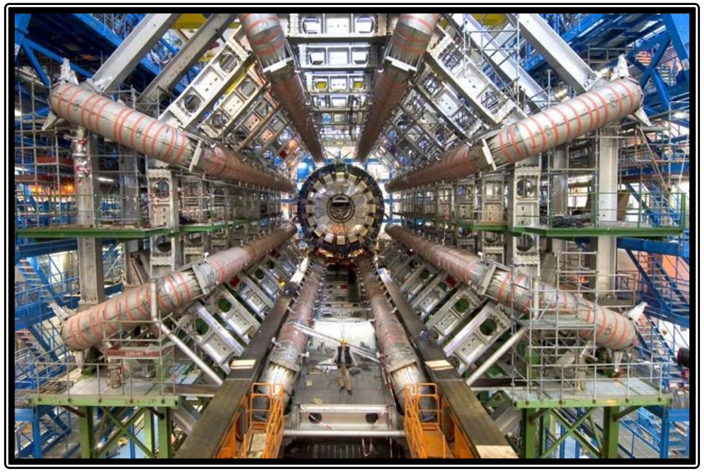
DOE mission

The mission of the Department of Energy is to enhance U.S. security and economic growth through transformative science, technology innovation, and market solutions to meet our energy, nuclear security, and environmental challenges.*

* DOE 2014 Strategic Plan

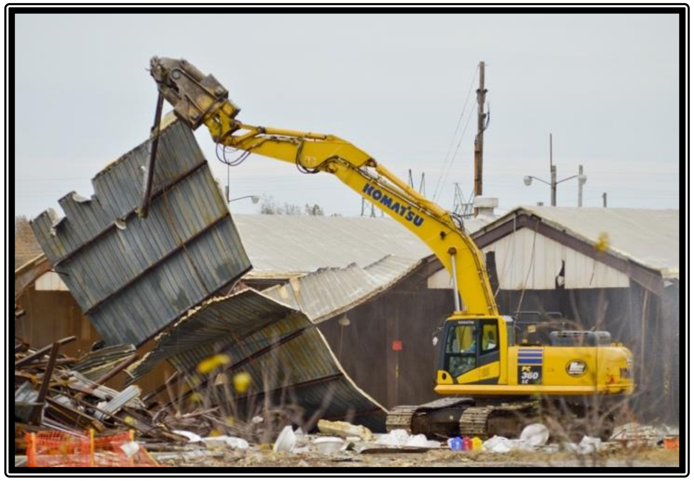
Department of Energy Mission Areas

Science



Energy

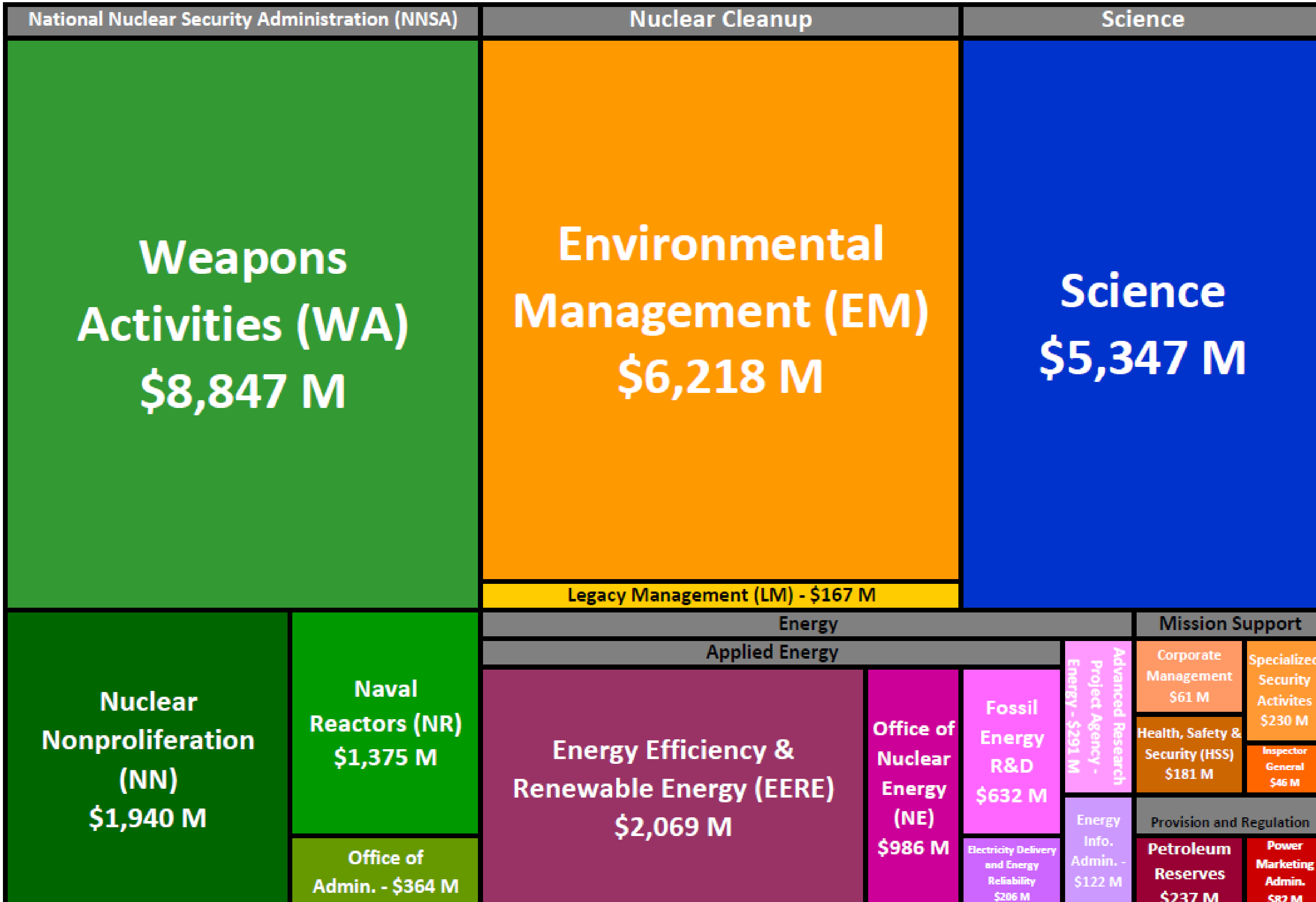
Nuclear Safety and Security



Environmental Cleanup

The DOE Portfolio

FY 2016 enacted budget is $29.6 billion



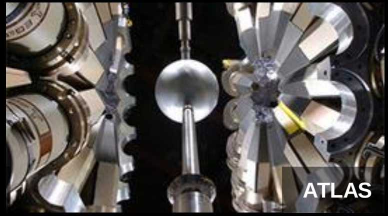
* Representation does not include - $199 M for All Other DOE

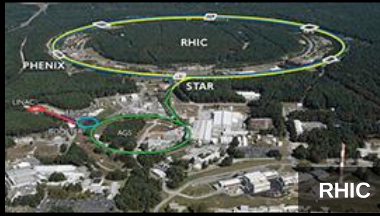
DOE Office of Science Research Portfolio*

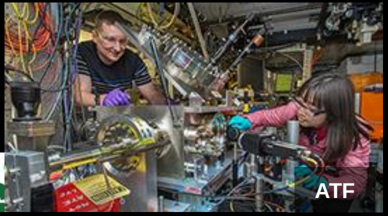
Basic Energy Sciences	• Understanding, predicting, and ultimately controlling matter and energy at the electronic, atomic, and molecular levels
Advanced Scientific Computing Research	• Extending the frontiers of science through world leading computational science, supercomputers, and networking
Biological and Environmental Research	• Understanding complex biological and environmental systems
Fusion Energy Sciences	• Studying matter at very high temperatures and densities and the scientific foundations for fusion
High Energy Physics	• Exploring the elementary constituents of matter and energy, the interactions between them, and the nature of space and time
Nuclear Physics	• Discovering, exploring, and understanding all forms of nuclear matter

** Also Includes the SBIR/STTR Programs*

FY 2016
28 user facilities
33,000 users







U.S. DEPARTMENT OF
ENERGY
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17 DOE National Laboratories

Office of Science Laboratories

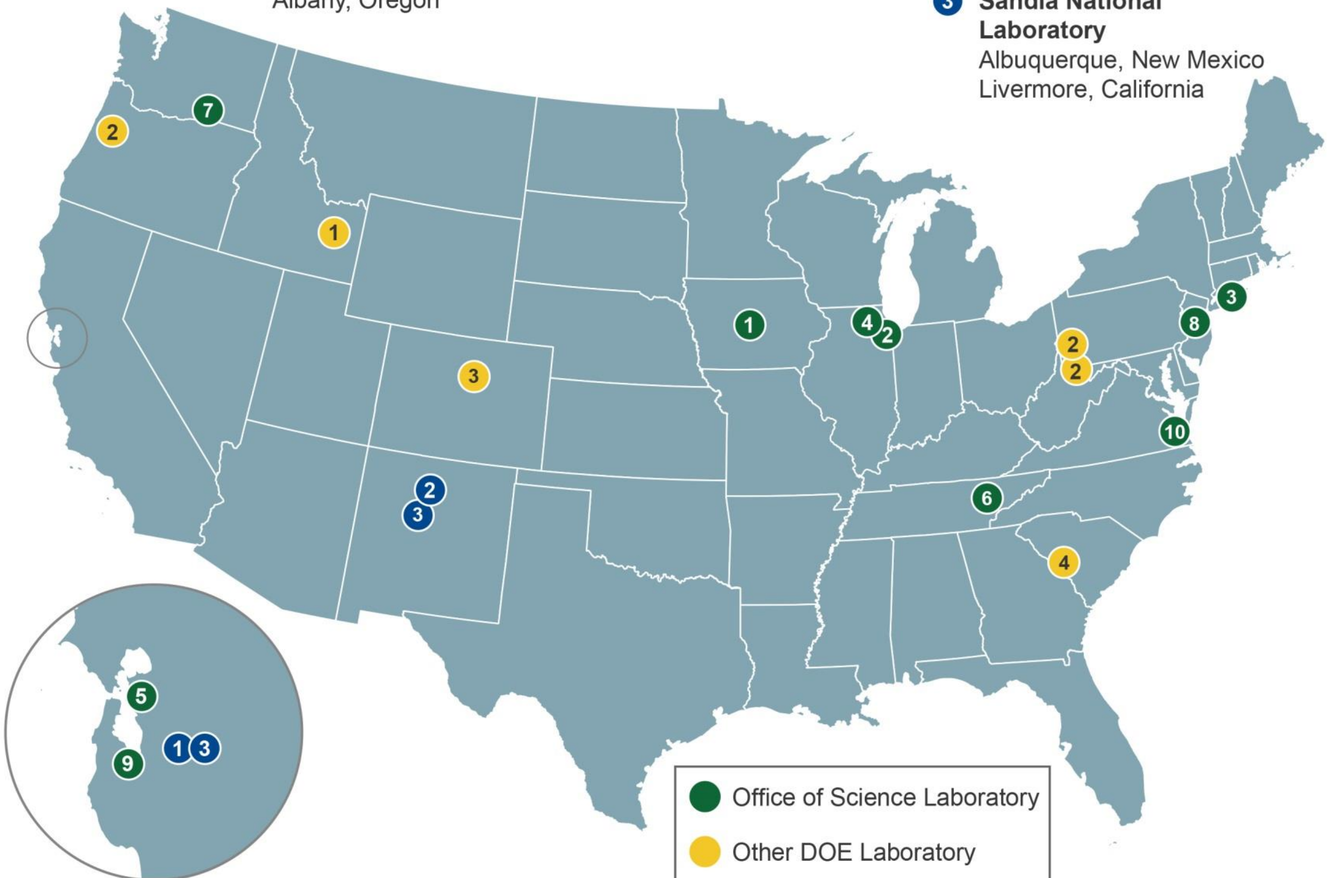
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

NNSA Laboratories

1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California



DOE Office Mission-Specific Responsibilities

To understand how DOE assesses impact of its R&D investments, one must understand the mission specific responsibilities

Science Mission Responsibilities:*

- Deliver results on the science mission.
- Steward whole fields of science for the U.S.
- Support basic research to enable breakthroughs that advance other DOE mission areas.
- Provide enabling scientific capabilities for U.S. researchers (instrumentation and open-access user facilities).
- Disseminate research results.
- Manage effective research programs and projects.
- Effectively steward 10 DOE labs.

Energy Mission Responsibilities:*

- Deliver results on the energy mission.
- Advance techno-economic goals for energy technologies (technical and cost milestones).
- Support applied R&D where DOE has unique capabilities or technology is too far from market realization.
- Transition breakthroughs to the private sector for commercialization.
- Develop efficiency standards.
- Energy security.
- Manage effective R&D programs and projects.
- Effectively steward 3 DOE labs.

** Not a comprehensive list; this discussion considers the basic science and energy R&D activities only.*

Desired Outcomes from R&D

The desired outcomes and impacts from DOE R&D investments depend on where you sit within DOE.

Basic Science Programs	Applied Energy Technology Programs*
▪ New, transformative scientific discoveries ▪ Advance fields of basic research ▪ Enable new fields of basic research ▪ New knowledge leads to predictive understanding and/or reduced uncertainty ▪ Creation of next-generation enabling scientific tools (instrumentation, open-access user facilities, software) ▪ Train the next generation of scientists and engineers ▪ Maintain scientific leadership in the U.S.	▪ Commercialized technologies, products, processes ▪ Knowledge diffusion ▪ Reduced energy costs ▪ Reduced energy use ▪ Growth in market share of new and clean energy technologies ▪ Reduced environmental impacts ▪ Economic return on investment supporting domestic economic growth ▪ Train students and workers for careers in energy

*Generalized for DOE Applied Technology Offices

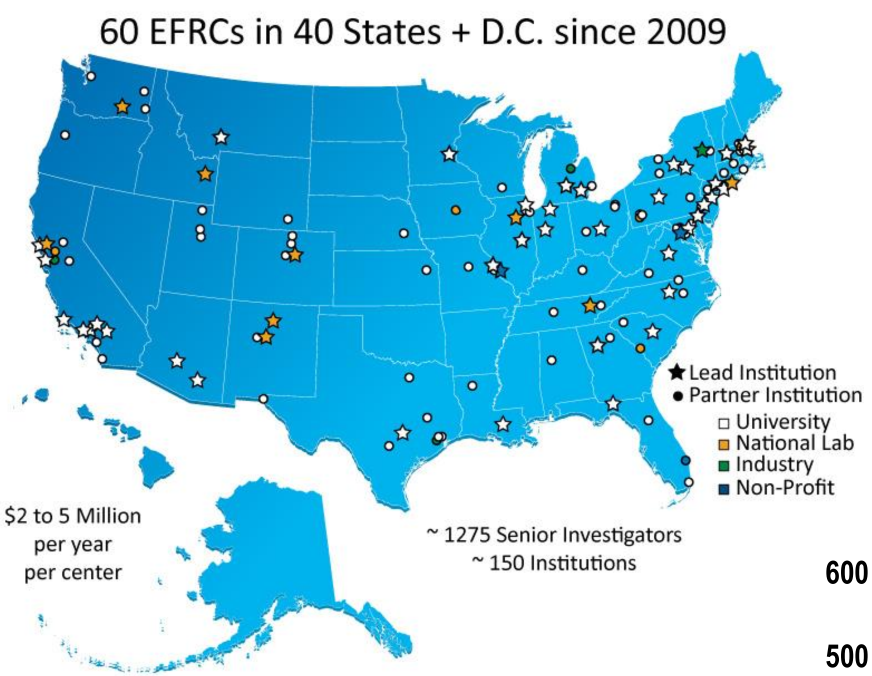
Outcomes, Outputs, Program Activities

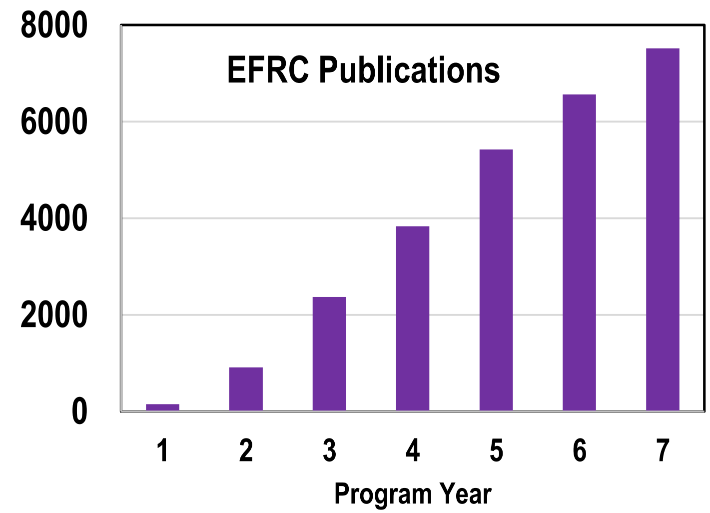
Basic Science Programs – *Scientific field focused*

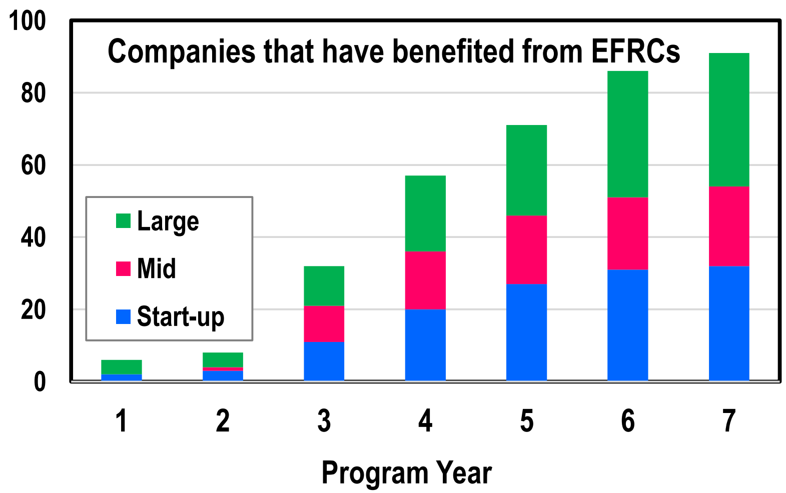
Desired Outcomes	Outputs/Measures	Program Activities
▪ New, transformative scientific discoveries ▪ New knowledge leads to predictive understanding and/or reduced uncertainty ▪ Advance fields of basic research ▪ Enable new fields of basic research ▪ Created next-generation enabling scientific tools (instrumentation and open-access user facilities) ▪ Train the next generation of scientists and engineers ▪ Maintain scientific leadership in the U.S.	▪ Peer-reviewed Publications (research and facilities) and citations; conference proc. ▪ Public datasets; data set usage ▪ Open source software ▪ Facility usage/over subscription of facilities ▪ Awards, prizes, honors (national & international) ▪ students trained, PhDs obtained ▪ Inventions, patents, licenses, spin-off companies ▪ Program-specific (e.g. Early Career)	▪ Track outputs (both at the PM/award, subprogram or program office level) ▪ Peer review of portfolios and facilities (annual or triennial) ▪ Annual PI meetings ▪ FACA Assessments ▪ Committee of Visitor (COV) Reviews ▪ "3-column charts" (basic-applied-industry) ▪ NAS/ decadal studies ▪ *Modernize electronic Business systems* ▪ *Facility User Statistics* ▪ *PAGES – public access*

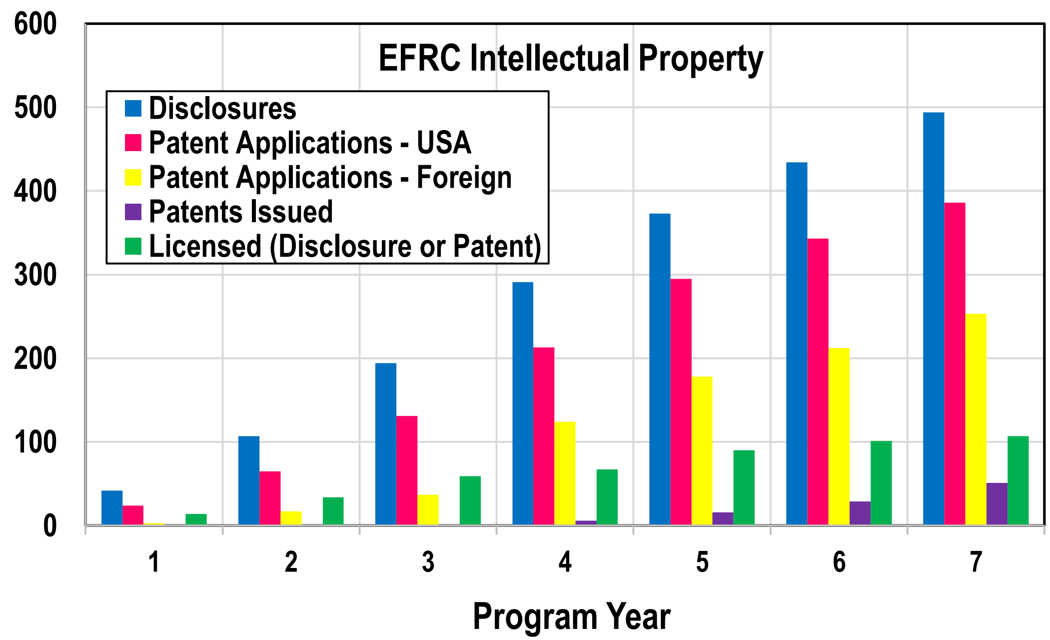
Energy Frontier Research Centers

Original 60 EFRC (2009-2015)









Website: http://science.energy.gov/bes/efrc/

Outcomes and Outputs

Applied Energy Technology Programs – *Technology & Portfolio Focused*

Desired Outcomes	Outputs/Measures
▪ Commercialized technologies, products, processes ▪ Knowledge diffusion ▪ Reduced energy costs ▪ Reduced energy use ▪ Growth in market share of new and clean energy technologies ▪ Reduced environmental impacts ▪ Economic return on investment supporting domestic economic growth ▪ Train students and workers for careers in energy	▪ Knowledge created (publications, patents, licensing) ▪ Established public-private partnerships ▪ Achievement of techno-economic milestones ▪ Validated new technologies under real-world conditions ▪ Funded-partner achievements (commercialized technology, growth in market share, sales, royalties) ▪ Energy produced and/or installed ▪ Reduced waste

EERE Retrospective Impact Evaluation Studies

Since 2010, the Office of Energy Efficiency and Renewable Energy (EERE) has commissioned five R&D impact evaluation studies to answer the question about economic return on investment (ROI) in energy R&D.   Independent evaluators use a rigorous counterfactual analysis method to help address the question:

"Would today's commercialized technologies likely have happened at the same time, and with the same scope and scale, without EERE's efforts?"

The five studies were conducted by independent professional evaluators and economists, covering about one-third of EERE's total R&D investments over the period 1976 to 2012 for solar photovoltaic energy systems, wind energy, vehicle combustion engine, advanced battery technologies for electric-drive vehicles, and geothermal technology R&D.

Conclusion: The combined results of these studies show that the total EERE taxpayer investment of $12 billion (inflation-adjusted 2013 dollars) for the R&D investments evaluated has already yielded an estimated net economic benefit to the United States of more than $230 billion, with an overall annual rate of return on investment of more than 20%.

For Reports: https://energy.gov/eere/analysis/strategic-priorities-and-impact-analysis-publications

For Methodology: https://energy.gov/sites/prod/files/2015/05/f22/evaluating_realized_rd_mpacts_9-22-14.pdf

DOE National Labs Address Multidisciplinary S&T Challenges

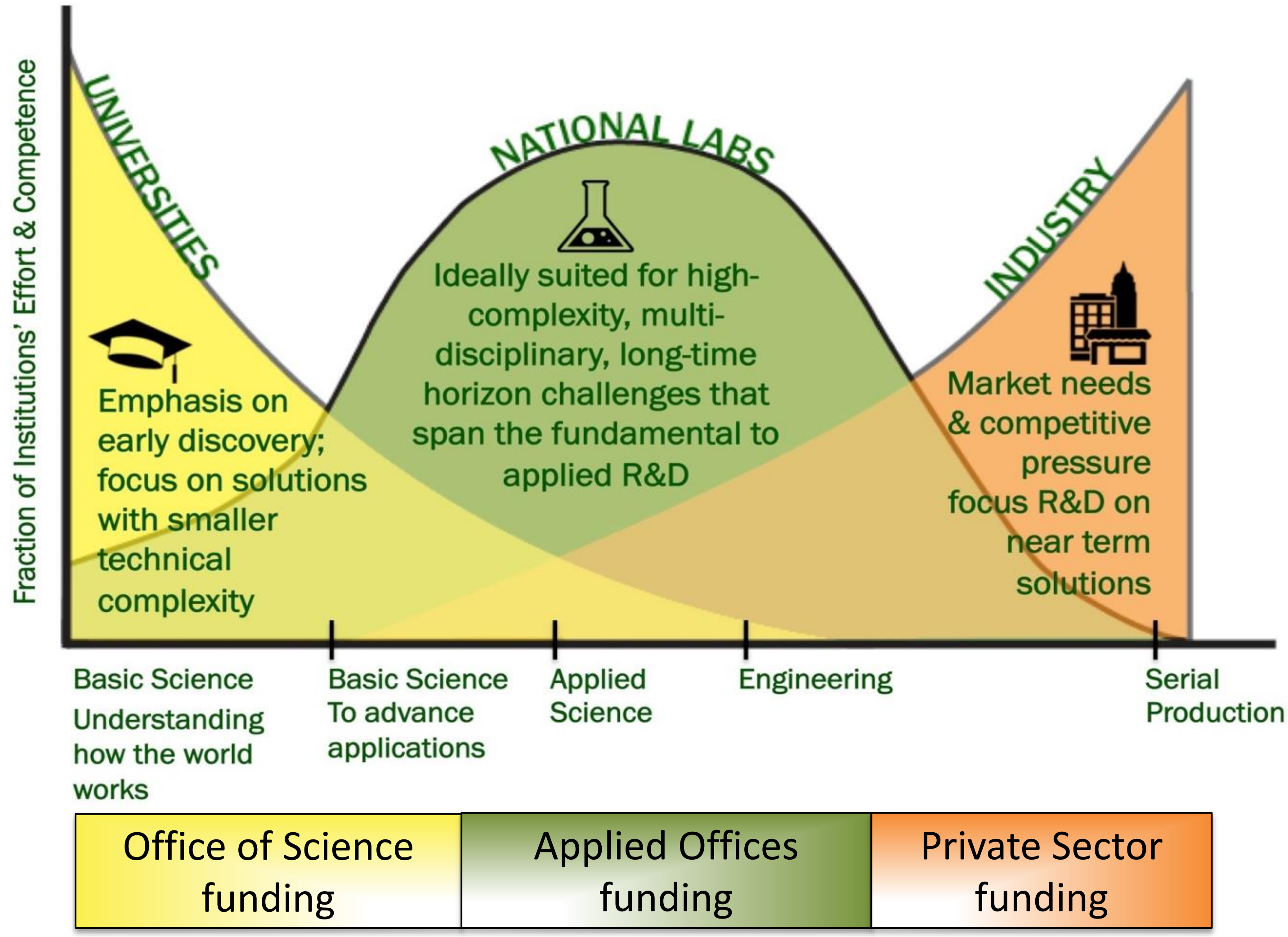


Figure: National Laboratory Directors Council

DOE Laboratory: Institutional Perspective Example

Relevant Measures for Assessing Performance at the Institutional Level*

- *How prepared is the organization to meet its mission?*
- *What are the quality outputs of the R&D organization?*
- *What is the impact of the R&D that was performed?*

Preparedness Indicators	S&T Quality	S&T Impact
▪ Core technical capabilities (areas of core S&T strength) ▪ Project portfolios (projects & programs, alignment, potential for growth) ▪ Distinctive assets (facilities, capital equipment) ▪ Human capital readiness (staff alignment, recruitment, succession planning) ▪ Partnerships & collaborations (universities, industry, other DOE labs)	▪ Peer Review (external S&T or operations reviews, successful funding proposals) ▪ Bibliometrics (publications and citations) ▪ IP and tech transfer (disclosures, patents, patent citations, CRADAs, licenses, start-up companies) ▪ External honors and awards (society officers, advisory panels, elected membership, R&D 100, FLC awards)	▪ Science & technology advances (resolved critical scientific challenge, deployed innovative solutions) ▪ Thought leadership (staff lead the communities) ▪ Economic benefits (economic impact of products, regional economic impacts) ▪ Trained students and scientists

* *Battelle internal document (2014)*

Agency Challenges to Tracking Impact

- Volume of data collection involved, from multiple sources, much of it not currently easily digitally accessible
- Funding attribution (groups funded from multiple sources)
- Inconsistent citations for new, "1st class" research products (datasets, software)
- Growing interdisciplinary nature of science (e.g. computation and big data)
- Long-lead time for results from basic research
- Efforts largely ignore the benefit of failure
- Modernizing electronic business systems takes time; IT evolves faster
- Quality of historic data varies and requires checking
- External retrospective assessments require additional resources
- Changing agency and administration priorities
- Changing market drivers

Background

Relationship between DOE R&D Offices and w/ Industry

DOE Offices fund competitive R&D at >350 universities, 17 DOE national labs, and industry.