Energy Frontier Research Centers   Fact Sheet

The Department of Energy's Office of Science supports Energy Frontier Research Centers (EFRCs), major collaborative research efforts to accelerate high-risk, high-reward fundamental research that will provide a strong scientific basis for transformative energy technologies of the future.

The EFRCs represent a unique approach to energy research, bringing together the skills and talents of teams of investigators to perform energy-relevant, basic research with a scope and complexity beyond that possible in typical single-investigator or small group research projects. The EFRCs have world-class teams of researchers, often from multiple institutions, bringing together leading scientists from universities, national laboratories, nonprofit organizations, and for-profit firms. These integrated, multi-investigator Centers are tackling some of the toughest scientific challenges hampering advances in energy technologies.

Research Areas

The EFRC awards span the full range of energy research challenges described in the Basic Energy Sciences series of workshop reports (see http://science.energy.gov/bes/news-and-resources/reports/) in which the community defined basic research that is needed to enable advances related to clean energy technologies, including: solar energy utilization, clean and efficient combustion, electrical energy storage, carbon capture and sequestration, advanced nuclear systems, catalysis, materials in extreme environments, hydrogen science, solid state lighting, and superconductivity. The EFRCs also address scientific grand challenges described in the report, Directing Matter and Energy: Five Challenges for Science and the Imagination.

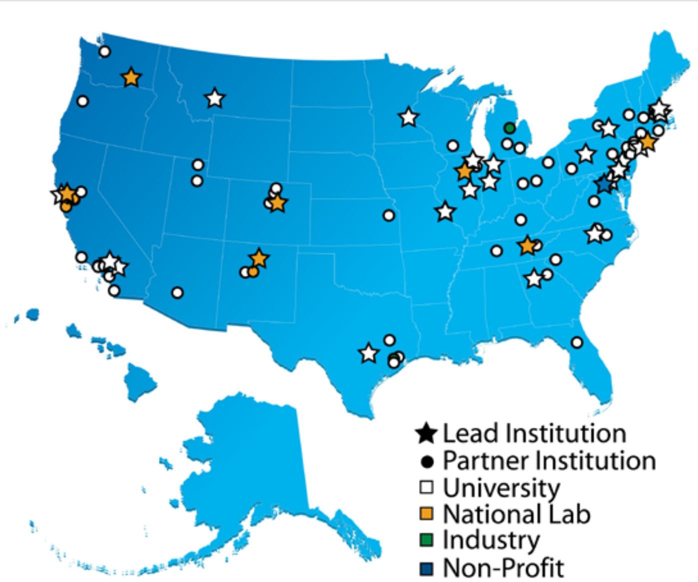
The EFRCs provide an important bridge between basic research and energy technologies and complement other research activities funded by the Department of Energy. EFRCs accelerate energy science by providing an environment that encourages high-risk, high-reward research that would not be done otherwise; integrating synthesis, characterization, theory, and computation to accelerate the rate of scientific progress; developing new, innovative experimental and theoretical tools that illuminate fundamental processes in unprecedented detail; and training an enthusiastic, inter-disciplinary community of energy-focused scientists.

History

In 2009, 46 Centers were selected based on scientific peer review and funded at $2-5 million per year for a five-year initial award period for a total investment of $777 million ($277 million from the American Recovery and Reinvestment Act). An open recompetition of the program in 2014 resulted in awards to 32 centers, 22 of which are renewals and 10 of which are new EFRCs.

Current EFRCs

- Lead institutions by type:
  - 23 universities
  - 8 DOE National Laboratories
  - 1 nonprofit organization
- Over 100 participating institutions, located in 33 states plus the District of Columbia
- 525 senior investigators and, on a full- or part-time basis, an additional estimated 900 researchers, including postdoctoral associates, graduate students, undergraduate students, and technical staff
- 32 awards of $2-4 million per year for an award term of up to four years



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

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Energy Frontier Research Centers: Impact

EFRCs have collectively demonstrated the potential to substantially impact the scientific understanding underpinning transformational energy technologies. A 2012 mid-term assessment of the research productivity and progress for each Energy Frontier Research Center concluded that the centers:

- Enable high-risk, high-reward research that would not otherwise be attempted;
- Bring together cross-disciplinary teams that challenge their members to ask more difficult questions, leading to potentially transformational results;
- Accelerate the rate of both success and failure, from which lessons are rapidly learned and adjustments quickly made;
- Seamlessly integrate synthesis, characterization, theory, and computation to enhance both the quality and quantity of scientific progress;
- Develop outstanding new experimental and theoretical tools, many of which are available to the entire research community;
- Train next generation energy scientists by attracting high-quality students and postdoctoral researchers, most of whom—based on the reviewers' discussions with these individuals—want to continue a career in energy science.

The scientific output from the EFRCs is impressive and many EFRCs have reported that their results are already impacting both technology research and industry. Students are completing their training and are growing an energy-savvy workforce in industry and academia. Both a BES Committee of Visitors and a Secretary of Energy Advisory Board Task Force have found the EFRC program to be highly successful in meeting its goals.

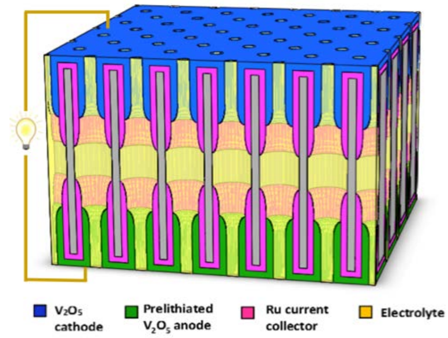
<u>EFRC Impact by the Numbers (46 centers; 2009-2014)</u>

Scientific and Workforce Impact

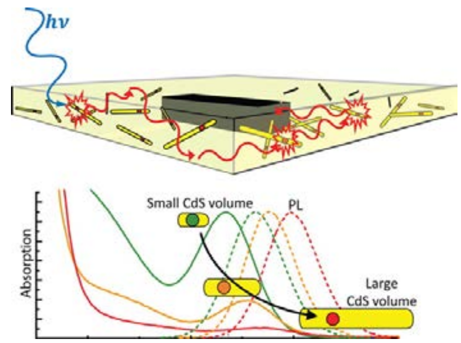
- Nearly 6,000 peer-reviewed publications, including more than 215 publications in *Science* and *Nature*
- EFRC students and staff are entering the workforce:
  - Over 300 to university faculty and staff positions
  - Over 475 to industrial positions
  - Over 200 to national laboratories, government and not-for-profit positions

Technology Impact

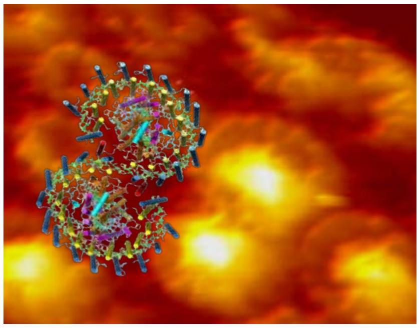
- ~280 U.S. and 180 foreign patent applications
- ~100 unpatented invention disclosures
- ~70 licenses
- ~70 companies have benefited from EFRC research



Nanostructured batteries promise to deliver energy at much higher power and with a longer lifetime than conventional technology. With rational design and controlled fabrication, researchers have demonstrated nanopore batteries that can quickly charge and discharge over many cycles.



Luminescent solar concentrators based on tunable CdSe/CdS nanorods enable concentration of both direct and diffuse sunlight onto highly efficient micro-silicon solar cells, demonstrating a practical path to operation in the high-concentration regime.



The 3D structure of the reaction center–light harvesting complex of a photosynthetic bacterium has been determined using multiple experimental techniques. This provides insight into how structure can mediate the efficiency of light harvesting and energy conversion, and the possibility of exploiting or mimicking photosynthesis in artificial systems.

Websites: http://science.energy.gov/bes/efrc/ Research highlights: http://science.energy.gov/discovery-and-innovation/

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Updated February 3, 2015