Basic Energy Sciences

Center for Nanophase Materials Sciences User Meeting

September 19, 2011

Linda L. Horton
Director, Materials Sciences and Engineering Division
Basic Energy Sciences
Office of Science
U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

Secretary
Steven Chu

Deputy Secretary
Daniel B. Poneman

Advanced Research Projects Agency – Energy
Arun Majumdar

Under Secretary for Nuclear Security/Administrator for National Nuclear Security Administration
Thomas P. D'Agostino

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- Defense Programs
- Naval Reactors
- Counter-terrorism
- Defense Nuclear Security
- Emergency Operations

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Steven E. Koonin

Office of Science
William Brinkman
Patricia Dehmer

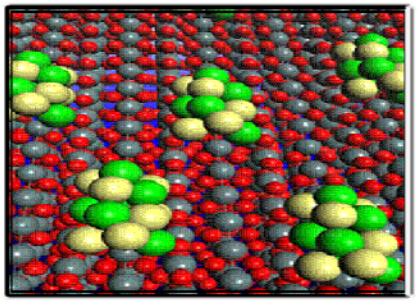
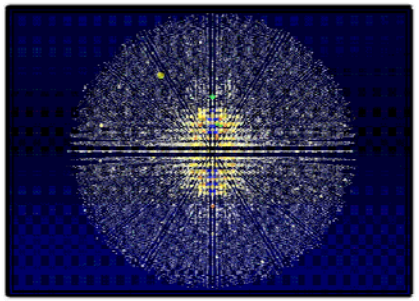
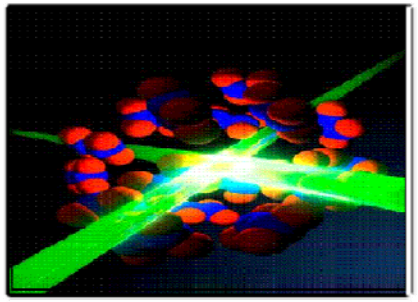
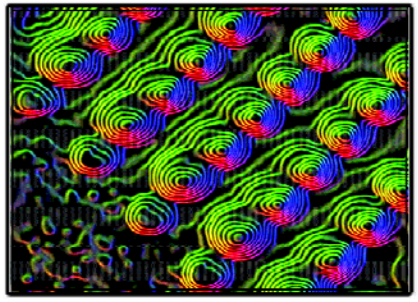
- **Basic Energy Sciences** — Harriet Kung
- **High Energy Physics** — Mike Procario (A)
- **Advanced Scientific Computing Research** — Dan Hitchcock (A)
- **Nuclear Physics** — Tim Hallman
- **Biological & Environmental Research** — Sharlene Weatherwax
- **Fusion Energy Sciences** — Ed Synakowski
- **SBIR/STTR** — Manny Oliver
- **Workforce Develop. for Teachers & Scientists** — Patricia Dehmer (A)

Under Secretary

- **Energy Efficiency & Renewable Energy** — Henry Kelley (A)
- **Fossil Energy** — Victor Der (A)
- **Nuclear Energy** — Pete Lyons
- **Electricity Delivery & Energy Reliability** — Pat Hoffman

Basic Energy Sciences Mission

- Fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels
- Provide the foundations for new energy technologies to support DOE's missions in energy, environment, and national security
- Plan, construct, and operate world-leading scientific user facilities for the Nation

Office of Basic Energy Sciences

Office of Basic Energy Sciences
Harriet Kung, Director

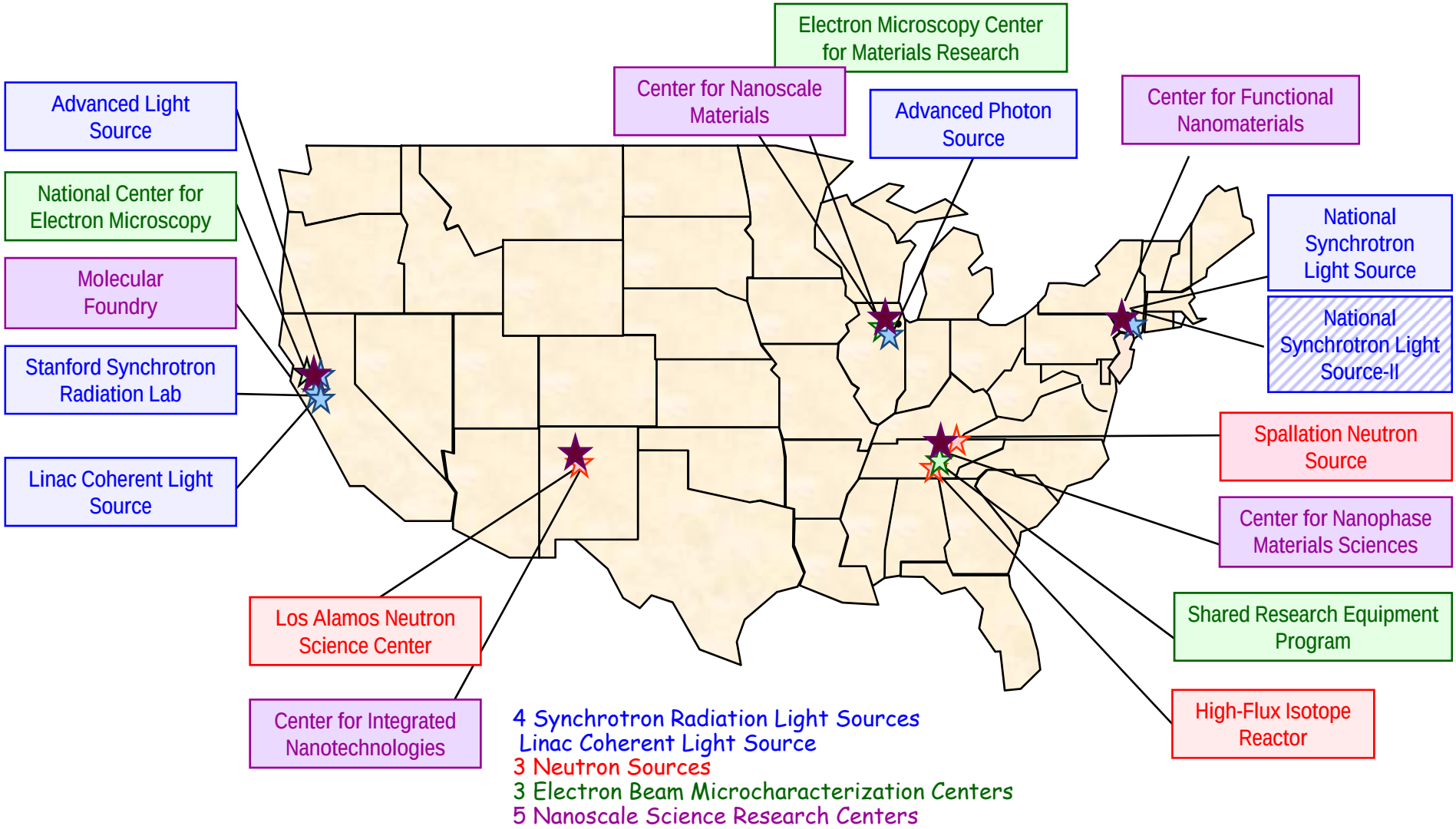
Materials Sciences and Engineering Division
- Materials Discovery, Design and Synthesis
- Condensed Matter and Materials Physics
- Scattering and Instrumentation Sciences

Scientific User Facilities Division
- X-Ray and Neutron Scattering Facilities
- Nanoscience and Electron Microscopy Centers

Chemical Sciences, Geosciences and Biosciences Division
- Fundamental Interactions
- Photochemistry and Biochemistry
- Chemical Transformations

Research grouped by scientific topics
-- not by specific energy technologies

BES Scientific User Facilities: Resources for Research

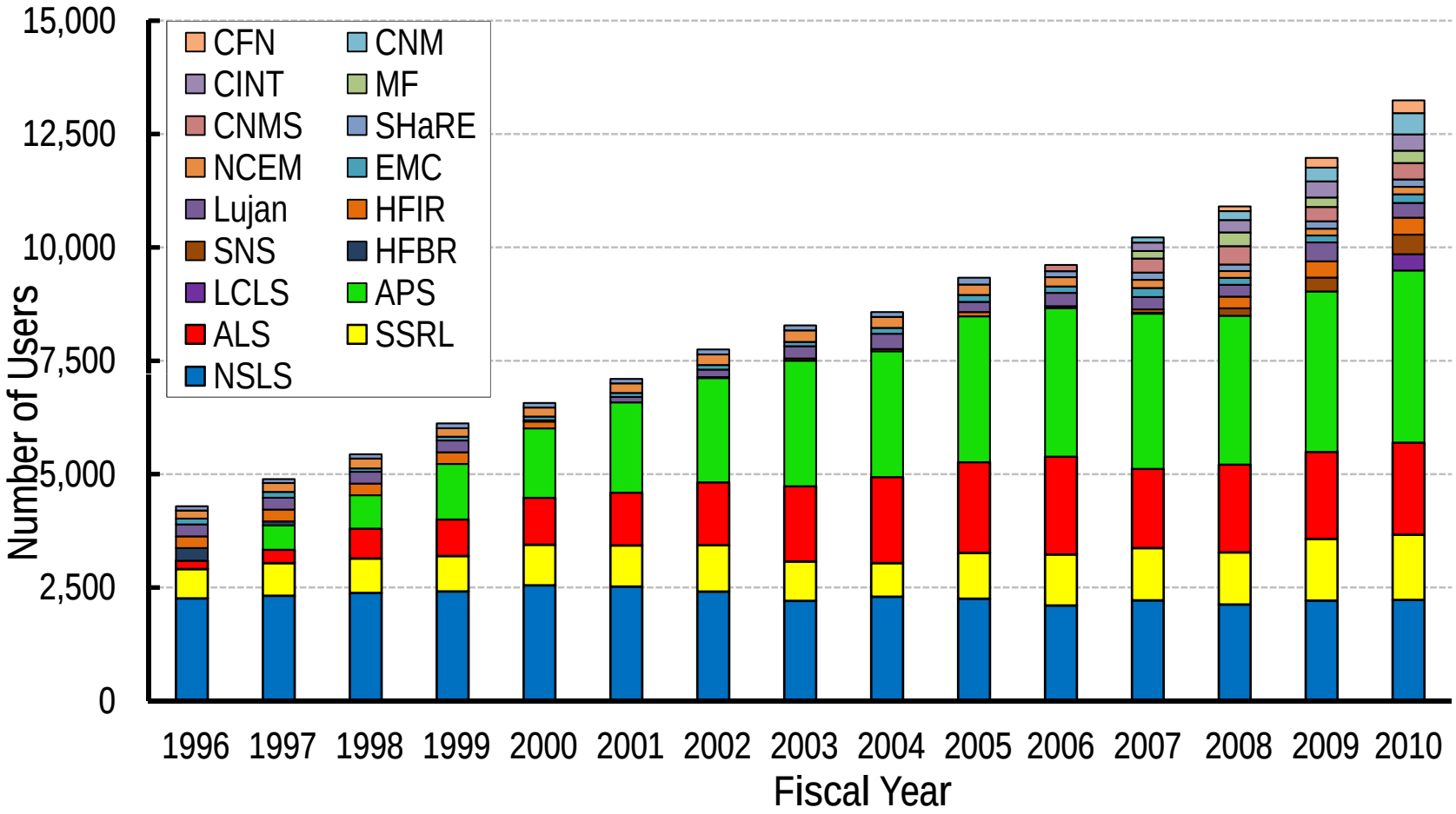


4 Synchrotron Radiation Light Sources
Linac Coherent Light Source
3 Neutron Sources
3 Electron Beam Microcharacterization Centers
5 Nanoscale Science Research Centers

Transforming the Discovery Process

- Over the past 2 decades, the U.S. has developed and deployed the world's most powerful collection of research facilities for materials and chemical sciences
  - World-leading x-ray and neutron sources
  - Nanoscale science centers
  - High-performance computers
- For the first time in history, we are able to synthesize, characterize, and model materials and chemical behavior at the length scale where this behavior is controlled
- This transformational leap conveys a significant competitive advantage

BES User Facilities Hosted Over 13,000 Users in FY 2010



More than 300 companies from various sectors of the manufacturing, chemical, and pharmaceutical industries conducted research at BES scientific user facilities. Over 30 companies were Fortune 500 companies.

Energy Frontier Research Centers

Tackling Our Energy Challenges in a New Era of Science

- To engage the talents of the nation's researchers for the broad energy sciences
- To accelerate the scientific breakthroughs needed to create advanced energy technologies for the 21st century
- To pursue the fundamental understanding necessary to meet the global need for abundant, clean, and economical energy

46 centers awarded ($777M over 5 years), representing 102 participating institutions in 36 states and D.C.

Pursue *collaborative* basic research that addresses both energy challenges and science grand challenges in areas such as:

- Solar Energy Utilization
- Combustion
- Bio-Fuels
- Catalysis
- Energy Storage
- Solid State Lighting
- Geosciences for Energy Applications
- Superconductivity
- Advanced Nuclear Energy Systems
- Materials Under Extreme Environments
- Hydrogen

DOE Energy Innovation Hubs

Hubs funded in FY 2010:

- **Fuels from Sunlight (SC lead) – CalTech- LBNL**
- **Energy Efficient Building Systems Design (EERE) – Penn State**
- **Modeling and Simulation for Nuclear Fuel Cycles and Systems (NE) - ORNL**

Each Hub has a world-class, multi-disciplinary, and highly collaborative research and development team

Strong scientific leadership *is* located at the primary location of the Hub.

- **Clear organization and management plan**
- **"infuses" a culture of empowered central research management**

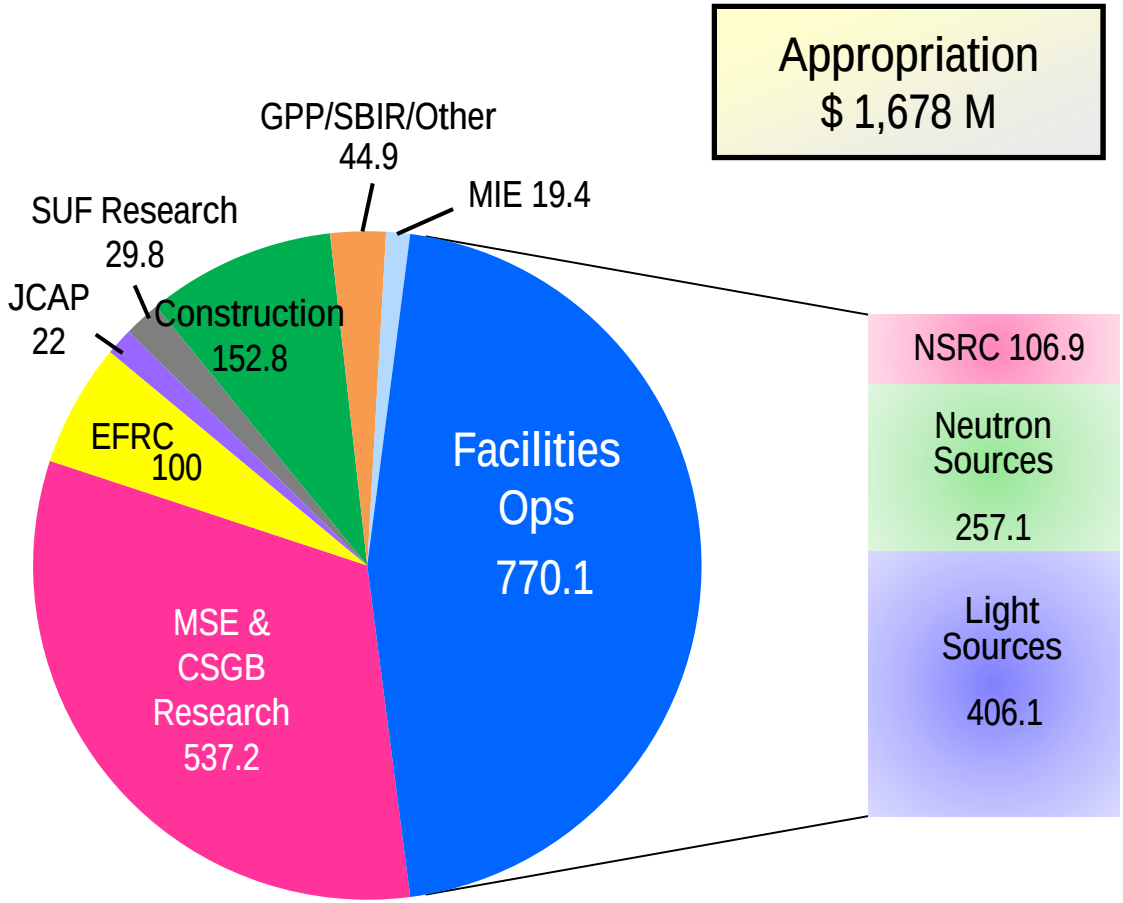
The Department has proposed three additional Hubs, including for Batteries and Energy Storage in FY 2012.

FY 2011 BES Budget Appropriation

- Core research
  - $100M for Energy Frontier Research Centers
  - Core research largely flat with FY 2010
  - EPSCoR funded at $8.2M per request
- Scientific user facilities operations

  Modest increase in operations funding:
  - Synchrotron light sources
  - Neutron scattering facilities
  - Nanoscale Science Research Centers
- Construction and instrumentation

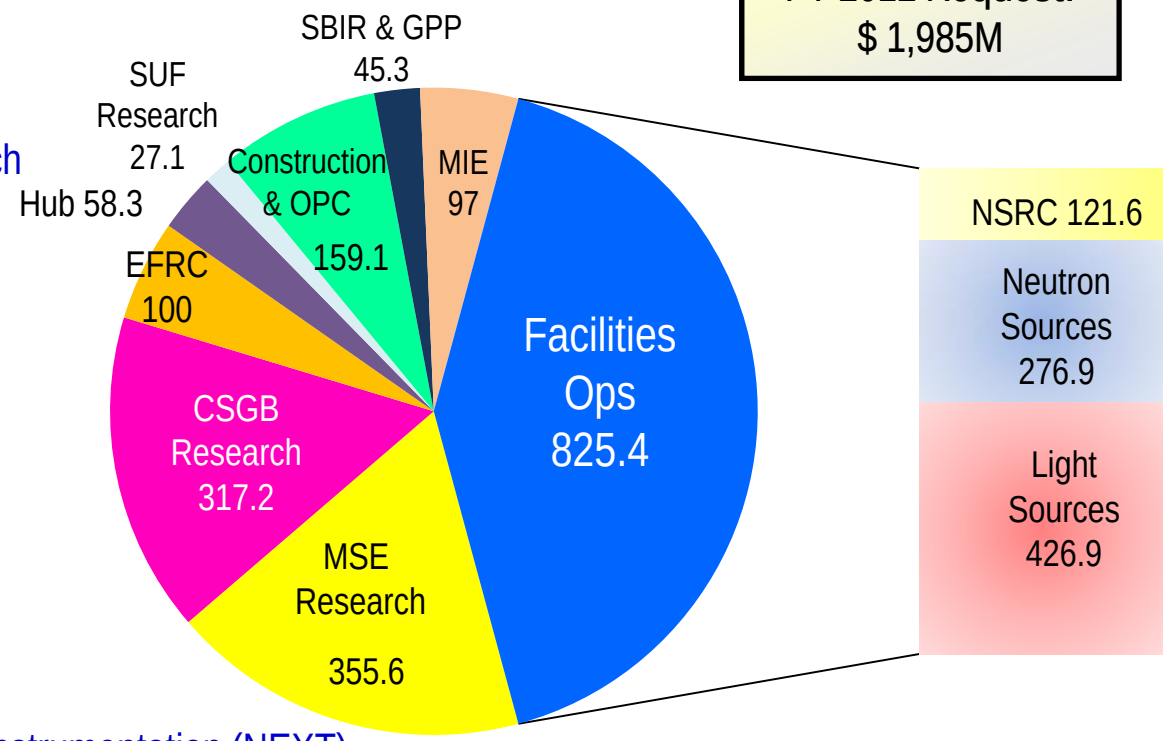
  Funding for:
  - National Synchrotron Light Source-II
  - Spallation Neutron Source instruments
  - SNS Power Upgrade



FY 2012 BES Budget Request

- Research programs
  - Energy Innovation Hubs
  - Energy Frontier Research Centers
  - Core Research: increases in basic research for energy; materials by design; nanoelectronics; methane hydrates
- Scientific user facilities operations
  - Synchrotron light sources
  - Neutron scattering facilities
  - Nanoscale Science Research Centers
  - Instrumentation for clean energy
- Construction and instrumentation
  - National Synchrotron Light Source-II and instrumentation (NEXT)
  - Spallation Neutron Source instruments & power upgrade
  - Advanced Photon Source upgrade
  - Linac Coherent Light Source-II
  - TEAM-II

FY 2012 Request:
$ 1,985M

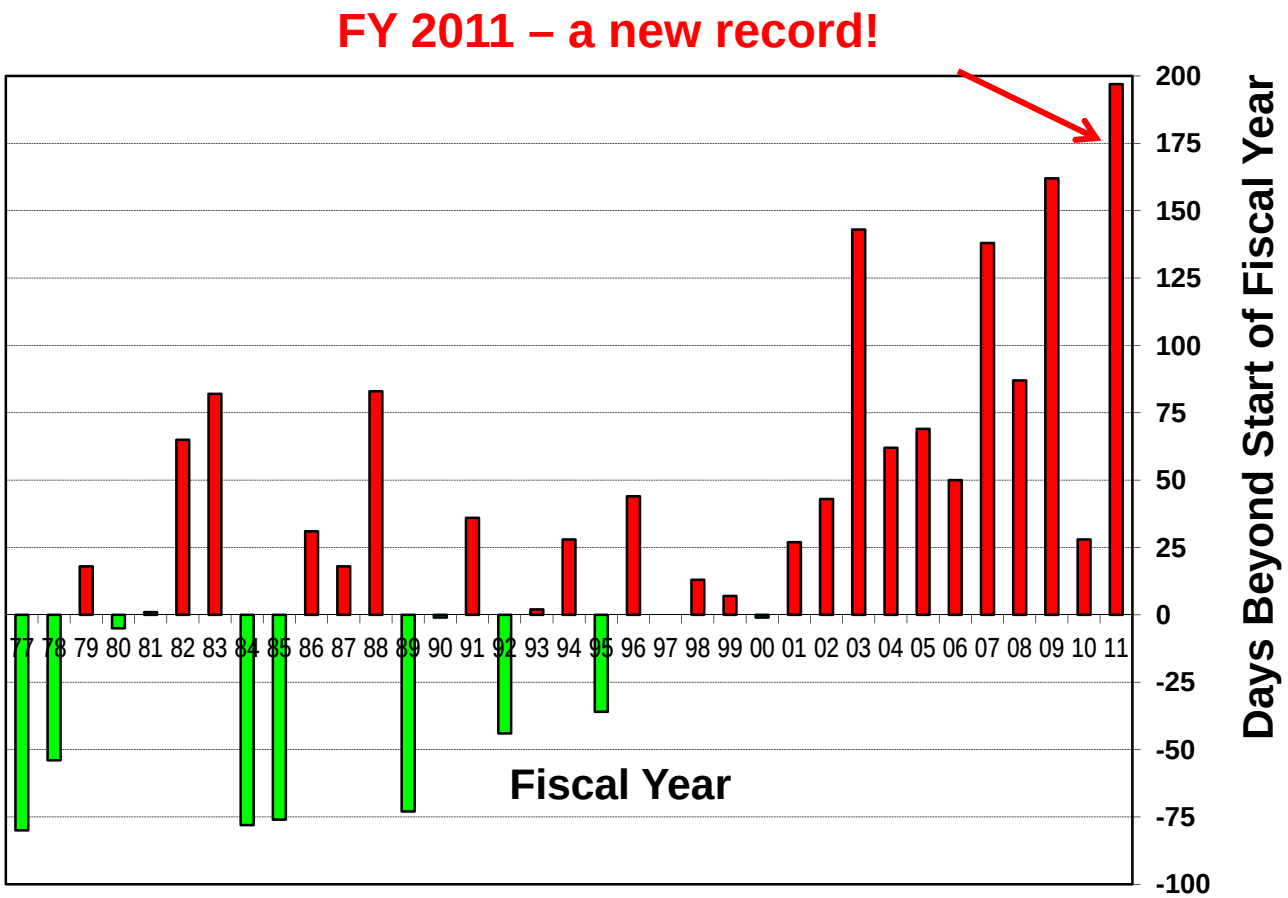


FY 2012 Budget Process – Where we are

BES part of Budget

FY 2011 Appropriation	FY 2012 President's Request	FY 2012 House Energy & Water Committee Recommendation	FY 2012 Senate Energy & Water Committee Recommendation
$1,678M	**$1,985M**	**$1,688M**	**$1,693M**
Included $8.5M for EPSCoR	EPSCoR request $8.5M	No funding for EPSCoR	Includes $20M for EPSCoR
Included $22M for one of the 3 Hubs in SC (JCAP)	Requests 3 new Hubs including Batteries Hub in SC	Includes $20M for new Batteries Hub	Includes $20M for new Batteries Hub

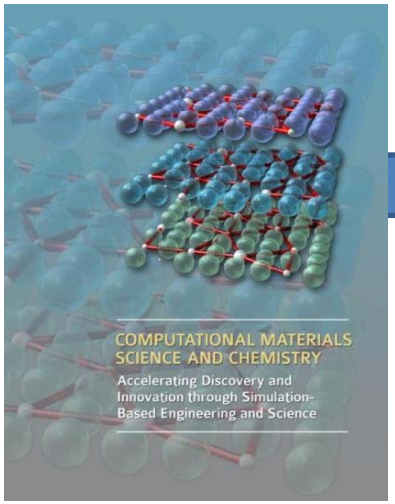
History of the Energy and Water Development (EWD) Appropriation



Budget Uncertainty = Chaos

Materials by Design – Materials Genome Initiative – American Manufacturing

Joint BES-ASCR Workshop, July 2010

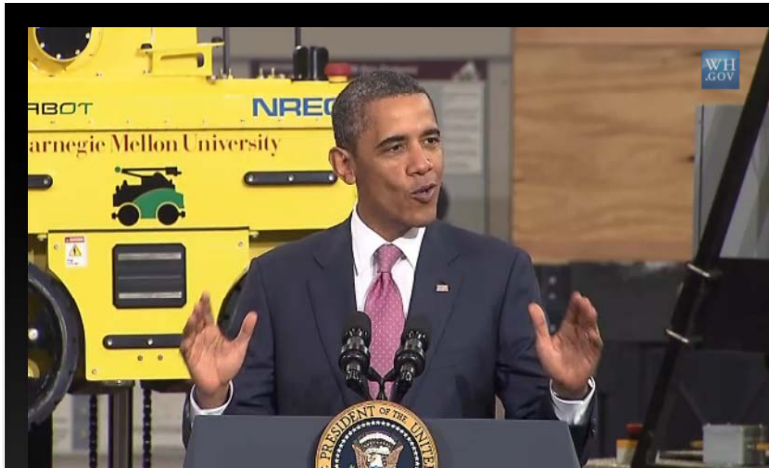


"We are at the threshold of a new era where predictive modeling will transform our ability to design new materials and chemical processes, thereby enabling rational discovery strategies for systems that were not tractable a few years ago."

National Science and Technology Council, Office of Science and Technology Policy

The Materials Genome Initiative will create a new era of materials innovation that will serve as a foundation for strengthening domestic industries …and offers a unique opportunity for the United States to discover, develop, manufacture, and deploy advanced materials at least twice as fast as possible today, at a fraction of the cost.

A Renaissance in American Manufacturing, President Obama Speech on June 24, 2011



President Obama kicks off the ***Advanced Manufacturing Partnership*** *(AMP), a national collaboration between the government, industries, and universities to invest in cutting-edge technologies, create new jobs and bring about a renaissance in American manufacturing. As part of his new AMP, the President is announcing an ambitious plan, the* ***Materials Genome Initiative****, to* *<u>double the speed with which we discover, develop, and manufacture new materials.</u>*

Recurring Themes - BES Strategic Planning

>>1,500 participants from academia, industry, and federal labs

Disruptive, Transformational Advances Require "Control"

Control of materials properties and functionalities through electronic and atomic design

- New materials discovery, design, development, and fabrication, especially materials that perform well under extreme conditions
- "Control" of photon, electron, spin, phonon, and ion transport in materials
- Science at the nanoscale, especially low-dimensional systems
- Designed catalysts
- Designed interfaces and membranes
- Structure-function relationships
- Bio-materials and bio-interfaces, especially at the nanoscale
- New tools for spatial characterization, temporal characterization, and for theory/modeling/computation

http://science.energy.gov/bes/news-and-resources/reports/

Office of Science Early Career Research Program

Proposed investment in FY 2012 would bring ~60 new scientists into the program

To support individual research programs of outstanding scientists early in their careers and to stimulate research careers in the disciplines supported by the Office of Science

Eligibility: Within 10 years of receiving a Ph.D., either untenured academic assistant professors on the tenure track or full-time DOE national lab employees

Award Size: University grants $150,000 per year for 5 years to cover summer salary and expenses

FY 2010 Results:

- 69 awards (47 university, 22 DOE lab) funded via the Recovery Act (ARRA)

FY 2011 Results:

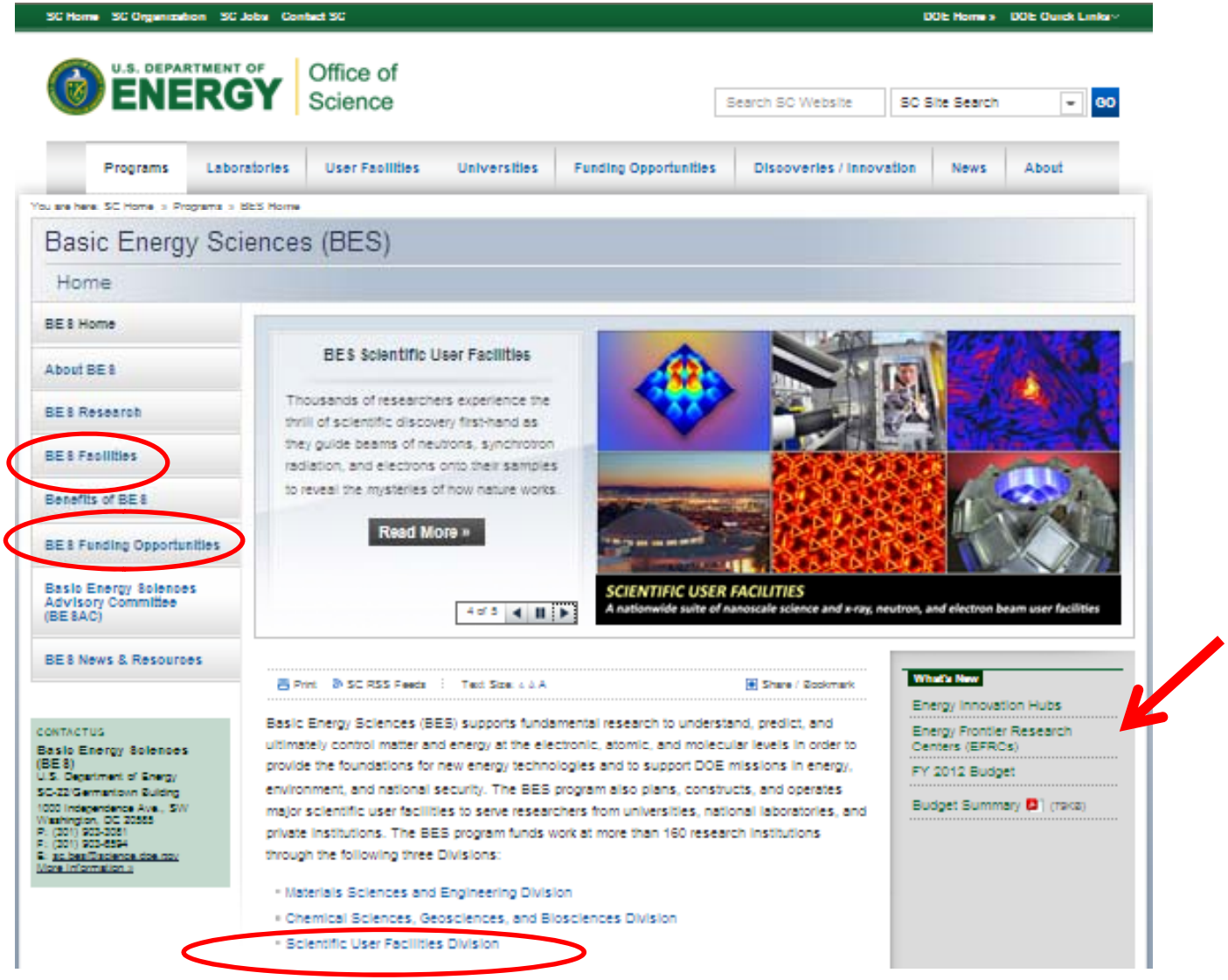
- 69 Awards (47 university, 22 DOE lab) announced in Spring 2011

FY 2012 Process:

- Funding Opportunity Announcement issued in July 2011
  - Pre-applications deadline Sept. 1, 2011
  - Full proposals due November 29, 2011
- Awards to be announced in the Spring of 2012

Currently under evaluation for eligibility and responsiveness to the FOA

More Information? http://science.energy.gov/bes/ *



* Or just Google "DOE BES"