U.S. DEPARTMENT OF ENERGY | Office of Science

Basic Energy Sciences Update

BES Advisory Committee Meeting

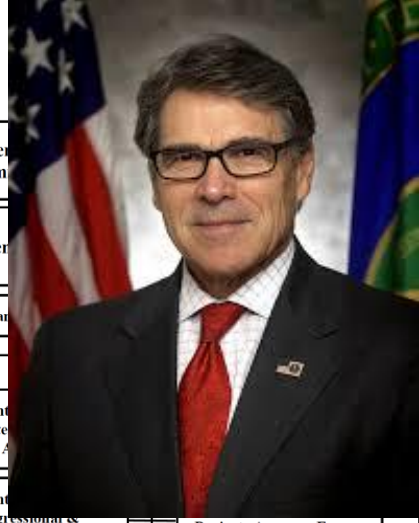
July 13, 2017

Harriet Kung
Director, Basic Energy Sciences
Office of Science, U.S. Department of Energy

Outline

- DOE and BES News
- FY 2017 Appropriation & Program Activities
- FY 2018 President's Request
- New BESAC Charge

DEPARTMENT OF ENERGY



Boards & Councils
- Secretary of Energy Advisory Board
- National Laboratory Policy Council
- Energy Council
- Credit Review Board
- Cyber Council
- Nuclear Security Council
- Jobs Council
- ESAAB

Office of the Secretary
Rick Perry
Secretary

Vacant
Deputy Secretary

Brian McCormack
Chief of Staff

Associate Deputy Secretary

Federal Ener… Regulatory Com…

Inspector Ge…

Ombudsma…

Office of the Under Secretary for Nuclear Security and National Nuclear Security Administration

Frank G. Klotz
Under Secretary for Nuclear Security
Administrator, NNSA

Vacant
Principal Deputy Administrator
NNSA

- Deputy Administrator for Defense Nuclear Nonproliferation
- Deputy Administrator for Naval Reactors
- Associate Administrator for Defense Nuclear Security
- Associate Administrator for External Affairs
- Associate Administrator for Management & Budget
- Office of General Counsel
- Deputy Administrator for Defense Programs
- Deputy Under Secretary for Counter-terrorism & Counter-proliferation
- Associate Administrator for Emergency Operations
- Associate Administrator for Safety, Infrastructure & Operations
- Associate Administrator for Acquisition & Project Management
- Associate Administrator for Information Management & Chief Information Officer

Office of the Under Secretary for Science & Energy

Patricia Hoffman
Acting, Under Secretary for Science and Energy

- Office of Science
- Assistant Secretary for Energy Efficiency and Renewable Energy
- Assistant Secretary for Fossil Energy
- Assistant Secretary for Nuclear Energy
- Assistant Secretary for Electricity Delivery and Energy Reliability
- Indian Energy Policy and Programs
- Office of Technology Transitions[2]

Office of the Under Secretary for Management & Performance

Gena Cadieux
Acting, Under Secretary for Management and Performance

- National Laboratory Operations Board
- Associate Under Secretary for Environment, Health, Safety & Security
- Assistant Secretary for Environmental Management
- Economic Impact & Diversity
- Management
- Chief Human Capital Officer
- Chief Information Officer[1]
- Project Management Oversight & Assessments
- Legacy Management
- Hearings & Appeals

Assistant… Inte…

Assistant… Congressional & Intergovernmental Affairs

- General Counsel
- Chief Financial Officer
- Intelligence & Counterintelligence
- Enterprise Assessments
- Public Affairs
- Small and Disadvantaged Business Utilization
- Projects Agency - Energy
- Energy Policy & Systems Analysis
- Loan Programs Office
- Bonneville Power Administration
- Southwestern Power Administration
- Southeastern Power Administration
- Western Area Power Administration

14 March 2017

[1] The CIO reports directly to the Secretary for the purposes of carrying out responsibilities under Subchapter 44 U.S.C.§ 3506(a)(2)(A).
[2] The director of the Office of Technology Transitions also serves as DOE's Technology Transfer Coordinator who reports to the Secretary of Energy

President Trump Visiting DOE: Unleashing American Energy

June 29, 2017

"The truth is that we have near-limitless supplies of energy in our country. Powered by new innovation and technology, we are now on the cusp of a true energy revolution."

"Today, I am proudly announcing six brand-new initiatives to propel this new era of American energy dominance. First, we will begin to revive and expand our nuclear energy sector -- which I'm so happy about -- which produces clean, renewable and emissions-free energy."

"We will bring new opportunity to the heartland, new prosperity to our inner cities, and new infrastructure all across our nation. When it comes to the future of America's energy needs, we will find it, we will dream it, and we will build it."

Source: Excerpts from President Trump's remarks at the June 29 event.

Office of Basic Energy Sciences

Harriet Kung, Director

Wanda Smith, Administrative Specialist

BES Budget and Planning
Vacant, Financial Management
Donetta Herbert, Financial Management
Thomas Russell, Senior Technical Advisor

BES Operations
Kerry Hochberger, Program Support Specialist
Robin Hayes, Program Manager
Natalia Melcer, Program Manager
Katie Runkles, Program Analyst / BESAC*
Andy Schwartz, Senior Technical Advisor for EFRCs*

* Basic Energy Sciences Advisory Committee
* Energy Frontier Research Centers

Materials Sciences and Engineering Division

Linda Horton, Director
Teresa Crockett, Program Analyst
Vacant, Secretary

Materials Discovery, Design, and Synthesis
Helen Kerch, Acting
Vacant, P.A.

- Materials Chemistry

Condensed Matter and Materials Physics
Jim Horwitz
Marsophia Agnant, P.A.

- Experimental Condensed

Scattering and Instrumentation Sciences
Helen Kerch
Vacant, P.A.

Scientific User Facilities Division

James Murphy, Director
Vacant, Program Support Specialist
Rocio Meneses, Program Assistant

Operations

- X-ray and Neutron

Construction

- Linac Coherent Light Source-II
  Phil Kraushaar
- ilities Upgrades and MIE*** Projects
  Phil Kraushaar
  Ed Stevens

Major Items of Equipment

Chemical Sciences, Geosciences, and Biosciences Division

Bruce Garrett, Director
Diane Marceau, Program Analyst
Vacant, Program Assistant

Fundamental Interactions
Jeff Krause
Vacant, P.A.

- Atomic, Molecular, and Optical Sciences
  Tom Settersten
- Gas Phase Chemical Physics
  Wade Sisk
- Condensed Phase and Interfacial Molecular Science
  Gregory Fiechtner
- Computational and Theoretical Chemistry
  Mark Pederson

Photochemistry and Biochemistry
Gail McLean
Vacant, P.A

- Solar Photochemistry
  Mark Spitler
  Christopher Fecko
- Photosynthetic Systems
  Stephen Herbert
- Physical Biosciences
  Robert Stack
- Fuels from Sunlight Energy Innovation Hub
  Christopher Fecko

Chemical Transformations
Raul Miranda
Vacant, P.A.

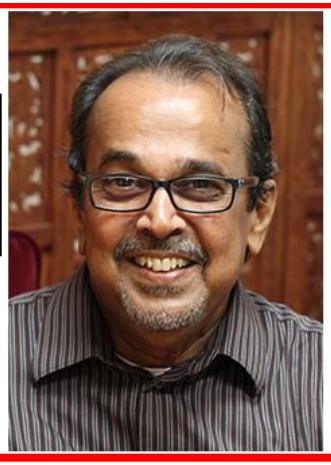
- Catalysis Science
  Viviane Schwartz
  Chuck Peden
  Chris Bradley
- Separations and Analysis
  Philip Wilk
  Vacant
- Heavy Element Chemistry
  Philip Wilk
- Geosciences
  James Rustad

P.A. Program Assistant

Dr. Aravinda Kini

Retired from BES (3/2017) after 15 years' service

Team Lead
Materials Discovery, Design, and Synthesis
Materials Sciences and Engineering Division
Office of Basic Energy Sciences



Dr. Kini joined the Materials Sciences and Engineering Division of DOE's Office of Basic Energy Sciences in February 2002 as the program manager for Materials Chemistry and Biomolecular Materials. He is presently the team lead for the Materials Discovery, Design and Synthesis team. Prior to joining DOE (1986-2002), he worked as a staff scientist in the Chemistry and Materials Science Divisions at Argonne National Laboratory, Argonne, Illinois.

Vacancy

BES FY 2017 Omnibus Appropriation

ENERGY AND WATER DEVELOPMENT AND RELATED AGENCIES APPROPRIATIONS ACT, 2017
May 5, 2017

	FY16 Enacted	FY17 Request	FY17 Enacted
Basic energy sciences:			
Research	1,648,700	1,746,730	1,681,500
Construction:			
13-SC-10 LINAC coherent light source II, SLAC	200,300	190,000	190,000
Subtotal, Basic energy sciences	1,849,000	1,936,730	1,871,500

"Basic Energy Sciences (BES) -The following is the only direction provided for BES. The agreement provides $15,000,000 for the Experimental Program to Stimulate Competitive Research; $26,000,000 for exascale systems; $24,088,000 for the Batteries and Energy Storage Hub; $15,000,000 for the Fuels from Sunlight Hub; $42,500,000 for the Advanced Photon Source Upgrade; $494,059,000 for optimal operations of the five BES light sources, of which $5,000,000 is for the Advanced Light Source Upgrade; and $266,000,000 for the High-Flux Neutron Sources, of which $200,000,000 is for the Spallation Neutron Source, $65,000,000 is for the High-Flux Isotope Reactor, and $1,000,000 is for the Lujan Neutron Scattering Center. The agreement provides the requested level of funding for the Nanoscale Science Research Centers."

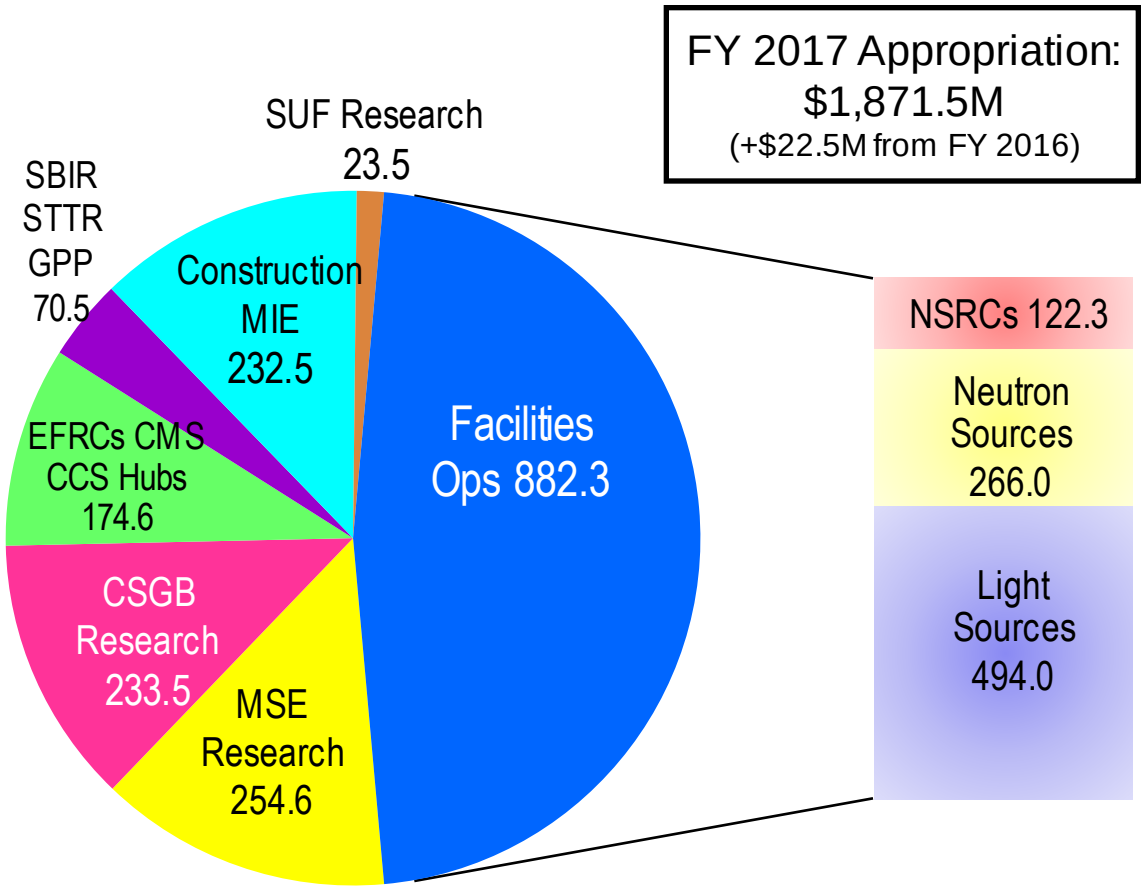
FY 2017 BES Budget Appropriation

Research programs

- Computational Chemical Sciences ($13.5M; Δ = +$13.5M)
- Computational Materials sciences, Energy Frontier Research Centers & Energy Innovation Hubs at FY 2016 level ($161.1M)
- Core research ~2% below FY 2016 ($488.1M; Δ = -$8.1M)

Scientific user facilities

- Facilities at or above optimal operations ($882.3M; Δ = +$17M)
- Lujan D&D ($1M; Δ = -$2M)
- Accelerator & Detector Research ($23.5M; Δ = +$1.3M)



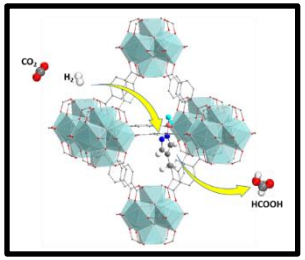
Construction

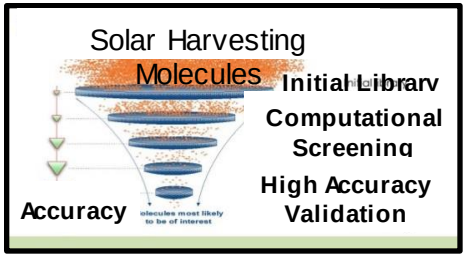
- Advanced Photon Source Upgrade (42.5M; Δ = +$22.5M)
- Linac Coherent Light Source-II ($190M; Δ = -$10.3M)

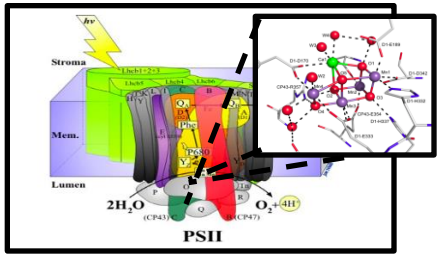
Computational Chemical Sciences
in support of the Exascale Computing Initiative

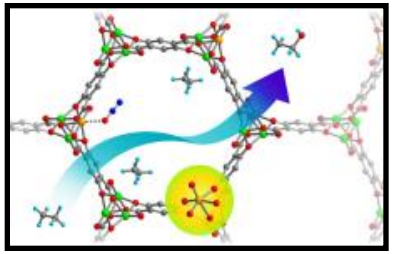
Goal: Open-source community codes to accurately model chemical processes relevant to BES using current petascale and future exascale computers

- $13.5M included in FY17 omnibus appropriation (May 5, 2017)
  - FY17 plan – short timeline required two approaches:
    - Issued lab solicitation for $6M (up to 3 awards of $1.5-2.5M/yr for 4 years) starting in FY17
    - Fund appropriate university grants under the open solicitation for $7.5M
  - Outyear plan – pending appropriation of CCS funding; assumes $13.5M/yr
    - Forward-funded university projects will allow additional CCS awards in FY18
    - Ongoing 4-year cycle with new solicitations in FY21 and FY22, pending funding availability
- Opportunities to advance computational chemical sciences identified in Computational Materials Science and Chemistry (2010) and BES Computing and Data Requirements in the Exascale Age (2017)









Images illustrate examples of target applications (catalysis, solar photochemistry, photosynthesis, separations)

NSLS-II Experimental Tools (NEXT) at BNL

The project has delivered five world-class scientific instruments for NSLS-II:

- Electron SpectroMicroscopy (ESM)
- In-Situ and Resonant Hard X-ray Studies (ISR)
- Inner Shell Spectroscopy (ISS)
- Soft Inelastic X-ray Scattering (SIX)
- Soft Matter Interfaces (SMI)

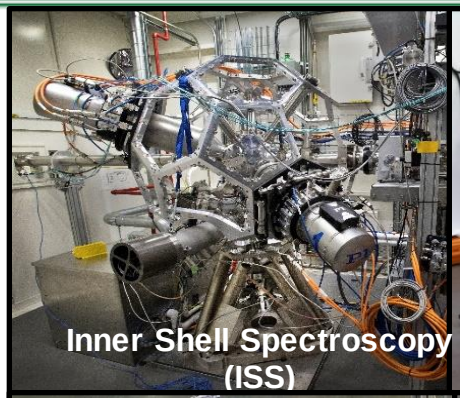
Total Project Cost: $90M

Project Status:

- Office of Project Assessment Review May 31- June 1, 2017, **recommending CD-4 approval**

Timeline:

✓ May 2010 CD-0, Approve Mission Need
✓ Dec 2011 CD-1, Approve Alternative Selection & Cost Range
✓ Oct 2013 CD-2, Approve Performance Baseline
✓ Jul 2014 CD-3, Approve Start of Construction
Aug 2017 CD-4, Approve Start of Operations



Basic Research Needs for Future Nuclear Energy

August 9-11, 2017

Workshop Chair: Kelly Beierschmitt (INL)

Associate Chairs: Michelle Buchanan (ORNL)
Aurora Clark (WSU)
Ian Robertson (UW-Madison)

SC Technical Leads: Linda Horton and John Vetrano (BES)

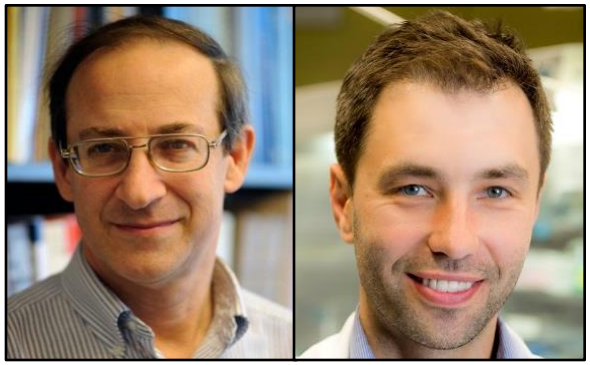
Charge: Identify high priority basic research to enable future generations of nuclear energy systems. The workshop will identify basic research needs for understanding and improving the performance of materials and chemistry in the extreme environments anticipated for future nuclear reactors for civilian energy generation. Significant technological challenges have emerged as new concepts for next generation systems are planned and imagined. These challenges relate to enhanced performance and lifetimes of materials and fuels in environments that couple radiation with corrosion, high temperatures, and extended lifetimes.

Breakout Sessions and Chairs:

Design and Discovery of Coolants and Liquid Fuels: Phil Britt (ORNL) and Alexandra Navrotsky (UC-Davis)
Physics and Chemistry of Interfaces: Amit Misra (U of Michigan) and Jim Wishart (BNL)
Understanding Behavior at Coupled Extremes: Bruce Mincher (INL) and Izabela Szlufarska (UW-Madison)
Design and Discovery of Structural Materials and Solid Fuels: Peter Burns (Notre Dame) and Pete Tortorelli (ORNL-retired)
Crosscutting Themes: Paul Fenter (ANL), Andy Gewirth (UIUC) and Brian Wirth (UT- Knoxville)

Plenary Session Speakers: Kevan Weaver, TerraPower; John Herczeg, DOE Office of Nuclear Energy; Sheng Dai, ORNL; Laura Gagliardi, University of Minnesota; Robin Grimes, Imperial College

BES Research Opportunities at the Frontiers of XFEL Ultrafast Science



Roundtable Co-Chairs: Tony Heinz (SLAC)
Oleg Shpyrko (UCSD)

Dates: October 25-26, 2017

Location: Gaithersburg Marriott Washingtonian Center

Size: Up to 30 external participants (national and international)

BES Team: Helen Kerch (lead), Tom Settersten, Lane Wilson

Charge:

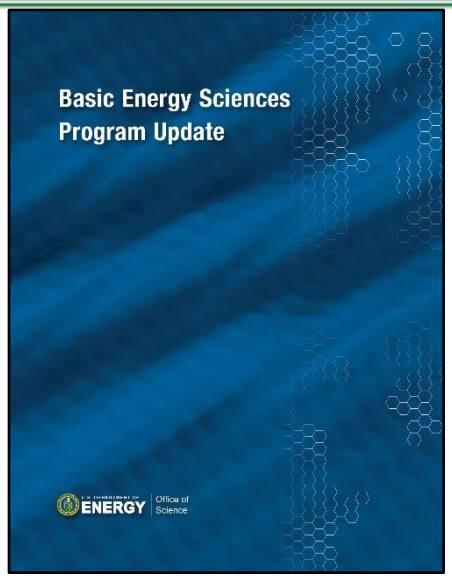
- Identify the research priorities, key science drivers and research strategies for the BES research portfolio that uses LCLS, including its prospective upgrades.
- Illuminate areas where gaps exist between the current BES research portfolio and LCLS-II capabilities.

Breakout Panels / Discussion Topics:

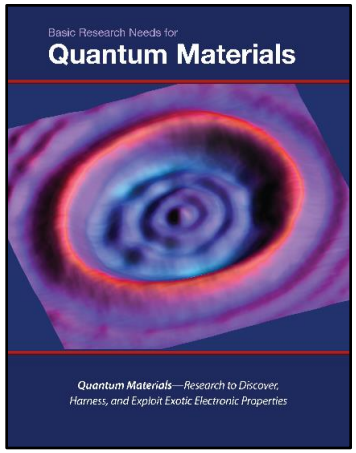
- Imaging Nuclear Dynamics
- Imaging Charge Dynamics
- Inducing and Probing Collective States
- High Field, Attosecond Frontier

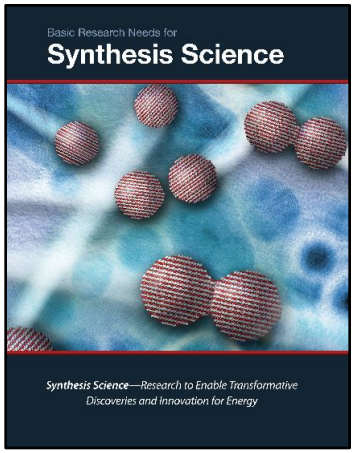
BES Communications

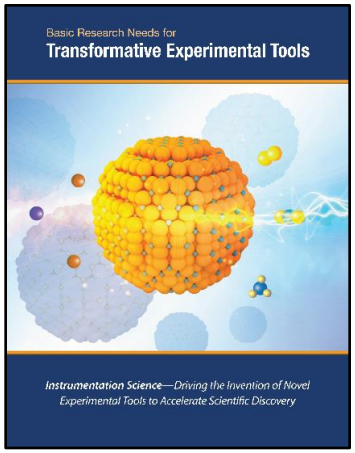
- **BES 2017 Program Update**
  - Annual publication that describes updates to the BES program in FY 2016, including major new awards and strategic planning activities. It also describes select research highlights from the three divisions in BES.

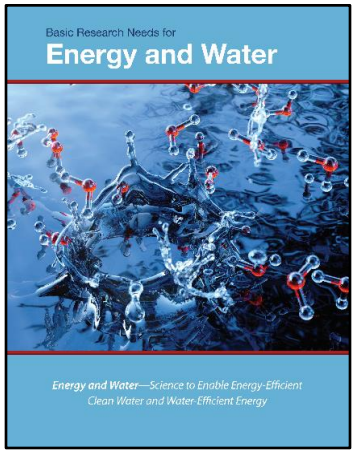


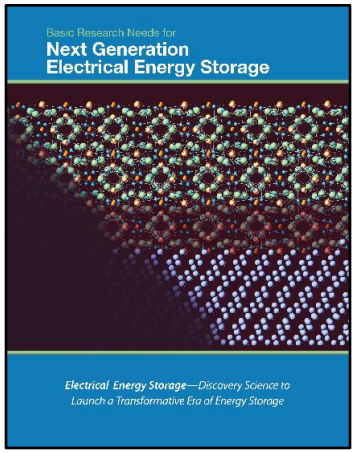
- **BRN Workshop Report Brochures**





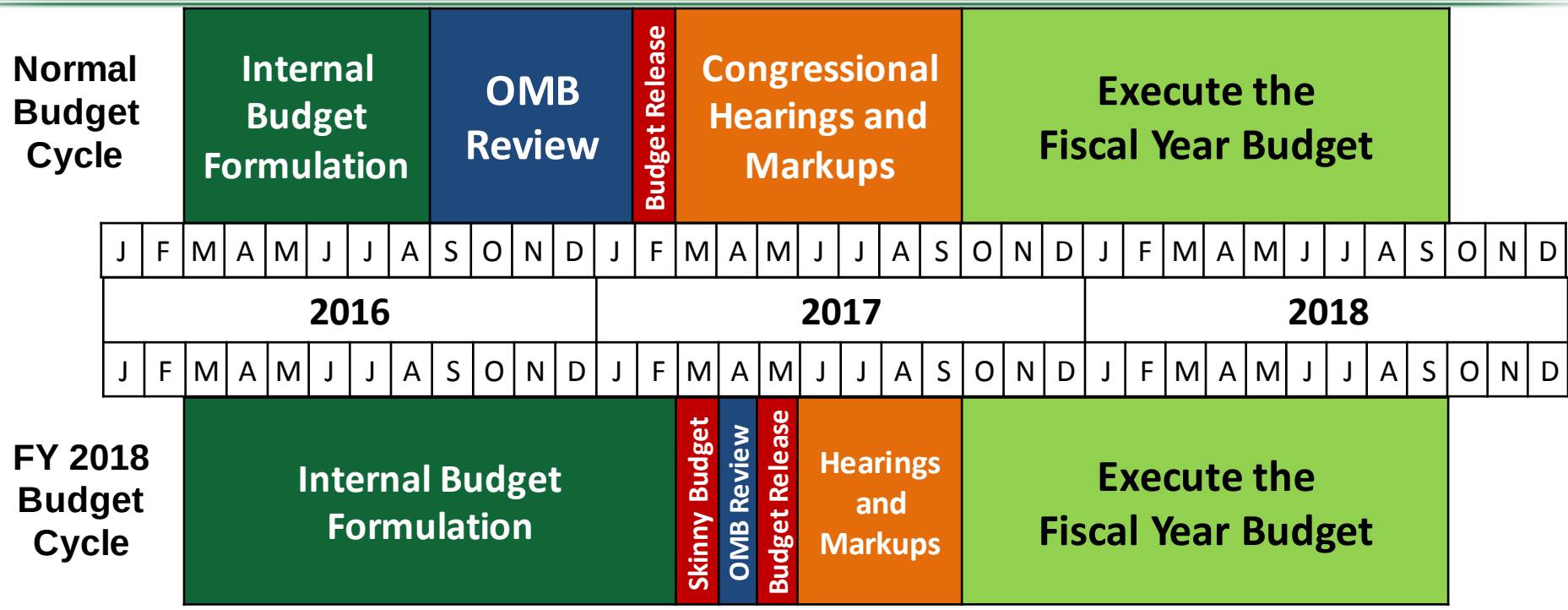






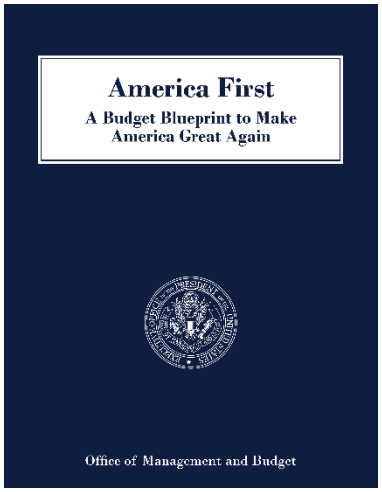
https://science.energy.gov/bes/community-resources/overview-brochures/

FY 2018 Federal Budget Cycle



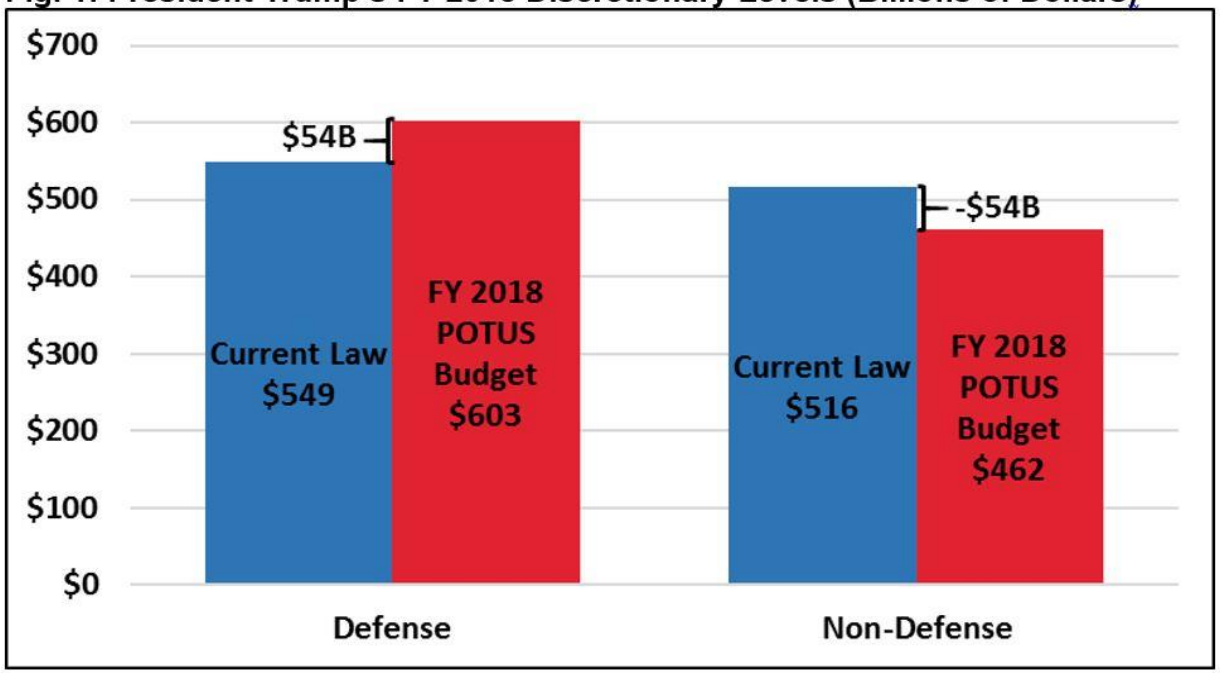
- The White House released the Skinny Budget on March 13th which included the bottom line for the Office of Science.
- The FY 2018 President's Budget Request was released on May 23rd with lower level details.
- The budget cycle was compressed this year due to the change in Administration.
- Since 1977, Congress passed all twelve regular appropriations bills by October 1st in: 1977, 1989, 1995, and 1997.

FY 2018 President's Budget Blueprint



March 13, 2017

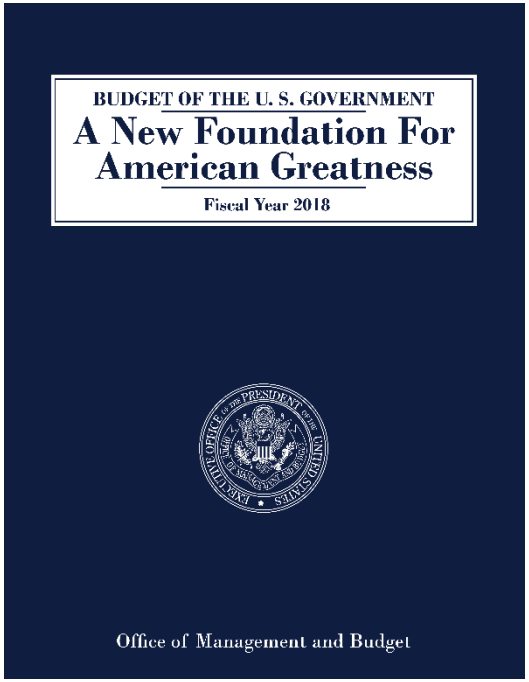
Fig. 1: President Trump's FY 2018 Discretionary Levels (Billions of Dollars)



Sources: Office of Management and Budget, Congressional Budget Office
http://www.crfb.org/papers/president-trumps-fy-2018-skinny-budget

"The core of my first Budget Blueprint is the rebuilding of our Nation's military without adding to our Federal deficit. There is a $54 billion increase in defense spending in 2018 that is offset by targeted reductions elsewhere."
- President Trump, America First: A Budget Blueprint to Make America Great Again

FY 2018 President's Budget Request

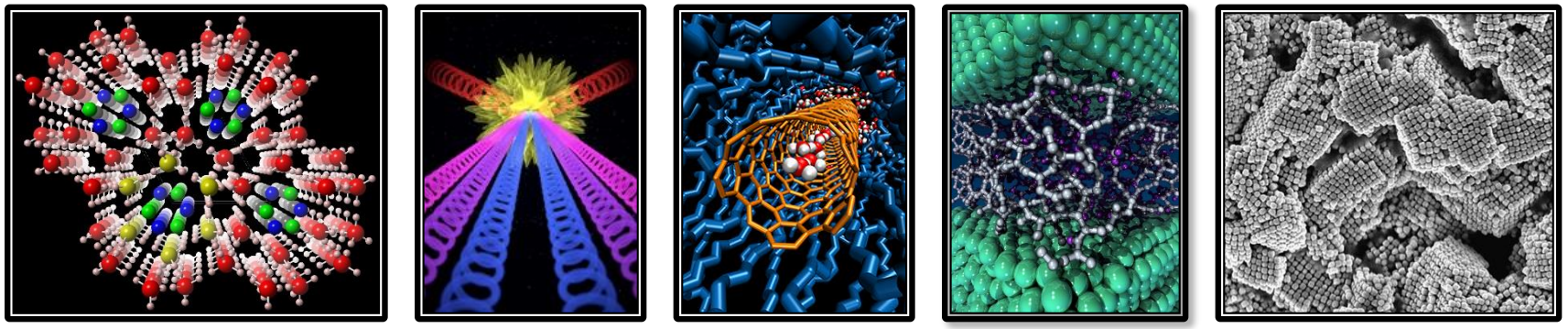


May 23, 2017

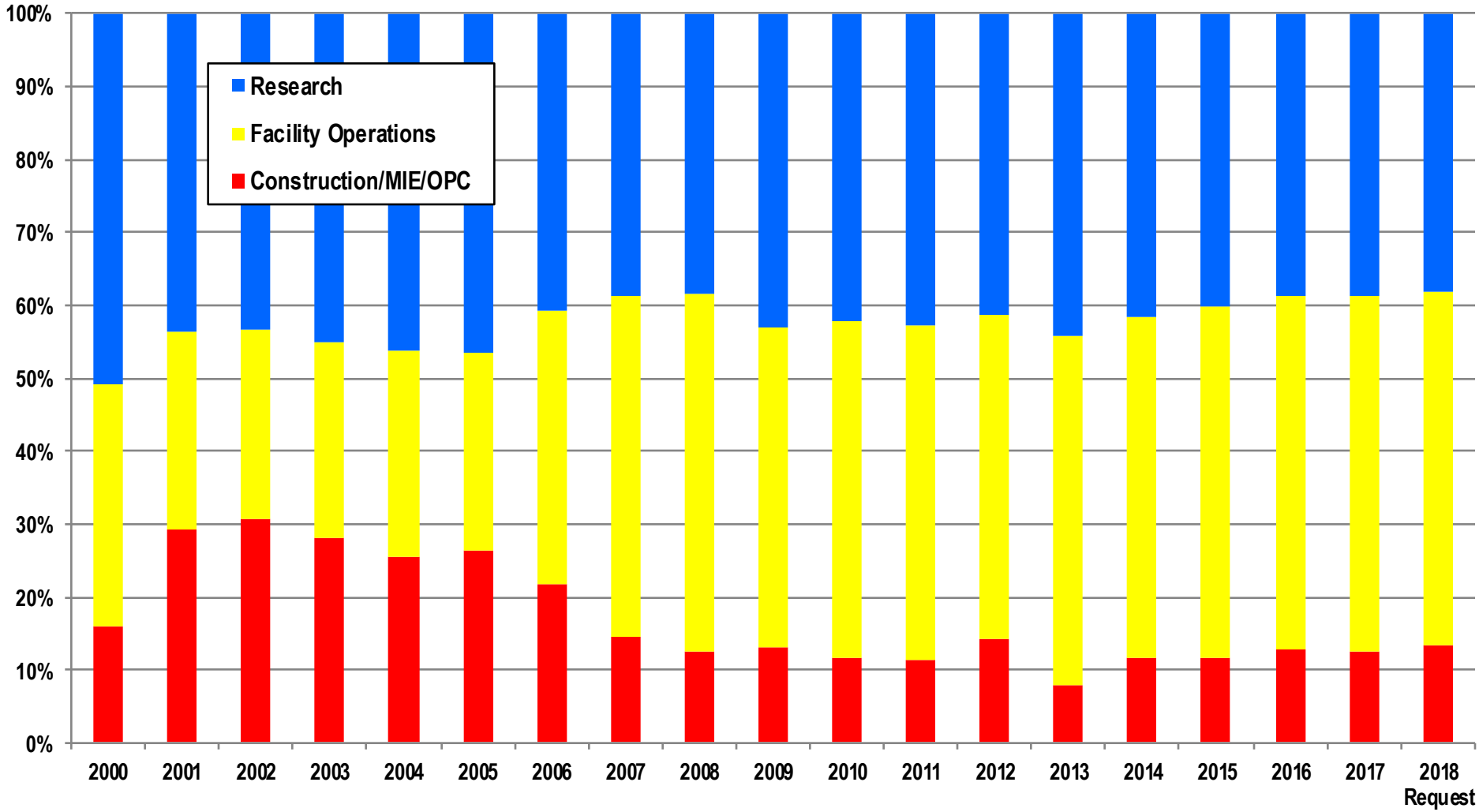
- The FY 2018 budget attempts to refocus and refine DOE's mission on several critical fronts that directly affect the safety and security of the American public:
  - Modernize the country's nuclear weapons arsenal
  - Achieve exascale computing
  - Advance the Nation's nuclear waste management program
  - Protect the national electric grid from cyberattacks
  - Shift the Department's focus to early-stage research and development
- The BES FY 2018 Request is an overlay of:
  - Administration priorities
  - SC priorities (e.g., exascale computing, quantum information science)
  - BES priorities (BESAC reports, BES strategic planning in "Basic Research Needs" workshops)

Overview of BES FY 2018 President's Request

- The BES FY 2018 Request of **$1,554.5 million** is a decrease of $317 million or 17% from the FY 2017 Enacted level.
- The overall research funding in FY 2018 is reduced by 18% from FY 2017, requiring a significant shift in priorities with targeted reductions of activities that extend to later-stage fundamental research. Both the core research and the EFRC program will emphasize emerging high priorities in quantum materials and chemistry, catalysis science, synthesis, and instrumentation science.
- No funding is requested for the two BES-supported **Energy Innovation Hubs**, Batteries and Energy Storage and Fuels from Sunlight, or for the DOE Experimental Program to Stimulate Competitive Research.
- All BES **user facilities** will operate at below optimal levels. Selected light source beamlines and neutron flight paths will be shut down. The Stanford Synchrotron Radiation Lightsource will operate up to the first quarter and then transition to a warm standby status. No funding is requested for two **Nanoscale Science Research Centers:** the Center for Functional Nanomaterials or the Center for Integrated Nanotechnologies.
- No funding is requested for **Long Term Surveillance and Maintenance** or for the disposition of unused equipment for the **Lujan Neutron Scattering Center**.
- To maintain international competitiveness of our facilities, BES will continue to support the **Linac Coherent Light Source-II (LCLS-II)** and **Advanced Photon Source Upgrade (APS-U)** projects. APS-U will transitions from a major item of equipment to a line item construction project.



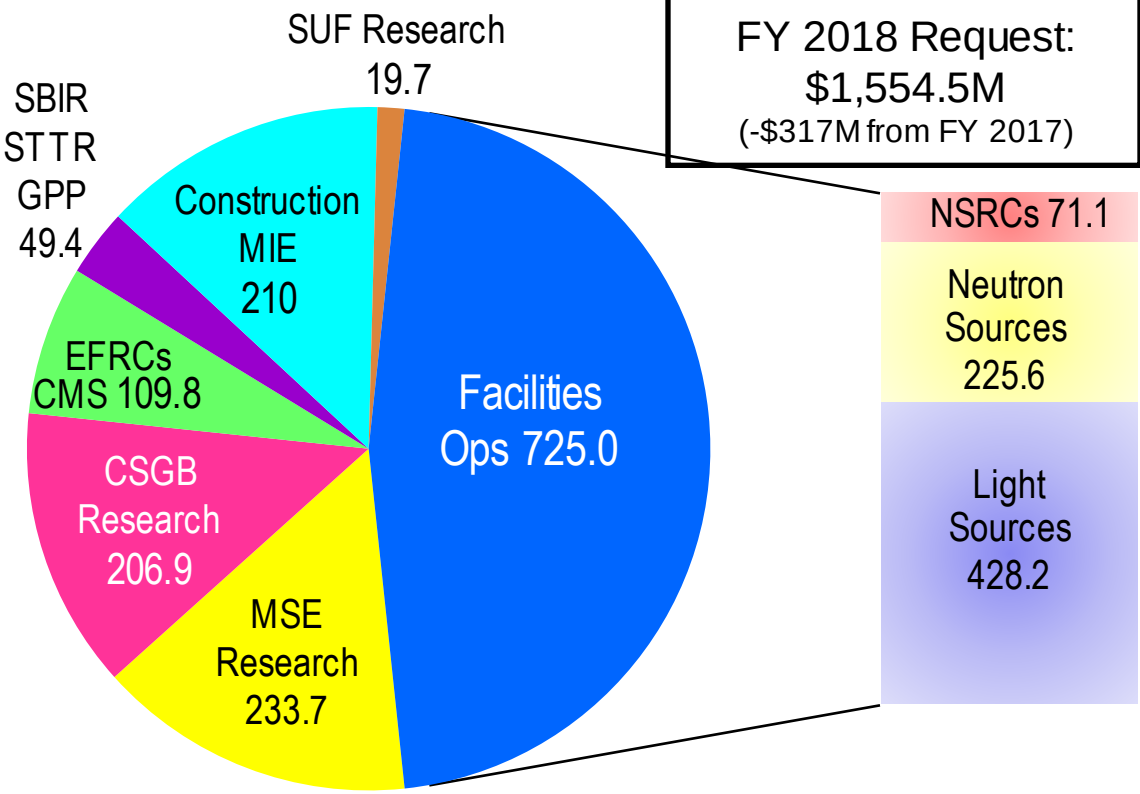
BES Portfolio Balance



FY 2018 BES Budget Request

Research programs

- Core Research reductions will target lower priority topics, while emphasizing quantum materials and chemistry, catalysis science, synthesis, and instrumentation science. (Δ = -$36.8M)
- Energy Frontier Research Centers will be recompeted. (Δ = -$11.1M)
- No funding is requested for the two Energy Innovation Hubs. (Δ = -$39.1M)
- No funding is requested for EPSCoR. (Δ = -$14.5M)



Scientific user facilities

- SSRL transitions to warm standby. (Δ = -$22M)
- No funding is requested for CFN and CINT (Δ = -$44M), Lujan equipment disposition (Δ = -$1.0M), or Long Term Surveillance and Maintenance. (Δ = -$10.7M)
- Remaining facilities at below optimal operations (Δ = -$90.4M)

Construction

- Advanced Photon Source Upgrade (transitions from major item of equipment to line item construction) (Δ = -$22.5M)
- Linac Coherent Light Source-II (at FY 2017 level)

BES Research Priorities

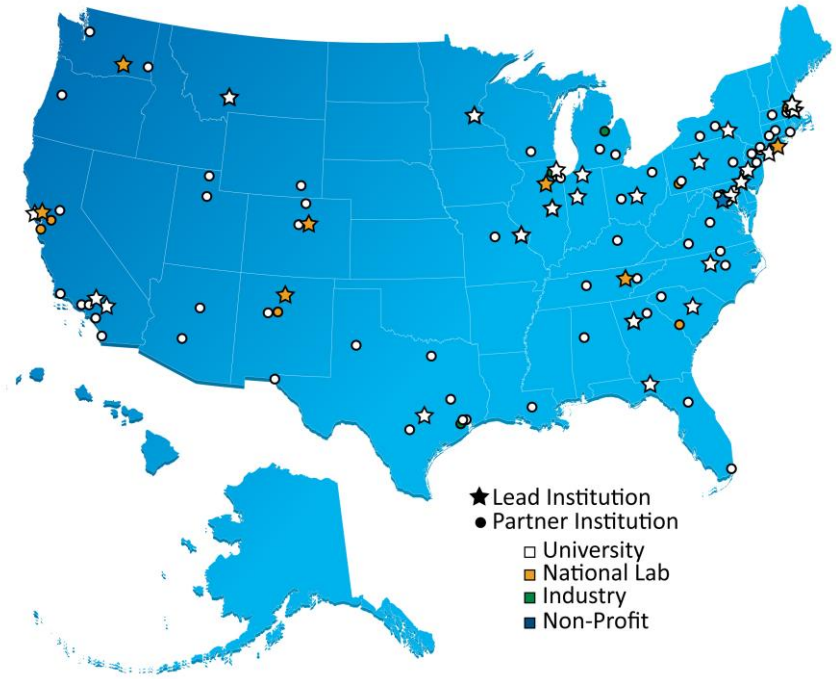
FY 2017 = $488.1M; FY 2018 = $440.6M

- **Transformative Opportunities for Discovery Science**
  - Five new transformative opportunities that have the potential to further transform key technologies involving matter and energy
- **Quantum Materials and Chemistry**
  - Discover novel materials and chemistries whose properties result from strong and coherent interactions of constituent electrons with each other, the atomic lattice, or light. Focus on low-dimensional systems, multilayered two-dimensional structures, and studies of electronic properties.
- **Catalysis Science**
  - Develop the understanding of catalytic mechanisms required to discover and design novel selective catalysts for conversions of complex feedstocks using lower temperature and pressures.
- **Energy-Water Issues**
  - Generate fundamental knowledge of the role, dynamics, and control of aqueous systems in energy and chemical conversions to better understand the interdependency of energy-water use and production.
- **Energy Storage**
  - Provide the scientific foundation for next-generation energy storage, building on in situ and operando measurements and comprehensive computer models to capture coupled electro-chemical-mechanical phenomena, including dynamics and mesoscale effects.
- **Crosscutting: Synthesis and Instrumentation**
  - Investigate controlled synthesis and assembly of nanoscale materials and molecules into functional matter with desired properties, low temperature synthesis under mild conditions, and bio-inspired synthetic approaches.
  - Develop real-time monitoring tools, *in situ* diagnostic techniques, and instrumentation to study changes in structure and properties of materials and chemical processes at the levels of atoms and molecules in real-world systems.

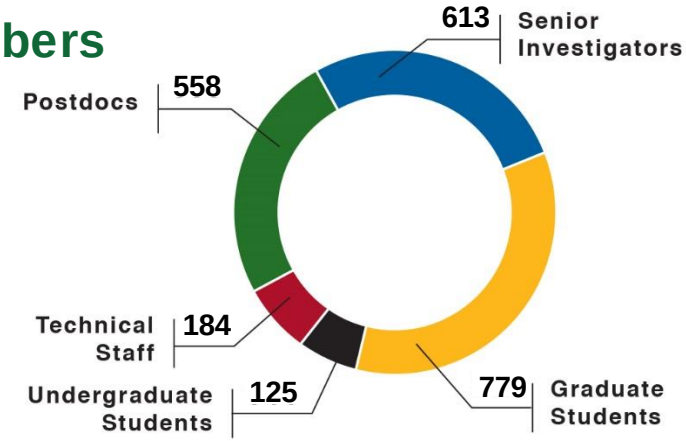
Energy Frontier Research Centers
FY 2017 = $110M; FY 2018 = $99M

Current EFRCs

- 36 awards of $2-4M per year for 4 years
- Lead institutions by type: **26 universities; 9 DOE national laboratories; 1 nonprofit organization**
- Over 115 participating institutions, located in 34 states plus the District of Columbia



EFRC Members



FY 2018 President's Request

- Planned open recompetition of the EFRC program in FY 2018, soliciting both new and renewal proposals
- Continued focus on the use of the team research modality to tackle "grand challenges" and "transformative opportunities" identified in BESAC reports
- Emphasis on emerging science priorities related to quantum materials and chemistry, catalysis, synthesis, instrumentation, next-generation energy storage, future nuclear energy, and energy-water issues

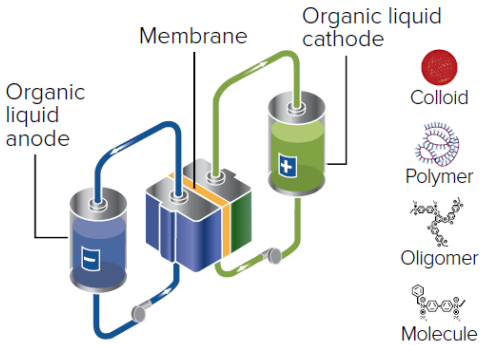
Energy Innovation Hubs
Joint Center for Artificial Photosynthesis (JCAP) & Joint Center for Energy Storage Research (JCESR)

FY 2018 Request:
- No funding is requested in FY 2018 for the BES-supported Energy Innovation Hubs
- BES will work with JCAP and JCESR to implement a plan to ensure tools and knowledge created in the Hubs are available to the broader scientific communities.

JCAP Legacies:
- Stable integrated research prototype that splits water to produce hydrogen at greater than 10% efficiency
- Novel experimental high throughput and benchmarking capabilities for catalysts and light absorbers
- Basic scientific understanding of complex catalytic mechanisms and new materials for driving photochemical transformations

JCESR Legacies:
- Library of fundamental scientific knowledge of energy storage phenomena and materials at the atomic and molecular level, including data and software
- Novel approaches, materials, and chemistries incorporated into research prototype batteries for grid and transportation
- New paradigm for energy storage research

Solar simulator and photoelectrochemical cell for testing light harvesting by thin-film electrodes



Revolutionary membranes and redox-active macromolecules for flow batteries

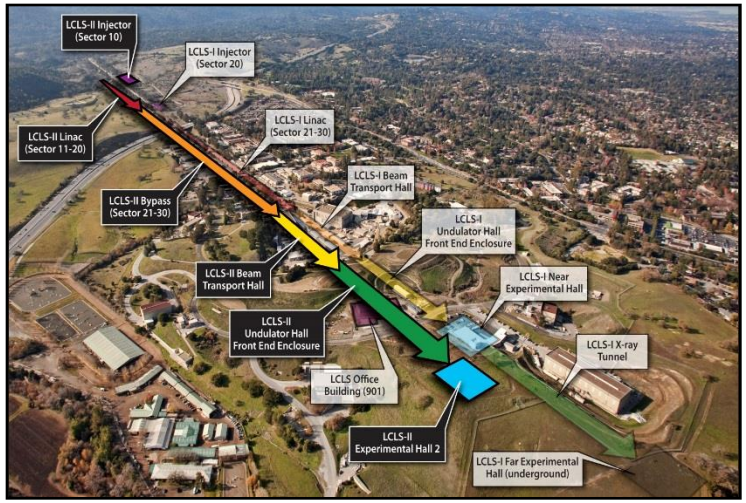
BES Scientific User Facilities
FY 2017 = $882.3M; FY 2018 = $725M

- **Four of the five x-ray light sources will continue operations and be supported at ~10% below FY 2017 Enacted level at about 85% optimal operation level**
- **The Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory will have limited operations up to the first quarter of the fiscal year before transitioning to a warm standby status.**
- **The Spallation Neutron Source and High Flux Isotope Reactor operations will be reduced by ~15% from the FY 2017 enacted level at about 82% optimal operation level.**
- **Three of the five NSRCs will be supported at ~9% below FY 2017 with reduced scientific thrusts and core capabilities.**
- **No funding is requested for the Center for Functional Nanomaterials at Brookhaven National Laboratory and the Center for Integrated Nanotechnologies at Sandia and Los Alamos National Laboratories.**
- **For operating facilities:**
  - Operating hours and user support will be reduced.
  - Some beamlines/instruments may have to be shut down with a commensurate reduction in staff and users.
  - Maintenance, upgrades, and procurement activities will be deferred.

LCLS-II and APS-U Construction Projects

Linac Coherent Light Source-II (LCLS-II)

- FY 2017 = $190,000K; FY 2018 = $190,000K for R&D, design, prototyping, long lead procurement, construction of technical systems, installation, and commissioning.
- When completed, LCLS-II will provide high-repetition-rate, ultra-bright, transform-limited femtosecond x-ray pulses with polarization control and pulse length control to ~1 femtosecond. The hard x-ray range will be expanded to 25 keV.
- The upgrade adds a 4 GeV superconducting linac; an electron injector; and two undulators, which will provide x-rays in the 0.2–5 keV energy range.



Advanced Photon Source Upgrade (APS-U)

- FY 2017 = $42,500K; FY 2018 = $20,000K for R&D, design, prototyping, and long lead procurements.
- **APS-U is transitioned from a major item of equipment to line item construction project.**
- APS-U will provide a multi-bend achromat lattice to provide extreme transverse coherence and extreme brightness.
- Initial conceptual design for the new lattice completed; conducting R&D and key component prototyping in support of the new design. -Key performance parameters are being defined for the project and the new storage ring.

SCIENCE

Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for science activities in carrying out the purposes of the Department 8 of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or facility or for plant or facility acquisition, construction, or expansion, and purchase of not more than 16 passenger motor vehicles for replacement only, including one ambulance and one bus, **$5,392,000,000**, to remain available until expended: Provided, That of such amount, **$177,000,000** shall be available until September 30, 2019, for program direction.

BASIC ENERGY SCIENCES

The Basic Energy Sciences program funds basic research in materials science, chemistry, geoscience, and bioscience. **The science breakthroughs in this program enable a broad array of innovation in energy technologies and other industries critical to American economic competitiveness.**
Research.-The recommendation provides no funding for the continued operation of the Batteries and Energy Storage Innovation Hub and the Fuels from Sunlight Innovation Hub. However, the recommendation includes **$10,000,000** for competitive awards that continue similar research activities previously supported by the Hubs. Within available funds, the Committee directs the continued support of all the nanoscience research centers and urges optimal operations for all the light sources. The recommendation includes **$15,000,000** for the Experimental Program to Stimulate Competitive Research, **$489,109,000** for facilities operations of the nation's light sources, **$261,000,000** for facilities operations of the high flux neutron sources, and $**122,272,000** for facilities operations of the nanoscale science research centers.

FY 2018 HEWD Appropriations: Basic Energy Sciences

July 11, 2017

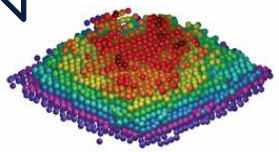
	FY 2017 Enacted Approp.	FY 2018 President's Request	FY 2018 House Mark	FY 2018 House Mark vs. FY 2017 Enacted		FY 2018 House Mark vs. FY 2018 President's Request	
Research	1,681,500	1,352,400	1,612,400	-69,100	-4.11%	260,000	19.23%
Construction							
13-SC-10 Linac Coherent Light Source-II, SLAC	190,000	182,100	192,100	2,100	1.11%	10,000	5.49%
18-SC-10 APS Upgrade, ANL	.....	20,000	67,000	67,000	0.00%	47,000	235.00%
Total, Construction	190,000	202,100	259,100	69,100	34.19%	57,000	28.20%
Total	**1,871,500**	**1,554,500**	**1,871,500**	.....	**0.00%**	**317,000**	**20.39%**

- Core research increases ~1% over FY17.
- EFRCs, CMS, CCS, EPSCoR flat with FY17.
- No funding for the Hubs, but $10M designated for competitive awards to continue similar research.
- All facilities funded at or near FY17 levels.
- APS-U increases to $67M (+$24.5M) and converts to line item construction.
- LCLS-II increases to $200M, $10M above FY17.

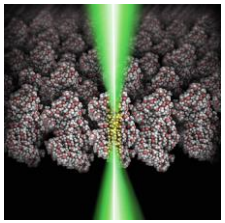
BES & Quantum Information Science

- Quantum materials and chemistry supported by BES core research and EFRCs are foundational to exploring and controlling novel quantum behaviors.
- BES Nanoscale Science Research Centers capabilities are key to nano-to-micro-scale electronic/ photonic quantum structure fabrication. Integration and testing will couple closely with theory, design and systems efforts.
- Research will enable next-generation qubit concepts, innovative quantum and classical architectures (beyond ion traps, quantum dots, nitrogen vacancies, donor centers, etc.)

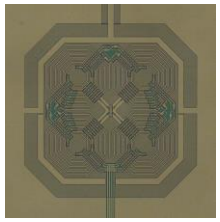
Theory, Modeling, Synthesis, Characterization, Design, Fabrication, Prototypes



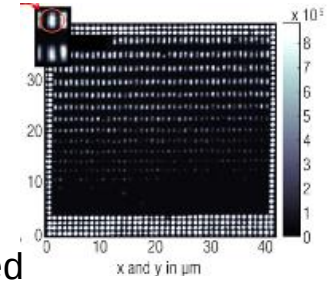
Characterization with Atomic Spatial Resolution and Ultrafast Precision



Single-nm lithography



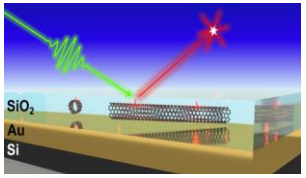
Quantum-Limited Sensors



Entangled Qubit Arrays

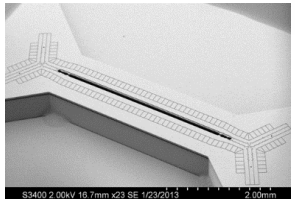
Quantum Chip Testing

Atomic Precision Fabrication



Single Photon Emitters and Detectors

Nanoscale 3D Printing



Waveguides, Cavities, Traps

Quantum Computing

Encrypted Communi-cations

Sensors & Detectors

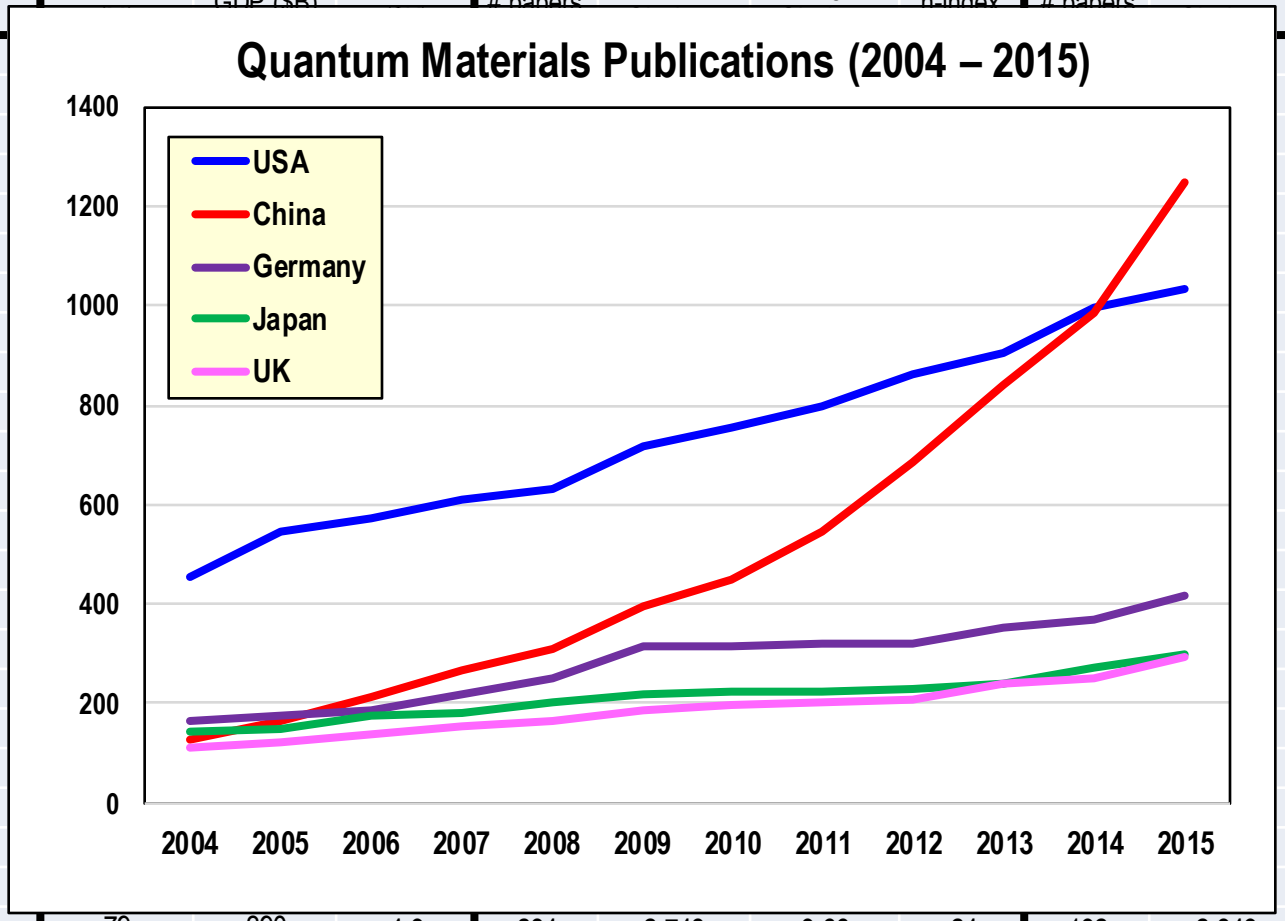
ASCR, HEP NP, BER

U.S. DEPARTMENT OF ENERGY | Office of Science

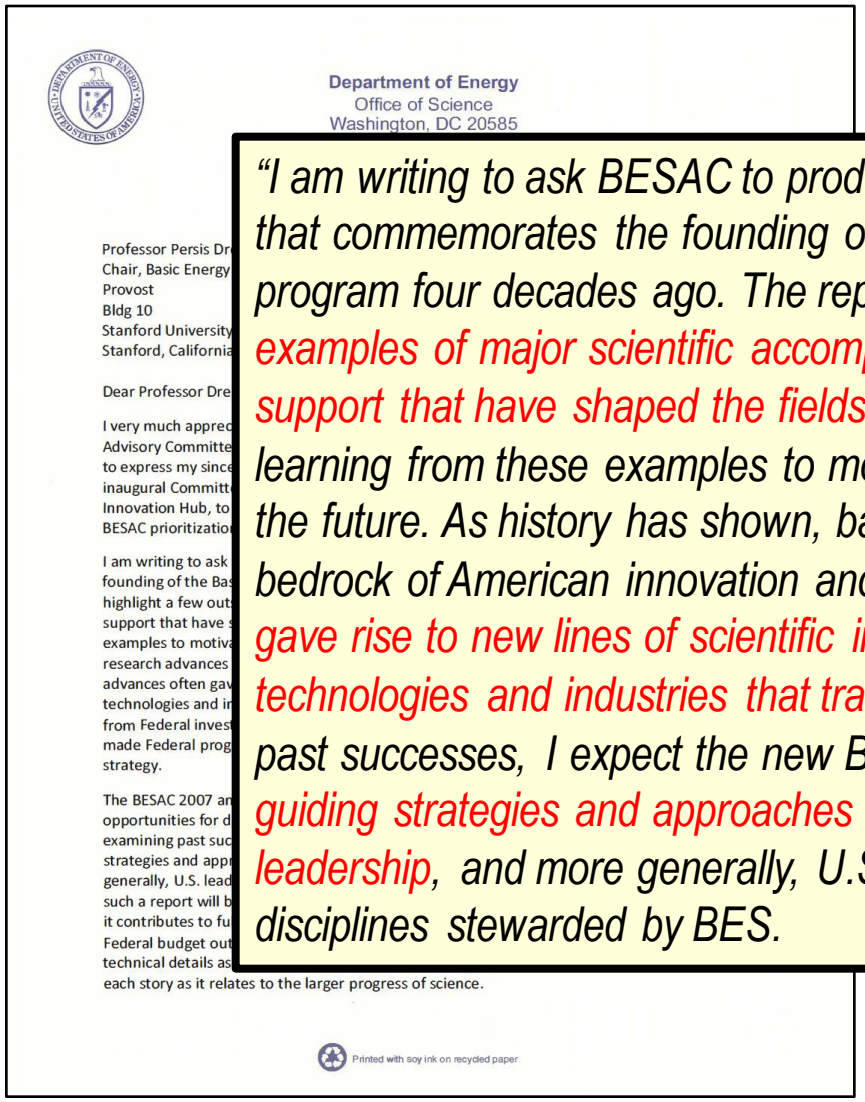
BES

Quantum Materials & Quantum Chemistry:
Web of Science Stats: 2004 - 2015

				Quantum Materials				Quantum Chemistry			
Country	Population	GDP ($B)	GDP/PC	# papers	Total Citations	Avg. Citations	h-index	# papers	Total Citations	Avg. Citations	h-index
USA										38.06	163
China										17.85	90
Germany										35.51	100
Japan										20.44	57
UK										46.84	79
France										34.17	75
India										14.75	40
South Korea										37.75	41
Italy										25.5	59
Canada										32.79	58
Russia										20.72	37
Spain										24.14	58
Taiwan										23.28	30
Switzerland										41.18	56
Australia										29.58	43
Poland										16.31	36
Netherlands										77.09	47
Sweden										40.44	50
Brazil										14.11	27
Singapore										57.21	25
Belgium										22.11	41
Austria										27.79	31
Iran	79	390	4.9	284	2,743	9.66	24	192	2,349	12.23	23
Israel	8.4	299	36	272	13,022	47.88	54	147	3,675	25	31
Czech Rep	11	185	17	257	5,947	23.14	35	227	5,739	25.28	32
Denmark	5.7	295	52	194	6,873	35.43	39	143	5,220	36.5	31



New BESAC Charge from Dr. Binkley (June 16, 2017)



Department of Energy
Office of Science
Washington, DC 20585

Professor Persis Dr
Chair, Basic Energy
Provost
Bldg 10
Stanford University
Stanford, California

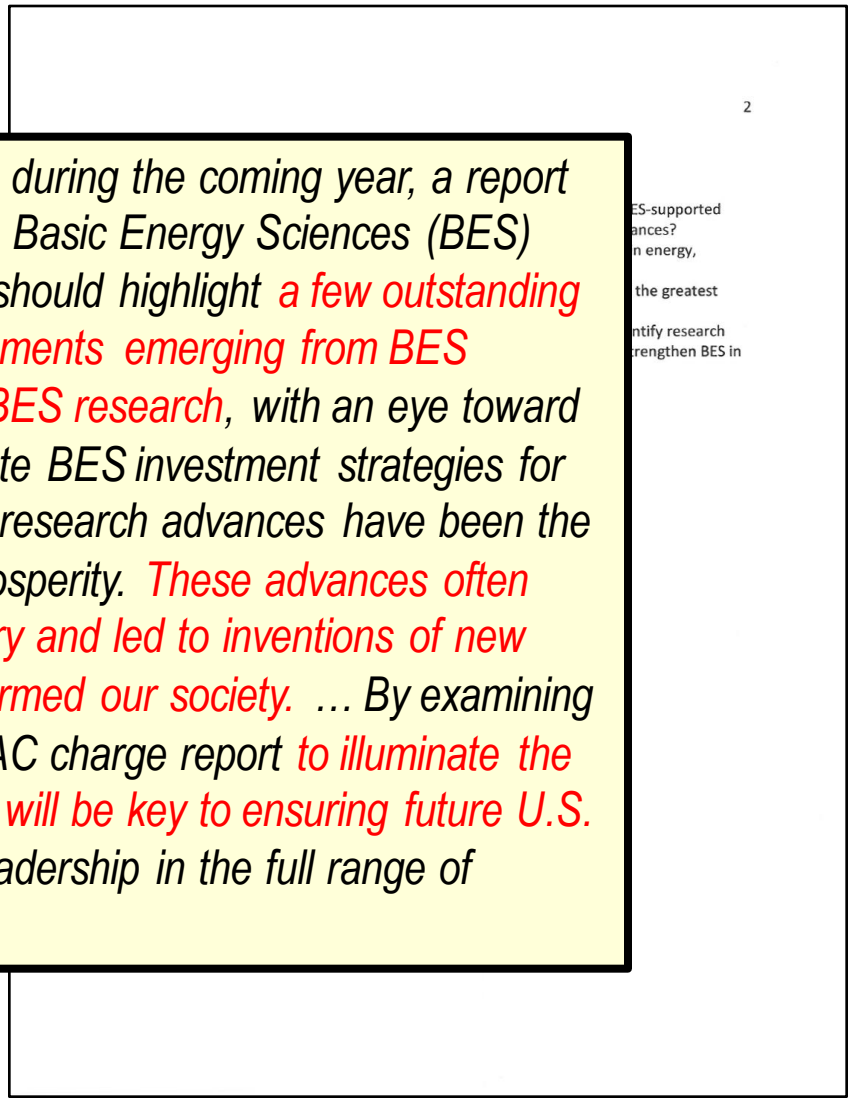
Dear Professor Dre

I very much appre
Advisory Committe
to express my since
inaugural Committ
Innovation Hub, to
BESAC prioritizatio

I am writing to ask
founding of the Ba
highlight a few out
support that have
examples to motiva
research advances
advances often ga
technologies and i
from Federal inves
made Federal prog
strategy.

The BESAC 2007 ar
opportunities for d
examining past suc
strategies and appr
generally, U.S. lead
such a report will b
it contributes to fu
Federal budget out
technical details as
each story as it relates to the larger progress of science.

Printed with soy ink on recycled paper



2

ES-supported
ances?
n energy,

the greatest

ntify research
trengthen BES in

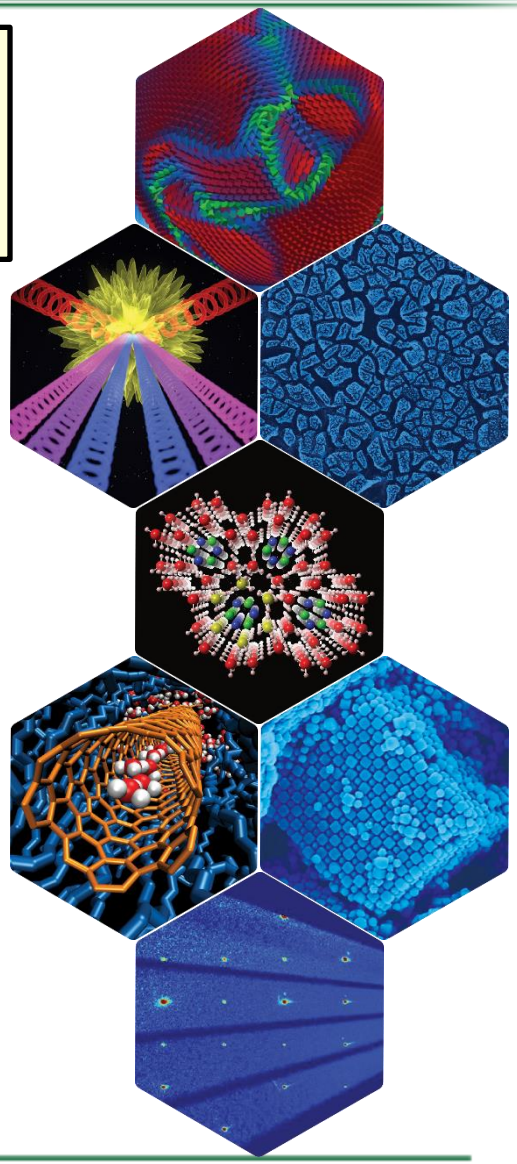
"I am writing to ask BESAC to produce, during the coming year, a report that commemorates the founding of the Basic Energy Sciences (BES) program four decades ago. The report should highlight a few outstanding examples of major scientific accomplishments emerging from BES support that have shaped the fields of BES research, with an eye toward learning from these examples to motivate BES investment strategies for the future. As history has shown, basic research advances have been the bedrock of American innovation and prosperity. These advances often gave rise to new lines of scientific inquiry and led to inventions of new technologies and industries that transformed our society. … By examining past successes, I expect the new BESAC charge report to illuminate the guiding strategies and approaches that will be key to ensuring future U.S. leadership, and more generally, U.S. leadership in the full range of disciplines stewarded by BES."

A Citation Analysis of BES-supported Research:
Examples of Highly Cited Publications

Publications	Citations	Notes
1985_Nature_Kroto_Smalley.pdf	10318	Nobel 1996 Chemistry, buckminsterfullerene
2000_Nature_Wimberly_Ramakrishnan.pdf	1432	Nobel 2009 Chemistry, ribosome, used light sources
2005_MolCell_Schmeing_Steitz.pdf	182	Ditto; Nobel Committee: "jewel in the crown", "crystallographic tour de force"
2000_Cell_Schluenzen_Yonath.pdf	689	Nobel 2009 Chemistry, ribosome, used light sources
2011_Nature_Rasmussen_Kobilka.pdf	1145	Nobel 2012 Chemistry, protein receptors, Committee: "crowning achievement", used APS
2009_JComputChem_Brooks_Karplus.pdf	2863	Nobel 2013 Chemistry, CHARMM code for multiscale models
2012_Science_Deng_Yaghi.pdf	575	Nobel 2016 Chemistry, J.F. Stoddart post-Nobel, MOFs
2010_RevModPhys_Hasan_Kane.pdf	5569	Related to Nobel 2016 Physics, topological insulators
2011_RevModPhys_Qi_Zhang.pdf	3799	Related to Nobel 2016 Physics, topological insulators
2009_NaturePhys_Zhang_Zhang.pdf	2405	Related to Nobel 2016 Physics, topological insulators
2009_NaturePhys_Xia_Hasan.pdf	1762	Related to Nobel 2016 Physics, topological insulators
1990_InorgChem_Kini_Whangbo.pdf	565	2001 Discoveries, New Types of Superconductors
1990_InorgChem_Williams_Whangbo.pdf	363	2001 Discoveries, New Types of Superconductors
1984_InorgChem_Williams_Crabtree.pdf	232	2001 Discoveries, New Types of Superconductors
1984_PhysRevB_Daw_Baskes.pdf	4128	2001 Discoveries, Modeling Metals
1994_AngewChem_Miller_Epstein.pdf	1375	2001 Discoveries, Organic-Based Magnets: A New Frontier
1991_Science_Manriquez_Miller.pdf	713	2001 Discoveries, Organic-Based Magnets: A New Frontier
1990_PhysRevLett_Ho_Soukoulis.pdf	1817	2001 Discoveries, Manipulating Light in Photonic Crystals
2001_PhysRevLett_Bud'ko_Canfield.pdf	796	2001 Discoveries, Unraveling the Mystery of High-Temperature Superconductivity
1999_Nature_Backhaus_Swift.pdf	295	2001 Discoveries, Harnessing the "Thermoacoustic" Effect
2011_Science_Zhu_Ruoff.pdf	2394	Graphene
2008_PhysChemChemPhys_Chai_Head-Gordon.pdf	2739	Hybrid density functionals
2010_PhysRevLett_Mak_Heinz.pdf	3651	Molybdenum disulfide
2010_NanoLett_Splendiani_Wang.pdf	2501	Molybdenum disulfide
2009_Science_Lim_Xia.pdf	1671	Nanodendrites
2010_AdvMat_Liang_Yu.pdf	2595	Organic photovoltaics
2011_Science_Chen_Mao.pdf	2024	Photocatalysis

Basic Energy Sciences Mission

To understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels



BES fulfills its mission through:

- Supporting basic research to discover new materials and design new chemical processes that underpin a broad range of energy technologies
- Operating world-class scientific user facilities in x-ray, neutron, and electron beam scattering as well as in nanoscale research
- Managing construction and upgrade projects to maintain world-leading scientific user facilities