Research Opportunities in the Office of Basic Energy Sciences at the Department of Energy

Jim Horwitz

Division of Materials Sciences and Engineering

Office of Basic Energy Sciences

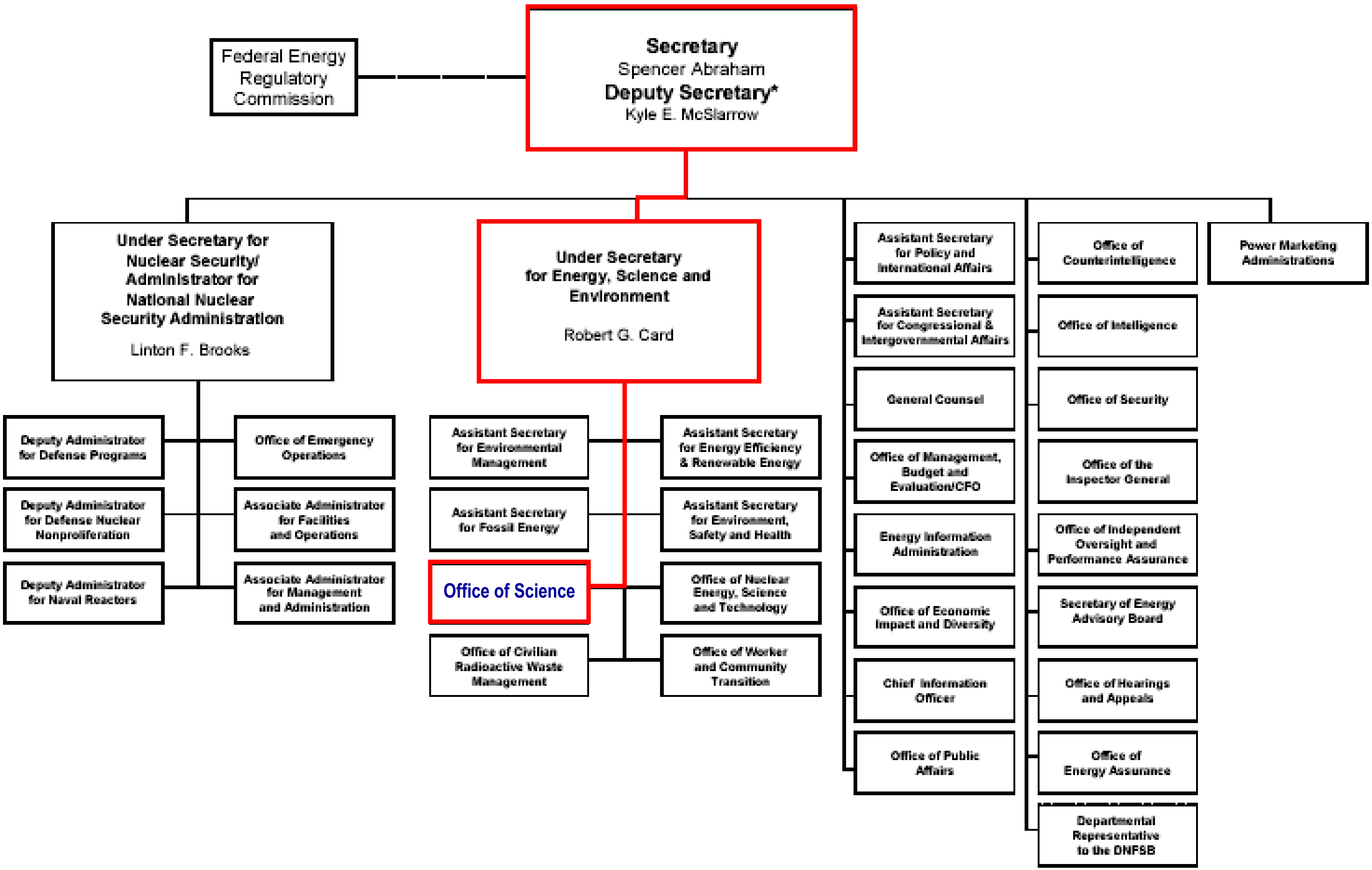
U.S. Department of Energy

LPC Workshop

Jefferson Labs

March 10, 2004

Department of Energy Organization



* The Deputy Secretary also serves as the Chief Operating Officer

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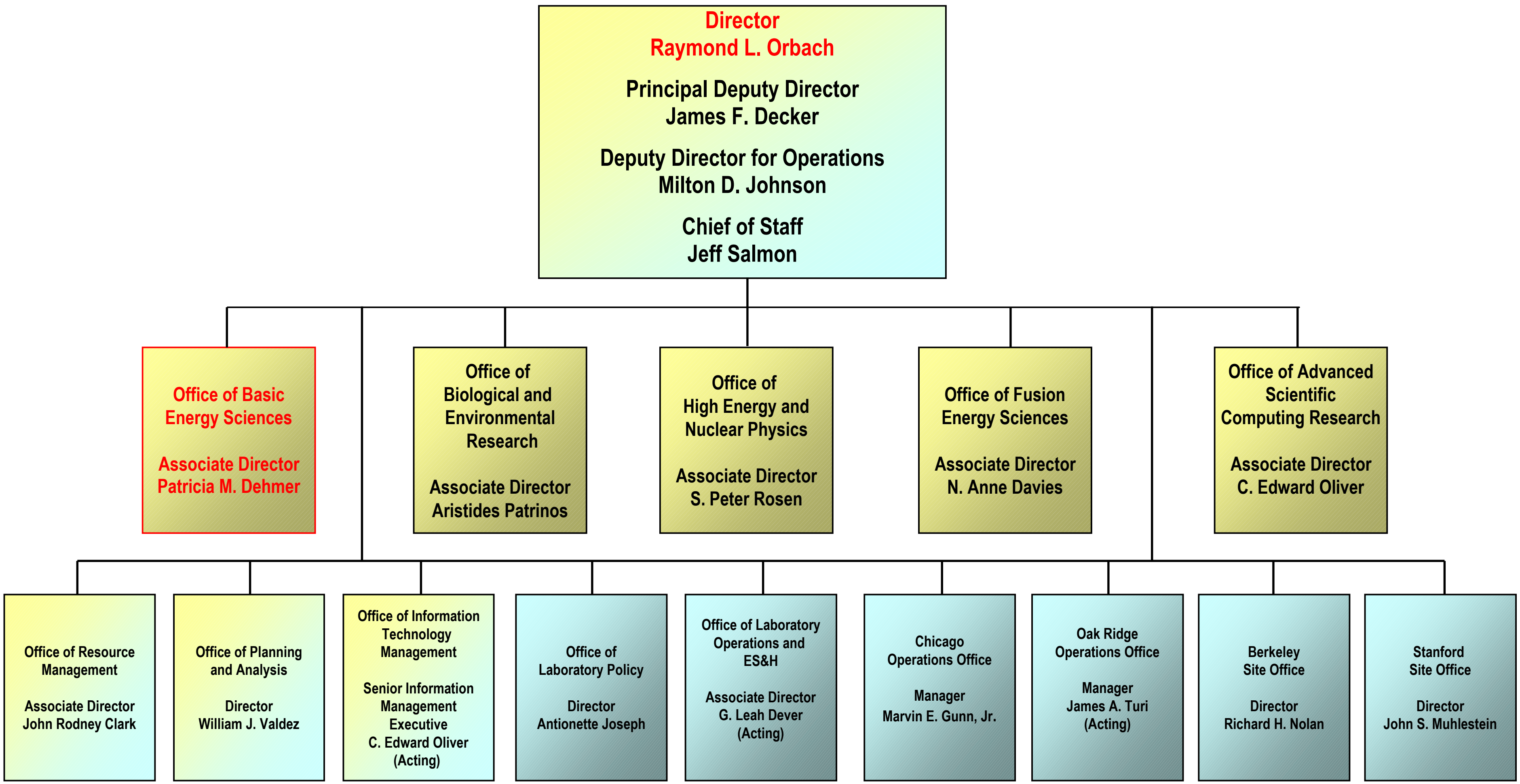
Office of Science



NOTE: Director of Science equivalent to Assistant Secretary position and filled by Presidential Appointment (Senate confirmed); Principal Deputy Director equivalent to Principal Deputy Assistant Secretary; Associate Directors equivalent to Deputy Assistant Secretaries.

Office of Basic Energy Sciences

Patricia Dehmer, Director
Mary Jo Martin, Administrative Specialist

Director's Office Staff

- Robert Astheimer
- F. Don Freeburn
- Stanley Staten
- Fred Tathwell
- Margie Marrow
- Program Analyst (Vacant)

Materials Sciences and Engineering Division

Patricia Dehmer, Director (Acting)
Christie Ashton, Program Analyst
Anna Lundy, Secretary

Materials and Engineering Physics

Robert Gottschall
Terry Jones, Prog. Asst.

- **Structure & Composition of Materials** – Altaf (Tof) Carim
- **Mechanical Behavior of Materials & Rad Effects** – Yok Chen
- **Physical Behavior of Materials** – Harriet Kung
- **Synthesis & Processing Science** – Jane Zhu; ◆Darryl Sasaki
- **Engineering Research** – Timothy Fitzsimmons

Condensed Matter Phys and Materials Chemistry X-Ray & Neutron Scat.

William Oosterhuis
Melanie Becker, Prog. Asst.

- **Experimental Condensed Matter Physics** – James Horwitz
- **Theoretical Condensed Matter Physics** – Dale Koelling
- **Materials Chemistry & Biomolecular Materials** – Dick Kelley; Aravinda Kini
- **X-ray & Neutron Scattering** – Helen Kerch
- **Experimental Program to Stimulate Competitive Research (EPSCoR)** – Matesh Varma

Scientific User Facilities Division

Patricia Dehmer, Director (Acting)
Linda Cerrone, Program Support Specialist

- **X-ray & Neutron Scattering Facilities** – Pedro Montano; Vacant
- **Spallation Neutron Source (Construction)** – Jeffrey Hoy
- **Nanoscale Science Research Centers (Construction)** – Kristin Bennett; Altaf (Tof) Carim
- **Linac Coherent Light Source (Construction)** – Jeffrey Hoy
- **SNS, LCLS, and X-ray&Neutron Scattering Instrument MIEs** – Kristin Bennett

Chemical Sciences, Geosciences, and Biosciences Division

Walter Stevens, Director
Karen Talamini, Program Analyst
Sharon Snead, Secretary

Fundamental Interactions

Eric Rohlfing
Robin Felder, Prog. Asst.

- **Atomic, Molecular, and Optical Science** – Vacant; Eric Rohlfing; ◆David Ederer, ANL
- **Chemical Physics** – Richard Hilderbrandt; ◆Frank Tully, SNL
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Molecular Processes and Geosciences

William Millman
Diane Marceau, Prog. Asst.

- **Catalysis and Chemical Transformation** – Raul Miranda; ◆John Gordon, LANL
- **Separations and Analysis** – John Miller
- **Heavy Element Chemistry** – Lester Morss; ■Norman Edelstein, LBNL
- **Chemical Energy and Chemical Engineering** – Paul Maupin
- **Geosciences Research** – Nicholas Woodward; ●David Lesmes, George Washington U.

Energy Biosciences Research

James Tavares
Program Assistant (Vacant)

- **Plant Sciences** – James Tavares
- **Biochemistry and Biophysics** – Sharlene Weatherwax

Legend:
- ● IPA
- ◆ Detailee
- ■ Detailee, 1/4 time, not at HQ

February 2004

The Basic Energy Sciences Program …

- … is one of the Nation's largest sponsors of basic research.
- … supports research in more than 150 academic institutions and 13 DOE laboratories.
- … supports world-class scientific user facilities.
- … is uniquely responsible in the Federal government for supporting research in materials sciences, chemistry, geosciences, and aspects of biosciences related to energy resources, production, conversion, efficiency, and use – all in an environmentally conscientious manner.

FY 2004 President's Request

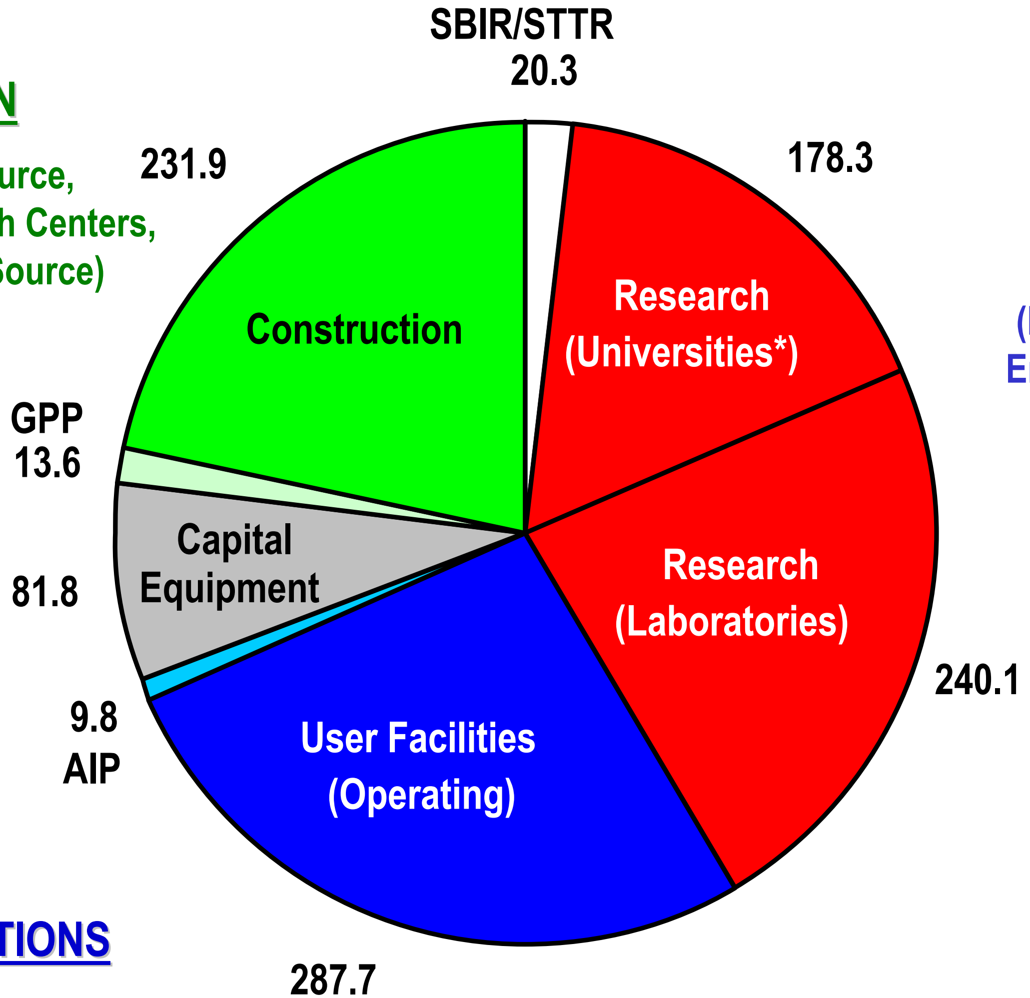
		FY 2002 Comparable Approp.*	FY 2003 Budget Request	FY 2004 Budget Request
1	Materials Sciences and Engineering			
2	Research	223,701	251,422	253,759
3	MIE, SSRL SPEAR3 Upgrade (SLAC)	8,300	9,300	0
4	MIE, ANL Nanoscale Research Center	0	0	10,000
5	Facility Operations	268,032	274,118	290,004
6	SBIR/STTR	0	12,737	13,948
7	Total, Materials Sciences and Engineering	500,033	547,577	567,711
8				
9	Chemical Sciences, Geosciences, and Energy Biosciences			
10	Research	194,150	208,488	209,597
11	MIE, SSRL SPEAR3 Upgrade (SLAC)	700	700	0
12	Facility Operations	5,377	5,805	5,967
13	SBIR/STTR	0	5,022	5,350
14	Total, Chemical Sciences, Geosciences and Energy Biosciences	200,227	220,015	220,914
15				
16	Construction			
17	Spallation Neutron Source (ORNL)	276,300	210,571	124,600
18	PED, Nanoscale Science Research Centers	3,000	11,000	3,000
19	Center for Nanophase Materials Sciences (ORNL)	0	24,000	20,000
20	The Molecular Foundry (LBNL)	0	0	35,000
21	Center for Integrated Nanotechnologies (SNL, LANL)	0	0	29,850
22	PED, Linac Coherent Linac Source (SLAC)	0	6,000	7,500
23	Total Construction	279,300	251,571	219,950
24				
25	Total, Basic Energy Sciences	979,560	1,019,163	1,008,575
26				

27 * Excludes $16,612,000 that was transferred to the SBIR and STTR programs.

BES FY 2005 President's Budget Request

CONSTRUCTION

(Spallation Neutron Source,
Nanoscale Science Research Centers,
& Linac Coherent Light Source)



RESEARCH

(Materials Sciences and
Engineering Subprogram
&
Chemical Sciences,
Geosciences,
and Biosciences
Subprogram)

FACILITY OPERATIONS

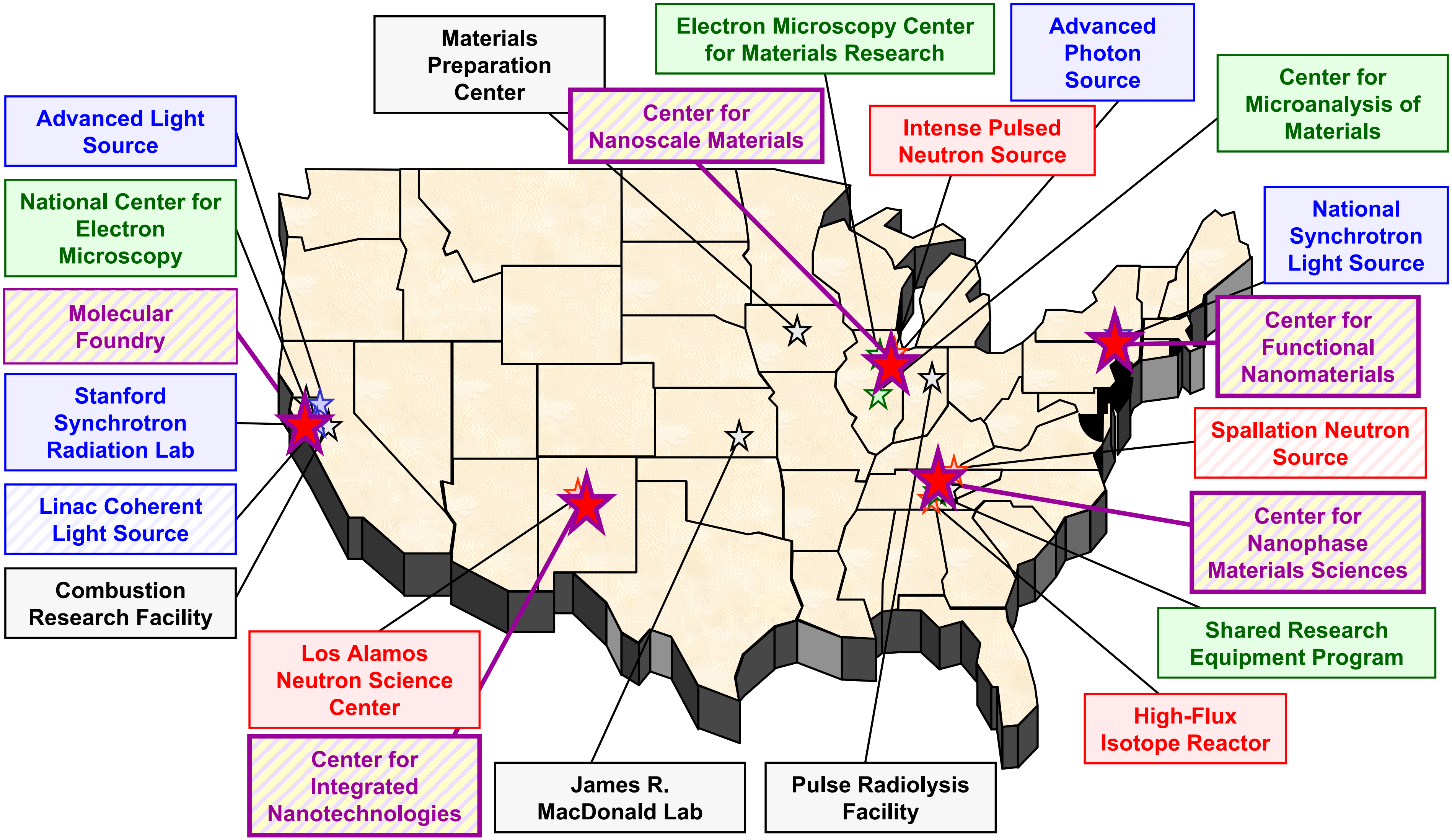
(X-ray and Neutron Scattering Facilities &
the Combustion Research Center)

B/A in millions of dollars

$ 1,063.5

* Includes the funding for not-for-profits, other agencies, and private institutions.

NSRCs (★) and the BES User Facilities



Under construction

In design/engineering

In design/engineering

- *4 Synchrotron Radiation Light Sources*
- *Linac Coherent Light Source (CD0 approved)*
- *4 High-Flux Neutron Sources (SNS under construction)*
- *4 Electron Beam Microcharacterization Centers*
- *4 Special Purpose Centers*
- *5 Nanoscale Science Research Centers*

Nanoscale Science Research Centers (NSRCs)

- Research facilities for synthesis, processing, and fabrication of nanoscale materials
- Co-located with existing user facilities (synchrotron radiation light sources, neutron scattering facilities, other specialized facilities) to provide characterization and analysis capabilities
- Operated as user facilities; available to all researchers; access determined by peer review of proposals
- Provide specialized equipment and support staff not readily available to the research community
- Conceived with broad input from university and industry user communities to define equipment scope
- Extensively reviewed by external peers, by the Basic Energy Sciences Advisory Committee, and by the Office of Science construction project management division

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February 2004

Experimental Condensed Matter Physics

Condensed Matter Physics
and Materials Chemistry Team
Materials Sciences and Engineering Division

Strategic Themes in Condensed Matter and Materials Physics

√ **Understanding magnetism and superconductivity**

√ **Materials synthesis, processing and nanofabrication**

√ **Structure and properties of materials at reduced dimensionality**

√ **Controlling electrons and photons in solids on the atomic scale**

√ **Properties of materials under extreme conditions**

√ **Quantum mechanics of large, interacting systems**

√ **Nonequilibrium processes and the relationship between molecular and mesoscopic properties**

√ **Materials with increasing complexity in composition, structure and function**

Portfolio

- **Fundamental research program in experimental condensed matter and materials physics**
  - Provide the understanding of the physical phenomena and processes underlying the properties and behavior of advanced materials
- **Development of advanced experimental techniques, instrumentation and methodology**
- **Provide the knowledge base for energy technologies**

Major Historical Impacts

- **<u>Thermoacoustic refrigeration:</u>** **Discovered, developed and expanded the field of thermoacoustic refrigeration, having applied the scientific discoveries to the development of cryocoolers, a stirling cycle thermoacoustic refrigerator, and a thermoacoustic natural gas-fired gas liquifier. Numerous publications, several patents, licensing agreements and practical devices have resulted. The technology won a R&D 100 award in 1999.**
- **<u>Z-contrast microscopy:</u>** **Invention and perfection of a high resolution scanning transmission electron microscopy capable of both atomic resolution and chemical element identification. This microscopy has had major impact on the study of materials structure. A sub-Angstrom resolution microscope is now under development. The technology won a R&D 100 award in 1990.**
- **<u>Photonic Band Gap Materials:</u>** **The predictive design, and the fabrication and characterization of photonic band gap materials, regular array structures which transmit, reflect or guide photons of specific frequencies. These materials offer great promise for the development of antennas, resonant filters, detectors and optical signal handling systems.**
- **<u>Ion channeling/Ion implantation:</u>** **Discovered, initially by computer simulations, verified and developed the phenomenon of ion channeling-one of the first materials physics discoveries using computers. The effect has been expanded into such diverse and important applications as Rutherford Back Scattering, ion implantation and ion beam modification of materials.**

Challenges

- Materials Synthesis and Crystal Growth
  - Superconductors
  - Complex oxides
  - Carbon species
  - Magnetic materials
- Low Temperature Physics
  - Superconductivity
  - 2-D electron systems
- Very High Magnetic Field Research Program
  - 60 and 100T magnets at LANL
  - Support novel quantum phenomena research

Challenges Continued

- Correlated Electron Systems
  - Mechanisms of magnetism and superconductivity
  - Low dimensional electron systems
  - Novel quantum effects, e.g. Bose-Einstein
  - Condensation, fractional quantum hall effect
- Nanoscale Systems
  - Electronic properties of nanoscale materials and structures
  - Doping of clusters and nanocrystals
  - Quantum effects in nanocrystals and nanoscale arrays
- Underway
  - Laser/Material Interactions
  - Casimir Force

Interactions

- **BES**
  - **Joint funding with EPSCoR**
  - **Key participant in two Center of Excellence in Synthesis and Processing thrusts**
- **DOE**
  - **EE - Photovoltaics; superconductivity; materials**
  - **DP - Photoemission characterization of actinides; laser crystals; positron spectroscopy**
  - **EM, FE - Granular materials; fluids; thermoacoustics**
- **National**
  - **Joint funding with several agencies of the Solid State Sciences Committee of the National Academy of Sciences**
  - **Periodic joint funding with the National Science Foundation**

Funding Summary

Dollars in Thousands

FY 2002	FY 2003 Request	FY 2004 Request
33,667	38,020	37,968

Performer	Funding Percentage
DOE Laboratories	77%
Universities	23%

These are percentages of the operating research expenditures in this area; they do not contain laboratory capital equipment, infrastructure, or other non-operating components.

FY 2003 -2004 Highlights

- **Atomic Resolution Electron Energy Loss Spectroscopy Imaging In Aberration Corrected Scanning Transmission Electron Microscopy," S. Pennycook, ORNL**

  Phys. Rev. Lett. 91, 105503/1 (2003).

- **First observation of superconductivity in a magnetically doped semiconductor ($PtSb_2$/1% Yb) , M. Aronson, Univ. of Michigan**
- **Phase Separations under Pressure, D. J. Buttrey, U. Delaware**

  Stoichiometry-controlled layered perovskites of nickel show very complex oxygen-content phase diagrams exhibiting multiple phase separations. Under hydrostatic pressure, phase separations can be made to appear or disappear as oxygen defects migrate between coexisting phases or generate new phases

- **Josephson Plasmon Microscopy, D.N. Basov UCSD** A novel technique: Josephson plasmon microscopy has been proposed to investigate spatial non-uniformities of superconducting condensate within the CuO2 planes in high-Tc superconductors. This approach enables experimental access to phase segregation of the superfluid density on the length scales of the order of 200-300 A.

FY 2003 -2004 Highlights

- **The catalytic activity of nanogold, S. Pennycook ONRL,** Sub-nanometer gold rafts found in highly active nanogold. First-principles theory shows rafts bind both O2 and CO - Franceschetti, Lupini, et al., to be submitted to Science**.**

- **Vibrational Dynamics of Hydrogen and Deuterium in Crystalline and Amorphous Silicon, N. H. Tolk and L. C. Feldman, Vanderbilt University, and G. Lupke, College of William and Mary**Significant progress in reaching this goal has been accomplished in recent landmark studies exploring the excitation and dynamics of vibrational states associated with hydrogen in crystalline and amorphous silicon. The lifetime of the Si-H stretch mode, is found to be extremely dependent on the local solid-state structure, ranging from picoseconds to several nanoseconds. Such large variations in lifetime (transition probability) are extraordinarily rare in solid-state science.

- **Tunneling and Transport in Nanowires, A. M. Goldman, University of Minnesota-Twin Cities** A scanning tunneling microscope system has been developed which permits the low temperature study of the properties of one-dimensional wires of metallic atoms grown *in situ*. For sufficiently small wires, conventional Fermi liquid theory will fail, and the tunneling density of states should be a power law in voltage. This is a signature of Luttinger liquid behavior. One dimensional structures such as those being studied may emerge as interconnects in electronic device systems as very small feature sizes are realized

FY 2003 -2004 Highlights

- **Time-reversal symmetry breaking in high-*T*C superconductors:** Angle resolved photoelectron spectroscopy revealed the existence of time-reversal symmetry breaking in the pseudogap phase of underdoped Bi2212 superconductors (Kaminski, Ames Laboratory)

- **Development of the Thermal Spin Valve** – PRL **86**, 1 (2001); PRL **88**, 9 (2002); PRL **91**, 14 (2003. In many layered antiferromagnets the thermal conductivity can be dramatically increased with application of a modest magnetic field. This is analogous to a conventional spin valve, in which the electrical conductivity can be increased with application of magnetic field. (Mandurs, ORNL)

- **Crystal Growth and Characterization of Layered Cobaltate Metals and Superconductors** – PRL **91**, 217001 (2003). Layered cobaltates are exotic "21st century" materials in which charge, spin, and structural degrees of freedom couple in new ways to produce new phenomena. Theoretically, these materials have attracted interest because in $Na_{0.3}CoO_2 \cdot 1.4H_2O$ the intercalation of water produces an anomalous superconductor on a triangular lattice of Co ions. Practically, the extraordinarily high thermopower of some metallic cobaltates makes these materials attractive for potential power generation applications. (Mandurs, ORNL)

Basic Research Needs to Assure a Secure Energy Future

A Basic Energy Sciences Advisory Committee Study


BASIC RESEARCH NEEDS
TO ASSURE
A SECURE ENERGY FUTURE

A Report from the
Basic Energy Sciences Advisory Committee

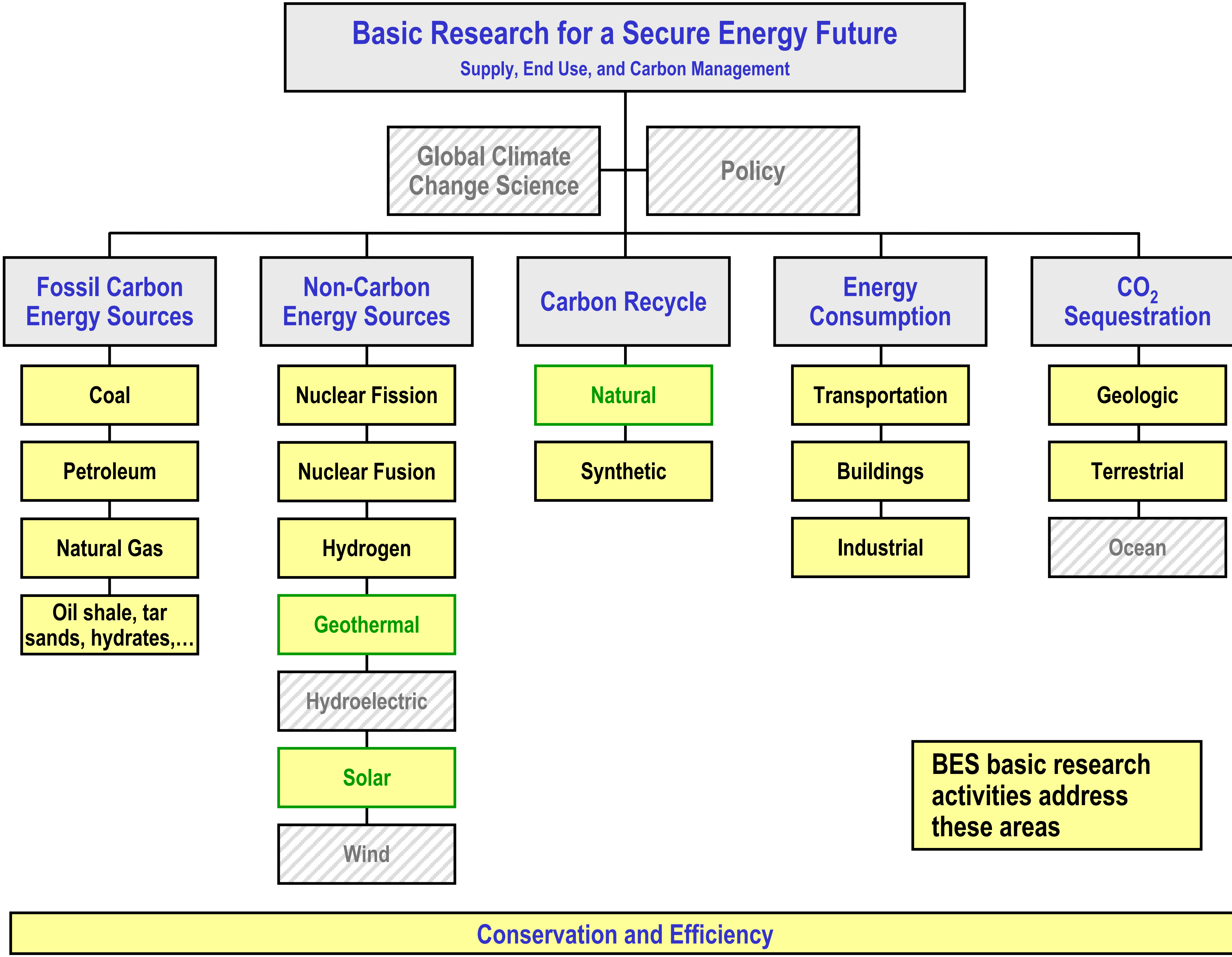
The Charge:

What are the 21st century fundamental scientific challenges that BES must consider in addressing the DOE missions in energy efficiency, renewable energy resources, improved use of fossil fuels, safe and publicly acceptable nuclear energy, future energy sources, science-based stockpile stewardship, and reduced environmental impacts of energy production and use?

Dr. John Stringer, EPRI, Chair

Dr. Linda Horton, ORNL, Co-Chair

Workshop: October 21 – 25, 2002


Basic Research for a Secure Energy Future
Supply, End Use, and Carbon Management
Global Climate Change Science
Policy
Fossil Carbon Energy Sources
Non-Carbon Energy Sources
Carbon Recycle
Energy Consumption
CO_2 Sequestration
Coal
Petroleum
Natural Gas
Oil shale, tar sands, hydrates,…
Nuclear Fission
Nuclear Fusion
Hydrogen
Geothermal
Hydroelectric
Solar
Wind
Natural
Synthetic
Transportation
Buildings
Industrial
Geologic
Terrestrial
Ocean
BES basic research activities address these areas
Conservation and Efficiency

The Products of the BESAC Workshop

- A set of 37 Proposed Research Directions (PRDs)

  Fossil Energy
  Nuclear Fission Energy
  Fusion Energy
  Renewable and Solar Energy
  Distributed Energy, Fuel Cells, and Hydrogen
  Transportation Research
  Residential, Commercial, and Industrial Energy
  Energy Biosciences Research
  Cross Cutting Research and Education

- Supporting statements for each PRD in the form of a one-page Executive Summary and three pages of detailed information

- A set of 10 General Research Areas derived from the 37 PRDs

- A "Factual Document" summarizing the status of energy supply and use.

- Web address: http://www.science.doe.gov/bes/BESAC/reports.html

- No single solution to secure energy future

- Required research areas are highly interdisciplinary

- Basic science has to be accompanied by applications

The Hydrogen Fuel Initiative

"Tonight I'm proposing $1.2 billion in research funding so that America can lead the world in developing clean, hydrogen-powered automobiles… With a new national commitment, our scientists and engineers will overcome obstacles to taking these cars from laboratory to showroom, so that the first car driven by a child born today could be powered by hydrogen, and pollution-free."

President Bush
State-of the-Union Address
January 28, 2003

Basic Research for Hydrogen Production, Storage, and Use

May 13-15, 2003

Workshop Chair: Millie Dresselhaus (MIT)
Associate Chairs: George Crabtree (ANL)
Michelle Buchanan (ORNL)

Breakout Sessions:

Hydrogen Production
Tom Mallouk, PSU & Laurie Mets, U. Chicago

Hydrogen Storage and Distribution
Kathy Taylor, GM (retired) & Puru Jena, VCU

Fuel Cells and Novel Fuel Cell Materials
Frank DiSalvo, Cornell & Tom Zawodzinski, CWRU

Pre-Workshop Briefings by EERE:

Hydrogen Storage	JoAnn Milliken
Fuel Cells	Nancy Garland
Hydrogen Production	Mark Paster

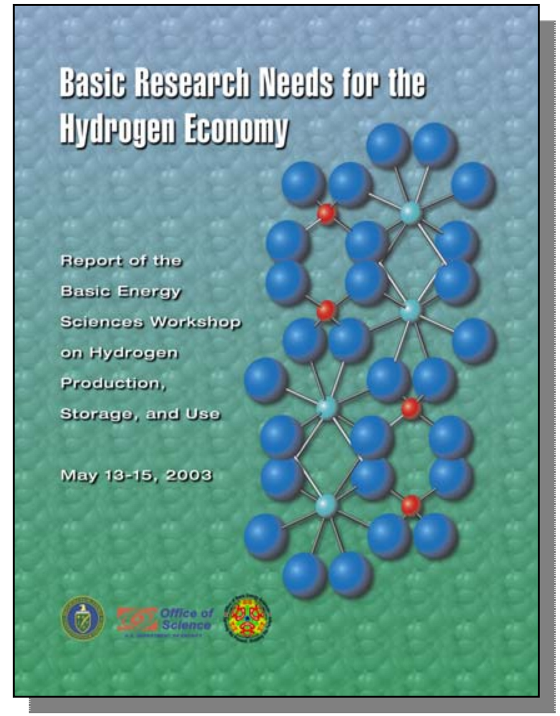
Workshop Plenary Session Speakers:

Steve Chalk (DOE-EERE) -- overview
George Thomas (SNL-CA) -- storage
Scott Jorgensen (GM) -- storage
Jae Edmonds (PNNL) -- environmental
Jay Keller (SNL-CA) – hydrogen safety

Charge: *To identify fundamental research needs and opportunities in hydrogen production, storage, and use, with a focus on new, emerging and scientifically challenging areas that have the potential to have significant impact in science and technologies. Highlighted areas will include improved and new materials and processes for hydrogen generation and storage, and for future generations of fuel cells for effective energy conversion.*

Basic Research Needs for the Hydrogen Economy

- There exists an enormous gap between present state-of-the-art capabilities and requirements that will allow hydrogen to be competitive with today's energy technologies:
  - Production: 9M tons $\Rightarrow$ 40M tons (vehicles)
  - Storage: 4.4 MJ/L (10K psi gas) $\Rightarrow$ 9.72 MJ/L
  - Fuel cells: \$3,000/kW $\Rightarrow$ \$35/kW (gasoline engine)
- Major R&D efforts will be required:
  - Simple improvements of today's technologies will not meet requirements
  - Technical barriers can be overcome only with high risk/high payoff basic research
- Research is highly interdisciplinary, requiring chemistry, materials science, physics, biology, engineering, nanoscience, computational science.
- Basic and applied research should couple seamlessly.



Workshop: May 13-15, 2003
Report: Summer 2003

Priority Research Areas in Hydrogen Production

Fossil Fuel Reforming

Molecular level understanding of catalytic mechanisms, nanoscale catalyst design, high temperature gas separation

Solar Photoelectrochemistry/Photocatalysis

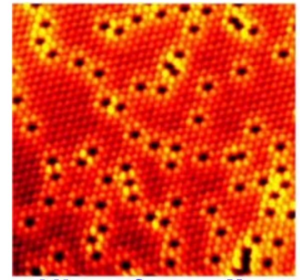
Light harvesting, charge transport, chemical assemblies, bandgap engineering, interfacial chemistry, catalysis and photocatalysis, organic semiconductors, theory and modeling, and stability

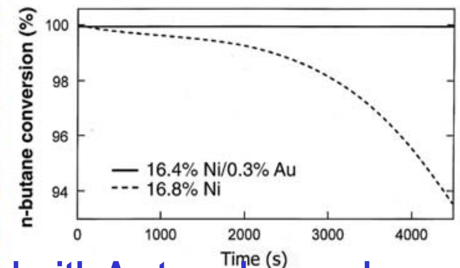
Bio- and Bio-inspired H_2 Production

Microbes & component redox enzymes, nanostructured 2D & 3D hydrogen/oxygen catalysis, sensing, and energy transduction, engineer robust biological and biomimetic H_2 production systems

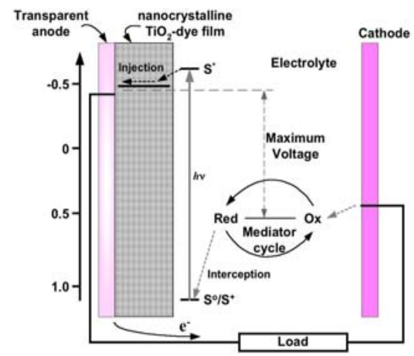
Nuclear and Solar Thermal Hydrogen

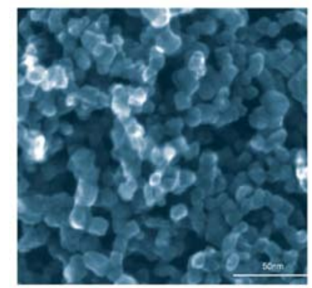
Thermodynamic data and modeling for thermochemical cycle (TC), high temperature materials: membranes, TC heat exchanger materials, gas separation, improved catalysts



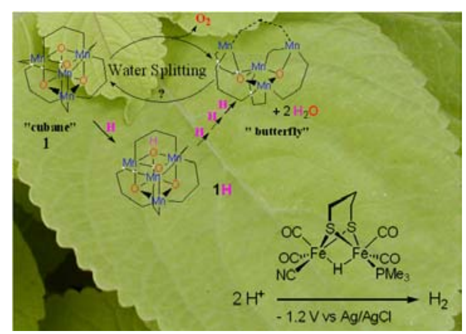


Ni surface-alloyed with Au to reduce carbon poisoning





Dye-Sensitized Solar Cells



Synthetic Catalysts for Water Oxidation and Hydrogen Activation

Priority Research Areas in Hydrogen Storage

Metal Hydrides and Complex Hydrides

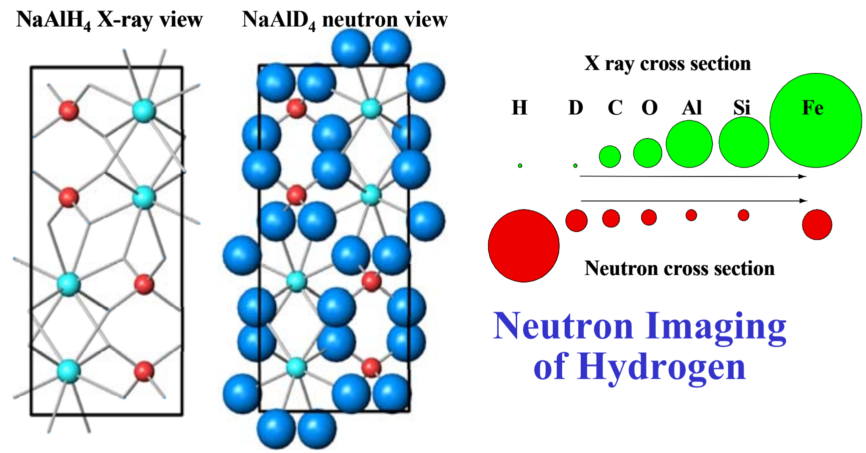
Degradation, thermophysical properties, effects of surfaces, processing, dopants, and catalysts in improving kinetics, nanostructured composites

Nanoscale/Novel Materials

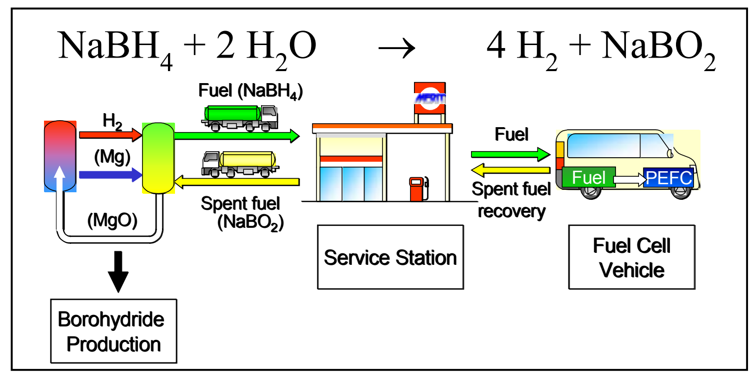
Finite size, shape, and curvature effects on electronic states, thermodynamics, and bonding, heterogeneous compositions and structures, catalyzed dissociation and interior storage phase

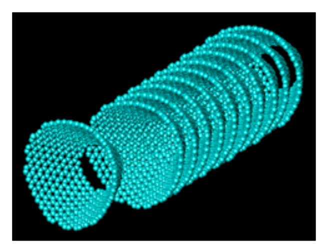
Theory and Modeling

Model systems for benchmarking against calculations at all length scales, integrating disparate time & length scales, first principles methods applicable to condensed phases

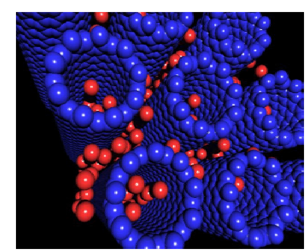


Neutron Imaging of Hydrogen





Cup-Stacked Carbon Nanofiber

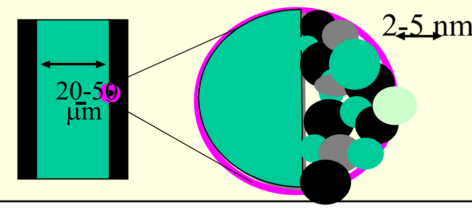


H Adsorption in Nanotube Array

Priority Research Areas in Fuel Cells

Electrocatalysts and Membranes

Oxygen reduction cathodes, minimize rare metal usage in cathodes and anodes, synthesis and processing of designed triple percolation electrodes

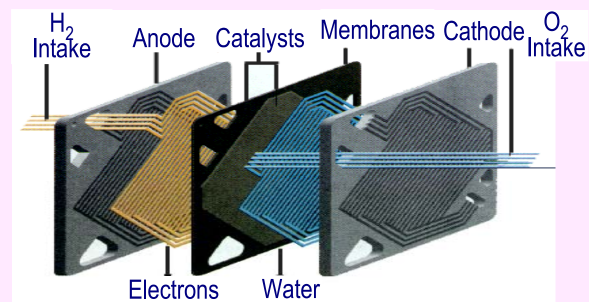


Controlled design of triple percolation nanoscale networks: ions, electrons, and porosity for gases

Low Temperature Fuel Cells

'Higher' temperature proton conducting membranes, degradation mechanisms, functionalizing materials with tailored nano-structures

Internal view of a PEM fuel cell

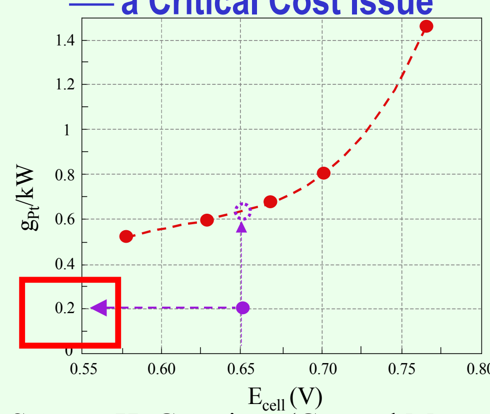


Source: T. Zawodzinski (CWRU)

Solid Oxide Fuel Cells

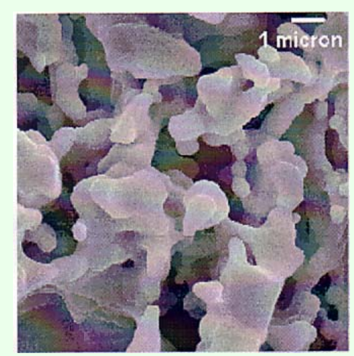
Theory, modeling and simulation, validated by experiment, for electrochemical materials and processes, new materials-all components, novel synthesis routes for optimized architectures, advanced in-situ analytical tools

Mass of Pt Used in the Fuel Cell — a Critical Cost Issue



Source: H. Gasteiger (General Motors)

YSZ Electrolyte for SOFCs



Porosity can be tailored

Source: R. Gorte (U. Penn)

Office of Science and Technology Policy
Executive Office of the President
Eisenhower Executive Office Building
Washington, DC 20502

HYDROGEN FUEL INITIATIVE

Research and Development Funding in the President's 2005 Budget

The Hydrogen Fuel Initiative (HFI), announced in the President's 2003 State of the Union address, seeks to help industry develop practical and cost-effective technologies for using hydrogen to power automobiles by 2015. HFI focuses primarily on development of technologies for the production, storage, and delivery of hydrogen, and on development of fuel cell technologies that can be used to power automobiles with virtually no emissions of air pollutants or greenhouse gases. Widespread use of fuel-cell vehicles would make the United States much less dependent on foreign sources of energy. The 2005 Budget for HFI is $228 million, 43% larger than the amount just enacted for FY 2004.

Hydrogen Fuel Initiative Budget ($ million)

Department/Office	2001 Actual*	2004 Enacted**	2005 Request	Dollar Change, 2001 to 2005	Percent Change, 2001 to 2005
Energy / Energy Efficiency and Renewable Energy	73	147	173	100	137
Energy / Fossil Energy (coal)	0	5	16	16	-
Energy / Nuclear Energy	0	6	9	9	-
Energy / Basic Energy Sciences	0***	0***	29	29	-
Transportation	0	0.6	0.8	0.8	-
TOTAL	**73**	**159**	**228**	**155**	**212**

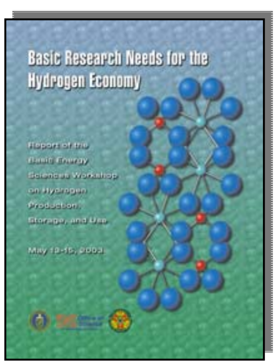
* Reflects funding for baseline activities that HFI augments and/or redirects. 2004 was the first year for the HFI.

** Reflects rescissions, general reductions, and other adjustments included in relevant 2004 appropriations.

*** Base funding for hydrogen-related activities in Basic Energy Sciences was roughly $8 million in 2001 and 2004. These activities have been reoriented and expanded to support the goals of the President's HFI in 2005.

BES Plans for a Solicitation for Research in Support of the President's Hydrogen Fuel Initiative – I http://www.sc.gov/bes/BESAC/Meetingshtml#0204

- **Approximately $21.5 million will be awarded in FY 2005, pending appropriations.**
- **A solicitation will request pre-applications for *innovative basic research* proposals to establish the scientific basis that underpins the physical, chemical, and biological processes governing the interaction of hydrogen with materials. We seek to support *outstanding fundamental research* programs to ensure that discoveries and related conceptual breakthroughs from basic research will provide a solid foundation for the innovative design of materials and processes to usher in hydrogen as the clean and sustainable fuel of the future.**
- **Five high-priority research directions, encompassing both short-term showstoppers and long-term grand challenges, will be the focus of the solicitation. They are:**



  - **Novel Materials for Hydrogen Storage**
  - **Membranes for Separation, Purification, and Ion Transport**
  - **Design of Catalysts at the Nanoscale**
  - **Solar Hydrogen Production**
  - **Bio-Inspired Materials and Processes**

BES Plans for a Solicitation for Research in Support of the President's Hydrogen Fuel Initiative – II

- **These five focus areas will be described in greater detail in the solicitation.**
- **PREAPPLICATIONS ARE REQUIRED. No applications will be accepted without a preapplication followed by a BES response encouraging a full application.**
- **Preapplications must be submitted electronically as specified in the call.**
- **Each FFRDC is limited to the submission of up to six preapplications as leading institution. For FFRDCs, BES reserves the right to encourage, in whole or in part, any, all, or none of the preapplications submitted, and BES may issue further guidance on the scope of full proposal submissions of those encouraged.**
- **The solicitation will be silent on issues of project size, number of PIs, number of institutions, interdisciplinary or multidisciplinary nature of the work, etc.**
- **It is anticipated that up to $12 million annually will be available for multiple awards for each of the following: universities and FFRDCs. Initial awards will be in Fiscal Year 2005, and applications may request project support for up to three years. All awards are contingent on the availability of funds and programmatic needs.**
- **BES will coordinate with all appropriate groups both inside and outside of DOE, particularly EERE.**

BES Plans for a Solicitation for Research in Support of the President's Hydrogen Fuel Initiative – III

Important Dates

February 23, 2004	Discussion at BESAC
May 15, 2004	Call for preapplications published
July 15, 2004	Preapplications due
September 1, 2004	Decisions on preapplications sent to PIs
January 1, 2005	Full proposals due
June – July 2005	Awards made

Information Sheet for Grant Applicants is Available

Some information that may be of interest to grant applicants

Division of Materials Sciences and Engineering
Office of Basic Energy Sciences
Office of Science
U.S. Department of Energy

Please note that many of the suggestions and procedures below are specific to the Division of Materials Sciences and Engineering, and pertain only to applications submitted under our "core" research program - not to special initiatives or other announced program opportunities.

Fundamental science is the primary concern in the work that our Division supports. Studies that are directed primarily towards engineering, demonstration, or development goals, such as producing specific devices or identifying optimal processing for a particular application, are less likely to compete successfully. However, our portfolio does include scientific instrument development that enables fundamental materials research.

Practical details:

Electronic Submission: Please note that the Office of Science is moving over to a secure, web-enabled proposal submission system. **Effective June 1, 2002**, applications should be submitted in PDF format through this system at http://e-center.doe.gov. Paper applications will continue to be accepted until September 30, 2002. Further information is available at DOE's Grants and Contracts web site: http://www.sc.doe.gov/production/grants/grants.html.

Pre-proposals (2 pages or less) may be submitted but are not required, and in general (for our core program) they will be used mainly to establish whether the topic area falls within our purview. If you do wish to submit a pre-proposal, electronic submission as an e-mail attachment is preferred. We will respond to them by phone or e-mail.

Proposal handling: Most new proposals are examined by most of the program managers within our Division, with one taking the lead on handling it. Some may be declined without external peer review. On the other hand, we are required to obtain outside peer reviews for any that we intend to fund.

Timing of submissions and awards: Proposals may be submitted at any time, but we recommend that they be sent to us between April 1st and September 30th. This allows sufficient time for completion of the peer review process prior to the annual cut-off date for new award decisions. Proposals that arrive later run the risk of being turned down regardless of the quality of reviews because all funds for the fiscal year may be committed prior to completion of the review process. Decisions on new proposals are usually made early in the following calendar year.

Typical term of support: Usually three or four years for a new proposal and three years for subsequent renewals. Renewal applications should be submitted at least nine months in advance of the scheduled termination date.

Names of reviewers: Within our Division, we do not ask applicants to suggest reviewers, and typically do not use anyone so suggested. We will honor any request to not use a specific reviewer; no reason is needed.

Sabbaticals or other leaves of absence during the grant should be discussed with us in advance.

Conferences, symposia, workshops, and meetings, other than those we initiate, are rarely supported.

Contacts within our Division, including phone and e-mail information, are available on the second web site listed below. The corresponding organization chart can be reached via a click button on this site. For further inquiries, please contact the program manager whose areas of expertise and/or responsibility most closely match the topic area.

Web sites with further information:

- http://www.science.doe.gov/bes (Office of Basic Energy Sciences)
- http://www.science.doe.gov/bes/besstaff.html (BES staff contacts and directory; click to org chart)
- http://www.science.doe.gov/bes/dms/dmshome.html (Division of Materials Sciences & Engineering)
- http://www.science.doe.gov/production/grants/grants.html (sponsored research details)
- http://www.science.doe.gov (Office of Science)
- http://www.energy.gov/scitech/index.html (science and technology across the Dept. of Energy)

- General information
- Comments on:
  - Electronic Submission
  - Submission Timing
  - Pre-proposals
  - Proposal Handling
  - Grant Lengths
- Listing of Web Sites (including staff contacts, submission details, etc.)

Relevant web sites for DOE-SC-BES programs:

- http://www.science.doe.gov/bes
  (Office of Basic Energy Sciences)
- http://www.science.doe.gov/bes/besstaff.html
  (BES staff contacts and directory; click to org chart)
- http://www.science.doe.gov/bes/dms/dmshome.html
  (Division of Materials Sciences & Engineering)
- http://www.science.doe.gov/production/grants/grants.html
  (sponsored research details)
- http://www.science.doe.gov
  (Office of Science)
- http://www.energy.gov/scitech/index.html
  (science and technology across the Dept. of Energy)