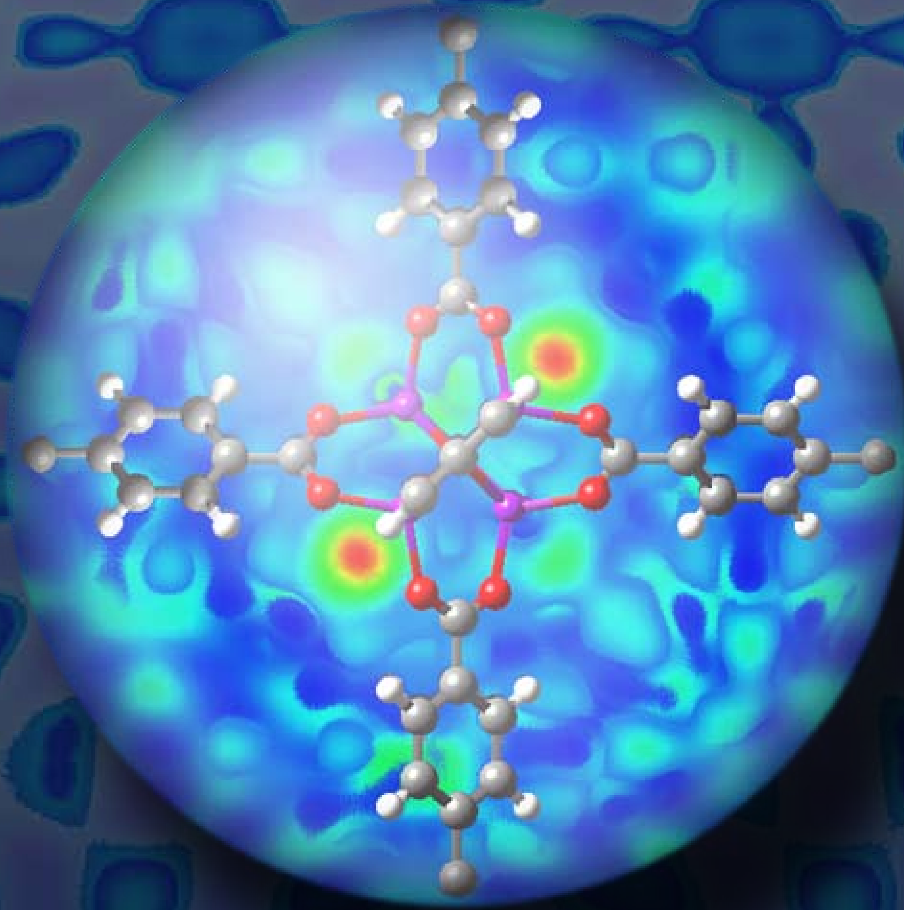
THE NATIONAL NANOTECHNOLOGY INITIATIVE

Research and Development Leading to a Revolution in Technology and Industry

Supplement to the President's FY 2008 Budget



About the National Science and Technology Council

The National Science and Technology Council (NSTC) was established by Executive Order on November 23, 1993. The Cabinet-level council is the principal means by which the President coordinates science, space, and technology policies across the Federal Government. NSTC coordinates the diverse parts of the Federal research and development enterprise. An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas ranging from nanotechnology and health research to improving transportation systems and strengthening fundamental research. The Council prepares research and development strategies that are coordinated across Federal agencies to form a comprehensive investment package aimed at accomplishing multiple national goals. To obtain additional information regarding the NSTC, visit the NSTC website at http://www.ostp.gov/nstc/.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP's responsibilities include advising the President in policy formulation and budget development on all questions in which science and technology (S&T) are important elements; articulating the President's S&T policies and programs; and fostering strong partnerships among Federal, State, and local governments, and the scientific communities in industry and academia. The Director of OSTP also serves as Science Advisor to the President and manages the NSTC for the President. For additional information regarding OSTP, visit the OSTP website at http://www.ostp.gov/.

About this document

This document is a supplement to the President's 2008 Budget Request submitted to Congress on February 5, 2007. It gives a description of the activities underway in 2007 and planned for 2008 by the Federal Government agencies participating in the National Nanotechnology Initiative (NNI), primarily from a programmatic and budgetary perspective. It is based on the NNI Strategic Plan released in December 2004 and reports estimated investments for 2007 and requested investments for 2008 by program component area (PCA), as called for under the provisions of the 21st Century Nanotechnology Research and Development Act (Public Law 108-153). Additional information regarding the NNI is available on the NNI website at http://www.nano.gov/.

About the cover

The central image shows the location of the strongest hydrogen binding sites (red-green areas) in a metal-organic cage structure (ball and stick model superimposed) as measured at National Institute of Standards and Technology by neutron diffraction methods. The strength of the hydrogen binding at various sites in this system was also calculated (T. Yildirim and M. Hartman, *Phys. Rev. Lett.* 95, 215504, 2005). This work indicates that a mass fraction of up to 11% hydrogen can be stored in this structure at low temperatures. This work illustrates the synergy of theory and experiment in nanomaterials research, as well as the potential for novel nanostructured materials to contribute to national priorities such as advanced energy storage technologies.

Cover and book design

Cover design is by Nicolle Rager of Sayo-Art. Book design is by staff members of the National Nanotechnology Coordination Office (NNCO).

Copyright information

Printed in the United States of America. 2007.

The National Nanotechnology Initiative

Research and Development Leading to a Revolution in Technology and Industry

Supplement to the President's 2008 Budget

July 2007

Subcommittee on Nanoscale Science, Engineering, and Technology
Committee on Technology
National Science and Technology Council

Report prepared by

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL
COMMITTEE ON TECHNOLOGY (CT)
SUBCOMMITTEE ON NANOSCALE SCIENCE, ENGINEERING, AND TECHNOLOGY (NSET)

CT Co-Chairs: Richard Russell, Associate Director, Office of Science and Technology Policy (OSTP)
Robert Cresanti, Under Secretary of Commerce for Technology

CT Executive Secretary: Jason Boehm, National Institute of Standards and Technology

NSET Subcommittee Agency Co-Chair:
Altaf Carim

NSET Subcommittee OSTP Co-Chair:
Celia Merzbacher

National Nanotechnology Coordination Office Director:
Clayton Teague

NSET Subcommittee Executive Secretary:
Geoffrey Holdridge

Department and Agency Representatives

Office of Science and Technology Policy (OSTP)
Celia Merzbacher
Travis M. Earles

Office of Management and Budget (OMB)
Irene Kariampuzha

Bureau of Industry and Security (BIS/DOC)
Kelly Gardner

Consumer Product Safety Commission (CPSC)
Mary Ann Danello
Treye Thomas

Cooperative State Research, Education, and Extension Service (CSREES/USDA)
Hongda Chen

Department of Defense (DOD)
James Short
David Stepp
Richard Colton
Mihal Gross
Gernot Pomrenke

Department of Education (DOEd)
Richard LaPointe
Sharon Lee Miller

Department of Energy (DOE)
Patricia Dehmer
Kristin Bennett
Altaf Carim
Aravinda Kini
John Miller
Brian Valentine

Department of Homeland Security (DHS)
Richard Lareau
Eric Houser
Keith Ward

Department of Justice (DOJ)
Stanley Erickson

Department of Labor (DOL)
Brad Wiggins

Department of State (DOS)
George Atkinson
Ralph Braibanti
Christopher Rothfuss
Robert Rudnitsky

Department of Transportation (DOT)
Richard John
Annalynn Lacombe
Richard Livingston

Department of the Treasury (DOTreas)
John Bobalek

Environmental Protection Agency (EPA)
Stephen Lingle
Flora Chow
Nora Savage
Philip Sayre

Food and Drug Administration (FDA/DHHS)
Norris Alderson
Richard Canady

Forest Service (FS/USDA)
Christopher Risbrudt
Theodore Wegner

Intelligence Technology Innovation Center (ITIC)
Susan Durham

International Trade Commission (ITC)
Elizabeth Nesbitt

National Aeronautics and Space Administration (NASA)
Minoo Dastoor
Murray Hirschbein

National Institutes of Health (NIH/DHHS)
Piotr Grodzinski
Eleni Kousvelari
Peter Moy
Jeffery Schloss

National Institute for Occupational Safety and Health (NIOSH/CDC/DHHS)
Vladimir Murashov

National Institute of Standards and Technology (NIST/DOC)
Michael Postek
Robert Shull

National Science Foundation (NSF)
Lance Haworth
Maryanna Henkart
Mihail Roco
James Rudd

Nuclear Regulatory Commission (NRC)
Mark Cunningham

Technology Administration (TA/DOC)
Connie Chang
John Sargent

U.S. Geological Survey (USGS)
Sarah Gerould

U.S. Patent and Trademark Office (USPTO/DOC)
Charles Eloshway
Bruce Kisliuk

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Washington, D.C. 20502

July 31, 2007

MEMBERS OF CONGRESS:

I am pleased to forward with this letter the annual report on the multi-agency National Nanotechnology Initiative (NNI). This Supplement to the President's Budget for Fiscal Year 2008 describes the programs and activities taking place across all 26 of the agencies that are participating today in the NNI. Nanotechnology research and development (R&D) is inherently multidisciplinary and the rate of progress depends on the strong interagency coordination that is taking place, as described in this report, to leverage expertise throughout the Federal Government.

The NNI is now in its seventh year, and the proposed budget for Fiscal Year (FY) 2008 has grown to more than triple the amount spent at the outset in FY 2001, bringing the total investment to $8.3 billion. This sustained investment is advancing our understanding of the unique phenomena and processes that occur at the nanometer scale and expediting the responsible use of this knowledge to address national and global needs in the areas such as energy, security, and public health.

Along with its investment in the development and application of nanotechnology, the NNI supports a coordinated program, with participation by both research and regulatory agencies, to understand potential health and environmental effects of nanotechnology. In addition, the NNI is expanding its activities to assess and address societal and ethical concerns associated with this emerging area of technology.

In the coming years and decades, advances in nanotechnology will lead to new products, tools, processes, and ways of doing business. Whereas the economic impact is difficult to estimate, the widespread potential argues for continued public and private investments. As described in this report, the NNI is taking steps to leverage resources across all agencies to ensure that the Federal program leads to the expeditious and responsible development of nanotechnology for the Nation's benefit and in support of our continued global leadership.

Sincerely,

John H. Marburger, III
Director

Table of Contents

1. Introduction and Overview

What is Nanotechnology?

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers (a nanometer is one-billionth of a meter), where unique phenomena enable novel applications. Encompassing nanoscale science, engineering, and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale. At this level, the physical, chemical, and biological properties of materials may differ in fundamental and valuable ways from the properties of individual atoms and molecules or bulk matter. Nanotechnology research and development (R&D) is directed toward understanding and creating improved materials, devices, and systems that exploit these new properties.

Thanks to the continuing support of this Administration and Congress, the U.S. National Nanotechnology Initiative (NNI) is a major driver for the responsible development of nanotechnology in the United States and the world.

Overview of National Nanotechnology Initiative

The NNI is a multi-agency U.S. Government program initiated in 2001[1] aimed at accelerating the discovery, development, and deployment of nanometer-scale science, engineering, and technology. The NNI is a coordinated program involving nanotechnology-related activities of 26 Federal agencies, 13 of which have budgets for nanotechnology R&D for 2008 (see Table 1).

The vision of the NNI is a future in which the ability to understand and control matter on the nanoscale leads to a revolution in technology and industry. The current NNI Strategic Plan[2] specifies four goals aimed at achieving that overall vision: (1) maintain a world-class research and development program aimed at realizing the full potential of nanotechnology; (2) facilitate transfer of new technologies into products for economic growth, jobs, and other public benefit; (3) develop educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology; and (4) support responsible development of nanotechnology.

Toward these goals, the NNI agencies have:

- Funded thousands of individual R&D projects since the NNI's inception, contributing to U.S. world leadership in share of citations in leading nanoscience and nanotechnology journals
- "Produced significant advances in [a variety of potential] application areas and are progressing from fundamental discovery to technological applications and commercialization," as reported by the National Academies[3]
- Funded almost $200 million in nanotechnology-related Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) projects between 2004 and 2006 to aid in the commercialization of nanotechnology

---

1 **General note:** In conformance with Office of Management and Budget style, references to years in this report are to fiscal years unless otherwise noted.

2 http://nano.gov/NNI_Strategic_Plan_2004.pdf

3 *A Matter of Size, Triennial Review of the National Nanotechnology Initiative*, National Research Council, 2006, p. 36.

Table 1 List of Federal Agencies Participating in the NNI During 2007
Federal agencies with budgets dedicated to nanotechnology research and development
Cooperative State Research, Education, and Extension Service (CSREES, Department of Agriculture)
Department of Defense (DOD)
Department of Energy (DOE)
Department of Homeland Security (DHS)
Department of Justice (DOJ)
Department of Transportation (DOT)
Environmental Protection Agency (EPA)
Forest Service (FS, Department of Agriculture)
National Aeronautics and Space Administration (NASA)
National Institute of Standards and Technology (NIST, Department of Commerce)
National Institute for Occupational Safety and Health (NIOSH, Department of Health and Human Services/Centers for Disease Control and Prevention)
National Institutes of Health (NIH, Department of Health and Human Services)
National Science Foundation (NSF)
Other participating agencies
Bureau of Industry and Security (BIS, Department of Commerce)
Consumer Product Safety Commission (CPSC)
Department of Education (DOEd)
Department of Labor (DOL)
Department of State (DOS)
Department of the Treasury (DOTreas)
Food and Drug Administration (FDA, Department of Health and Human Services)
International Trade Commission (ITC)
Intelligence Technology Innovation Center (ITIC)
Nuclear Regulatory Commission (NRC)
Technology Administration (TA, Department of Commerce)
U.S. Geological Survey (USGS, Department of Interior)
U.S. Patent and Trademark Office (USPTO, Department of Commerce)

- Organized and conducted 16 workshops on cross-cutting areas of nanotechnology applications to solicit input from industry and academia in support of NNI strategic planning efforts
- Organized and conducted two workshops as a means to coordinate Federal, State, and regional efforts in nanotechnology
- Brought regulatory and research agencies to work together as expeditiously as possible to formulate strategies for promoting commercialization of nanotechnology-based applications that are now emerging, while protecting public health, safety, and the environment
- Developed an extensive infrastructure of 64 major interdisciplinary research and education networks, centers, and user facilities across the country (see map on p. 21 and list in Appendix A, starting on p. 29)
- Organized and conducted workshops on public participation; environmental, health, and safety research needs for engineered nanoscale materials; and ethical aspects of nanotechnology

- In 2005 through 2007, invested over $120 million in environmental, health, and safety R&D to understand and address potential risks associated with nanotechnology
- Put in place major networks for developing public awareness of nanotechnology and formal educational programs in K-12, undergraduate, and graduate institutions

The NNI Strategic Plan lays out seven categories of investment, or program component areas (PCAs), within the NNI, each aimed at helping to achieve one or more of the above goals. The PCAs are as follows:

1. Fundamental nanoscale phenomena and processes
2. Nanomaterials
3. Nanoscale devices and systems
4. Instrumentation research, metrology, and standards for nanotechnology
5. Nanomanufacturing
6. Major research facilities and instrumentation acquisition
7. Societal dimensions

Federal agencies are making coordinated, strategic R&D investments related to the above categories, in support of national goals and agency missions. Through communication, coordination, and joint programs, NNI participating agencies continue to work together to strengthen the integration of their efforts into a comprehensive Federal nanotechnology program whose "whole," in terms of NNI outputs, is truly greater than the sum of the individual agency contributions.

Purpose of this Report

This document provides supplemental information to the President's Budget for 2008 and serves as the Annual Report on the NNI called for in the 21st Century Nanotechnology Research and Development Act (PL 108-153). In particular, the report summarizes NNI programmatic activities for 2006 and 2007, as well as those planned for in 2008. NNI budgets for 2006–2008 are presented by agency and PCA. In addition, PCA 7 (societal dimensions) is divided into (a) research on environmental, health, and safety (EHS) and (b) education and ethical, legal, and other societal aspects of nanotechnology. The report also discusses progress that has been made toward achieving the goals set out in the NNI Strategic Plan and an analysis of external reviews of the NNI and how their recommendations are being addressed. Information on use of the SBIR and STTR program funds to support nanotechnology research and commercialization activities, also called for in PL 108-153, is included at the end of the next section of this report.

2. NNI Investments

Budget Summary

The 2008 National Nanotechnology Initiative budget request for nanotechnology R&D across the Federal Government is over $1.44 billion, more than triple the estimated $464 million spent when the initiative started in 2001, and an increase of 13% over the 2007 request. The growth in NNI investments over the past seven years, along with a total cumulative funding for the NNI since its inception of $8.3 billion, reflects the consistent, strong support of this Administration and of Congress. This support is based on the potential of the NNI to expand our fundamental knowledge and to make important contributions to national priorities such as economic competitiveness, homeland and national security, and public health.

The five agencies investing the most in nanotechnology R&D (i.e., National Science Foundation, Department of Defense, Department of Energy, National Institutes of Health, and National Institute for Standards and Technology) each have investments distributed across all seven PCAs. Funding among the PCAs by all 13 agencies with nanotechnology R&D budgets reflects a balanced strategic investment. Planned 2008 funding by PCA is as follows: (1) fundamental nanoscale phenomena and processes ($491.8 million); (2) nanomaterials ($290.7 million); (3) nanoscale devices and systems ($277.4 million); (4) instrumentation research, metrology, and standards for nanotechnology ($83.6 million); (5) nanomanufacturing ($44 million); (6) Major research facilities and instrumentation acquisition ($159.8 million); and (7) societal dimensions ($97.5 million).

The NNI investments are complementary to those of the American Competitiveness Initiative (ACI) announced in the President's 2006 State of the Union address. In particular, proposed spending for basic research in physical sciences and engineering called for in the ACI, and included in the President's 2007 and 2008 budgets, includes many nanotechnology R&D programs described in this report. The enhanced Federal investments in mathematics and science education and in workforce development and training called for by the ACI leverage complementary NNI investments addressing education and workforce issues associated with advancing and realizing the benefits of nanotechnology.

A summary of NNI investments for 2006 through 2008 is provided in Tables 2–7. Table 2 provides the 2006 actual budget, the 2007 estimated budget, and the 2008 funding request for those Federal agencies with R&D budgets dedicated to nanotechnology research and development. Tables 3–5 provide 2006 actual, 2007 estimated, and 2008 planned investments by program component area for each of these agencies. Tables 6 and 7 show estimates for agency investments in the societal dimensions PCA in two subcomponents: programs that are primarily directed at environmental, health, and safety (EHS) R&D, and programs for education-related activities and research on the broad implications of nanotechnology for society, including economic, workforce, educational, ethical, and legal implications. Finally, Table 8 (p. 24) shows SBIR and STTR investments related to nanotechnology for 2005 and 2006.

Table 2 NNI Budget, 2006–2008 (dollars in millions)			
	2006 Actual	**2007 Estimate**	**2008 Proposed**
NSF	359.7	373.2	389.9
DOD*	423.9	417.2	374.7
DOE	231.0	235.2	331.5
DHHS (NIH)	191.6	193.8	202.9
DOC (NIST)	77.9	84.2	96.6
NASA	50.0	25.0	24.0
EPA	4.5	8.5	10.2
USDA (CSREES)	3.9	3.4	3.0
DHHS (NIOSH)	3.8	6.6	4.6
USDA/FS	2.3	2.6	4.6
DHS	1.5	2.0	1.0
DOJ	0.3	1.4	0.9
DOT (FHWA)	0.9	0.9	0.9
TOTAL†	**1,351.2**	**1,353.9**	**1,444.8**

* DOD budgets for 2006 and 2007 include Congressional additions of approximately $76 million and $63 million, respectively.

† Totals may not add due to rounding.

Key points about the 2007 and 2008 NNI investments

- The 2008 NNI budget request is over $1.44 billion, an increase of 13% over the 2007 request.
- Overall NNI spending between 2006 and 2007 remained essentially flat at $1.35 billion, although the balance of investments by PCA changed somewhat. For example, investments related to societal dimensions of nanotechnology rose 17%, from $73.5 million in 2006 to an estimated $85.9 million in 2007.
- The 2008 request for EHS R&D of $58.6 million is an increase of 55% over actual 2006 investments. This growth addresses concerns that have been expressed in Congress and elsewhere about the adequacy of the NNI investments in this area, but also reflects a strategy of building capacity for nanotechnology-related EHS research through systematic program development. This figure includes funding for two joint interagency solicitations, one led by EPA focused on potential environmental implications of nanotechnology, and a second led by NIH focused on potential human health implications. The $58.6 million figure does not include significant other EHS-related investments classified by the agencies as falling primarily under other NNI program component areas (e.g., instrumentation and metrology research that may result in new tools for EHS research).
- The NNI investment by NSF, DOE's Office of Science, and NIST in 2008 compared to 2006 actual expenditures will be increased by 22% collectively. This investment is consistent with the President's commitment to double funding for these agencies over the next ten years as part of the American Competitiveness Initiative, and with their prioritization of nanotechnology research.

Table 3
Actual 2006 Agency Investments by Program Component Area (dollars in millions)

	Fundamental Phenomena & Processes	Nanomaterials	Nanoscale Devices & Systems	Instr. Research, Metrology, & Standards	Nano-manufacturing	Major Research Facilities & Instr. Acquisition	Societal Dimensions	NNI Total
NSF	147.3	52.5	43.7	6.6	20.3	37.2	52.1	**359.7**
DOD	184.6	109.7	110.4	10.8	3.1	4.3	1.0	**423.9**
DOE	49.5	57.4	5.5	11.0	0.5	106.1	1.0	**231.0**
DHHS (NIH)	39.6	16.8	117.2	6.9	1.7	0.1	9.3	**191.6**
DOC (NIST)	21.9	8.4	18.7	14.9	6.9	4.7	2.4	**77.9**
NASA	11.0	18.0	20.0	0.0	1.0	0.0	0.0	**50.0**
EPA	0.2	0.3	0.3	0.0	0.0	0.0	3.7	**4.5**
USDA (CSREES)	0.5	1.0	2.1	0.0	0.1	0.0	0.2	**3.9**
DHHS (NIOSH)	0.0	0.0	0.0	0.0	0.0	0.0	3.8	**3.8**
USDA (FS)	0.4	1.0	0.2	0.5	0.2	0.0	0.0	**2.3**
DHS	0.0	0.0	1.5	0.0	0.0	0.0	0.0	**1.5**
DOJ	0.0	0.0	0.0	0.3	0.0	0.0	0.0	**0.3**
DOT (FHWA)	0.9	0.0	0.0	0.0	0.0	0.0	0.0	**0.9**
TOTAL†	**455.9**	**265.1**	**319.6**	**51.0**	**33.8**	**152.4**	**73.5**	**1,351.2**

† Totals may not add due to rounding.

The following three sections provide narrative descriptions of interagency and single-agency nanotechnology activities as well as changes by program component area (PCA) with an emphasis on changes for 2007 and 2008. These descriptions are not intended to be inclusive of all ongoing activities, but rather represent a sampling of some of the most notable items.

Interagency Highlights

- **All NNI Agencies:** As discussed in more detail later in this report, members of the NSET Subcommittee's Nanotechnology Environmental and Health Implications (NEHI) Working Group are working closely together in the development of an NNI-wide strategy for research addressing potential EHS implications of nanotechnology.
- **DOT, NSF:** The Federal Highway Administration and NSF are jointly supporting research to improve fundamental understanding of nanoscale mechanisms controlling setting of Portland cement concrete.
- **EPA, NSF, DOE:** Participation in an interagency solicitation addressing potential environmental implications of nanotechnology will expand. DOE will begin participating in this multi-agency activity in 2008, joining EPA and NSF.

Table 4
Estimated 2007 Agency Investments by Program Component Area (dollars in millions)

	Fundamental Phenomena & Processes	Nanomaterials	Nanoscale Devices & Systems	Instr. Research, Metrology, & Standards	Nano-manufacturing	Major Research Facilities & Instr. Acquisition	Societal Dimensions	NNI Total
NSF	131.8	58.0	50.3	15.0	27.2	31.9	59.0	**373.2**
DOD	181.0	84.8	107.5	9.5	4.8	28.6	1.0	**417.2**
DOE	51.8	58.8	15.6	12.0	0.5	95.9	0.5	**235.2**
DHHS (NIH)	43.1	16.7	115.9	6.7	1.7	0.1	9.4	**193.8**
DOC (NIST)	25.7	7.8	13.4	20.4	9.6	4.2	3.0	**84.2**
NASA	1.0	12.0	11.0	0.0	1.0	0.0	0.0	**25.0**
EPA	0.2	0.2	0.2	0.0	0.0	0.0	7.9	**8.5**
USDA (CSREES)	0.5	0.8	1.8	0.0	0.1	0.0	0.2	**3.4**
DHHS (NIOSH)	0.0	0.0	0.0	0.0	0.0	1.7	4.9	**6.6**
USDA (FS)	0.4	1.3	0.7	0.0	0.2	0.0	0.0	**2.6**
DHS	0.0	0.0	2.0	0.0	0.0	0.0	0.0	**2.0**
DOJ	0.0	0.0	0.6	0.8	0.0	0.0	0.0	**1.4**
DOT (FHWA)	0.9	0.0	0.0	0.0	0.0	0.0	0.0	**0.9**
TOTAL†	**436.5**	**240.4**	**319.1**	**64.5**	**45.1**	**162.4**	**85.9**	**1,353.9**

† Totals may not add due to rounding.

- **NASA, NSF:** These two agencies held a joint principal investigator meeting in December 2006 to facilitate interchange between the nanotechnology R&D centers that they have funded, as part of an ongoing collaboration between NASA, NSF, and other NNI agencies.
- **NIH, EPA, NIOSH:** A new interagency solicitation focused on potential health implications of nanotechnology is starting in 2007. This is led by NIH's National Institute of Environmental and Health Sciences (NIEHS) and includes participation by five other NIH institutes as well as EPA and NIOSH.
- **NIH, FDA, NIST:** The Nanotechnology Characterization Lab (NCL) of the National Cancer Institute (NCI) is developing a battery of characterization tests for preclinical evaluation of nanomaterials intended for cancer therapeutics. This work is being done in partnership with FDA and NIST and is aimed at stimulating further development of nanoparticles, development of standards for their characterization, and accelerating transition of these technologies to the clinic.
- **NIH, FDA, NIOSH:** The National Toxicology Program (led by NIEHS) is developing and carrying out research and testing programs addressing health and safety issues in collaboration with NIOSH, the FDA National Center for Toxicological Research, and the NCI Nanotechnology Characterization Lab.
- **NIH, NSF, DOE:** Several NIH program solicitations have explicitly called attention to resources provided by the centers that are supported by other agencies (e.g., NSF, DOE). Resulting NIH-supported projects collaborate actively with those centers.

Table 5
Planned 2008 Agency Investments by Program Component Area (dollars in millions)

	Fundamental Phenomena & Processes	Nanomaterials	Nanoscale Devices & Systems	Instr. Research, Metrology, & Standards	Nano-manufacturing	Major Research Facilities & Instr. Acquisition	Societal Dimensions	NNI Total
NSF	142.7	60.2	51.1	14.5	26.9	31.6	62.9	**389.9**
DOD	179.1	91.7	70.6	8.3	1.0	23.0	1.0	**374.7**
DOE	85.4	99.8	13.5	26.7	2.0	100.6	3.5	**331.5**
DHHS (NIH)	53.3	16.5	114.9	6.7	1.7	0.1	9.7	**202.9**
DOC (NIST)	27.1	8.0	13.5	26.4	11.1	4.5	6.0	**96.6**
NASA	1.0	12.0	10.0	0.0	1.0	0.0	0.0	**24.0**
EPA	0.2	0.2	0.2	0.0	0.0	0.0	9.6	**10.2**
USDA (CSREES)	0.4	0.8	1.5	0.0	0.1	0.0	0.2	**3.0**
DHHS (NIOSH)	0.0	0.0	0.0	0.0	0.0	0.0	4.6	**4.6**
USDA (FS)	1.7	1.5	1.0	0.2	0.2	0.0	0.0	**4.6**
DHS	0.0	0.0	1.0	0.0	0.0	0.0	0.0	**1.0**
DOJ	0.0	0.0	0.1	0.8	0.0	0.0	0.0	**0.9**
DOT (FHWA)	0.9	0.0	0.0	0.0	0.0	0.0	0.0	**0.9**
TOTAL*	**491.8**	**290.7**	**277.4**	**83.6**	**44.0**	**159.8**	**97.5**	**1,444.8**

- **NIST, NASA, NIOSH:** These agencies have initiated a coordinated effort to develop the first Reference Material (RM) for residual catalyst content in carbon nanotube (CNT)-bearing material, enabling manufacturers to produce uniform materials that meet the requirements of the marketplace. Carbon nanotubes have the potential of leading to significant advances in microelectronics and materials manufacturing because of their potential for improving the mechanical, thermal, and electrical properties of the materials in which they are incorporated.
- **NSF, DOD, NIST:** The National Nanomanufacturing Network established in 2007 will become fully operational in 2008. This is a partnership between four NSF Nanoscale Science and Engineering Centers (NSECs), DOD laboratories, and NIST. Industry, business, and professional organizations working for nanotechnology development will also participate. The central node of the network will be the Center for Hierarchical Manufacturing at the University of Massachusetts/Amherst. Three other nodes will be the Center for High-Rate Nanomanufacturing at Northeastern University, the Center for Scalable and Integrated Nanomanufacturing at UCLA, and the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems at the University of Illinois, Urbana-Champaign.
- **NSF, DOD, NASA:** These agencies are coordinating their efforts on simulations in nanoelectronics.
- **NSF, DOD, NIH:** These agencies are coordinating their nanoscience and nanotechnology research and training activities.

Table 6 Budget for Environmental, Health, and Safety R&D, 2006–2008 (dollars in millions)			
	2006 Actual	2007 Estimate	2008 Request
NSF	21.0	25.7	28.8
DOD	1.0	1.0	1.0
DOE	0.5	0.0	3.0
DHHS (NIH)	5.2	5.4	5.7
DOC (NIST)	2.4	2.8	5.8
NASA	0.0	0.0	0.0
EPA	3.7	7.9	9.6
USDA (CSREES)	0.1	0.1	0.1
DHHS (NIOSH)	3.8	4.9	4.6
USDA (FS)	0.0	0.0	0.0
DHS	0.0	0.0	0.0
DOJ	0.0	0.0	0.0
DOT (FHWA)	0.0	0.0	0.0
TOTAL	**37.7**	**47.8**	**58.6**

Table 7 Budget for Education and Ethical, Legal, and Other Societal Issues, 2006–2008 (dollars in millions)			
	2006 Actual	2007 Estimate	2008 Request
NSF	31.0	33.4	34.2
DOD	0.0	0.0	0.0
DOE	0.5	0.5	0.5
DHHS (NIH)	4.1	4.0	4.0
DOC (NIST)	0.0	0.2	0.2
NASA	0.0	0.0	0.0
EPA	0.0	0.0	0.0
USDA (CSREES)	0.1	0.1	0.1
DHHS (NIOSH)	0.0	0.0	0.0
USDA (FS)	0.0	0.0	0.0
DHS	0.0	0.0	0.0
DOJ	0.0	0.0	0.0
DOT (FHWA)	0.0	0.0	0.0
TOTAL	**35.7**	**38.2**	**39.0**

Changes for Individual Agencies

DOD: Since DOD is a mission-oriented agency, its nanotechnology programs are distinguished from some other Federal agencies in that the program activities are simultaneously focused on scientific and technical merit and on relevance to the agency. With respect to scientific and technical merit, in keeping with the NNI vision, the overall technical objective of these programs is to develop understanding and control of matter at dimensions of approximately 1 to 100 nanometers, where the physical, chemical, and biological properties may differ in fundamental and valuable ways from those of individual atoms, molecules, or bulk matter. With respect to relevance to the agency's mission, DOD continues to pursue the overall objective of discovering and exploiting unique phenomena at nanoscale dimensions to enable novel applications enhancing war fighter and battle systems capabilities. Scientific breakthroughs and advances in the last ten years demonstrate the potential for nanotechnology to impact a tremendous number of key capabilities for future war fighting, e.g., chemical and biological warfare defense; high-performance materials for platforms and weapons; unprecedented information technology; revolutionary energy and energetic materials; and uninhabited vehicles and miniature satellites.

DOD requests for 2008 include sustained emphasis on fundamental phenomena and processes, with slightly reduced requests compared to prior years in nanoscale devices and systems and in nanomanufacturing. An increase in DOD's requests in major research facilities and instrumentation acquisition shows the agency's important contribution to this investment mode. DOD investments for 2006 and 2007 shown in Tables 2–4 include significant amounts of Congressional additions (earmarks). These additions, particularly notable in the nanomaterials PCA, are outside the DOD planned programs and R&D and significantly complicate the assessment of current and proposed funding levels for the DOD investment in nanotechnology.

In order to identify and capture the critical technological breakthroughs needed to provide revolutionary advantages for war fighter and battle systems capabilities, it is critical for DOD to maintain a nanotechnology research and development investment portfolio that is stable (relative to the overall DOD research and development budget) and strategic (relative to the worldwide investment). Additional details are available from DOD's annual report to Congress outlining its nanoscience and nanotechnology R&D programs; see http://nano.gov/html/res/pdf/DefenseNano2007.pdf.

DOE: The 2008 DOE request for NNI activities represents an overall increase of about $38 million (or 13%) over the 2007 request, based on reporting from the Office of Science (SC) (including the Offices of Basic Energy Sciences, Biological and Environmental Research, and Advanced Scientific Computing Research) and the Office of Energy Efficiency and Renewable Energy (EERE). The Office of Science request includes additional funding for activities related to the hydrogen economy and for research relevant to environmental and ecological aspects of nanomaterials. Among the program component areas, the largest increase for DOE/SC is in fundamental nanoscale phenomena and processes, but there are increases in most other PCAs as well.

EERE is reporting nanotechnology investments for 2006–2008 that were not captured in earlier NNI reports and tabulations; these amount to nearly $46 million of the 2008 request. DOE/EERE funds are greatest, and show the largest increase, in the nanomaterials PCA; additional EERE investments in nanoscale devices and systems and in nanomanufacturing also will increase in 2008.

A major milestone in 2008 is the planned project completion and start of full operations at DOE's fifth Nanoscale Science Research Center (NSRC) user facility, the Center for Functional Materials (CFN) at Brookhaven National Laboratory. It joins the four other DOE NSRCs: the Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory; the Molecular Foundry at Lawrence Berkeley National Laboratory; the Center for Integrated Nanotechnologies (CINT) at Sandia and Los Alamos National Laboratories; and the Center for Nanoscale Materials (CNM) at Argonne National Laboratory. These major facilities are available to all prospective users, with equipment and staff time allocated on the basis of peer review of proposals. Further information on the NSRCs and on other DOE NNI efforts can be found at http://www.nano.energy.gov.

DOT: The Federal Highway Administration is supporting research aimed at improving fundamental understanding of the structure and properties of highway construction materials at the nanoscale. For example, asphalt research conducted under contract to the Western Research Institute concerns the use of atomic force microscopy to characterize the morphology of asphaltenes, which are the nanoparticle components of asphalt, as a function of temperature, chemical composition, and other factors.

EPA: EPA is developing a nanotechnology research strategy for fiscal years 2007–2012 that is problem-driven, focused on addressing the agency's needs. The framework for this strategy involves conducting research to understand engineered nanoscale materials, in particular those with the greatest potential to be released into the environment and that pose potentially significant risks to human health or ecosystems, from a life cycle perspective. EPA also will conduct research to identify approaches for detecting and measuring engineered nanoscale materials, through SBIR contracts and internal and external research.

In 2007 and 2008, EPA will focus on the following high-priority areas: environmental fate, transport, transformation, and exposure; and monitoring and detection methods. The agency is collaborating with academia and industry to fill knowledge gaps in these areas. The agency is also working on a variety of international efforts including participation in the Organization for Economic Cooperation and Development's efforts to address possible EHS implications of engineered nanoscale materials. EPA is launching a collaborative process to design a Nanoscale Materials Stewardship Program under the Toxic Substances Control Act (TSCA), to complement and support its efforts on new and existing nanoscale materials. Depending on the process, components of the Stewardship Program could include: assembling existing data and information from manufacturers and processors of existing chemical nanoscale materials; encouraging the development of test data needed to provide a firm scientific foundation for future work and regulatory/policy decisions; and identifying and encouraging use of a basic set of risk management practices in developing and commercializing applications of engineered nanoscale materials.
EPA's investments in EHS research have more than doubled—from $3.7 million in 2006 to $9.6 million requested for 2008. This increase is a key component of the agency's specific goals and the NNI's overall strategy of increasing investments in this area. For the first time in 2007 this program includes intramural research within EPA's Office of Research and Development, as well as the extramural program that has been in place for several years. EPA will redirect $1.6 million in 2008 to research aimed at understanding and characterizing the fate, transport, and transformation of engineered nanoscale materials.

By the end of 2007, EPA's extramural nanotechnology R&D program will have awarded a cumulative total of approximately 35 grants totaling over $12 million for development of environmental *applications* of nanotechnology, and 51 grants totaling over $17 million to study potential health and ecological *implications* of nanotechnology. The grants for implications research support work related to engineered nanoscale materials for toxicological and biological effects; environmental and biological fate, transport, and transformation; exposure/bioavailability for humans and other species; and life cycle assessment. They are being funded as EPA's part of a series of interagency research solicitations designed to coordinate research activities in this area. The EPA's SBIR program has awarded 32 contracts to small businesses for nanotechnology research. Future SBIR awards are expected to be targeted towards detection of engineered nanoscale materials in various environmental media.

EPA has drafted a Nanotechnology White Paper[4] that identifies key science issues and research needs related to identifying and understanding potential applications of nanotechnology for environmental protection as well as potential human health and ecological impacts from exposure to engineered nanoscale materials in the environment.

FDA: Efforts are underway at FDA to address scientific and policy concerns and issues related to nanotechnology use for the entire spectrum of FDA-regulated products. These activities are being conducted under the auspices of the recently established FDA Nanotechnology Task Force and the Nanotechnology Interest Group (NIG). The NIG comprises review-level scientists who are uniquely qualified to provide input on nanotechnology-enabled product development.

FDA has launched a website (http://www.fda.gov/nanotechnology/) for sharing and communicating information and new scientific findings about nanotechnology.

NASA: NASA focuses on the application of nanotechnology to space exploration, in keeping with the priorities of the agency's missions. Special emphasis is placed on NASA unique requirements, namely structures and devices that function in the extreme environments of space (e.g., radiation and wide temperature fluctuations). The agency's present investments in nanotechnology are in the following three areas: (1) high-strength, lightweight materials, with an eventual goal to progress towards multifunctional materials; (2) devices and sensor suites that operate with a high degree of sensitivity, reliability, and autonomy under low power requirements; and (3) radiation-resistant and fault-tolerant systems capable of sustained performance under extreme environments. The University Research, Engineering, and Technology Institutes (URETIs) that NASA funded early in the NNI are nearing the end of their five-year funding commitments. However, the regional NASA centers are continuing to invest in nanotechnology R&D within their normal programs, as opportunities arise for exploiting nanotechnology-based solutions to their programmatic needs.

Some examples of where NASA centers are exploring such opportunities are as follows. The agency has demonstrated the ability to rapidly cure ceramic precursor materials designed for use in the on-orbit repair of carbon reinforced materials. NASA's Johnson Space Center (JSC) is working with the State of Texas and the Nanoelectronics Research Initiative to investigate the use of a laser ablation process to produce conductive "armchair" single-wall carbon nanotubes (CNTs). JSC and the Ames Research Center have initiated a multidisciplinary effort focused on the incorporation of carbon nanotubes into a phenolic ablative material intended for use on next-generation spacecraft thermal protection systems. NASA Glenn Research Center has developed polymer cross-linked aerogels—modified silica aerogels with significantly enhanced durability and mechanical properties—and has fabricated novel nanocomposites that will be tested on the International Space Station. NASA Glenn continues to work on taking advantage of enhanced

[4] See http://epa.gov/osa for the current draft

electromechanical properties in CNT nanocomposites to enable low-voltage electroactive material systems. There is great potential for using CNT composites in sensors and actuators.

NIH: NIH's priorities for nanotechnology research continue to be creation of improved diagnostic and therapeutic approaches and devices, and development of new research capabilities to understand fundamental biomedical mechanisms. This research aims to improve the health of the U.S. population and to reduce suffering from disease and disability. There is no significant change in priorities from 2007 to 2008. NIH is continuing a network of nanotechnology research centers, funded both by individual NIH institutes and under the NIH-wide Nanomedicine Roadmap Initiative. NIH also has created an NIH-wide Nanotechnology Task Force to coordinate nanotechnology-related investments at the various institutes.

The core of NIH-supported nanotechnology research continues to be investigator-initiated grants whose topics range from exploring basic phenomena at the nanotechnology/biomedical interface to the application of that knowledge for disease diagnosis and remediation. NIH's centers programs promote multidisciplinary R&D that engages basic biological science, physical science, and clinical perspectives and expertise. They leverage and enhance the investments of other Federal agencies in their nanotechnology R&D centers.

A consortium of 17 NIH institutes has re-released the solicitation, "Nanoscience and Nanotechnology for Biology and Medicine," for regular research grants and feasibility projects. The number of active awards resulting from this opportunity has more than tripled between 2004 and 2007. This program is expected to remain active in 2008. A parallel SBIR/STTR program solicitation involving 19 institutes and centers was reissued in 2006 and has resulted in as many as 44 active awards in a single fiscal year. Large centers and related programs at the NCI, NHLBI, and Nanomedicine Roadmap Initiative will continue in 2008. The National Institute of Dental and Craniofacial Research investment in PCA 2 is expected to increase in 2007 as a result of a 2006 request for applications (RFA) for development of nanostructured dental composite materials.

The Trans-NIH Nanotechnology Task Force has been created for the purposes of achieving better information exchange, planning, and coordination, both inside the NIH and with external partners. Within NIH, assessment of the current portfolio to identify potential gaps and develop an integrated strategy to improve public health through nanomedicine is underway. NIH is also actively exploring opportunities to form partnerships in several areas related to that mission.

NIEHS has expanded its nanomaterials health and safety research activities through participation in two workshops sponsored by the International Council on Nanotechnology (ICON), Rice University, through a grant funded by NSF. The first workshop was cosponsored by the Trans-NIH Nanotechnology Task Force and NIEHS. The workshops identified global research priorities for classification of nanomaterials and for development of predictive models of toxicity. They also provided an opportunity to expand academic, industrial, and global dialogue on nanotechnology. Additionally, NIEHS, in partnership with the National Institute of Biomedical Imaging and Bioengineering, is developing an integrated health and safety research framework, the NanoHealth Initiative, for consideration by the task force.

For 2007-2008, the NIEHS National Toxicology Program (NTP) will continue its research program as outlined under the NTP Nanotechnology Safety Initiative (http://ntp.niehs.nih.gov/go/nanotech). The goal is to evaluate the toxicological properties of major nanoscale materials classes representing a cross-section of composition, size, surface coatings, and physicochemical properties. These nanoscale materials classes will then be used as model systems to investigate fundamental questions concerning if and how nanoscale materials can interact with biological systems. Specific classes of nanomaterials being evaluated primarily in rodent toxicology models include quantum dots, metal oxides, and carbon fullerenes. Programs to investigate several other classes of materials are being developed.

The NCI's Nanotechnology Characterization Laboratory performs preclinical efficacy and toxicity testing of engineered nanoscale materials intended for cancer therapies and diagnostics. Such testing lays a scientific foundation that will enable FDA to make sound decisions concerning the safety and efficacy of nanoscale materials for cancer diagnostics, imaging agents, and therapeutics. Recently NCL has extended its work to *in vivo* models and testing by working with the NCI intramural small animal facility. NCL and NCI's Office of Technology and Industrial Relations are also founding entities of new small animal imaging infrastructure in Frederick, Maryland, jointly with the Center for Cancer Research and the NCI Molecular Imaging Program. NCI has launched a website (http://ncl.cancer.gov/) for sharing and communicating information about its nanotechnology R&D program.

NIOSH: NIOSH continues to ramp up its important investments in R&D related to worker health and safety, in close coordination with other DHHS agencies (e.g., those participating in the National Toxicology Program). The NIOSH budget request has increased from $3.0 million for 2006 to $4.6 million for 2008. This overall increase between 2006 and 2008 will allow support for additional intramural and extramural projects targeted to address critical research gaps around occupational safety and health of nanotechnology and nanomaterials. The investment for 2007 includes a one-time allocation of $1.7 million for acquisition of specialized equipment and facilities to be used in NIOSH's intramural nanotechnology research program.

In 2006 NIOSH's Nanotechnology Research Center conducted a critical gap analysis of research needs in the area of occupational safety and health of nanotechnology and announced an intramural RFA to address identified gaps. Following internal and external peer review, six additional projects were selected for funding in 2007 and 2008. The projects will look into (1) conducting a risk assessment on carbon nanotubes, (2) identifying the next important area of toxicology research such as a class of nanoparticles or a not widely studied organ system, (3) advancing metrology in a way that will help in risk assessment, and (4) filling an important information gap in NIOSH control guidance.

NIST: In 2006 NIST launched the Center for Nanoscale Science and Technology (CNST), a state-of-the-art center for collaborative nanotechnology research at its Gaithersburg campus. Scientists from U.S. companies, universities, and government will focus on overcoming major technical obstacles to cost-effective manufacturing of products made with components the size of atoms and molecules. Additional foci at NIST include the development of standard reference materials for nanotechnology and other research related to nanomanufacturing.

In the quest for ever-higher and faster electronic storage capacity, the ability to move information stored in magnetic domains by a flowing current suggests novel approaches to future storage device designs. NIST's CNST has imaged and modeled the novel phenomenon of current-induced domain wall motion in magnetic nanowires.

NSF: Increased support is expected for use of quantum phenomena in nanoscale devices, self-assembly processes at various length scales, and active nanostructures and nanosystems. As discussed in more detail on

p. 23 in the section describing changes in balance of investments by PCA, NSF will establish a new center on environmental implications of nanotechnology in 2008. The national outreach of the nanotechnology research and education networks (National Nanotechnology Infrastructure Network, Network for Computational Nanotechnology, Nanotechnology in Society Network, Nanoscale Center for Learning and Teaching, Nanoscale Informal Science Education, Nanoscale Science and Engineering Centers, National Nanomanufacturing Network, and Materials Research Science and Education Centers) will be expanded. There will be an increased focus on using nanotechnology for water filtration and energy conversion. Further information on the NSF NNI efforts can be found at http://www.nsf.gov/nano.

USDA/CSREES: The Cooperative State Research, Education, and Extension Service (CSREES) continues to explore new ways to accelerate advances of nanotechnology-based devices and systems (including those that are wearable, implantable, and portable) for biological processes critical to agriculture production, food safety and quality, agricultural biosecurity, and human health (e.g., issues related to weight management and obesity). The Nanoscale Science and Engineering for Agriculture and Food Systems Program, under the USDA/CSREES National Research Initiative (NRI) competitive research grant program, will combine the resources from both 2007 and 2008 for solicitation at an anticipated level of approximately $5 million in 2008.

The funding distribution among the PCAs is expected to be similar to that of 2006. Issues of particular interest to CSREES include (1) monitoring energy balance to effectively manage individual food intake for controlling weight and obesity; (2) sensitive early detection of zoonotic diseases; (3) sensitive and rapid tools for simultaneous quantification and qualification of multiple pathogenic organisms; (4) intelligent tools for improving animal reproduction; and (5) food and agricultural product identity tracking and preservation.

As a result of fundamental research supported by other NNI agencies (e.g., NSF, DOE, NIH, and others), new nanomaterials have become available, and new concepts and prototypes of nanotechnology-based devices and systems have been explored. USDA/CSREES intends to utilize these new capabilities to address some of the most challenging issues facing agriculture and foods.

USDA/FS: The Forest Service, which reported R&D spending on nanotechnology for the first time in 2007, plans to increase its R&D expenditures in nanotechnology by $1–2 million per year. Advances in nanoscale science and engineering support the agency's efforts to understand the material properties of wood in order to improve the range of applications and performance of wood-based products. Knowledge of the nanoscale biological processes that give wood its useful properties may also lead to novel methods of manufacturing.

In 2007 and 2008, Forest Service R&D is focused in a number of research areas: developing artifact-free metrology techniques to study the nanoscale properties of wood and wood-based materials; improving wood-based specimen preparation techniques to enable enhanced characterization; improving wood adhesive bond durability; investigating methods for making more accurate measurement of the chemistry at the nanoscale interface of adhesives and the wood-cell walls; studying cellulose nanocrystals for use as a potentially low-cost source of nanoscale fibers with benefits similar to carbon nanotubes but at a fraction of their cost; and evaluating the utilization of nanoscale carbon particles in waste streams from wood processing facilities, such as sawmills and wood composite plants, as reinforcing agents in structural wood-based composites.

USPTO: The USPTO hosts an annual Nanotechnology Customer Partnership meeting so that USPTO officials and patents stakeholders can confer on a regular basis to share concerns and information related to the patenting of nanotechnology. The agency continues to provide both enhanced in-depth technical training for patent examiners on the state of the art in nanotechnology and greater access to nanotechnology technical information to improve the knowledge base of USPTO examiners. The USPTO has an ongoing classification project related to nanotechnology. The agency completed an expansion of this single-subclass digest by developing a comprehensive nanotechnology cross-reference art collection classification (Class 977, Nanotechnology). Class 977 includes 263 subclasses, definitions, and search notes. It is the first fully-expanded patent-related nanotechnology classification schedule developed by any major intellectual property office in the world.

Changes in Balance of Investments by PCA[5]

PCA 1: Fundamental Phenomena and Processes

Significant increases in funding are requested for 2008 for fundamental phenomena and processes across most of the major funding agencies, with the exception of NSF and NASA. NSF funding in this PCA remains relatively level. NASA funding for this PCA has dropped by 90% since 2006, as the agency continues to put emphasis on near-term mission priorities in a constrained budget environment.

- *DOE:* As DOE's largest category of NNI research support (outside of the development of major user facilities under PCA 6), substantial increases in research related to fundamental nanoscale phenomena and processes constitute the largest share of the overall DOE increase in NNI activity from 2007 to the 2008 request. This is also commensurate with the implementation of the American Competitiveness Initiative.
- *NSF:* Increased focus will be placed on understanding quantum phenomena and their use in devices and systems, self-assembly on multiple scales, and complex behavior of large nanosystems. The convergence of nanotechnology with information technology, modern biology, and social sciences will reinvigorate discoveries and innovation.
- *USDA/FS:* New efforts have begun at the Forest Service to investigate and improve fundamental understanding of the structure and properties of cellulose at the nanoscale.

PCA 2: Nanomaterials

An increase in the aggregate NNI spending on nanomaterials research is requested for 2008, although not across all agencies.

- *DOD:* Congressional additions constitute a significant portion of the DOD research and development budget focused on nanotechnology. These additions significantly complicate the assessment of current and proposed funding levels for the DOD investment in nanotechnology, as they are difficult to identify and to evaluate. Congressional additions explain most of the change between 2006 investments in this area and those shown for the 2007 investment and the 2008 request in Tables 4 and 5 above.
- *DOE:* The substantial increases in this PCA from year to year that are reflected in the tables, and the increases in the numbers reported here versus those reported previously for the same years, result both from research initiatives that are in support of the American Competitiveness Initiative and from the addition of reporting from the Department's Office of Energy Efficiency and Renewable Energy.

---

[5] Changes are as compared to NNI investments described in the *NNI Supplement to the President's 2007 Budget*.

- *NSF:* Increased focus will be placed on nanostructured materials with emergent behavior and support for study of biologically-based or -inspired systems that exhibit novel properties and potential applications. Simulation-based design of nanostructured materials will be emphasized.
- *USDA/FS:* New efforts are focused on specialized bark cell wall characterization and utilization of nanoscale carbon materials recovered from gasification of woody biomass.

PCA 3: Nanoscale Devices and Systems

The apparent reduction in funding for this PCA is primarily due to the difference between the reported 2007 investment and the 2008 President's budget request for DOD. This difference is largely due to Congressional set asides, which are included in the reported 2007 investment, but cannot be included in the President's 2008 budget request.

- *NIH:* While NIH's request for this PCA is essentially level with 2007 estimates, the National Heart, Lung, and Blood Institute (NHLBI) has increased its investment in this PCA by $3 million as a result of doubling of the budgets of the existing centers in the NHLBI Programs of Excellence in Nanotechnology.
- *NSF:* Under this PCA, NSF continues its research focus on active nanostructures and nanosystems, including new concepts to understand interactions among nanoscale devices in complex systems, such as the physical, chemical, and biological interactions between nanostructures and device components. Research on nanoelectronics "beyond silicon" and complementary metal-oxide semiconductors (CMOS) will explore replacing electron charge as the information carrier, bottom-up device assembly technologies at the atomic and molecular levels, and new system architectures using nanoscale components.

PCA 4: Instrumentation Research, Metrology, and Standards for Nanotechnology

Steady increases in funding are projected for instrumentation, metrology, and standards research, particularly at DOE and NIST. Some of this increased spending is related to instrumentation, metrology, and standards needs for EHS research.

- *DOE:* A moderate increase in this PCA for DOE reflects overall increases across the various types of nanotechnology research supported in DOE's Office of Basic Energy Sciences in 2008.
- *NIST, NASA, NIOSH:* Carbon nanotubes have the potential of leading to significant advances in microelectronics and materials manufacturing because of their ability to improve the mechanical, thermal, and electrical properties of the materials in which they are found. NIST, NASA, and NIOSH have initiated a coordinated effort to develop the first Reference Material for residual catalyst content in carbon nanotube-bearing material, enabling manufacturers to produce uniform materials that meet the requirements of the marketplace.
- *NSF:* A special challenge is developing tools for measuring and restructuring matter with atomic precision, for time resolution of chemical reactions, and for domains of biological and engineering relevance. A new focus will be on behavior of nanostructured materials under extreme conditions such as low temperature and high magnetic fields.

PCA 5: Nanomanufacturing

Across the NNI as a whole, increased spending on nanomanufacturing is expected in 2007 and 2008 compared to earlier years, with substantial increases over 2006, particularly at NIST and NSF.

- *DOD:* The variations in DOD funding for nanomanufacturing research are due to typical turnover within the programs and the changes in Congressional additions within the data (approximately $2 million of the 2007 amount for this PCA).
- *DOE:* The Office of Energy Efficiency and Renewable Energy expects to increase its nanomanufacturing-related activities in 2008.
- *NIST:* Measurement science and standards at NIST in support of nanomanufacturing continues to be substantial and includes nanoparticle standards for improved characterization of manufactured products. Efforts focus on developing the technical and measurement infrastructure required by U.S. industry to translate potential nanotechnologies into manufacturable, market-ready products.
- *NSF:* A focus will be creating active nanostructures and complex nanosystems. This will include R&D and integration of ultra-miniaturized top-down processes, increasingly complex bottom-up or self-assembly processes, nanobiomanufacturing, and developing novel concepts for high-rate synthesis and processing of nanostructures and nanosystems.

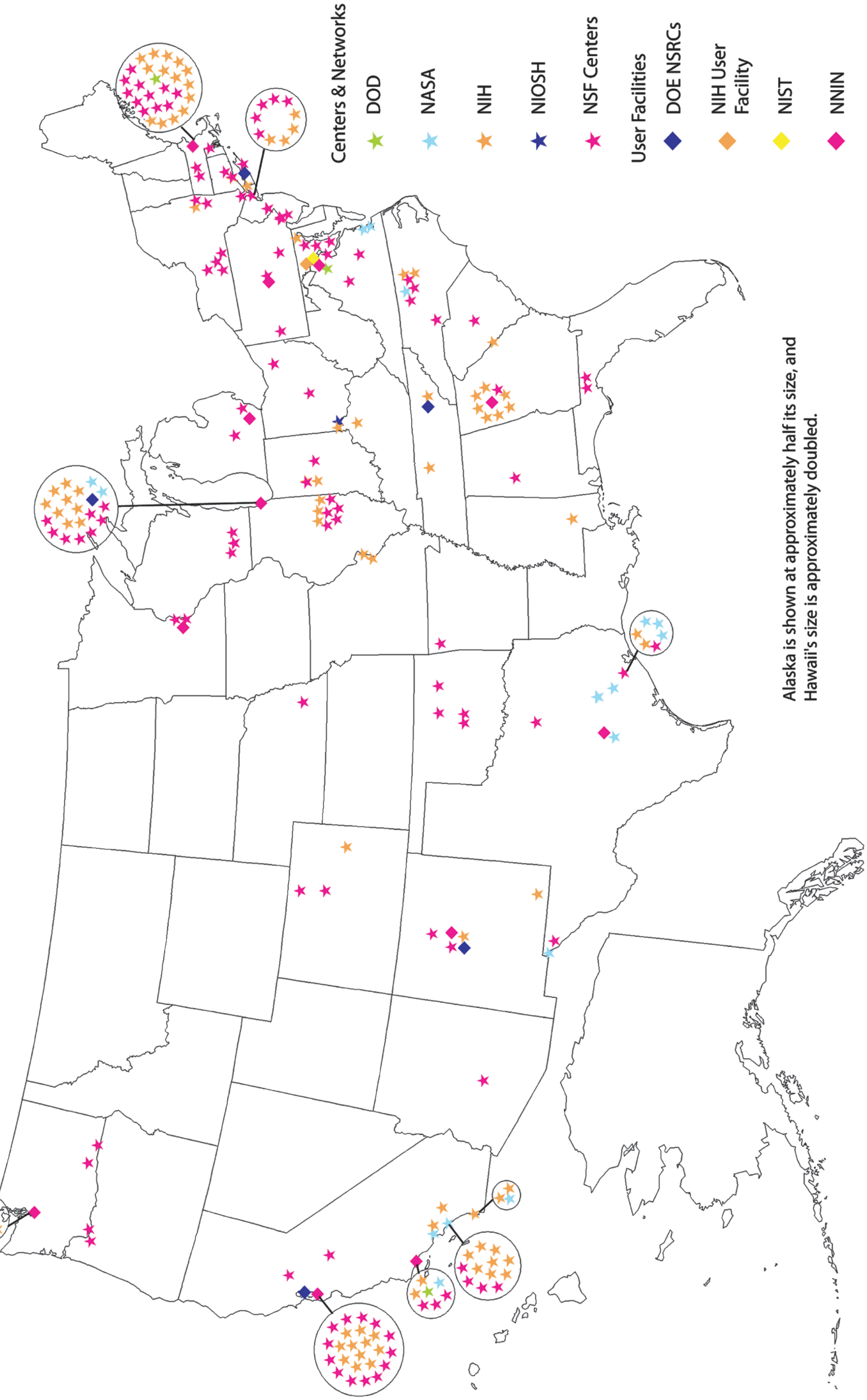
PCA 6: Major Research Facilities and Instrumentation Acquisition

As described in Section 1 and validated by the National Academies report released in 2006, a key element of the NNI investment strategy is to create a network of interdisciplinary research centers and user facilities with state-of-the-art equipment for nanoscale science and technology research. Figure 1 (p. 21) shows the geographic location of all agency centers, networks, and user facilities that have been created under NNI auspices over the past seven years. These are listed in Appendix A.

Relatively flat funding is expected for major research facilities and instrumentation acquisition as NSF and DOE near completion of their major infrastructure development efforts.

- *DOD:* The 2007 program for this PCA includes an expected increase of approximately $21 million in order to develop novel lithography instrumentation for affordable, high-performance, low-volume, and application-specific integrated circuits (ASICs). Furthermore, this new facility and instrumentation initiative will provide a cost-effective manufacturing technology for low-volume nanoelectromechanical systems (NEMS) and nanophotonic devices.
- *DOE:* The funds within this PCA change relatively little from previous years to 2008, but there is a substantial shift in activity to facility operations as physical construction and initial outfitting of the Nanoscale Science Research Centers are completed. These major user facilities are a primary component of the scientific infrastructure developed through the NNI. All five DOE NSRCs are anticipated to be in full operation by the middle of 2008.
- *NIOSH:* In 2007 NIOSH has allocated $1.7 million for a one-time investment in equipment and facilities in support of its intramural nanotechnology research programs.
- *NIST:* The staff of NIST's state-of-the-art collaborative nanotechnology research center, the Center for Nanoscale Science and Technology, launched in 2006, will continue to grow in both 2007 and 2008. Equipment purchases for making, testing and characterizing prototype nanoscale devices and materials within the Center will also continue.

Figure 1. NNI Centers, Networks, and User Facilities



- *NSF:* NSF is funding the acquisition of major instrumentation, as well as other activities that develop, support, or enhance the scientific infrastructure for the conduct of nanoscale science, engineering, and technology research and development. It also supports ongoing operations of the nanotechnology research and education networks: the National Nanotechnology Infrastructure Network (NNIN), the Network for Computational Nanotechnology (NCN), the Nanotechnology Center for Learning and Teaching (NCLT), the Nanoscale Informal Science Education (NISE) Network, the National Nanomanufacturing Network (NNN), the Nanoscale Science and Engineering Centers (NSECs), and the Materials Research Science and Engineering Centers (MRSECs).

PCA 7: Societal Dimensions

The NNI as a whole is experiencing a marked increase in spending on societal dimensions of nanotechnology, particularly in environmental, health, and safety (EHS) research, where NNI spending has increased by over 55% between 2006 actual expenditures ($37.7 million) and planned 2008 investments ($58.6 million). This reflects the high priority that the Administration places on research toward identifying and managing potential EHS impacts of nanoscale materials in order to support commercialization of nanotechnology-based innovations while protecting public health and the environment. Spending on education-related activities and research on the broad implications of nanotechnology for society is up to approximately $39 million requested for 2008 from the $35.7 million spent in 2006. This funding supports workforce development, educational activities, and research into economic, ethical, legal, and other societal issues.

- *All NNI Agencies:* EHS research planning continues to be a priority. The NSET Subcommittee published a report prepared by its Nanotechnology Environmental and Health Implications (NEHI) Working Group entitled *Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials* (http://nano.gov/NNI_EHS_research_needs.pdf) in September 2006, and held a public meeting on EHS research needs and prioritization in January 2007. In the coming year, the NEHI Working Group will identify gaps in the research portfolio and work with agencies to address research priority areas. In parallel, a growing number of agencies are participating in two joint solicitations addressing potential environmental and health implications of nanotechnology. One led by EPA that is focused on environmental implications is now in its third year (DOE will join EPA and NSF in 2008). A second is a new solicitation starting in 2007 that is focused on human health implications and is led by NIH's National Institute of Environmental and Health Sciences and includes participation by five other NIH institutes as well as EPA and NIOSH.
- *DOE:* The DOE Office of Biological and Environmental Research continues support for activities relating to ethical, legal, and other societal issues of emerging technologies including nanotechnology in 2007 and 2008. In addition, new funds are requested in 2008 for research on environmental and ecological impacts of nanomaterials that could find application in energy technologies. DOE plans to implement this program by participating in the annual multi-agency solicitation for extramural research proposals (led by EPA and also involving NSF) on environmental effects of manufactured nanomaterials, with an expected focus on the fate and transport of nanomaterials in the environment.
- *EPA:* Virtually all of EPA's requested increases in nanotechnology-related funding for 2007 and 2008 fall within this PCA—part of an NNI-wide effort to ramp up research on potential EHS implications of nanotechnology and foster the development of this field. Starting in 2008, not only extramural but also intramural research investments supported by EPA's Office of Research and Development are being reported under the NNI funding crosscut. EPA will redirect $1.6 million in 2008 to research on

understanding and characterizing the fate, transport, and transformation of engineered nanoscale materials.

- *NIOSH:* The increased NIOSH budget request (from $3.8 million in 2006 to $4.6 million for 2008) is targeted at intramural and extramural projects to address critical research gaps around occupational safety and health of nanotechnology and nanomaterials. The $6.6 million NIOSH nanotechnology budget for 2007 included one-time investments in research infrastructure.
- *NIH:* At NIH's National Institute of Environmental Health Sciences, a $1.9 million increase in EHS research under this PCA was derived from approximately equal increases in the investment in the National Toxicology Program and in extramural grants in response to the 2006 interagency solicitation on environmental and health implications of engineered nanomaterials.
- *NIST:* In September 2007, NIST will be hosting a workshop for the NNI that will include representatives from Federal research and regulatory agencies, industrial and medical communities, as well as environmental organizations. Utilizing discussions with toxicologists and stakeholders from outside the Government, the workshop will provide guidance on what physical and documentary standards are required to enable sound risk assessment and risk management of engineered nanomaterials. This effort will facilitate the development of standards needed for understanding and managing: occupational exposure to engineered nanomaterials; nanomaterial fate and transport in the environment; and nanomaterial potential impacts on human health and the environment.
- *NSF:* Four centers/networks are investigating the safety of manufacturing nanoparticles: the NSECs at (1) Rice University (evolution of manufacturing nanoparticles in the wet environment), (2) Northeastern University (occupational safety during nanomanufacturing), (3) the University of Pennsylvania (interaction between nanomaterials and cells), and (4) the National Nanotechnology Infrastructure Network (with two nanoparticle characterization centers at the University of Minnesota and Arizona State University). In 2008 NSF will begin supporting a new multidisciplinary center to conduct fundamental research on the interactions between nanoparticles and materials and the living world at all scales. Essential elements of this will be research on bioaccumulation and its effects on living systems; the impacts of nanostructures dispersed in the environment; and methods and instrumentation for nanoparticle detection, characterization, and monitoring, including interactions of nanomaterials with cellular constituents, metabolic networks, and living tissues.

  Research directed at identifying and quantifying the broad implications of nanotechnology for society, including social, economic, workforce, educational, ethical, and legal implications, will be included in projects awarded to interdisciplinary groups and centers. Two networks for nanotechnology education will increase their national outreach: the NCLT and the NISE Network. The Nanotechnology in Society Network—with four main nodes at Arizona State University, University of California at Santa Barbara, University of South Carolina, and Harvard University—will address ethical, legal, and other social implications of nanotechnology.

Utilization of SBIR and STTR Programs to Advance Nanotechnology

As called for by the 21st Century Nanotechnology Research and Development Act, this report includes information on use of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) programs in support of nanotechnology development. Five NNI agencies—DOD, NSF, DHHS, DOE, and NASA—have STTR programs. In addition to these agencies, EPA, NIOSH, NIST, and USDA also have SBIR programs. Table 8 shows 2005 and 2006 agency funding for SBIR and STTR awards for nanotechnology R&D.

A number of NNI agencies (e.g., EPA and NIH) have nanotechnology-specific topics in their SBIR and STTR solicitations. Others (e.g., NSF) have had solicitations in other areas (i.e., manufacturing) that result in funding of substantial numbers of nanotechnology-related SBIR and STTR awards. NIOSH reported nanotechnology-related SBIR funding for the first time in 2006.

Table 8
2005 and 2006 Agency SBIR and STTR Awards
(dollars in millions)

	2005			2006		
	SBIR	STTR	Total	SBIR	STTR	Total
DOD*	7.5	5.5	13.0	12.6	5.6	18.2
NSF	12.1	2.2	14.3	13.9	1.8	15.7
DHHS (NIH)	11.1	5.2	16.3	15.1	2.1	17.2
DHHS (NIOSH)	n.a.	n.a.	n.a.	0.1	0.0	0.1
DOE	7.7	0.4	8.1	18.2	1.6	19.8
NASA	6.0	0.0	6.0	6.8	0.5	7.3
EPA	1.0	n.a.	1.0	1.2	0.0	1.2
USDA	0.0	n.a.	0.0	0.1	n.a.	0.1
DOC (NIST)	0.1	n.a.	0.1	0.1	0.0	0.1
TOTAL	**45.5**	**13.3**	**58.8**	**68.1**	**11.6**	**79.7**

* DOD has revised its estimates for nanotechnology-related SBIR and STTR awards in 2005 from those previously published in the NNI Supplement to the President's 2007 Budget.

3. NNI Management Structure and Key Management Activities in 2006–2008

National Science and Technology Council, NSET Subcommittee, and its Working Groups

The National Nanotechnology Initiative is managed within the framework of the National Science and Technology Council (NSTC), the Cabinet-level council by which the President coordinates science, space, and technology policies across the Federal Government. The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the NSTC coordinates planning, budgeting, program implementation, and review of the initiative. The NSET Subcommittee is composed of representatives from agencies participating in the NNI. A listing of official NSET Subcommittee members is given at the front of this report. Contact information for NSET Subcommittee participants is given in Appendix C. The National Nanotechnology Coordination Office (NNCO) acts as the primary point of contact for information on the NNI; provides technical and administrative support to the NSET Subcommittee; supports the subcommittee in the preparation of multi-agency planning, budget, and assessment documents, including this report; and develops, updates, and maintains the NNI website.

The NSET Subcommittee has established several formal and informal working groups. Formal working groups include the Global Issues in Nanotechnology (GIN) Working Group, the Nanotechnology Environmental and Health Implications (NEHI) Working Group, and the Nanotechnology Innovation and Liaison with Industry (NILI) Working Group. Additional informal groups have been formed to help coordinate agency efforts with respect to nanomanufacturing and public engagement and communication in nanotechnology.

Global Issues in Nanotechnology Working Group

The GIN Working Group facilitates international collaboration on precompetitive and noncompetitive aspects of nanotechnology, and international engagement on trade, commercialization, and regulatory issues. Members of the working group represent the United States at the International Organisation for Standardization (ISO), the Organisation for Economic Cooperation and Development (OECD), and the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, as well as in agency-specific and bilateral engagements with numerous countries.

NSET Subcommittee and GIN Working Group members are active participants in the ISO Technical Committee on Nanotechnologies (ISO TC 229). The NSET Subcommittee has provided initial financial support to the American National Standards Institute's Nanotechnology Standards Panel (ANSI-NSP) and the ANSI-accredited Technical Advisory Group (TAG) that represents the United States on ISO TC 229. The NNCO Director chairs the TAG and heads the U.S. delegation to ISO TC 229. The ANSI-NSP leads the ISO TC 229 working group on EHS aspects of nanotechnology. The development of common terminology and internationally recognized standards will play a critical role in the successful commercialization of nanotechnology.

The United States played a key role in the creation of two new OECD Working Parties: the Working Party on Manufactured Nanomaterials under the Chemicals Committee (WPMN-CC) and the Working Party on Nanotechnology under the Committee for Scientific and Technological Policy (WPN-CSTP). The

United States currently chairs both parties, and GIN Working Group members have taken leadership roles in developing detailed project plans for the working parties.

The NSET Subcommittee has approved a financial contribution to aid in the establishment of the WPN-CSTP in order to stimulate its work in assessing and understanding the economic impacts of nanotechnology; comparing the R&D programs and educational opportunities in member countries; and facilitating dialogues among policymakers and with the public.

Nanotechnology Environmental and Health Implications Working Group

The NEHI Working Group has been engaged over the past year in a high-priority exercise aimed at identifying and prioritizing EHS research needs related to nanomaterials. In September 2006 the NSET Subcommittee published a report prepared by the NEHI Working Group entitled *Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials*. This document represents one of the NEHI Working Group's initial steps toward the identification, prioritization, and implementation of the research and other activities required to support responsible research and development of nanotechnology. This document describes the environmental, health, and safety research and information needed to enable sound risk assessment and risk management decision making. In 2007 the working group will be prioritizing among the research needs identified in the report. A more detailed assessment of current research will allow for the working group to complete a gap analysis and to develop a strategy for addressing high-priority EHS research not already being adequately funded by the Federal Government.

The NEHI Working Group, with assistance from the GIN Working Group, coordinates the U.S. position and participation in international activities related to environmental, health, and safety implications of nanotechnology, including the programs of the OECD WPMN-CC. The working party projects include development of an international database on EHS research, identifying EHS research strategies for manufactured nanomaterials and collaborative approaches for addressing research needs, cross-country communication and coordination of voluntary programs for nanomaterials, safety testing of a representative set of manufactured nanomaterials, development of guidelines for standardized testing of nanomaterials, and cooperation on risk assessment and exposure measurement.

Nanotechnology Innovation and Liaison with Industry Working Group

The NILI Working Group has been pursuing opportunities for enhanced collaboration and information sharing between nanotechnology-related activities in U.S. industry and Government, as well as between the Federal Government and regional, State, and local nanotechnology R&D and commercialization activities. There have been successful interactions in recent years between NNI representatives and the semiconductor/electronics industry (including a joint funding announcement), the chemical industry, and the Industrial Research Institute. The NILI Working Group recently concluded a similar arrangement for collaboration with the forest products industry and will be seeking opportunities for engagement with other industries. NILI Working Group members have assisted the NSET Subcommittee and NNCO in organizing a workshop on regional, State, and local nanotechnology initiatives, the second such workshop designed to find opportunities for enhanced cooperation between and leveraging among Federal and local nanotechnology activities. These local initiatives often are vital to successful commercialization of the results of nanotechnology research funded by the Federal Government and also provide a key source of funding for construction of new laboratory facilities and other research infrastructure used by Federally-funded researchers.

External Reviews of the NNI

Public Law 108-153 calls for a triennial external review by the National Research Council of the National Academies of several aspects of the National Nanotechnology Initiative, including its technical accomplishments, the appropriateness of agency funding levels, successes in technology transfer, and consideration of societal interests. It also calls for two one-time studies: (1) a study on the technical feasibility of molecular self-assembly for manufacturing of materials and devices at the molecular scale, and (2) a study on the responsible development of nanotechnology. The National Academies delivered the report from its first triennial assessment and the two one-time studies to the NSET Subcommittee in December 2006. The full report is available at http://books.nap.edu/catalog/11752.html. The following is a compilation of some of the report's key findings:

- *NNI-related R&D is world-class and in many instances world-leading, and… is making invaluable contributions to the advancement of knowledge and innovation in the United States.* [p. 22]
- *Increased interagency cooperation—which has enhanced the development of interdisciplinary research, led to improvements in the R&D infrastructure, and stimulated new areas in research—is an important impact of the NNI.* [p. 5]
- *The articulation* [in the NNI Strategic Plan] *of the NNI's strategic goals and the development of the related PCAs are an important outcome of the NNI that has had a positive impact on the provision of federal support for the fields and disciplines involved in research and development at the nanoscale... the strategy has led to the NNI contributing to the education of the 21st Century R&D workforce, as well as addressing societal issues such as health effects and environmental impact.* [pp. 24–25]
- *The flexible structure of the* [NSET] *working groups… help*[s] *to promote effective interagency communication, coordination, and joint program development and enable*[s] *the NSET Subcommittee to efficiently address societal issues by giving it ready access to regulatory experts and health professionals in various agencies.* [pp. 25–26]
- *The working groups and other outreach and coordination efforts stimulated by and established under the NNI have made a considerable contribution to coordination of R&D efforts in pursuit of realizing the potential of nanotechnology.* [p. 27]
- *A significant impact of the NNI has been the development of new collaborations across agencies and between different units within agencies that are conducting R&D relevant to the broad goals articulated by the NNI…* [p. 27]
- *A critically important impact of the NNI has been the focused investment by the NNI-participating agencies in the establishment and development of multidisciplinary research and education centers devoted to nanoscience and nanotechnology. Many such centers are designated as user facilities available to researchers from academia and the private sector, and to scientists at the national laboratories.* [p. 29]
- *NNI-related science and technology R&D and the strong federal support for discovery-based research and interdisciplinary collaborations at university centers are attracting and exciting students…* [However, the] *committee believes that the public's curiosity about nanotechnology could be leveraged more effectively to build public support for the federal support of R&D in the physical and biomedical sciences, as well as attract new talent into U.S. undergraduate and graduate education.* [pp. 34–35]
- *Although good comparative indicators of investment in nanotechnology R&D, resultant innovation, and economic exploitation of nanotechnology do not exist, existing data point to worldwide growth in investment in nanoscale research and innovation. The United States appears to remain in the lead, but with other countries closing this gap.* [pp. 58–59]

- *Currently, it is too early to gauge the economic impact of nanotechnology… any future analysis of economic impact will be hindered unless data are collected and metrics developed that will facilitate a rigorous analysis of economic indicators such as jobs created or individuals employed as a result of nanotechnology development.* [p. 69]
- *Materials and devices of moderate complexity can be designed and manufactured by molecular assembly…* [however,] *the eventually attainable perfection and complexity of manufactured products, while they can be calculated in theory, cannot be predicted with confidence… Research funding that is based on the ability of investigators to produce experimental demonstrations that link to abstract models and guide long-term vision is most appropriate to achieve this goal.* [p. 108]
- *It is not possible yet to make a rigorous assessment of the level of risk posed by* [engineered nanomaterials]. *Further risk assessment protocols have to be developed, and more research is required to enable assessment of potential EHS risks from nanomaterials.* [p. 90]

Many of the report's findings are also associated with recommendations. The following is a summary of key recommendations:

- *The federal government* [should] *sustain* [nanoscale science and technology] *investments in a manner that balances the pursuit of shorter-term goals with support for longer-term R&D and that ensures a robust supporting infrastructure, broadly defined. Supporting long-term research effectively will require making new funds available that do not come at the expense of much-needed ongoing investments in U.S. physical sciences and engineering research.* [pp. 7–8]
- *The federal government* [should] *establish an independent advisory panel with specific operational expertise in nanoscale science and engineering; management of research centers, facilities, and partnerships; and interdisciplinary collaboration…* [p. 8]
- *Federal agencies participating in the NNI, in consultation with the NNCO and the Office of Management and Budget,* [should] *continue to develop and enhance means for consistent tracking and reporting of funds requested, authorized, and expended annually. The current set of PCAs provides an appropriate initial template for such tracking.* [p. 9]
- *The NSET Subcommittee* [should] *carry out or commission a study on the feasibility of developing metrics to quantify the return to the U.S. economy from the federal investment in nanotechnology R&D.* [pp. 9–10]
- *Research on the environmental, health, and safety effects of nanotechnology* [should] *be expanded.* [p. 11]
- *The NSET Subcommittee* [should] *create a working group on education and the workforce that engages the Department of Education and the Department of Labor as active participants.* [p. 40]

The NSET Subcommittee is taking these findings and recommendations into consideration as it updates the NNI Strategic Plan, due to be completed by December 2007 under the provisions of Public Law 108-153.

As reported in the NNI Supplement to the President's 2007 Budget, the President's Council of Advisors on Science and Technology (PCAST), in its capacity as the National Nanotechnology Advisory Panel (NNAP) called for by Public Law 108-153, delivered its first report on the NNI in May 2005, and the NNI member agencies are responding to the PCAST recommendations now—see the NNI Supplement to the President's 2007 Budget[6] for details. The PCAST is preparing its second report. The NSET Subcommittee and the NNCO are providing information in support of the new study as requested.

[6] http://www.nano.gov/NNI_07Budget.pdf

Appendix A. List of Centers, Networks, and User Facilities Funded Under the NNI

In this table of NNI centers, networks, and user facilities, a large majority of the collaborators listed are receiving funds from the sponsoring agency. Additional partner institutions are listed where there are strong scientific collaborations underway.

Key: **Sponsoring Agency**

Agency Program

Name of Center or Network

Host Institution

Partner Institution(s)

Part 1: NNI Centers and Networks

Department of Defense

Institute for Soldier Nanotechnologies
Massachusetts Institute of Technology

Center for Nanoscience Innovation for Defense
University of California, Santa Barbara, Riverside and Los Angeles

Institute for Nanoscience
Naval Research Laboratory

NASA

University Research, Engineering and Technology Institutes

Institute for Cell Mimetic Space Exploration
University of California, Los Angeles
- University of California, Irvine
- California Institute of Technology
- University of California, Berkeley
- Texas A&M University

Institute for Intelligent Bio-Nanomaterials & Structures for Aerospace Vehicles
Texas A&M University
- Prairie View A&M University
- Rice University
- Texas Southern University
- University of Houston
- University of Texas, Austin

Biologically Inspired Materials Institute
Princeton University
- NASA Langley Research Center
- Northwestern University
- University of California, Santa Barbara
- University of North Carolina, Chapel Hill
- National Institute of Aerospace

Institute for Nanoelectronics and Computing
Purdue University
- Cornell University
- Northwestern University
- Texas A&M University
- University of California, San Diego
- University of Florida
- University of Texas, El Paso
- Yale University

National Institute for Occupational Safety and Health

Nanotechnology Research Center
Robert A. Taft Lab

National Institutes of Health

NHLBI Program of Excellence in Nanotechnology

Integrated Nanosystems for Diagnosis and Therapy
Washington University
- University of California, Berkeley
- University of California, Santa Barbara

Nanotechnology: Detection & Analysis of Plaque Formation
Emory University
Georgia Institute of Technology

Nanotherapy for Vulnerable Plaque
Burnham Institute for Medical Research
- Scripps Research Institute
- University of California, Santa Barbara

Translational Program of Excellence in Nanotechnology
Massachusetts General Hospital
- Harvard Medical School
- Broad Institute
- Massachusetts Institute of Technology
- Harvard University Faculty of Arts and Sciences
- Brigham and Women's Hospital

Nanomedicine Development Centers

Center for the Optical Control of Biological Function
University of California, Berkeley
- Lawrence Berkeley National Laboratory
- California Institute of Technology
- Scripps Research Institute
- Stanford University

Center for Cell Control
University of California, Los Angeles

Phi29 DNA-Packaging Motor for Nanomedicine
Purdue University
- University of Cincinnati
- University of California, Davis
- University of Southern Mississippi
- Duke University
- Oak Ridge National Laboratory
- North Carolina State University
- Indiana University School of Medicine
- Northwestern University
- University of Illinois, Urbana-Champaign

Nanomedicine Center for Nucleoprotein Machines
Georgia Institute of Technology
- Emory University
- Medical College of Georgia
- Cold Spring Harbor Laboratory
- California Institute of Technology
- New York University Medical Center
- German Cancer Research Institute

National Center for Design of Biomimetic Nanoconductors
University of Illinois, Urbana-Champaign
- Yale University
- University of Southern California
- University of Chicago
- Illinois Institute of Technology
- Sandia National Laboratories
- Argonne National Laboratory
- Oxford University
- Wabash College
- University of California, Davis
- Purdue University
- University of New Mexico

Center for Protein Folding Machinery
Baylor College of Medicine
- Stanford University
- Lawrence Berkeley National Laboratory
- Massachusetts Institute of Technology
- University of Texas, MD Anderson Cancer Center
- University of California, San Francisco

Nanotechnology Center for Mechanics in Regenerative Medicine
Columbia University
- New York University School of Medicine
- ETH Zurich Swiss Federal Institute of Technology
- Mount Sinai School of Medicine
- University of Heidelberg
- Weizmann Institute of Science

Engineering Cellular Control: Synthetic Signaling and Motility Systems
University of California, San Francisco
- University of California, Berkeley

Centers for Cancer Nanotechnology Excellence

Siteman Center of Cancer Nanotechnology Excellence
Washington University
- Siteman Center/Barnes Jewish Hospital
- University of Illinois, Urbana-Champaign
- Multiple industrial partners

Center of Nanotechnology for Treatment, Understanding, and Monitoring of Cancer, University of California
University of California, San Diego
- University of California, Riverside
- The Burnham Institute

Carolina Center of Cancer Nanotechnology Excellence
University of North Carolina
- University of California, San Francisco

Center for Cancer Nanotechnology Excellence Focused on Therapy Response
Stanford University
- University of California, Los Angeles
- Cedars-Sinai Medical Center
- Fred Hutchinson Cancer Research Center
- University of Texas at Austin
- General Electric Global Research

MIT-Harvard Center of Cancer Nanotechnology Excellence
Massachusetts Institute of Technology
- Massachusetts General Hospital
- Harvard University
- Dana-Farber/Harvard Cancer Center
- Harvard University Medical School
- Brigham and Women's Hospital
- The Burnham Institute

Nanotechnology Center for Personalized and Predictive Oncology
Emory University
Georgia Institute of Technology
- University of Washington, Seattle
- Johns Hopkins University
- Vanderbilt University
- Scripps Research Institute
- Oxonica (Nanoplex Technologies), Inc
- Fred Hutchinson Cancer Research Center

Nanomaterials for Cancer Diagnostics and Therapeutics
Northwestern University
University of Illinois, Urbana-Champaign
University of Chicago
Evanston Northwestern Healthcare

Nanosystems Biology Cancer Center
California Institute of Technology
Institute for Systems Biology
University of California, Los Angeles
University of Washington

National Science Foundation

Engineering Research Center

Center for Extreme Ultraviolet Science and Technology
University of Colorado, Boulder

Science and Technology Center

Nanobiotechnology Center
Cornell University
Princeton University
Oregon Health Sciences University
Clark Atlanta University
Whitman College
Howard University

Nanoscale Science and Engineering Centers

Hierarchical Manufacturing
University of Massachusetts, Amherst
University of Puerto Rico, Rio Pedras
Mount Holyoke College
TIAX LLC
Lucent Technologies
Springfield Technical Community College

Center for Nanoscale Systems
Cornell University

Science of Nanoscale Systems and their Device Applications
Harvard University
University of California, Santa Barbara
Massachusetts Institute of Technology
Museum of Science (Boston)

Center for Biological and Environmental Nanotechnology
Rice University

Center for Integrated Nanopatterning and Detection
Northwestern University
University of Chicago
University of Illinois, Urbana-Champaign
Argonne National Laboratory

Center for Electronic Transport in Molecular Nanostructures
Columbia University
Barnard College
City College of the City University of New York
Rowan University

Center for Directed Assembly of Nanostructures
Rensselaer Polytechnic Institute
University of Illinois, Urbana-Champaign
Los Alamos National Laboratory

Center for Scalable and Integrated Nano-Manufacturing
University of California, Los Angeles
University of California, Berkeley
Stanford University
University of California, San Diego
University of North Carolina, Charlotte

Center for Chemical-Electrical-Mechanical Manufacturing Systems
University of Illinois, Urbana-Champaign
California Institute of Technology
North Carolina Agricultural and Technological State University
Stanford University

Center on Templated Synthesis and Assembly at the Nanoscale
University of Wisconsin

Center for Probing the Nanoscale
Stanford University

Center for Affordable Nanoengineering of Polymeric Biomedical Devices
Ohio State University
Purdue University
Florida State University
University of California, San Francisco
University of Michigan
Duke University
Virginia Commonwealth University
University of Akron

Center of Integrated Nanomechanical Systems
University of California, Berkeley
California Institute of Technology
Stanford University
University of California, Merced

Nano-Bio Interface Center
University of Pennsylvania

Center for High Rate Nanomanufacturing
Northeastern University

Materials Research Science and Engineering Centers

Center for Nanoscale Science
Pennsylvania State University
The Franklin Institute
Rice University
Colorado State University
Naval Research Laboratory
University of Wisconsin/Platypus
Philips Research
Hershey Medical Center

Center for Quantum and Spin Phenomena in Nanomagnetic Structures
University of Nebraska, Lincoln

Center for Research on Interface Structure and Phenomena
Yale University
Southern Connecticut State University
Brookhaven National Laboratory

Genetically Engineered Materials
University of Washington–Seattle
Pacific Northwest National Laboratory

The four Materials Research Science and Engineering Centers (MRSECs) above are fully dedicated to nanotechnology research. In addition, other centers from the network of MRSECs having one or more interdisciplinary research groups focused on nanoscale science and engineering topics are listed below.

Center for Advanced Materials Research
Brown University

Center for the Science & Engineering of Materials
California Institute of Technology

Center for Nanostructured Materials
Columbia University
City College of the City University of New York

Cornell Center for Materials Research
Cornell University

Center for Materials Science and Engineering
Massachusetts Institute of Technology

Center for Sensor Materials
Michigan State University

Materials Research Science & Engineering Center
Northwestern University

Princeton Center for Complex Materials
Princeton University

Center on Polymer Interfaces and Macromolecular Assemblies
Stanford University
University of California, Davis
University of California, Berkeley

Center for Materials for Information Technology
University of Alabama

Materials Research Laboratory
University of California, Santa Barbara

Chicago Materials Research Center
University of Chicago

Materials Research Science and Engineering Center
University of Maryland

Materials Research Science and Engineering Center
University of Massachusetts, Amherst

Materials Research Science and Engineering Center
University of Minnesota

Center for Semiconductor Physics in Nanostructures
University of Oklahoma
University of Arkansas

The Laboratory for Research on the Structure of Matter
University of Pennsylvania

Center for Nanoscopic Materials Design
University of Virginia

NSF Nanoscale Science and Engineering Networks

Network for Computational Nanotechnology
Purdue University
Massachusetts Institute of Technology
Morgan State University
Northwestern University
Stanford University
University of California, Berkeley
University of Florida
University of Illinois, Urbana-Champaign
University of Texas, El Paso

Oklahoma Network for Nanostructured Materials
Oklahoma State University
University of Oklahoma
University of Tulsa

Nanoscale Informal Science Education Network
Core Partners
Museum of Science, Boston
Science Museum of Minnesota
The Exploratorium
Organizational Partners
Fort Worth Museum of Science and History
Ithaca Sciencenter and Main Street Science, Cornell University
Materials Research Society
New York Hall of Science
North Carolina Museum of Life and Science
Oregon Museum of Science and Industry
Purdue University
University of Wisconsin, Madison Materials Research Science and Engineering Center Interdisciplinary Education Group

Network for Nanotechnology in Society
Arizona State University (also an NSEC)
University of California, Santa Barbara (also an NSEC)
Harvard University
University of South Carolina

Experimental Program to Stimulate Competitive Research

New Mexico EPSCoR-Nanoscale Science of Energy & Water
University of New Mexico

Centers for Learning and Teaching

National Center for Learning and Teaching in Nanoscale Science and Engineering
Northwestern University
National Institute for Science Education
Global Nanotechnology Network
Network for Computational Nanotechnology, Purdue University Nano Hub
Directed Assembly of Nanostructures, Rensselaer Polytechnic Institute
Nanoscale Chemical-Electrical-Mechanical Mfg. Systems (Nano-CEMMS), UUIC

Part 2: NNI Nanotechnology User Facilities

Department of Energy

Nanoscale Science Research Centers

Center for Nanoscale Materials
Argonne National Laboratory

Molecular Foundry
Lawrence Berkeley National Laboratory

Center for Integrated Nanotechnologies
Sandia and Los Alamos National Laboratories

Center for Functional Nanomaterials
Brookhaven National Laboratory

Center for Nanophase Materials Sciences
Oak Ridge National Laboratory

National Institutes of Health

Nanotechnology Characterization Laboratory
National Cancer Institute-Frederick

National Institute of Standards and Technology

Center for Nanoscale Science and Technology
NIST Gaithersburg

National Science Foundation

National Nanotechnology Infrastructure Network
Cornell University
Georgia Institute of Technology
Harvard University
Howard University
Northwestern University
Pennsylvania State University
Stanford University
University of California, Santa Barbara
University of Michigan
University of Minnesota
University of New Mexico
University of Texas–Austin
University of Washington

Appendix B. Glossary

Act	Public Law 108-153, the 21st Century Nanotechnology Research and Development Act
Agencies	Departments, agencies, and commissions within the Executive Branch of U.S. Federal Government
ANSI	American National Standards Institute
ARO	Army Research Office (DOD)
BIS	Bureau of Industry and Security (DOC)
CNST	Center for Nanoscale Science and Technology (DOC/NIST)
CNT	Carbon nanotube
CPSC	Consumer Product Safety Commission
CSREES	Cooperative State Research, Education, and Extension Service (USDA)
CT	Committee on Technology of the NSTC
DHS	Department of Homeland Security
DHHS	Department of Health and Human Services
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOEd	Department of Education
DOJ	Department of Justice
DOL	Department of Labor
DOS	Department of State
DOT	Department of Transportation
DOTreas	Department of the Treasury
DTRA	Defense Threat Reduction Agency (DOD)
DURIP	Defense University Research Instrumentation Program (DOD)
EERE	[Office of] Energy Efficiency and Renewable Energy (DOE)
EPA	Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
FDA	Food and Drug Administration (DHHS)
FHWA	Federal Highway Administration (DOT)
FS	[U.S.] Forest Service (USDA)
GIN	Global Issues in Nanotechnology (NSET Subcommittee working group)
ITIC	Intelligence Technology Innovation Center
ISO	International Organization for Standardization
ITC	International Trade Commission
JSC	Johnson Space Center (NASA)
MANTECH	Manufacturing Technology (DOD)
MEMS	Microelectromechanical systems
MRSEC	Materials Research Science and Engineering Center (NSF)
MURI	Multidisciplinary Research Program of the University Research Initiative (DOD)
MWCNT	Multi-walled carbon nanotube
NASA	National Aeronautics and Space Administration
NCI	National Cancer Institute (DHHS/NIH)
NCL	Nanotechnology Characterization Laboratory (DHHS/NIH/NCI)
NCLT	Center for Learning and Teaching in Nanoscale Science and Engineering (NSF)

NCN	Network for Computational Nanotechnology (NSF)
NCTR	National Center for Toxicological Research (DHHS/FDA)
NEHI	Nanotechnology Environmental and Health Implications Working Group of the NSET Subcommittee
NEMS	Nanoelectromechanical systems
NHLBI	National Heart, Lung, and Blood Institute (DHHS/NIH)
NIEHS	National Institute of Environmental Health Sciences (DHHS/NIH)
NIH	National Institutes of Health (DHHS)
NILI	Nanotechnology Innovation and Liaison with Industry Working Group of the NSET Subcommittee
NIOSH	National Institute for Occupational Safety and Health (DHHS/Centers for Disease Control and Prevention)
NISE	Nanoscale Informal Science Education (NSF-supported network)
NIST	National Institute of Standards and Technology (DOC)
NNAP	National Nanotechnology Advisory Panel
NNCO	National Nanotechnology Coordination Office
NNI	National Nanotechnology Initiative
NNIN	National Nanotechnology Infrastructure Network (NSF program)
NNN	National Nanomanufacturing Network
NRC	Nuclear Regulatory Commission
NSEC	Nanoscale Science and Engineering Centers (NSF program)
NSET	Nanoscale Science, Engineering, and Technology Subcommittee of the NSTC
NSF	National Science Foundation
NSP	Nanotechnology Standards Panel (ANSI)
NSRC	Nanoscale Science Research Centers (DOE program)
NSTC	National Science and Technology Council
NTP	National Toxicology Program (DHHS)
OECD	Organisation for Economic Cooperation and Development
OMB	Office of Management and Budget (Executive Office of the President)
OSTP	Office of Science and Technology Policy (Executive Office of the President)
PCA	Program Component Area
PCAST	President's Council of Advisors on Science and Technology
RFA	Request for applications (NIH program solicitation)
SBIR	Small Business Innovation Research Program
SC	Office of Science (DOE)
TSCA	Toxic Substances Control Act
STTR	Small Business Technology Transfer Research Program
TA	Technology Administration (DOC)
USPTO	U.S. Patent and Trademark Office (DOC)
USDA	U.S. Department of Agriculture
WPMN-CC	Working Party on Manufactured Nanomaterials under the Chemicals Committee (OECD)
WPN-CSTP	Working Party on Nanotechnology under the Committee for Scientific and Technological Policy (OECD)

Appendix C. Contact List

OSTP

Dr. Celia I. Merzbacher
Assistant Director for Technology R&D
Office of Science and Technology Policy
Executive Office of the President
Washington, DC 20502
T: 202-456-6108
F: 202-456-6021
Celia_Merzbacher@ostp.eop.gov

Travis M. Earles
NSTC Representative (Nanobiotechnology)
Office of Science and Technology Policy
Executive Office of the President
725 17th Street, N.W., Rm. 5203-5
Washington, DC 20502
T: 202-456-6025
F: 202-456-6021
Travis_M._Earles@ostp.eop.gov

OMB

Irene Kariampuzha
Office of Management and Budget
Executive Office of the President
725 17th St., N.W.
Washington, DC 20503
T: 202-395-3535
F: 202-395-4652
Irene_Kariampuzha@omb.eop.gov

NNCO

Dr. E. Clayton Teague
Director
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-4319
F: 703-292-9312
cteague@nnco.nano.gov

Catherine B. Alexander
Communications Director
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-4399
F: 703-292-9312
calexand@nnco.nano.gov

Stephen B. Gould
Project Manager
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 240-351-3815
F: 703-292-9312
sgould@nnco.nano.gov

Audrey Haar
Assistant Communications Director
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-8288
F: 703-292-9312
ahaar@nnco.nano.gov

Liesl Heeter
Systems Administrator
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-4533
F: 703-292-9312
lheeter@nnco.nano.gov

Geoffrey M. Holdridge
Policy Analyst
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-4532
F: 703-292-9312
gholdrid@nnco.nano.gov

Dr. Philip H. Lippel
Policy Analyst
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-7741
F: 703-292-9312
plippel@nnco.nano.gov

Dr. Dianne L. Poster
Executive Secretary, NEHI Working Group (on assignment to NSTC/NNCO)
National Institute of Standards and Technology
100 Bureau Drive, MS 8329
Gaithersburg, MD 20899
T: 301-827-6686
poster@nist.gov

Victor Turner
Office Manager
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-8626
F: 703-292-9312
vturner@nnco.nano.gov

Dr. Roger D. van Zee
National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Suite 405
Arlington, VA 22230
T: 703-292-4503
F: 703-292-9312
rvanzee@nnco.nano.gov

CPSC

Dr. Mary Ann Danello
Associate Executive Director
Directorate for Health Sciences
Consumer Product Safety Commission
4330 East-West Highway, Suite 600
Bethesda, MD 20814
T: 301-504-7237
F: 301-504-0079
mdanello@cpsc.gov

Dr. Treye Thomas
Toxicologist
Directorate for Health Sciences
Consumer Product Safety Commission
4330 East-West Highway, Suite 600
Bethesda, MD 20814
T: 301-504-7738
F: 301-504-0079
tthomas@cpsc.gov

DHS

Dr. Richard T. Lareau
Science and Technology Directorate
Department of Homeland Security
William J. Hughes Technical Center, Bldg. 315
Atlantic City International Airport, NJ 08405
T: 609-813-2760
F: 609-383-1973
Richard.Lareau@dhs.gov

Dr. Eric J. Houser
Transportation Security Laboratory
Department of Homeland Security
Office of Research and Development
Science and Technology Directorate
Mail Code: TSL-200
William J. Hughes Technical Center, Bldg. 315
Atlantic City International Airport, NJ 08405
T: 609-813-2798
F: 609-383-1973
eric.houser@dhs.gov

Dr. Keith Ward
Science & Technology Directorate
Department of Homeland Security
7th and D Street, S.W.
Washington, DC 20590
T: 202-254-6132
Keith.Ward@dhs.gov

DOC/BIS

Kelly Gardner
Export Policy Advisor
Department of Commerce
Bureau of Industry and Security
Office of National Security and Technology Transfer Controls
14th St. & Constitution Ave., N.W., Rm. 2600
Washington, DC 20230
T: 202-482-0102
F: 202-482-3345
kgardner@bis.doc.gov

DOC/TA

Connie K. N. Chang
Research Director
Office of the Under Secretary
Technology Administration
Department of Commerce
1401 Constitution Ave., N.W.
Rm. 4820R
Washington, DC 20230
T: 202-482-6814
F: 202-501-2595
cchang@technology.gov

John F. Sargent, Jr.
Senior Policy Analyst
Office of Technology Policy
Technology Administration
Department of Commerce
14th St. & Constitution Ave., N.W.
Rm. 4823
Washington, DC 20230
T: 202-482-6185
F: 202-501-2595
jsargent@technology.gov

DOD

Dr. James Short
Acting Director for Basic Research
ODUSD (LABS)
Department of Defense
One Liberty Center
875 North Randolph Street, Suite #150
Arlington, VA 22203
T: 703-588-1476
F: 703-588-1423
james.short@osd.mil

Dr. David M. Stepp
Chief, Materials Science Division
Army Research Office
AMSRL-RO-PM (Materials Science Division)
P.O. Box 12211
Research Triangle Park, NC 27709
T: 919-549-4329
F: 919-549-4399
david.m.stepp@us.army.mil

Dr. Robert H. Cohn
Chief Scientist
Office of the Special Assistant for Chemical and Biological Defense and Chemical Demilitarization
Office of the Secretary of Defense
3050 Defense Pentagon, Rm. 3B253
Washington, DC 20301-3050
T: 703-693-6835
F: 703-695-0476
Robert.Cohn@osd.mil

Dr. Margaret E. Kosal
Science and Technology Advisor
Chemical and Biological Defense Program and
Defense Threat Reduction Agency
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6201
T: 703-693-6835

Dr. Mihal E. Gross
Program Officer
Office of Naval Research
Code 331
875 North Randolph St., Suite 1425
Arlington, VA 22217-5660
T: 703-696-0388
F: 703-696-0001
Mihal_Gross@onr.navy.mil

Dr. Richard Colton
Director, Institute for Nanoscience
Code 1100
Naval Research Laboratory
Washington DC 20375
T: 202-767-1803
F: 202-767-1821
rich.colton@nrl.navy.mil

Dr. Gernot S. Pomrenke
Program Manager - Optoelectronics, THz and Nanotechnology
AFOSR/NE
Directorate of Physics and Electronics
Air Force Office of Scientific Research
875 North Randolph Street
Suite 325, Rm. 3112
Arlington, VA 22203-1768
T: 703-696-8426
F: 703-696-8481
gernot.pomrenke@afosr.af.mil

DOE

Dr. Patricia M. Dehmer
Director
Office of Basic Energy Sciences
U.S. Department of Energy
SC-22/GTN
1000 Independence Ave., S.W.
Washington, DC 20585
T: 301-903-3081
F: 301-903-6594
Patricia.Dehmer@science.doe.gov

Dr. Altaf H. Carim
Division of Scientific User Facilities
Office of Basic Energy Sciences
U.S. Department of Energy
SC-22.3/GTN
1000 Independence Avenue, S.W.
Washington, DC 20585-1290
T: 301-903-4895
F: 301-903-1690
carim@science.doe.gov

Dr. Aravinda M. Kini
Division of Materials Sciences and Engineering
Office of Basic Energy Sciences
U.S. Department of Energy
SC-22.2/GTN
1000 Independence Ave., S.W.
Washington, DC 20585
T: 301-903-3565
F: 301-903-9513
Aravinda.Kini@science.doe.gov

Dr. John C. Miller
Division of Chemical Sciences, Geosciences, and Biosciences
Office of Basic Energy Sciences
U.S. Department of Energy
SC-22.1/GTN
1000 Independence Ave., S.W.
Washington, DC 20585
T: 301-903-5806
F: 301-903-4110
John.Miller@science.doe.gov

Dr. Brian Valentine
Office of Industrial Technologies
U.S. Department of Energy
Headquarters Bldg., EE-2F
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0121
T: 202-586-9741
F: 202-586-9234
Brian.Valentine@ee.doe.gov

DOEd

Dr. Richard LaPointe
Deputy Assistant Secretary for Vocational and Adult Education
Department of Education
Potomac Center Plaza
550 12th Street, S.W.
Rm. 11101
Washington, DC 20202-7100
T: 202-245-7704
F: 202-245-7837
richard.lapointe@ed.gov

Dr. Sharon Lee Miller
Director, Division of Academic and Technical Education
State Accountability and Administration Branch
Department of Education
Potomac Center Plaza
550 12th Street, S.W., Rm. 11060
Washington, DC 20202-7100
T: 202-245-7846
F: 202-245-7171
sharon.miller@ed.gov

DOJ

Dr. Stanley A. Erickson
Chief, Research and Technology Development Division
Department of Justice
Office of Science and Technology
National Institute of Justice
810 7th Street
Washington, DC 20531
T: 202-305-4686
F: 202-305-9091
Stanley.Erickson@usdoj.gov

DOL

Brad Wiggins
Business Relations Group
U.S. Department of Labor
Employment & Training Administration
200 Constitution Avenue, N.W.
Rm. N-4643
Washington, DC 20210
T: 202-693-3742
F: 202-693-3890
wiggins.brad@dol.gov

Linda Fowler
U.S. Department of Labor
Employment & Training Administration
200 Constitution Avenue, N.W.
Rm. N-4643
Washington, DC 20210
Fowler.Linda.M@dol.gov

DOS

Ralph L. Braibanti
Director, Office of Space and Advanced Technology
Department of State
1990 K Street N.W., Suite 410
Washington, DC 20006
T: 202-663-2390
F: 202-663-2402
BraibantiRL@state.gov

Dr. Robert Rudnitsky
Physical Science Officer
AAAS Science & Technology Diplomacy Fellow
OES/SAT
Department of State
1900 K Street, N.W., Suite 410
Washington, DC 20006
T: 202-663-2399
F: 202-663-2402
RudnitskyRG@state.gov

DOT

Dr. Richard R. John
Director Emeritus, Volpe National Transportation Systems Center
Department of Transportation
55 Broadway, Kendall Square
Cambridge, MA 02142
T: 617-494-2222
F: 617-494-3731
john@volpe.dot.gov

Annalynn Lacombe
Program Analyst, Transportation Strategic Planning & Analysis Office
Volpe National Transportation Systems Center
Department of Transportation
55 Broadway
Cambridge, MA 02142
T: 617-494-2161
F: 617-494-3688
Lacombe@volpe.dot.gov

Dr. Richard A. Livingston
Senior Physical Scientist
Office of Infrastructure R&D
Federal Highway Administration
6300 Georgetown Pike
McLean Virginia 22101
T: 202-493-3063
F: 202-493-3161
Dick.Livingston@fhwa.dot.gov

DOTreas

Dr. John F. Bobalek
Program Manager
Office of Research and Technical Support
Bureau of Engraving and Printing
Rm. 201-29A
14th and C Streets, S.W.
Washington, DC 20228-0001
T: 202-874-2109
F: 202-927-7415
John.Bobalek@bep.treas.gov

EPA

Dr. Nora F. Savage
National Center for Environmental Research
Office of Research and Development, 8722F
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
T: 202-343-9858
F: 202-343-0678
Savage.Nora@epamail.epa.gov

Dr. Philip Sayre
Associate Director
Risk Assessment Division
Office of Pollution Prevention and Toxics
Environmental Protection Agency
1200 Pennsylvania Ave., N.W.
Mail Code: 7403M
Washington, DC 20460
T: 202-564-7673
F: 202-564-7450
sayre.phil@epa.gov

FDA

Dr. Norris E. Alderson
Associate Commissioner for Science
Director, Office of Science and Health Coordination
Food and Drug Administration
5600 Fishers Lane
Rm. 14B-08 (HF-32)
Rockville, MD 20857
T: 301-827-3340
F: 301-827-3410
norris.alderson@fda.hhs.gov

Dr. Richard Canady
Office of Science and Health Coordination
Food and Drug Administration
5600 Fishers Lane
Rm. 14B-08 (HF-33)
Rockville, MD 20857
T: 301-827-8781
F: 301-827-3042
richard.canady@fda.hhs.gov

ITC

Elizabeth R. Nesbitt
International Trade Analyst for Biotechnology and Nanotechnology
Chemicals and Textiles Division
Office of Industries
International Trade Commission
500 E Street, S.W.
Washington, DC 20436
T: 202-205-3355
F: 202-205-3161
elizabeth.nesbitt@usitc.gov

ITIC

Susan Durham
DCI Intelligence Technology Innovation Center
Central Intelligence Agency
Washington, DC 20505
susaned0@ucia.gov

NASA

Dr. Minoo N. Dastoor
Special Assistant
National Aeronautics and Space Administration
NASA Headquarters, Rm. 6A20
Washington DC 20546-0001
T: 202-358-4518
F: 202-358-2920
mdastoor@mail.hq.nasa.gov

Dr. Murray S. Hirschbein
National Aeronautics and Space Administration
NASA Headquarters, Rm. 6D70
Washington DC 20546-0001
T: 202-358-4662
F: 202-358-2920
mhirschb@mail.hq.nasa.gov

Dr. Meyya Meyyappan
National Aeronautics and Space Administration
Ames Research Center
MS 229-3
Moffett Field, CA 94035
T: 650-604-2616
F: 650-604-5244
meyya@orbit.arc.nasa.gov

NIH

Dr. Piotr Grodzinski
Program Director, Nanotechnology in Cancer
Office of Technology and Industrial Relations
Office of the Director
National Cancer Institute
National Institutes of Health
31 Center Drive, 10A52
Bethesda, MD 20892
T: 301-496-1550
F: 301-496-7807
grodzinp@mail.nih.gov

Dr. Eleni Kousvelari
Chief, Cellular & Molecular Biology, Physiology, & Biotechnology Branch
National Institute of Dental and Craniofacial Research
National Institutes of Health
Natcher Building, Rm. 4AN 18A
Bethesda, MD 20892-6402
T: 301-594-2427
F: 301-480-8318
kousvelari@de45.nidr.nih.gov

Dr. Peter Moy
Program Director
National Institute of Biomedical Imaging and Bioengineering
National Institutes of Health
Democracy Two, Suite 200, MSC 5469
6707 Democracy Blvd.
Bethesda, MD 20892-5469
T: 301-496-9270
F: 301-480-0679
moype@mail.nih.gov

Dr. Jeffery A. Schloss
Program Director
Technology Development Coordination
National Human Genome Research Institute
National Institutes of Health
Suite 4076, MSC 9305
5635 Fishers Lane
Bethesda, MD 20892-9305
T: 301-496-7531
F: 301-480-2770
jeff_schloss@nih.gov

NIH/OD

Lynn Hudson
Deputy Director
Office of Science Policy & Planning
National Institutes of Health
Office of the Director
Building 1 - Shannon Bldg, Rm. 218
1 Center Drive
Bethesda, MD 20892
T: 301-496-0786
F: 301-402-0280
HudsonL1@od.nih.gov

Dr. Nancy E. Miller
Senior Science Policy Analyst
Office of Science Policy and Planning
Office of the Director
National Institutes of Health
1 Center Drive
Bldg 1, Rm. 218
Bethesda, MD 20892
T: 301-594-7742
F: 301-402-0280
MILLERN@od1tm1.od.nih.gov

NIH/FIC

George Herrfurth
Multilateral Affairs Coordinator
Division of International Relations
Fogarty International Center
National Institutes of Health
Building 31, Rm. B2C11
Bethesda, MD 20892-2220
T: 301-402-1615
F: 301-480-3414
herrfurg@mail.nih.gov

NIH/NCI

Travis M. Earles
Technology Program Manager
Office of Technology and Industrial Relations
Office of the Director
National Cancer Institute
National Institutes of Health
31 Center Drive, 10A52
Bethesda, MD 20892
T: 301-435-8437
F: 301-496-7807
travis.earles@nih.gov

Dr. Piotr Grodzinski
Program Director, Nanotechnology in Cancer
Office of Technology and Industrial Relations
Office of the Director
National Cancer Institute
National Institutes of Health
31 Center Drive, 10A52
Bethesda, MD. 20892
T: 301-496-1550
F: 301-496-7807
grodzinp@mail.nih.gov

Dr. Scott McNeil
Director, Nanotechnology Characterization Laboratory
National Cancer Institute at Frederick
National Institutes of Health
P.O. Box B, Building 469
1050 Boyles Street
Frederick, MD 21702-1201
T: 301-846-6939
F: 301-846-6399
mcneils@ncifcrf.gov

NIH/NHLBI

Dr. Denis Buxton
Heart Research Program, DHVD
National Heart, Lung, and Blood Institute
National Institutes of Health
6701 Rockledge Drive, Rm. 9186
Bethesda, MD 20817
T: 301-435-0504
F: 301-480-1454
BuxtonD@nhlbi.nih.gov

NIH/NIEHS

Dr. John R. Bucher
Associate Director
National Toxicology Program
National Institute of Environmental Health Sciences
National Institutes of Health
P.O. Box 12233
Research Triangle Park, NC 27709
T: 919-541-4532
F: 919-541-4225
bucher@niehs.nih.gov

Dr. Sally S. Tinkle
Senior Science Advisor to the Deputy Director
National Institute of Environmental Health Sciences
National Institutes of Health
P.O. Box 12233, MD B2-06
Durham, NC 27709
T: 919-541-0993
F: 919-541-5064
stinkle@niehs.nih.gov

NIOSH

Dr. Vladimir V. Murashov
Special Assistant to the Director
National Institute for Occupational Safety and Health
OD/NIOSH M/S-P12
395 E Street, S.W.
Suite 9200
Washington, DC 20201
T: 202-245-0668
F: 202-245-0628
vladimir.murashov@cdc.hhs.gov

NIST

Dr. Michael T. Postek
Program Manager/Group Leader
National Institute of Standards and Technology
Precision Engineering Division
100 Bureau Drive, Stop 8212
Gaithersburg, MD 20899-8212
T: 301-975-2299
F: 301-869-0822
postek@nist.gov

Dr. Robert D. Shull
Metallurgy Division
National Institute of Standards and Technology
100 Bureau Drive, Stop 8552
Gaithersburg, MD 20899-8552
T: 301-975-6035
F: 301-975-4553
robert.shull@nist.gov

Eric Steel
Acting Director, Program Office
National Institute of Standards and Technology
100 Bureau Drive, Stop 1060
Gaithersburg, MD 20899-1060
T: 301-975-3750
F: 301-216-0529
eric.steel@nist.gov

NRC
Mark A. Cunningham, Director
Division of Fuel, Engineering, and Radiological Research
Office of Nuclear Regulatory Research
Nuclear Regulatory Commission
Mail Stop T-10E7
Washington, DC 20555-0001
T: 301-415-5678
mac3@nrc.gov

NSF
Dr. Mihail C. Roco
Senior Advisor for Nanotechnology
National Science Foundation
Directorate for Engineering
4201 Wilson Blvd., Suite 505
Arlington, VA 22230
T: 703-292-8301
F: 703-292-9013
mroco@nsf.gov

Dr. Lance Haworth
Acting Director, Division of Materials Research
National Science Foundation
Directorate for Mathematical and Physical Sciences
4201 Wilson Blvd., Suite 1065
Arlington, VA 22230
T: 703-292-4916
F: 703-292-9035
lhaworth@nsf.gov

Dr. Maryanna P. Henkart
Director, Division of Molecular and Cellular Biology
National Science Foundation
Directorate for Biological Sciences
4201 Wilson Blvd., Suite 655S
Arlington, VA 22230
T: 703-292-8440
F: 703-292-9061
mhenkart@nsf.gov

Dr. T. James Rudd
Program Manager, SBIR/STTR
Office of Industrial Innovation
National Science Foundation
4201 Wilson Blvd., Rm. 550
Arlington, VA 22230
T: 703-292-4759
F: 703-292-9057
tjrudd@nsf.gov

USDA/CSREES
Dr. Hongda Chen
National Program Leader, Bioprocess Engineering
Cooperative State Research, Education and Extension Service
Department of Agriculture
1400 Independence Ave., S.W.
Mail Stop 2220
Washington, DC 20250-2220
T: 202-401-6497
F: 202-401-5179
hchen@csrees.usda.gov

USDA/FS
Dr. Christopher D. Risbrudt
Director
Forest Products Laboratory
USDA Forest Service
One Gifford Pinchot Drive
Madison, WI 53726-2398
T: 608-231-9318
F: 608-231-9567
crisbrudt@fs.fed.us

Dr. Theodore H. Wegner
Assistant Director
Forest Products Laboratory
USDA Forest Service
One Gifford Pinchot Drive
Madison, WI 53726-2398
T: 608-231-9434
F: 608-231-9567
twegner@fs.fed.us

Dr. George S. Foster
Staff Director, Resource Use Science
USDA Forest Service
1400 Independence Ave. S.W.
Mailstop Code: 1114
Washington, DC 20250-1114
T: 703-605-4195
F: 703-605-5137
gfoster@fs.fed.us

Dr. World Nieh
National Program Leader, Forest Products and Utilization
USDA Forest Service
1400 Independence Ave., S.W.
Mailstop Code: 1114,
Washington, DC 20250-1114
T: 703-605-4197
F: 703-605-5137
wnieh@fs.fed.us

Dr. Howard Rosen
Resource Use Science
USDA Forest Service
1400 Independence Ave., S.W.
Mailstop Code: 1114
Washington, DC 20250-1114
T: 703-605-4196
F: 703-605-5137
hrosen@fs.fed.us

USGS
Dr. Sarah Gerould
Bureau Program Coordinator, Contaminant Biology Program
U.S. Geological Survey
Mail Stop 301 National Center
12201 Sunrise Valley Drive
Reston, VA 20192
T: 703-648-6895
F: 703-648-4238
sgerould@usgs.gov

USPTO
Charles Eloshway
Patent Attorney
Office of International Relations
Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313
T: 571-272-9300
F: 571-273-0123
Charles.Eloshway@uspto.gov

Bruce Kisliuk
Patent Examining Group Director
Technology Center 1600
Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313
T: 571-272-0950
Bruce.Kisliuk@uspto.gov

National Science and Technology Council

Committee on Technology

Subcommittee on Nanoscale Science, Engineering, and Technology

National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Rm. 405
Arlington, VA 22230

703-292-8626 phone
703-292-9312 fax

www.nano.gov