Overview of the National Nanotechnology Initiative

WBT
March 17, 2010

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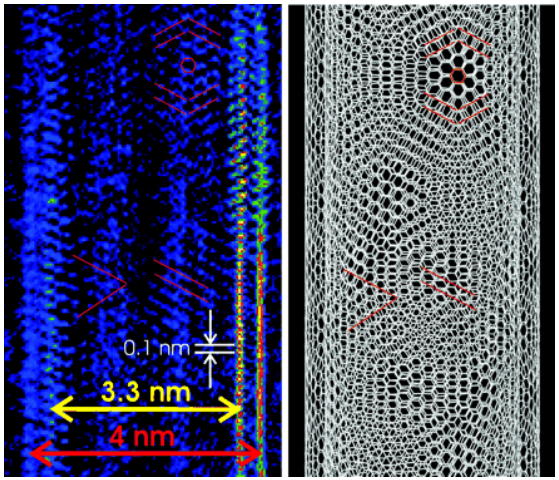
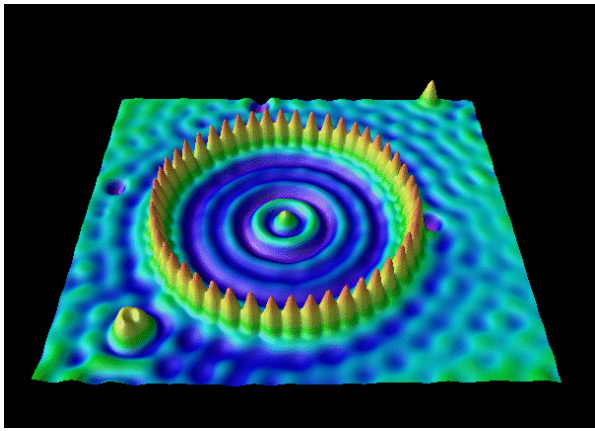
National Science Foundation
and National Nanotechnology Initiative

What Is nanotechnology?

- Research and technology development aimed to understand and control matter at dimensions of approximately 1 - 100 nanometer – the nanoscale
- Ability to understand, create, and use structures, devices and systems that have fundamentally new properties and functions because of their nanoscale structure
- Ability to image, measure, model, and manipulate matter on the nanoscale to exploit those properties and functions
- Ability to integrate those properties and functions into systems spanning from nano- to micro- to macro-scopic scales



Nanoarea Electron Diffraction of DW Carbon Nanotube - Zuo, et.al



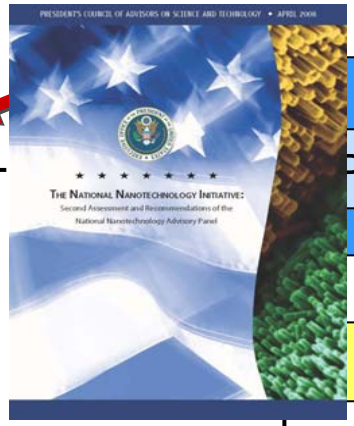
Corral of Fe Atoms - D. Eigler

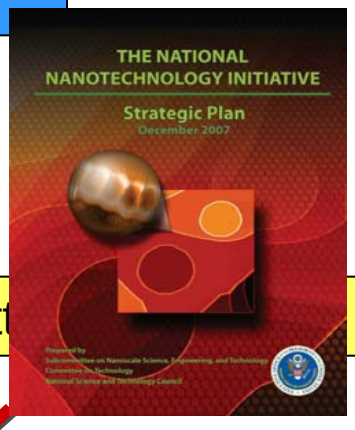

National Nanotechnology Initiative
Collaborative, Multi-agency, Cross-cut Program Among 25 Federal agencies, 15 of which have specific nanotechnology budgets
Funds R&D to advance understanding and control of matter at nanoscale toward:
National economic benefit
National and homeland security
Improved quality of life
OSTP
OMB
NIH
NSF
DOD
DOE
NIST
FDA
NASA
USDA
NIOSH
USDA FS
DOS
EPA
DOTr
NRC
DOT
USPTO
USGS
ITIC
DOL
DOJ
DOC BIS
DHS
CPSC
ITC
DOEd

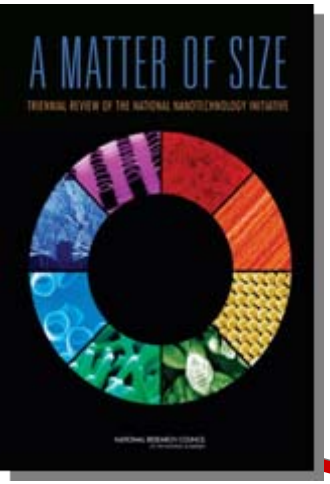
The National Nanotechnology Initiative: vision and goals

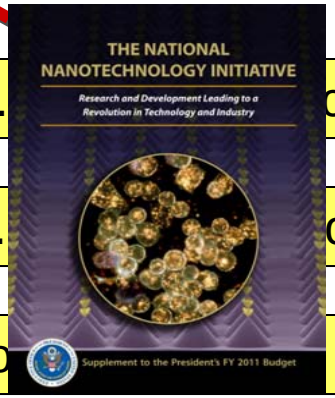
- **The vision of the NNI: a future in which the ability to understand and control matter on the nanoscale leads to a revolution in technology and industry that benefits society**

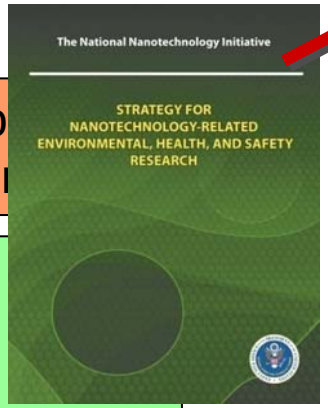
- **Four goals for nanoscale science, engineering, and technology, as described in the NNI's Supplement to the President's FY 2008 Budget and Strategic Plan:**
  - Advance a world-class research and development program
  - Foster technology transfer for commercial & public benefit
  - Develop & sustain educational resources, a skilled workforce, and the supporting research infrastructure and tools
  - Support responsible development of nanotechnology











EOP

PCAST (NNAP)

OMB

Committee on Technology

Committ

NSET Subcommittee

NNCO

Nano. Env. cat. WG

Nanomfg. on WG

Glo

Public Engagement/Communic. WG

Natio
Acade

Relationship

____Formal reporting

.....Informal reporting

_ _Administrative or contractual

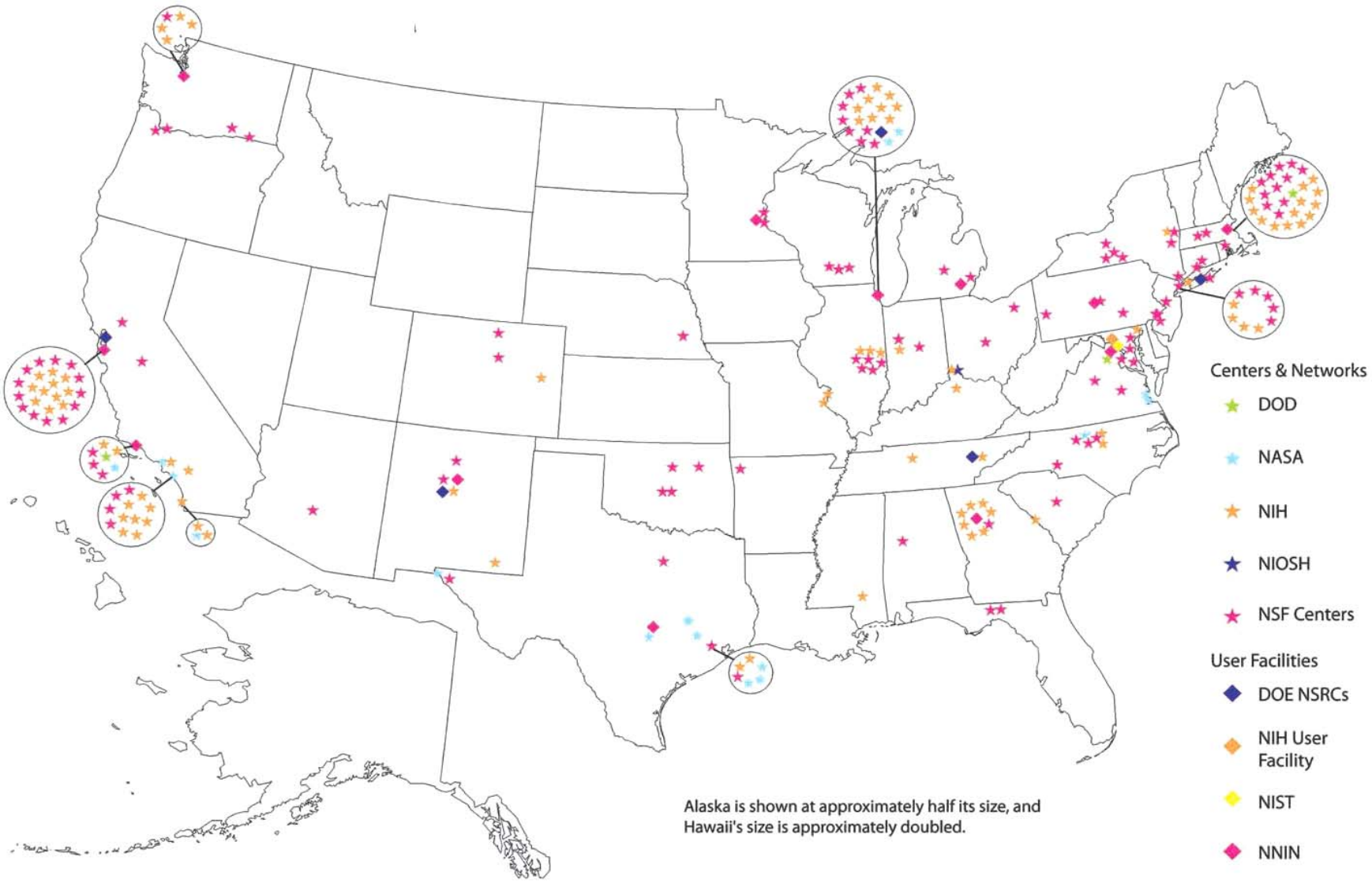
Broad brush view of NNI operations

- **Management** → **EOP + Agencies**
  - Establishment of nanotechnology as high priority R&D area
  - Budget creation and funding allocation to agencies
  - Negotiations with Congress
- **Coordination** → **NSET Subcommittee**
  - Coordinates development of strategic plan for NNI
  - Providing mechanisms for interagency communication and coordination on nanotechnology R&D
- **Reporting** → **NNCO**
  - Publishes reports on behalf of the NSET and the NNI for use by Congress, academia, industry, and the public
  - Serves as central public point of contact for NNI

Areas of Investment
(Program Component Areas)*

- Fundamental Nanoscale Phenomena and Processes
- Nanomaterials
- Nanoscale Devices and Systems
- Instrumentation Research, Metrology, and Standards for Nanotechnology
- Nanomanufacturing
- Major Research Facilities and Instrumentation Acquisition
- Environment, Health, and Safety (EHS)
- Education and Societal Dimensions

About 80 major NNI centers, networks, user facilities



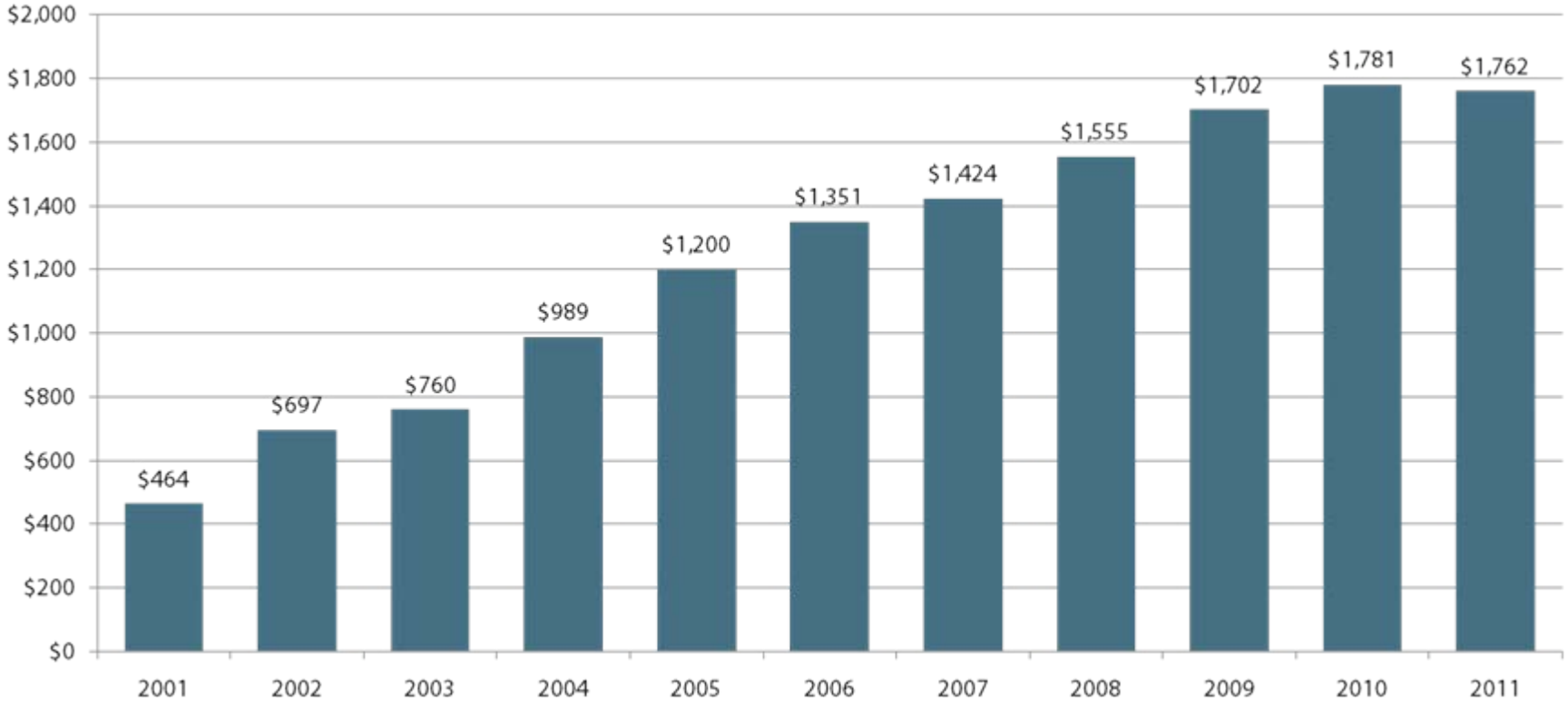
NNI Budget, Note

- Fiscal Year (FY) = October 1 thru September 30 (I.E., FY 2010 began on October 1, 2009)

- FY 2009 figures include amounts for FY ’09 in the regular budget; an additional $500 million was provided under the American Recovery and Reinvestment Act (ARRA)

NNI budget information

- **NNI expenditures* have grown from $464 million in FY '01 to an FY '11 request of nearly $1.8 billion.****



*** All numbers shown above are actual spending, except 2010, which is estimated spending for the current year and 2011 , which is requested amount for next year (FY '09 figure shown here does *not* include ~$500 million in additional ARRA funding).**

**** 2011 figure shown here does *not* include DOD earmarks included in previous yrs. ($117 M '09)**

NNI budget by agency, '09-'11

Agency	2009 Actual	2009 Recovery*	2010 Estimated	2011 Proposed
DOE	332.6	293.2	372.9	423.9
NSF	408.6	101.2	417.7	401.3
HHS/NIH	342.8	73.4	360.6	382.4
DOD**	459.0	0.0	436.4	348.5
DOC/NIST	93.4	43.4	114.4	108.0
EPA	11.6	0.0	17.7	20.0
HHS/NIOSH	6.7	0.0	9.5	16.5
NASA	13.7	0.0	13.7	15.8
HHS/FDA	6.5	0.0	7.3	15.0
DHS	9.1	0.0	11.7	11.7
USDA/NIFA	9.9	0.0	10.4	8.9
USDA/FS	5.4	0.0	5.4	5.4
CPSC	0.2	0.0	0.2	2.2
DOT/FHWA	0.9	0.0	3.2	2.0
DOJ	1.2	0.0	0.0	0.0
TOTAL	**1,701.5**	**511.3**	**1,781.1**	**1,761.6**

*** Based on allocations ARRA appropriations. Agencies may report additional ARRA funding for SBIR and STTR projects later.**

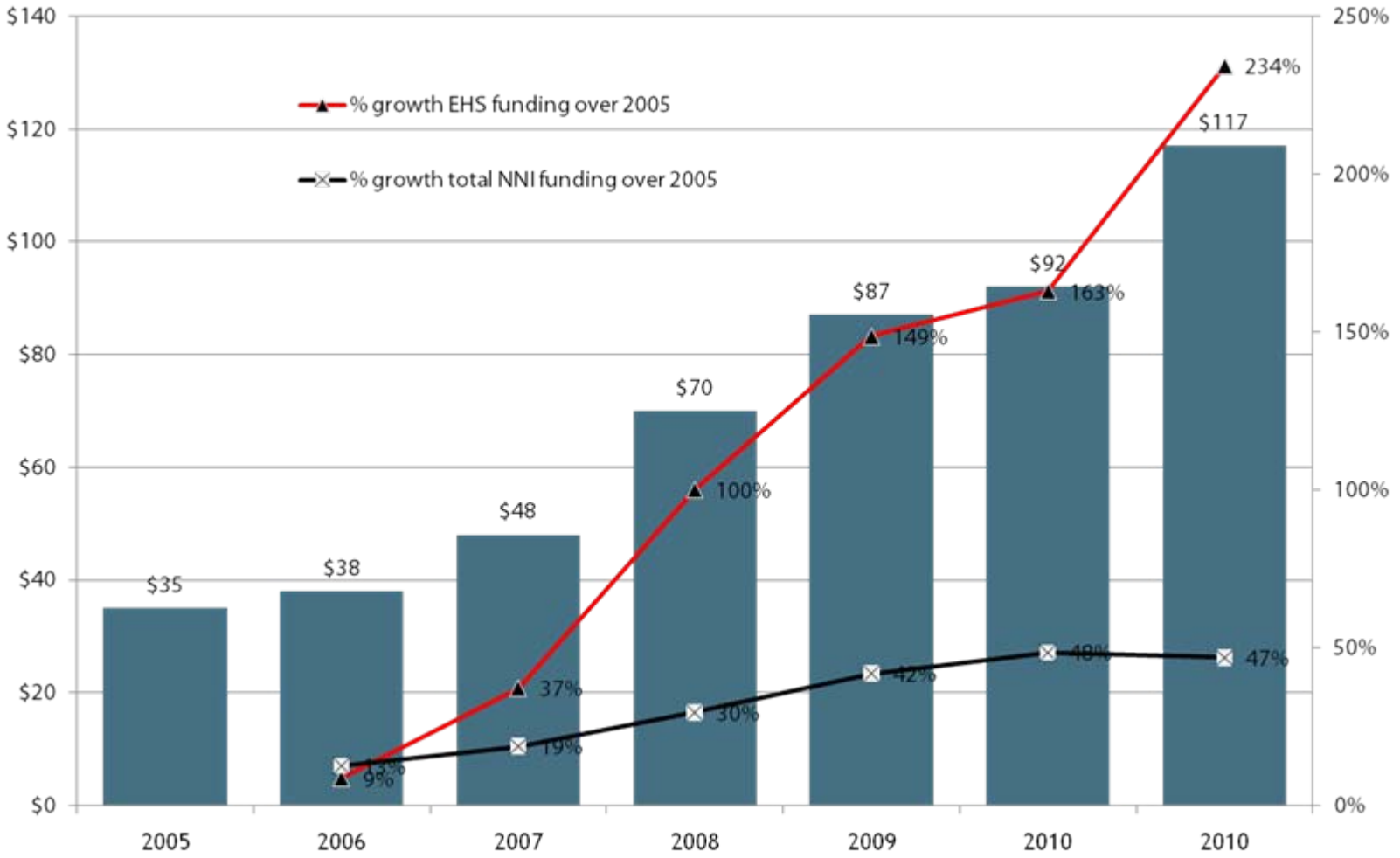
**** 2009 and 2010 DOD figures include Congressionally directed funding that is outside the NNI plan ($117 million for 2009).**

See NNI Supplement to the President's FY '11 Budget for additional details: http://www.nano.gov/NNI_2011_budget_supplement.pdf.

Environmental, Health, and Safety (EHS) Budget

NNI funding for nanotechnology-related EHS research* has grown much faster than the NNI as a whole.

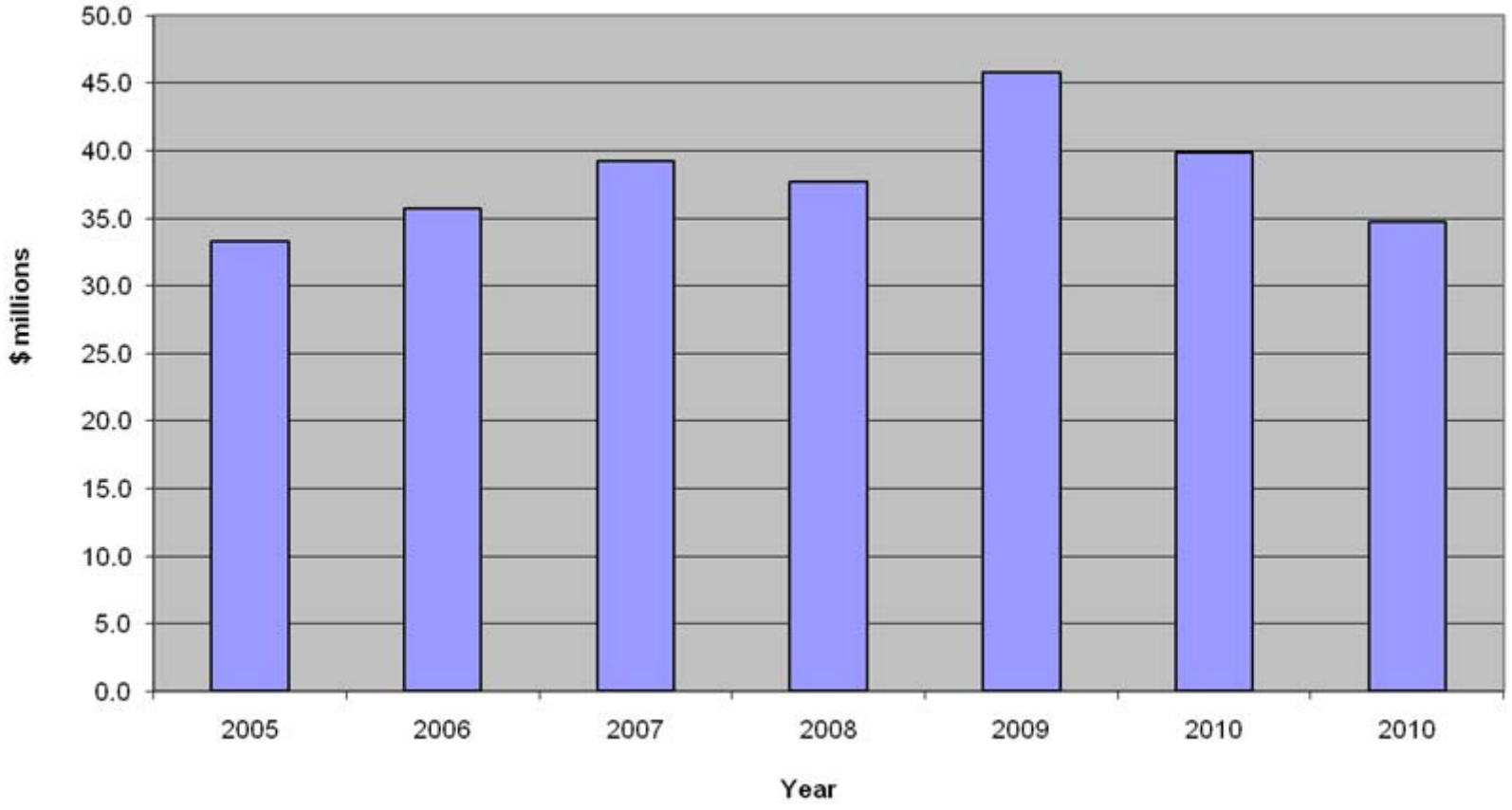
by fiscal year, in $ millions (FY 2010 is estimated, FY 2011 is requested)



*** research whose primary purpose is to understand and address potential risks to health and to the environment from nanotechnology, e.g., not including related instrumentation research**

NNI ELSI/Education Budget

Expenditures on education and societal dimensions ("ELSI") have held steady at ~$30-40 million per year, cumulative total $266 million.

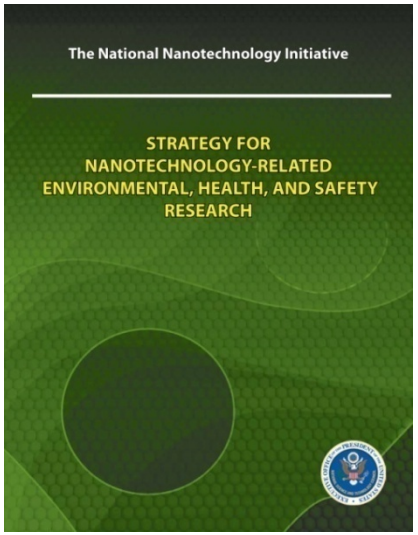


NNI EHS Strategy Development

- Nanotechnology Environmental and Health Implications (NEHI) Working Group formed as informal body in 2003, formalized in 2005
- Extraordinary collaboration between research and regulatory agencies
- Began with review of respective agencies' jurisdictions, responsibilities
- Industry and non-governmental organizations provided input throughout
- Environmental, health, and safety research needs published in September 2006: http://www.nano.gov/NNI_EHS_research_needs.pdf
- Public meeting held in January 2007 to gather additional input from research community and public
- Interim document for public comment, "Prioritization of Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials" published in August 2007: http://www.nano.gov/Prioritization_EHS_Research_Needs_Engineered_Nanoscale_Materials.pdf
- First comprehensive NNI strategy document published in February 2008: http://www.nano.gov/NNI_EHS_research_needs.pdf

NNI EHS Strategy

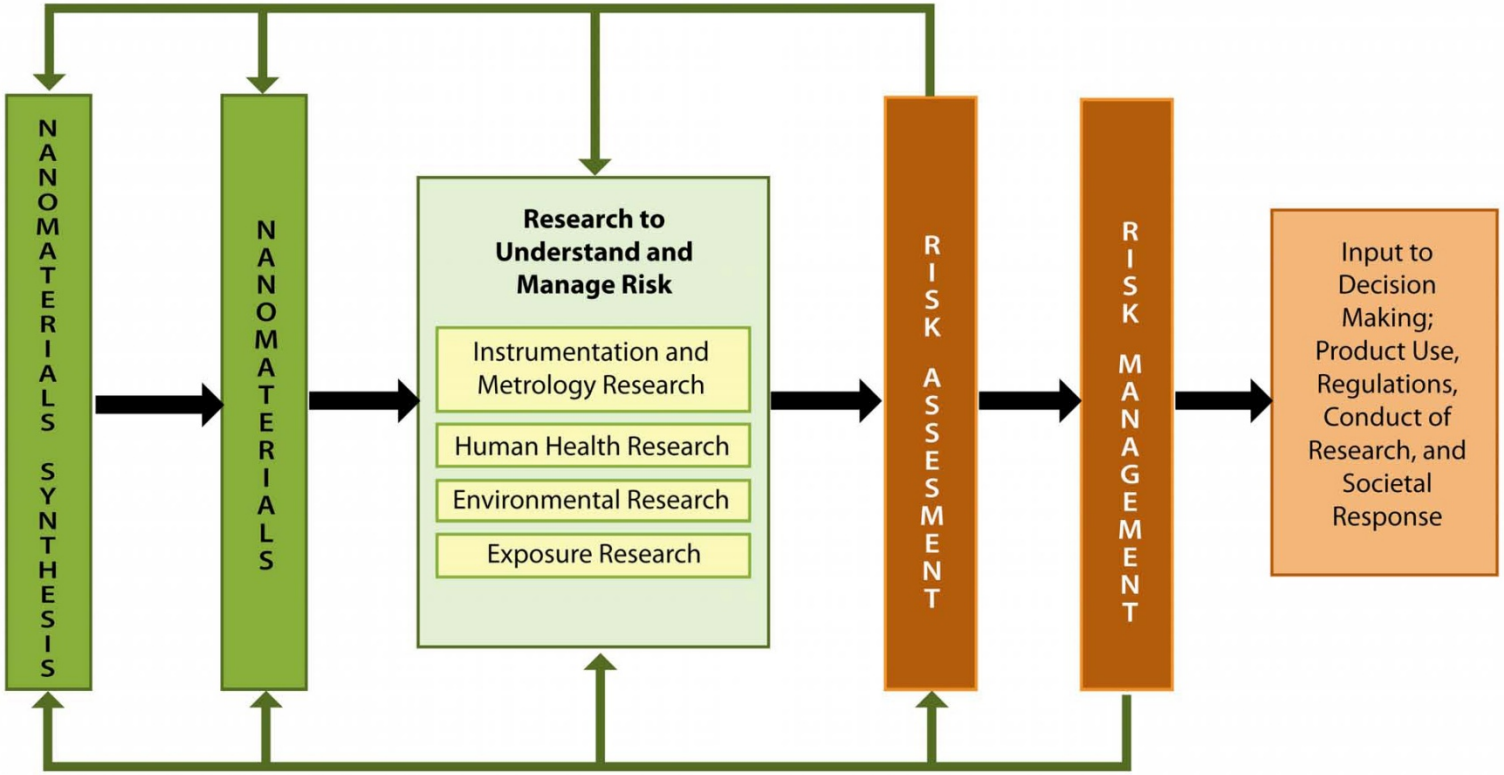
Strategy for Nanotechnology-Related Environmental, Health, and Safety Research (February 2008): http://www.nano.gov/NNI_EHS_research_needs.pdf



- Process:
  1. Identify priority needs
  2. Assess existing research
  3. Analyze strengths and weaknesses
  4. Periodic updates and revisions
- Five research categories:
  1. Instrumentation, metrology and analytical methods (NIST lead)
  2. Nanomaterials and human health (NIH lead)
  3. Nanomaterials and the environment (EPA lead)
  4. Human and environmental exposure assessment (NIOSH lead)
  5. Risk management methods (FDA and EPA lead)
- Includes list of FY '06 funded EHS projects

NNI EHS Strategy

Role of nanotechnology-related EHS research in risk management of nanomaterials*



* from Strategy for Nanotechnology-Related Environmental, Health, and Safety Research (February 2008): http://www.nano.gov/NNI_EHS_research_needs.pdf

NNI EHS Strategy: Next Steps

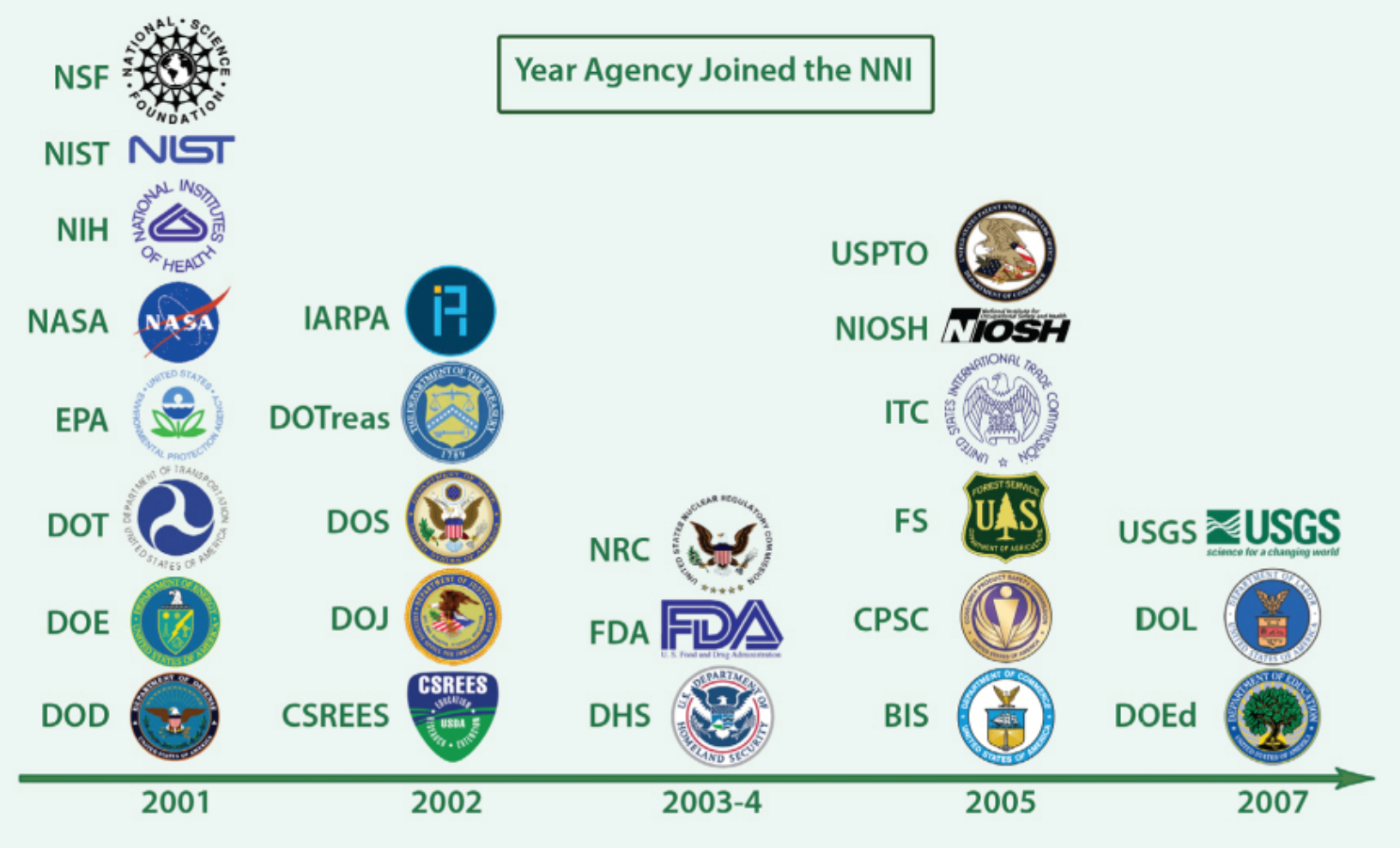
- Strategy document calls for periodic review and updates
- Workshops underway in 2009 and 2010 to refine research needs, priorities, and strategies for each of the five categories
- External evaluations of NNI strategy by National Academies, President's Council of Advisors on Science and Technology (PCAST)
  - PCAST review of NNI approach was very favorable overall: http://www.ostp.gov/galleries/PCAST/PCAST_NNAP_NNI_Assessment_2008.pdf
  - Addendum from PCAST reviewing the EHS strategy document specifically is also favorable: http://www.ostp.gov/galleries/PCAST/PCAST%20Addendum%20Letter.pdf
  - National Academies review of the NNI EHS strategy was critical
  - EPA has funded additional strategy study by National Academies
- ISO and OECD activities will provide additional feedback
  - International Organization for Standardization (ISO) Technical Committee on Nanotechnologies (ISO TC 229), met this June in Seattle
  - United States is the convenor for the ISO TC 229 Working Group on EHS aspects of nanotechnology
  - Organization for Economic Cooperation and Development (OECD) Working Party on Manufactured Nanomaterials, also chaired by U.S., is addressing EHS issues; international coordination of same

Summary: Approach to EHS, Other Potential Risks

- "Bottom-up", not "top-down" strategy development; input from research community, industry → individual agencies → overall USG strategy
- Interagency coordination is essential (see list of agencies, next slide)
- Science-based policy development; recommend precautions, just in case, while science results are still pending, especially in workplace settings; NIOSH is leading this effort in the United States
- EHS research effort integrated with overall NNI program, including EHS components within many NNI projects (for example, safety and efficacy testing is routine part of late-stage research)
- Over $480 million in "primary purpose" EHS R&D, 2005-2011 combined is supplemented by much larger efforts in basic science, materials characterization, understanding of interactions with biosystems, and especially instrumentation, metrology, & standards; total EHS-related investment is much higher counting all this related work
- Over $260 million in education and "ELSI" funding, 2005-2011
- International collaboration is also key: OECD, ISO, bilateral

NNI participation

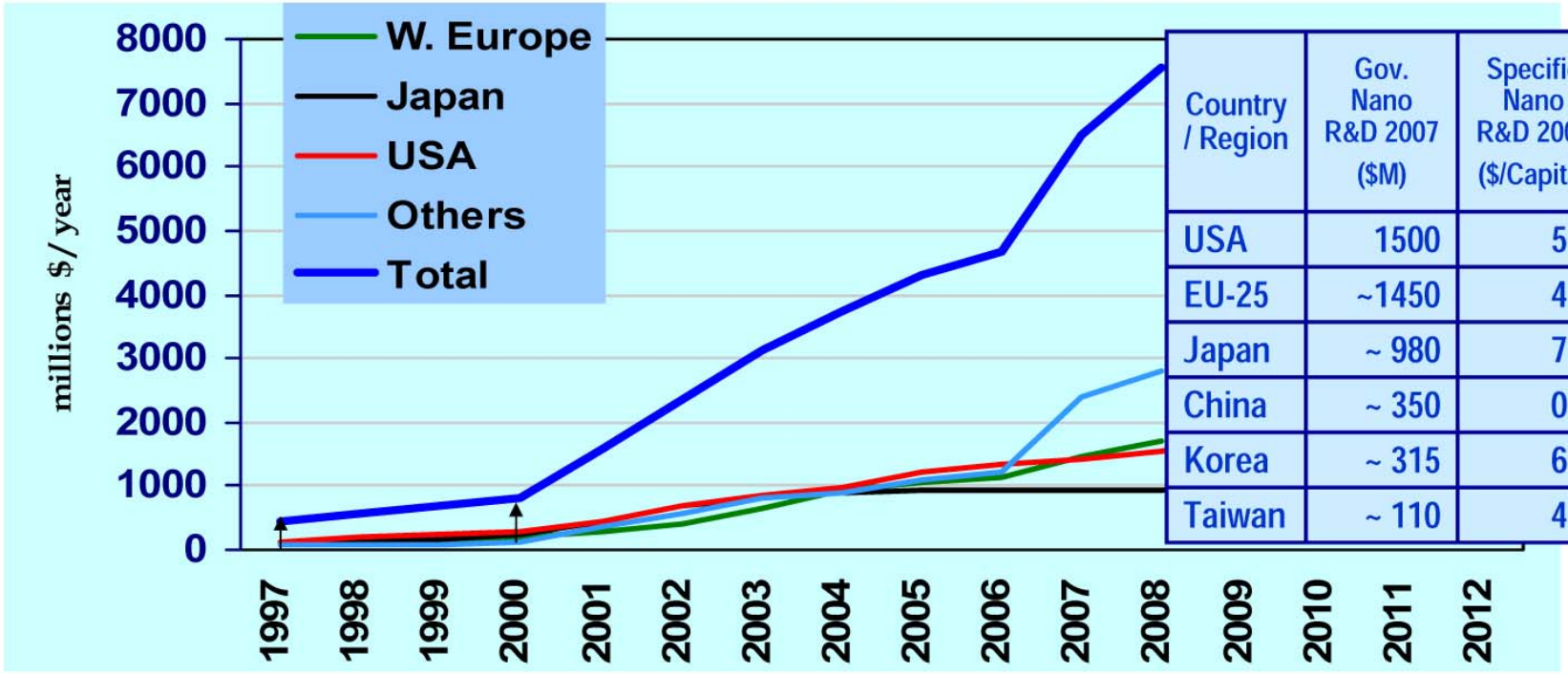
- **NNI participating agencies have grown from 8 in 2001 to 25 in 2008.**



International nanotech R&D investment

New announcements from Russia and EU recently indicate very large new investments

U.S. estimate for 2010 is $1.78 billion; 2011 request is ~$1.76 billion



Country / Region	Gov. Nano R&D 2007 ($M)	Specific Nano R&D 2007 ($/Capita)
USA	1500	5.0
EU-25	~1450	4.0
Japan	~ 980	7.5
China	~ 350	0.3
Korea	~ 315	6.0
Taiwan	~ 110	4.5

Seed funding (1991 -)

NNI Preparation (vision / benchmark)

1st Strategic Plan (passive nanostructures)

2nd Strategic Plan (active ns. & systems)

Source: M. C. Roco, NSF

Industry Consultative Boards for Advancing Nanotech
Key for development of nanotechnology, EHS coordination

- **Electronic Industry (Semiconductor Research Corporation lead), October/2003 -** Collaborative activities in key R&D areas 5 working groups, Periodical joint actions and reports; NSF-SRC agreement for joint funding; other joint funding

- **Chemical Industry (Council for Chemical Research lead) -** Joint road map for nanomaterials R&D; Report in 2004; 2 working groups, including one EHS Use of NNI R&D results, and one to identify R&D opportunities

- **Organizations and business (Industrial Research Institute lead) -** Joint activities in R&D technology management; 2 working groups (nanotech in industry, EHS) Exchange information, use NNI results, support new topics

- **Forest products industries (AF&PA lead), April 2007** – Facilitate forest products industry input to and communication with NSET

American Forest & Paper Association

New to the NNI for FY 2011: Signature Initiatives

To accelerate nanotechnology development in support of the President's priorities and innovation strategy, NNI member agencies have identified areas ripe for significant advances through close and targeted program-level interagency collaboration:

- Nanoelectronics for 2020 and Beyond (NSF, DOD, NIST, DOE, DNI)
- Sustainable Nanomanufacturing – Creating the Industries of the Future (NIST, NSF, DOE, EPA, NIH)
- Nanotechnology for Solar Energy Collection and Conversion (DOE, NIST, NSF, DOD, DNI, USDA/NIFA)

Additional details and updated information available at:
http://www.nano.gov/html/research/signature_initiatives.html

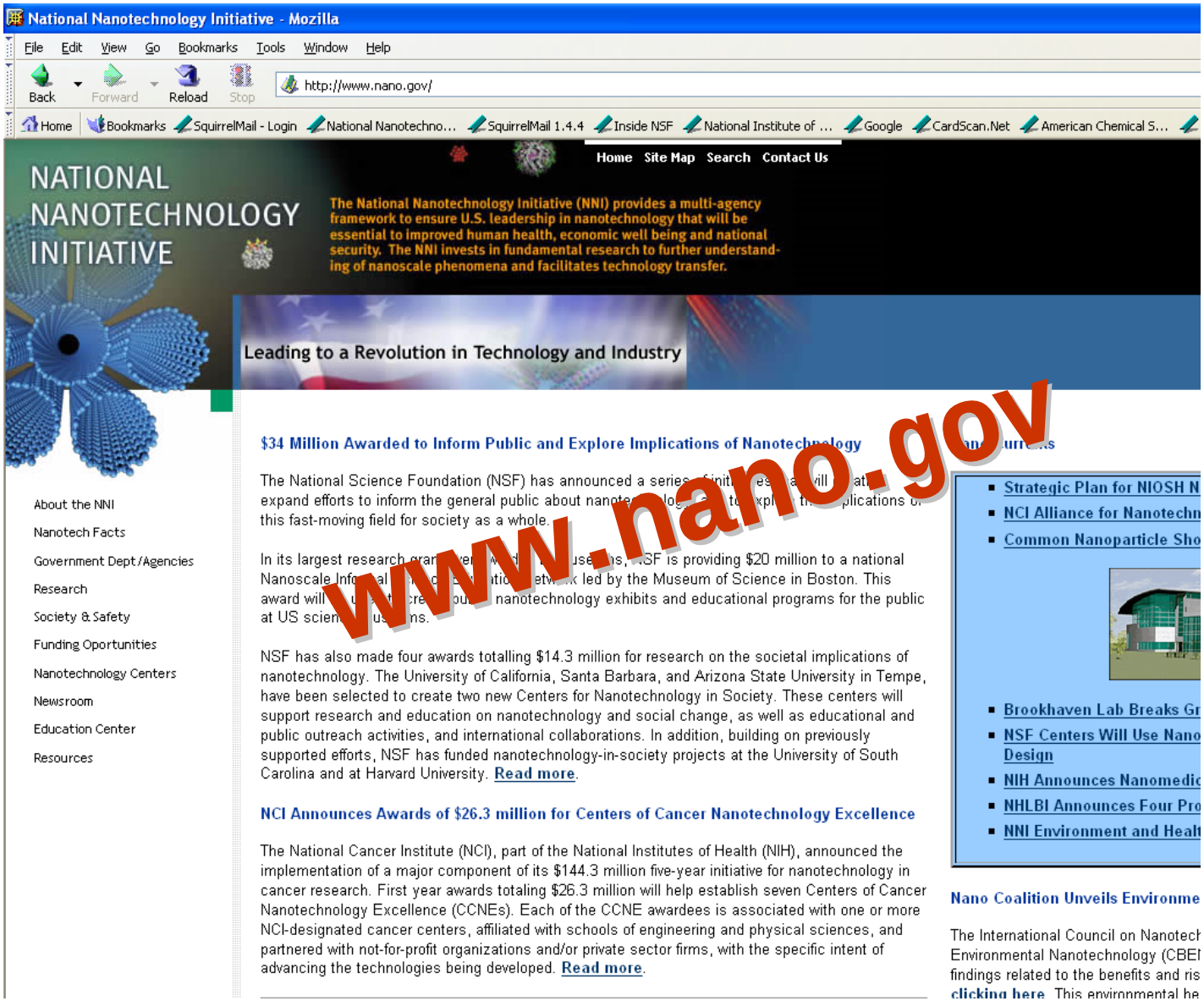
Summary: Recent NNI developments

- Cumulative NNI funding for nanoscale science and engineering research, 2001-2011: over $14 billion
- Over 60 NNI research centers, networks and user facilities funded
- Over $480 million in "primary purpose" EHS R&D, 2005-2011 combined; over $260 million in education and ELSI funding over the same period
- Reviews of NNI completed in the past 2 years by President's Council of Advisors on Science and Technology, National Academies; new PCAST assessment report due out late March 2010
- Current NNI Strategic Plan released Dec. '07; due for update this year
- NNI EHS strategy released Feb. '08; also due for update soon
- Activities now underway to implement the EHS strategy, e.g., series of workshops in 2009 and 2010
- Focus should remain on funding the needed research, as much as on process

NNI activities and documents inform agencies, report outcomes, and serve as resources

NATIONAL NANOTECHNOLOGY INITIATIVE

… if you want to know more about the NNI



What is NNCO?
(National Nanotechnology Coordination Office)

- **Interagency coordination office for the NNI, hosted by NSF**
- **Provides technical and administrative support to the NSET Subcommittee, for example:**
  - Coordinates preparation and publication of NNI planning, budget, and assessment documents (e.g., NNI Supplement to the President's Budget)
  - Organizes NSET Subcommittee and working group meetings
  - Organizes NNI-sponsored workshops; prepares and publishes WS reports
  - Coordinates development of information on NNI for Congress as requested
  - Supports external reviews of the NNI by National Academies, PCAST
- **Serves as central point of contact for Federal nanotechnology R&D activities**
- **Provides public outreach on behalf of the NNI (e.g., see www.nano.gov)**
- **Staffed by Federal agency detailees and contractors**