

National Science and Technology Council
Subcommittee for Buildings Technology R&D

Net Zero Energy High Performance Green Buildings

Rationale and Vision for the Federal R&D Agenda

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Department: U.S. Department of Commerce

Agency: NIST

Buildings Technology Subcommittee Overview



Co-Chairs

Shyam Sunder, Co-Chair (Director BFRL/NIST/DOC)

Jerry Dion, Co-Chair (Building Technologies/ EE&RE/DOE)

Purpose

Provide R&D guidance aimed at supporting advances in buildings technology and related infrastructure, with a particular focus on enabling the energy efficient, automated operation of buildings and building systems

Purpose

Provide R&D guidance to enable sustainable renewal of the nation's physical infrastructure, improve construction productivity, enhance disaster resilience of buildings, and benefit human health and productivity

Function

Identify R&D priorities and opportunities; develop long-range, interagency R&D plans; coordinate with other NSTC subcommittees (Infrastructure, Disaster Reduction,...); coordinate R&D implementation plans

Federal Membership

U.S. Department of Agriculture

U.S. Department of Commerce

U.S. Department of Defense

U.S. Department of Energy

*U.S. Department of Health and
Human Services*

*U.S. Department of Homeland
Security*

*U.S. Department of Housing and
Urban Development*

U.S. Department of the Interior

U.S. Department of Labor

U.S. Department of State

U.S. Department of Veterans Affairs

U.S. Environmental Protection Agency

U.S. General Services Administration

*National Aeronautics and Space
Administration*

National Science Foundation

Executive Office of the President

Office of the Architect of the Capital

Smithsonian Institution

Recent Subcommittee Activities

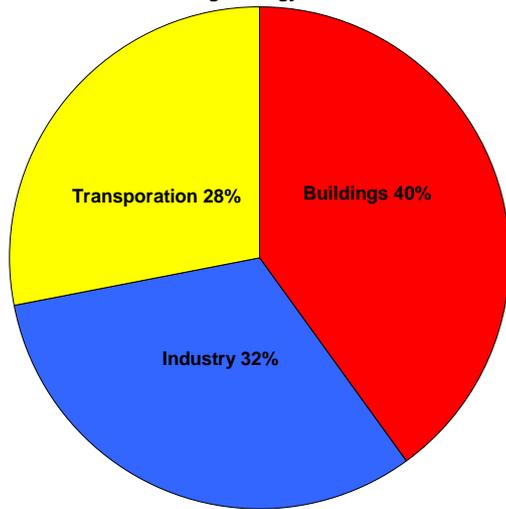
- Stood up BTRD Subcommittee: Sixteen Federal Executive Branch Agencies, Architect of the Capital, and Smithsonian Institution
 - Re-establishes federal R&D leadership for a critical sector of U.S. economy
 - Responsive to high-performance green building directives from EPA Act 2005 and EISA Act 2007

- Stakeholder workshop on “*Net Zero Energy, High-Performance Green Buildings*” including private/public sector participants
 - May 15, 2008 (8:30 am to 5:00 pm) and May 16, 2008 (8:30 am to Noon) at DOE Forrestal Auditorium

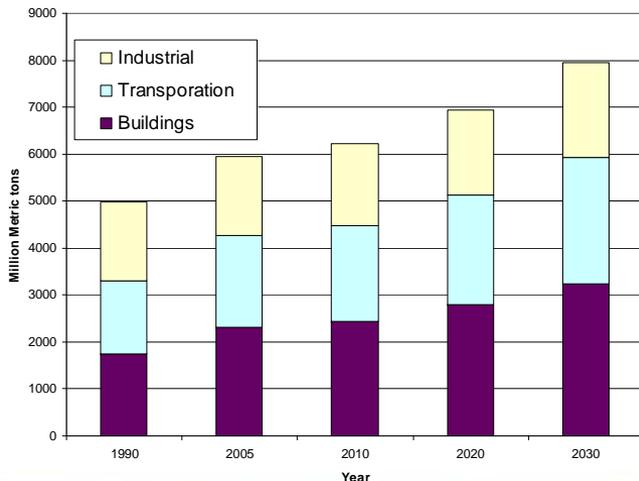
- Finalizing first report: “*Federal R&D Agenda for Net Zero Energy, High-Performance Green Buildings*”
 - Public release anticipated Summer 2008

Rationale

Share of U.S. Energy Consumption
2007 Buildings Energy Data Book



US Carbon Dioxide Emissions by Sector, 1990-2030 (million metric tons)
Data Source- EIA Annual Energy Outlook 2007 with Projections to 2030

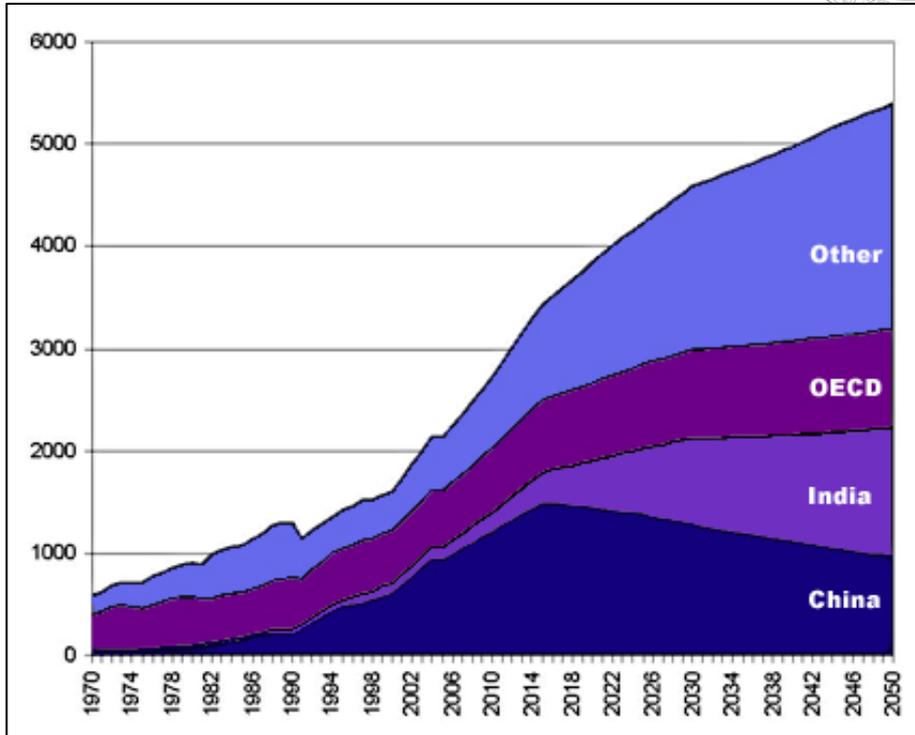


- Buildings represent largest user of energy (40%) and electricity (72%) and contributor of CO₂ emissions (39%)
 - U.S. spends \$572 B/year in energy costs for operation and use of constructed facilities
- An additional 5-8% of U.S. CO₂ emissions are attributable to cement production
 - 1 ton of cement produces about 1 ton of CO₂
 - 130 million tons/year used in U.S.; about 2.3 billion tons/year globally
- R&D Vision: Enable design of new buildings and retrofit of existing buildings that over the life cycle:
 - produce as much energy as they consume (i.e., net zero energy) while significantly reducing greenhouse gas emissions
 - double service life of building materials, products, and systems while minimizing life cycle impacts
 - halve use of domestic water (e.g., to 50 gal/day/person or less) while maximizing water recycling and rainwater harvesting and minimizing stormwater runoff
 - achieve breakthrough improvements in indoor occupant health, productivity, and comfort
- R&D vision can be achieved only (1) through use-inspired basic research that enables innovative building technologies, practices, and standards and (2) by overcoming technical barriers to technology adoption and implementation

Rationale (Contd.)

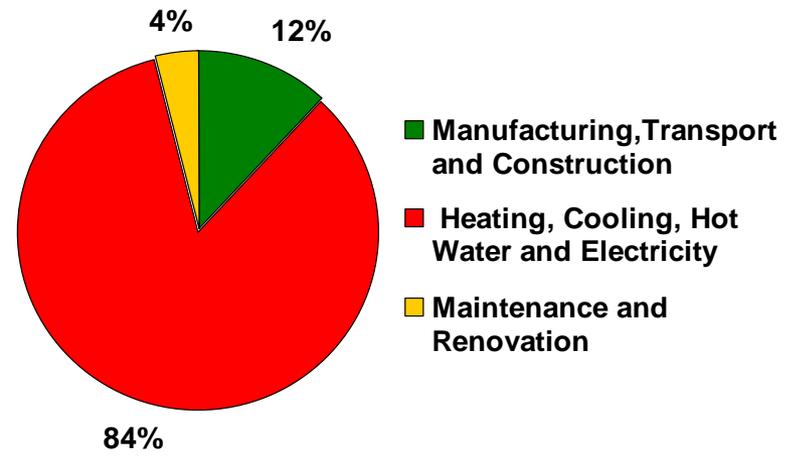


Global Cement Demand by Region and Country (1970-2050)



Source: USGS and IEA

Building Life Cycle Energy Use



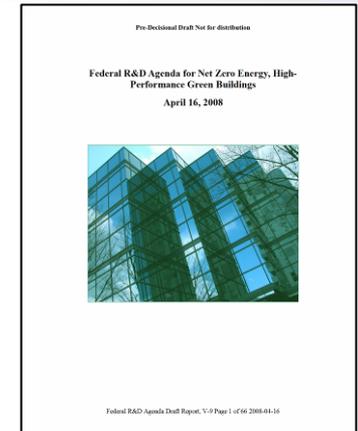
- Greatest potential in retrofitting and renovating existing buildings
 - Replacement rate of existing building stock roughly 1% per year
- New buildings also extremely important
 - 34 million new homes projected 2005-2030
 - 48% increase in commercial building floor space projected (from 73 to 108 billion sq. ft.)

Scope and Direction of the Federal R&D Agenda



- Integrated, Performance-Based Design and Operation
- Net Zero Energy Building Technologies and Strategies
- Water Use and Rainwater Retention
- Material Consumption, Waste, and Life Cycle Environmental Impacts
- Occupant Health and Performance
- Overcoming Barriers to Implementation

The scope of this report is limited to the development of new technologies, protocols, and practices at the building site, unless they apply as well to groups of buildings or communities.



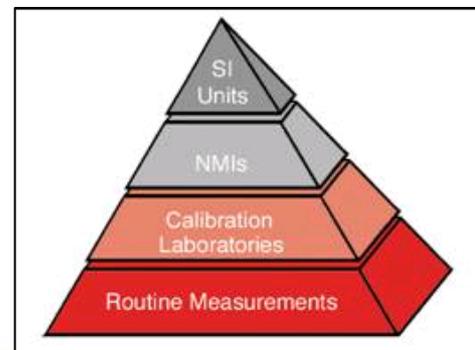
R&D Agenda Goal 1



Goal 1: Develop the enabling measurement science to achieve net zero energy, high-performance green building technologies.

R&D Priority a. Develop rigorous metrics that enable high-performance building goals to be predicted, assessed, monitored, and verified and new energy-efficient technologies, products, and practices to be developed.

R&D Priority b. Enable widespread adoption of high-performance goals by developing practical tools and processes to address the complex interactions of building components and systems throughout the building life cycle.



R&D Agenda Goal 2

Goal 2: Develop net zero energy building technologies and strategies.



R&D Priority a. Develop building envelope materials, components, systems, and construction techniques to minimize building energy loads.



R&D Priority b. Develop ultra energy-efficient components and subsystems that minimize energy and satisfy building needs.



R&D Priority c. Develop supply-side technologies that, when coupled with energy efficiency, can achieve net zero energy buildings and communities.



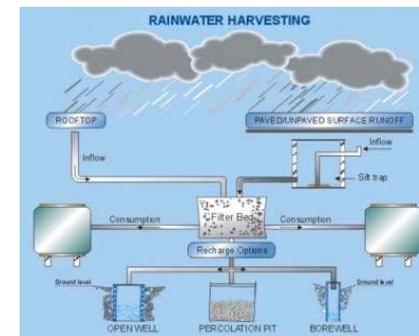
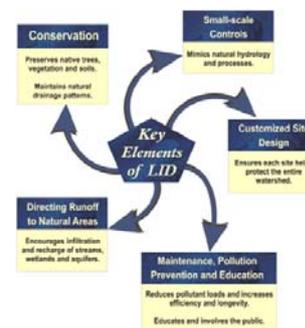
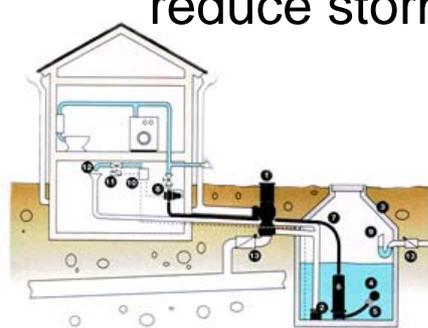
R&D Agenda Goal 3

Goal 3: Develop the scientific and technical bases for significant reductions in water use and improved rainwater retention.

R&D Priority a. Reduce water use by developing the next generation of water-saving appliances, fixtures, and systems.

R&D Priority b. Develop analyses and technologies to overcome environmental, health, and technical barriers to widespread water recycling and increased rainwater harvesting.

R&D Priority c. Develop low-impact development practices to significantly reduce stormwater runoff.



R&D Agenda Goal 4

Goal 4: Develop processes, protocols, and products for building materials that minimize resource consumption, waste, and life cycle environmental impacts.



R&D Priority a. Develop processes that minimize waste generation from building construction, renovation, and demolition.

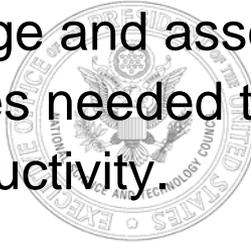
R&D Priority b. Extend life cycle assessment data and methods to identify full environmental and public health life cycle impacts of product and material choices.

R&D Priority c. Develop materials and products with minimal environmental and public health impacts over their life cycles.



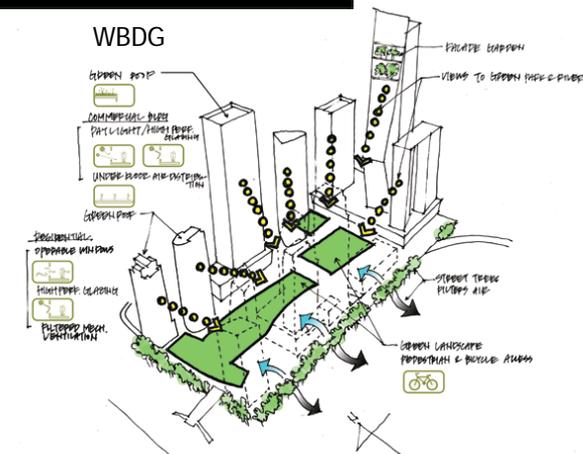
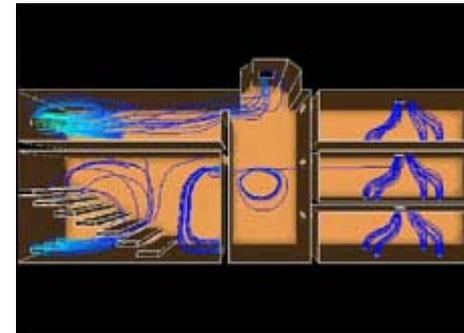
R&D Agenda Goal 5

Goal 5: Develop the knowledge and associated energy efficiency technologies and practices needed to promote occupant health, comfort, and productivity.



R&D Priority a. Develop technologies to improve indoor environmental quality and reduce building energy consumption.

R&D Priority b. Develop the knowledge necessary to support scientifically sound and building-specific standards and codes that address the health and comfort of building occupants.



West Side Yards
Goldman Sachs Image

R&D Agenda Goal 6

Goal 6: Enable technology transfer for net zero energy high-performance green buildings.



R&D Priority a. Develop high-performance building design tools and guidance for urban planners, architects, engineers, contractors, and owner/operators.

R&D Priority b. Develop tools and guides that enable the use of modern, adaptive performance-based building codes.

R&D Priority c. Research and develop effective incentives for adopting and using innovative technologies and practices.



Future High-Performance Technologies

Lighting Systems

- Solid State Lighting
- High visible light transmittance



Building Envelope Systems

- Dynamic response (shades and electrochromic windows)
- Highly insulating façade systems
- Natural lighting technologies/designs (Green)



Solar Tracking Facility to Characterize Performance of Photovoltaic Cell Technologies

A mixture containing 0.5% of nanoparticles improved the boiling heat transfer coefficient of R134a up to 275%

Potential impact - A 1% improvement in chiller efficiency would reduce U.S. electrical energy consumption by 320 billion kWh

Intelligent Systems and Controls

- Diagnostic and real-time monitoring tools
- Sensors for improved building monitoring
- Grid/consumer supply/demand integration

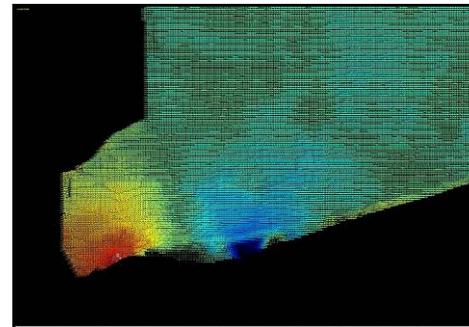


Heating, Cooling, and Refrigeration

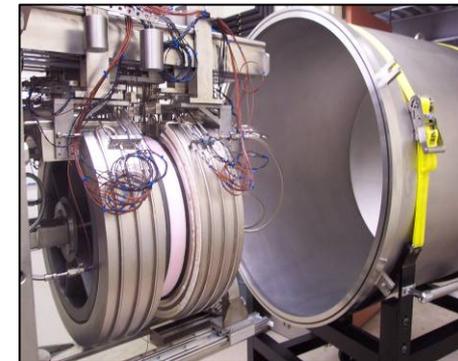


- Nano-fluids and lubricants
- Thermally-activated heat pumps
- Distributed refrigeration/water-source heat pump
- Thermoelectric cooling
- Frostless heat pump
- Improved residential HVAC distribution systems

Boris Acid Nano Lubricant



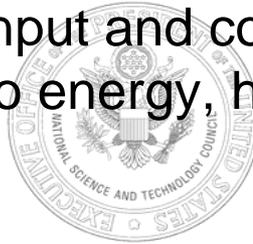
Particle Image Velocimetry Image of Air Flow Distribution through Heat Exchanger



NIST's 0.5 meter Guarded Hot Plate Capable of Providing Measurements of Thermal Insulation from 90 to 900 K

Purpose of the Workshop

Solicit workshop participant's input and comments on the research and development needs for net zero energy, high-performance green buildings



Establish a dialog on the Federal R&D Agenda for green buildings

Promote communication, interactions, and future collaboration with other workshop participants

Highlight current Federal R&D programs related to green building technology



Innovation Cycle

2008 Path Forward



Next Steps for the Federal R&D Agenda:



Development of detailed roadmaps for each of the R&D goals in partnership with key stakeholder organizations.

- Engage the key stakeholders — universities, National Laboratories, standard and code development organizations, professional societies, and private sector companies —to implement the R&D agenda.
- Publicize the Federal performance requirements for purchases and procurements.
- Evaluate successes and lessons learned.
- Refine the research agenda.

Complete and publish *Federal R&D Agenda Report*

- Two week workshop comment period
- Review and address stakeholder's input into the R&D Priorities Report
- Engage international collaboration and information sharing on R&D, best practices, and standards development
- Brief policy leaders on Federal R&D Priorities Report and implement **Next Steps**





Questions?

