

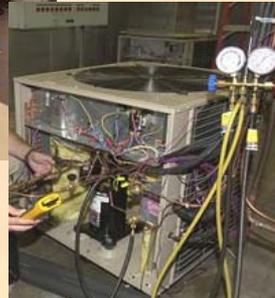
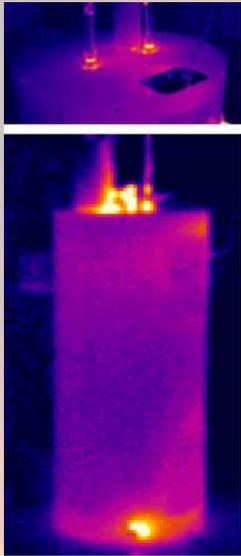
Measurement Science for Building Energy Technologies

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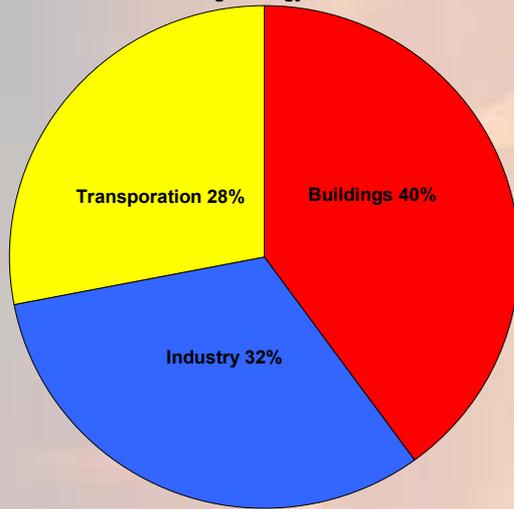
National Institute of Standards and Technology

Gaithersburg, Md.



Reduction of Building Energy Consumption/CO₂ Emissions

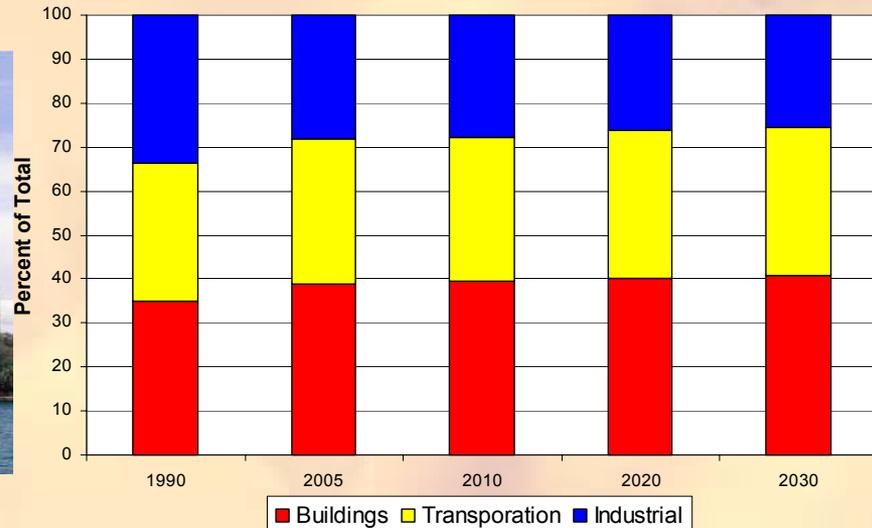
Share of U.S. Energy Consumption
2007 Buildings Energy Data Book



Technical Approach

- Enable Building Energy-Use Reduction through In-Situ Performance Measurements
- Enable Energy-Use Reduction through the Embedded Intelligence in Building Controls
- Provide Measurement Science for Emerging Building Energy Technologies
- Develop Carbon Footprint Metrics/Tools for Building Sustainability Performance Evaluation

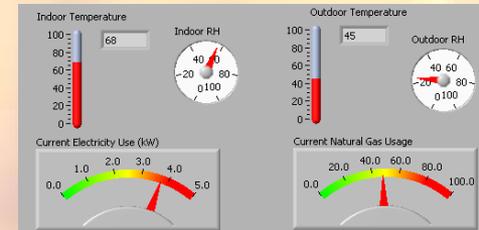
US Carbon Dioxide Emissions by Sector, 1990-2030
Data Source- EIA Annual Energy Outlook 2007



Enable Energy-Use Reductions Through In-Situ Performance Measurements

NIST will...

- **Develop measurement techniques to assess envelope integrity**
Outcome: Improved methods to detect gaps in walls and roofs through which unwanted heat flow occurs
- **Improve measurement of ventilation rates and indoor air contaminants in buildings**
Outcome: Ventilation control strategies can be implemented based on actual need instead of general guidelines, thus saving energy by ventilating only when necessary
- **Enhance measurement of refrigerant loss in vapor compression systems**
Outcome: Detection of inefficient performance of air-conditioning and heat pump systems in the field
- **Optimize measurement systems for energy information centers**
Outcome: Affordable monitoring systems that provide information to occupants regarding energy consumption, knowledge that has been shown to reduce energy use in buildings

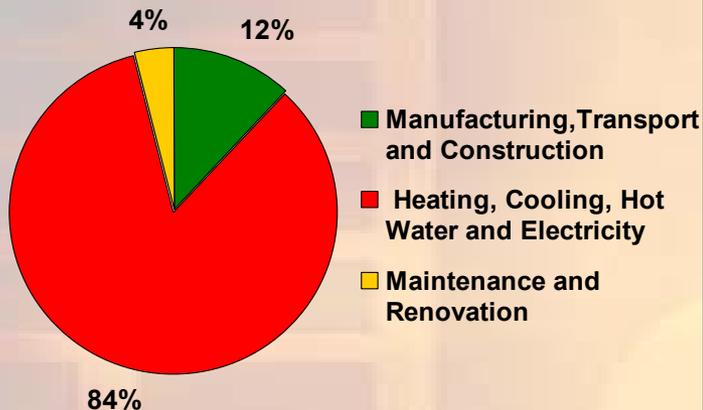


Enable Building Energy Use Reductions Through Embedded Intelligence



NIST Virtual Cybernetic Building Testbed

Building Life Cycle Energy Use



NIST will...

- **Determine the number and type of sensors required to detect building equipment faults and control errors**
Outcome: Technical basis for determining the type, number and location of sensors
- **Develop fault detection metrics/tools for heating, cooling ventilating, and air-conditioning (HVAC) equipment**
Outcome: Eliminating of faults/control errors
- **Develop hierarchical analysis techniques that can determine when an apparent fault in one piece of equipment is the result of component failure earlier in the process stream**
Outcome: Increased confidence in fault detection
- **Develop supervisory control techniques based on autonomous, intelligent agents that can optimize system performance**
Outcome: Substantial energy use reduction through more efficient control of building systems

Measurement Science for Emerging Building Energy Technologies



NIST's Photovoltaic and Lighting Research Facilities



NIST will...

- **Develop/characterize novel techniques to simulate the solar spectrum indoors**
Outcome: Removal of significant barrier to widespread deployment of photovoltaic systems – uncertainty in module power rating measurements
- **Develop the measurement science, methods of test, and performance metrics for solid state/organic light-emitting diode technologies and stationary fuel cell units**
Outcome: Accelerated commercialization of energy efficient lighting products and fuel cell units with combined heat and power capabilities
- **Develop measurement science to quantify 3-D performance of innovative insulation**
Outcome: Development of insulation technologies with 10X current performance
- **Develop characterization techniques for amorphous industrial waste stream products**
Outcome: Reduced energy use and CO₂ emissions during cement production

Develop Carbon Footprint Metrics and Tools for Building Sustainability Performance Evaluation

NIST will...

- **Develop carbon footprint databases**
Outcome: Building industry stakeholders can link energy technology innovation to environmental benefits and costs at the building scale
- **Develop carbon efficiency metrics**
Outcome: R&D investors can assess economic value of financing development and commercialization of new building technologies with measurable carbon reductions
- **Develop national carbon scorecarding metrics**
Outcome: Carbon trading markets are informed with the traceable measurements essential to enable reporting of the building industry's carbon footprint
- **Develop national carbon scorecarding tools**
Outcome: Communities and governments can readily track progress toward Net Zero Energy buildings



Building A vs. Building B

\$20/ton
carbon
saved



\$40/ton
carbon
saved

Technology Transfer

- Disseminate research to key industry organizations:



- Collaborate with industry to enable testing of prototype building energy technologies using NIST measurement science technology
- Provide university grants supportive of enabling sensor technology required for advances in building energy technologies
- Utilize NIST's Guest researcher Program and Technology Fellowship Program to collaborate with experts through joint research efforts
- Continue to support and contribute to DOE/industry strategic roadmapping activities that will identify needed measurement science for building energy technologies
- Peer reviewed journal articles and conference presentations

BFRL Energy Success Stories

- **Building Automation and Control** – enabling energy savings, reduced operating costs, and improved occupant comfort and safety via BACnet standard for integration of building automation and control systems adopted by ISO, CEN, and over 30 countries.
- **Energy Efficiency of Appliances** – enabling energy savings, reduced operating costs, and consumer awareness via standard DOE testing and rating procedures for HVAC, water heaters, and appliances
- **Indoor Air Quality** – enabling indoor air quality by providing minimum threshold standards for ventilation while ensuring efficient use of energy resources in buildings nationwide
- **Renewable Energy** - enabling the use of solar equipment through test method and rating procedure development that forms the basis of industry (Solar Rating and Certification Corporation) certification programs
- **Sustainability Assessment** – enabling science-based selection of cost-effective, environmentally preferable building products through incorporation in major U.S. “green building” rating systems

