COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
U.S. HOUSE OF REPRESENTATIVES

Pushing the Efficiency Envelope: R&D for High-Performance Buildings, Industries and Consumers

Tuesday, April 28, 2009
10:00 a.m. -12:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Tuesday, April 28 the Subcommittee on Energy and Environment will hold a hearing to receive testimony on the role of the Department of Energy's research and development programs in developing technologies, codes, and standards to enable deployment of net-zero energy, high-performance buildings and support energy efficiency in domestic industries.

WITNESSES

- **Mr. Steven Chalk** - Principal Deputy Assistant Secretary - Energy Efficiency and Renewable Energy - U.S. Department of Energy
- **Mr. William J. Coad** - President - Coad Engineering Enterprises, and Chairman of the High-Performance Building Council of the National Institute of Building Sciences
- **Mr. Paul Cicio** - President - Industrial Energy Consumers of America
- **Dr. Karen Ehrhardt-Martinez -** Research Staff, Economic and Social Analysis Program - American Council for an Energy-Efficient Economy (ACEEE)
- **Dr. J. Michael McQuade -** Senior Vice President, Science and Technology - United Technologies Corporation

BACKGROUND

Addressing public concerns about the high costs of energy, the looming threat of global climate change and the nation's economic health requires continual assessment of federal programs designed to mitigate the impacts of various economic sectors, including heavy industry and the built environment. The construction, operation, and demolition of buildings are recognized as major contributing factors to the increase in energy consumption, emission of greenhouse gases, depletion of valuable natural resources, and degradation of ecological services such as water supply. The domestic industrial sector, while making considerable gains in energy and resource efficiency in recent years, still comprises a significant portion of the country's emissions, and is more vulnerable than ever to rising costs of energy and raw materials. To reduce both emissions and waste, and improve the nation's overall energy efficiency new advancements in industrial and building technologies must be pursued by both the public and private sector.

Buildings consume more energy than any other sector of the U.S. economy (40%), including transportation (28%) and industry (32%). From 1980 to 2006, total building energy consumption in the United States increased more than 46 percent, and is expected to continue to grow at a rate of more than 1 percent per year over the next two decades. In addition, almost three-quarters of our nation's 81 million buildings were built before 1979. Because buildings are long-lived assets, significant improvement of their energy efficiency will require either retrofits or total replacement. Deployment of high-performance buildings can reduce the environmental impact of buildings while making them cheaper to operate.

Industry accounts for approximately one-third of all energy consumed in the U.S. with much of that usage concentrated in heavy industries such as chemical, glass, cement, and metals production, mining, petroleum refining, food processing, and forest and paper products. These industries also have relatively high carbon dioxide (CO_2) emissions. Despite their relatively high energy and emissions intensity, many industrial firms face competitive pressures that make it difficult to justify the technical and financial risks of R&D projects. Therefore, federal programs are essential to promote development and deployment of technologies and process improvements that increase energy efficiency, raise productivity, reduce and reuse wastes, and trim costs.

Building and Industrial Efficiency Technology Programs at DOE

The importance of energy efficiency and sustainability in the building and industrial sector has been recognized in various federal laws, executive orders, and other policy instruments in recent years. Among these are the energy policy acts (EPAct) of 1992 and 2005 (P.L. 102-486 and P.L. 109-58), the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), and the American Recovery and Reinvestment Act of 2009. Through these laws the Department of Energy (DOE) is authorized to carry out a range of activities to increase energy efficiency in a number of economic sectors.

Within the DOE Building Technologies Program both the High-Performance Buildings partnerships and Zero-Net Energy Commercial Building Initiative, work to improve the efficiency of buildings and the equipment, components, and systems used to control temperature, provide lighting, and plumbing.

A high-performance building as defined by EISA is a building that integrates and optimizes, on a life cycle basis, all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality and operational considerations. As part of this approach, DOE selected building industry groups to form a High-Performance Green

Building Consortium that works to accelerate the commercialization of high-performance building technologies. DOE and the National Renewable Energy Laboratory (NREL) also created the High Performance Buildings Database, which seeks to improve building performance measuring methods by collecting data on various factors that affect a building's performance, such as energy, materials, and land use. It is a unique central repository of detailed information and data on high-performance, green building projects across the United States and abroad.

The Net-Zero Energy Commercial Building Initiative aims to realize marketable net-zero energy commercial buildings by 2025. In general, a net-zero energy building produces as much energy as it uses over the course of a year. The program brings architects, engineers, builders, contractors, owners, and occupants together to optimize building performance, comfort, and savings through a whole-building approach to design and construction. The program is divided into three interrelated strategic areas designed to overcome technical and market barriers: research and development, equipment standards and analysis, and technology validation and market introduction. Key research areas include: commercial lighting solutions; indoor environmental quality; building controls and diagnostics; and space conditioning.

The Department also participates in a variety of activities to aid in standards and codes development for new building technologies, appliances, and compliance and design tools. For example the Building Technologies Program's Building Energy Codes initiative works with the National Institute of Standards and Technology, state and local governments, national codes organizations, and industries to help develop improved national model energy codes. Unlike conventional building codes which dictate only minimum requirements for construction, “model” building codes are designed to push the technological envelope of what can be achieved in building design, construction and operation. Ultimately, there may need to be a comprehensive and unified framework of standards which accounts for the full range of metrics and benchmarks to maximize building performance. DOE also updates and improves appliances and equipment standards by testing products and technologies, and ultimately conducting rulemaking through a public process.

The DOE Industrial Technologies Program (ITP) seeks to reduce manufacturing energy intensity and carbon emissions through coordinated research and development with industry, deployment of innovative energy efficient technologies, by providing energy assessments of industrial facilities, and through dissemination of industry best practices. The ITP invests in high-risk, high-value cost-shared R&D projects to reduce industrial energy use and process waste streams, while stimulating productivity and growth. Projects may be specific to a certain industry (ex: aluminum smelting), or applicable across a range of industrial applications (ex: fuel and feedstock flexibility). In addition, the ITP serves as an informational resource by making available information on other financial assistance and research opportunities, background on both existing and emerging technologies, as well as results of case studies from past ITP projects. The ITP also sponsors 26 University-Based Industrial Assessment Centers (IACs) that provide no-cost energy assessments primarily to small- and medium-sized manufacturers. By operating through university engineering programs the IACs serve as a training ground for the next-generation of energy and industrial engineers.

Pushing the Energy Efficiency Envelope

While these programs continue to demonstrate success in developing technologies and practices for high-performance buildings and sustainable industries, advancing the state of technology far beyond what is currently available will require the programs to incorporate entirely new technologies and approaches into their R&D agendas.

For instance, buildings of the future will be designed to operate as a singular system of interoperable components – a concept that is not possible today. A typical building is comprised of a complex array of components (wood, metals, glass, concrete, coatings, flooring, sheet rock, insulation, etc.) and subsystems (lighting, heating, ventilation and air conditioning, appliances, landscape maintenance, IT equipment, electrical grid connection, etc.) all of which are developed individually by independent firms that do not often design and test their performance in conjunction with other components and systems. Even after building completion, systems are rarely optimized together to improve overall energy efficiency and environmental performance. The inefficiencies attributable to this fragmentation of the building components and systems, and the lack of monitoring and verification of a building performance, point to a critical need for a more integrated approach to building design, operation, and technology development. An approach that couples buildings sciences, architecture, and information technologies could lead to entirely new "self-tuning" buildings with subsystems that are able to continuously communicate with each other and respond to a range of factors. Wide-scale deployment of these types of net-zero energy high performance buildings will likely require federal programs to play a larger coordinating role in the development of the common technologies, codes, and standards.

Pushing the efficiency envelope will also require engaging the social sciences in providing a much greater understanding of how people and organizations make energy-related decisions. Individual and collective behavior plays a critical role in efficiency, not only through direct demand for energy, but also by creating or failing to create market demand for more energy efficient technologies. Consumers make these decisions every day when weighing options such as what vehicle or appliance to purchase, whether to drive or take public transportation, what light bulbs to install, or whether to shut down their computers at night. In aggregate these decisions have an impact on the supply and demand curves that drive both energy prices and, ultimately, energy technology development.

In 2005, the National Academy of Sciences (NAS) produced a report on "Decision Making for the Environment: Social and Behavioral Science Research Priorities." In the chapter on *Environmentally Significant Individual Behavior*, the NAS panel states: "A basic understanding of how information, incentives, and various kinds of constraints and opportunities, in combination with individuals' values, beliefs, and social contexts, shape consumer choice in complex real-world contexts would provide an essential knowledge base for understanding, anticipating, and developing policies for affecting environmentally significant consumer behavior."[1] Integrating social science research into the larger energy R&D field will provide greater insight into the best ways to convey information to consumers and help them make decisions regarding energy efficiency and conservation. For instance, understanding consumer behavior will help in development of a whole building approach to design and operation of building systems, where components are integrated to reduce energy consumption through displaying information to occupants.

[1] National Research Council. 2005. *Decision Making for the Environment: Social and Behavioral Science Research Priorities*. Washington, DC. P. 78.