National Institute of
BUILDING SCIENCES
1090 Vermont Avenue, NW, Suite 700
Washington, DC 20005-4905
(202) 289-7800 phone
(202) 289-1092 fax
www.nibs.org

TESTIMONY OF

HENRY L. GREEN, HON. AIA

PRESIDENT, NATIONAL INSITUTE OF BUILDING SCIENCES

BEFORE THE

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SUBCOMMITTEE ON WATER AND POWER

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Chairwoman Shaheen, Ranking Member Lee, and members of the Subcommittee, thank you for the opportunity to provide testimony on water efficiency, buildings, and the connection between water and energy.

The National Institute of Building Sciences (Institute) was established by Congress in 1974 upon recognition of a lack of an authoritative national source to make findings and to advise both the public and private sectors on the use of building sciences and technology to achieve recognized goals (12 USC 1701j-2).

To achieve its mission to support advances in building science and technology to improve the built environment, the Institute has established a diverse portfolio of councils and programs that engage building industry experts in examining and developing tools, technologies and practices to meet identified needs. This testimony reflects the diversity of water-related issues identified by many of our councils, from the Multihazard Mitigation Council and Sustainable Buildings Industry Council to the Consultative Council.

Water and Energy Use in Buildings

As defined by Congress in the Energy Independence and Security Act of 2007 (EISA), a high performance building "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." While water is not explicitly mentioned, it is an essential consideration in many of these attributes.

It is becoming increasingly obvious that water, like energy, will serve as a fundamental focus of building related policies. Recent drought conditions nationwide, including those in Texas and Georgia, water shortage declarations in Kentucky and fire prone landscapes across the country demonstrate the growing need to focus on how we use water. The Environmental Protection Agency reports that 36 states expect to experience local, regional or statewide water shortages by 2013. [1] Just last week, the National Climatic Data Center reported that the nation is experiencing the largest drought since the 1950s. In June, about 55 percent of the country was in at least a moderate short-term drought—the highest level since December 1956—and at least 70 percent of the nation is in some state of drought.

Americans use more water in the home than in any other country in the world, except Canada. Going forward, the U.S. Census Bureau expects the greatest percentage of regional population growth in areas of the country where water resources already are stressed. As will be demonstrated by my testimony and the testimony of others, a holistic focus on opportunities to use both water and energy efficiently will provide an economically efficient opportunity to use our resources wisely.

As you may know, buildings are responsible for approximately 40 percent of the primary energy use in the United States.[2] Almost three quarters of the electricity produced in the U.S. is consumed in the building sector and represents over $300 billion in expenditures.[3] While these numbers alone are staggering, they do not reveal the associated impact on water resources. According to the U.S. Geological Survey, the generation of electricity is responsible for almost half of the nation's water withdrawals.[4] This equates to about 23 gallons per kilowatt hour generated. Therefore, any energy use avoided results in less water use.

In addition, reductions in water use can result in decreased energy demand. Energy is consumed in the conveyance of water from the source to the point of treatment, the treatment process itself, the distribution of water to the point of use, the heating of water during use, and the wastewater treatment process. The California Energy Commission found that 19% of the state's electric energy load comes from the pumping and treatment of drinking water and wastewater, and 32% of its gas load is related to the heating of water by consumers. However, few other states have done this analysis, and there has been no national research into this important area. These values reveal the huge potential to achieve significant energy savings through improved water efficiency measures.

Data and research on water use in the building sector is lacking and requires a focus at several scales of magnitude. While we have a long history of energy use data for the building stock in general, from programs like the Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS) and the Residential Energy Consumption Survey (RECS), no such resource exists for water use. While CBECS and RECS are not perfect and have recently suffered from funding issues, they remain a valuable resource in monitoring the progress of energy efficiency programs, facilitating

[1] U.S. Environmental Protection Agency (EPA), Water Supply and Use in the United States (2008).
[2] Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/, Table 1.1.3
[3] Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/, Table 1.1.9
[4] Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., 2009, Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344, 52 p.

changes in codes and standards, and establishing national goals. The need for more comprehensive building water use data is vital to the continued improvement of water management in buildings across the country. The next version of CBECS will include new data on water use, but more data and research is needed.

In addition to the need for water usage data for the building stock as a whole, water use benchmark data by distinct building types do not exist. Establishment of such a dataset could result in development of comprehensive benchmark data that supplies a general range of “water use intensity” values represented as gallons per square foot. Water use intensity values can be used within codes and standards to develop performance-based standards, by water utilities to identify large and inefficient users, by water auditors to develop water management strategies, and by federal and local governments to craft water use policies. This benchmark data also would provide a means to compare the water use of one building against another to determine a relative level of water efficiency.

Further, there is a lack of information on the end uses of water in commercial buildings and very little research has been conducted on the topic. Thus, while the aggregate usage data that can be obtained by traditional metering of various building types is important and will result in significant water savings, the proper sizing of plumbing systems and the implementation of other water efficiency strategies requires a greater understanding of the use patterns associated with discrete fixtures, appliances and equipment. Such research would monitor, in real-time, water consuming equipment and processes in commercial buildings, such as plumbing fixtures; commercial kitchen equipment; irrigation; laboratory/medical equipment; heating, ventilation and air conditioning (HVAC) systems; and ornamental fountains. This data could be examined to understand patterns in water end use and to support development of metrics that provide benchmarks on water end uses for distinct building types. To advance plumbing codes and inform development of water efficiency programs and proper pipe sizing methodologies, researchers, manufacturers, and utilities (with governmental support) should research and implement advanced metering and sub-metering technologies that can provide greater insight into how water is used in various building types. Building owners, designers, operations and maintenance staff, policymakers, and codes and standards developers could utilize such information to more accurately estimate water use by building type and the potential savings of efficiency opportunities.

As a first step to development of a water use benchmark and resulting opportunities to reduce water use, construction codes and standards must require increased use of water meters in all building types. This is especially true for multi-family residential buildings where residents currently lack financial incentive to repair or replace leaky pipes, plumbing fixtures and appliances. In addition, requiring water meters for specific use applications within a building will provide building facility managers with an effective water efficiency feedback mechanism. These include: makeup water to cooling towers, evaporative condensers, larger evaporative coolers, fluid coolers, large boilers, and makeup water supplies to swimming pools.

Given the value of water to the viability and resilience of communities, the construction community calls on this Committee, Congress at large, and the Administration to provide leadership and direction towards the development and support of research programs that will advance the establishment of accepted science-based metrics and allow better understanding of how to best achieve energy and water use efficiencies in buildings.

<u>Challenges in Reducing Water and Energy Use</u>

Currently, no federal agency has the mandate or the ability to adequately consider all high-performance building attributes and support the numerous goals placed upon the building community. Considering just green building programs (which include elements of water and energy efficiency), the Government Accountability Office identified 94 initiatives housed in 11 agencies.[5] Opportunities to increase collaboration across all building issues and within each individual issue area are necessary. A cross-agency working-group on building-related issues that could develop holistic strategies for achieving national goals would be incredibly valuable.

Unlike the somewhat straightforward nature of the energy delivery infrastructure, water delivery infrastructure provides unique challenges that are not completely understood. While net-zero energy use does not generally impact the safety inherent in existing delivery infrastructure, net-zero water efforts require careful consideration. Existing water infrastructure and plumbing is based on historic flow rates. Decisions to implement some water efficiency strategies that reduce water consumption levels without fully understanding the systemic implications of reducing flows in water supply pipes and sanitary systems can result in unintended consequences.

Continued flow reductions on both water supply and sanitary drain systems, without fully understanding the implications of these flow reductions, place the health and safety of occupants and the efficacy of plumbing systems at risk. Researchers need to better understand water use in buildings to properly size water pipes to balance the needs for energy and water efficiency with the need to maintain residual pressures for safety and other performance concerns.

While many water purveyors have fully metered systems, many water agencies surprisingly still charge customers flat rates, even in water-scarce regions of the United States. State and local governments must immediately begin to require that all buildings be metered for water use, at the gross building level at a minimum, but, ideally, sub-metered for all significant water uses within the building. Installing meters and billing according to usage has been shown to be the single most effective water conservation measure a water utility can initiate. As recently measured by utilities, unmetered water consumption is reduced 15% to 30% when utilities implement metering and commodity rates.[6]

Benchmarking of energy use by commercial building owners has grown considerably through the development of the Environmental Protection Agency's EnergyStar for Buildings Program and its Portfolio Manager Tool; the passage of rating and disclosure requirements in cities like Seattle, New York, Washington DC, and Philadelphia; and recognition programs such as ASHRAE's Building Energy Quotient, Building Owners and Managers Association 360 program, the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) and the Green Building Initiative's Green Globes

[5] GAO-12-79, Green Building: Federal Initiatives for the Nonfederal Sector Could Benefit from More Interagency Collaboration, November 2011
[6] The Alliance for Water Efficiency - 2011

Program. Similar tools and recognition opportunities do not exist relative to water use. The lack of benchmarking data for water use by building type and end use likely underlies the slow emergence of such programs.

Many institutional building owners, including governments, universities and hospitals, have been working with energy service companies (ESCOs) to implement and finance energy efficiency improvements where costs are paid through the resultant energy savings. Few programs of this type exist to finance water efficiency improvements. Many private companies may be unwilling to enter this market because of the lack of benchmark data and an ability to understand how potential upgrades will ultimately affect water savings and the associated cost savings. Further, the diversity of pricing structures for water and the relatively low cost may not make such efforts economically viable.

The lack of a national policy or plan for addressing water related issues has kept the need and opportunity in the background. Without a holistic view of our nation's water needs, policymakers at all levels of government will have difficulty making appropriate and responsive decisions. The Institute's Consultative Council has recommended that the federal government prioritize, coordinate, and support development of a national water strategy prior to the emergence of inevitable water shortages.

EPA's WaterSense program is an essential element of the development of a water focused benchmarking initiative, but focuses solely on individual pieces of equipment and not the use of water throughout a building. Increased funding for the WaterSense program can help to facilitate increased product coverage and potential development of a WaterSense for Buildings Program.

WaterSense designations only exist for a few product types. Existing rating systems like LEED and Green Globes only require efficient plumbing fixtures and do not consider all other indoor water consuming equipment in buildings, such as commercial kitchen equipment, cooling towers and water-consuming medical equipment, as well as non-critical functions, such as ornamental fountains. These partial requirements on their own do not assure water-efficient buildings because no benchmark data exists upon which to generate accurate and defensible performance-based goals. Green building programs in general provide specification criteria without providing the "how-to" information on effective implementation and integration within buildings. Codes and standards developers and professional organizations work to fill this gap. Model code developers have already developed comprehensive "green" building or plumbing codes that, while prescriptive in nature, do address commercial and institutional applications. Ensuring cooperation across these organizations and their criteria can help realize the achievement of water efficient buildings.

Education and training on the connection between energy and water and the opportunities to reduce their use is essential to achieving national goals in these areas. Specific audiences include operations and maintenance personnel, architects and engineers, state and local building departments, policymakers and building occupants. Buildings have a complex life cycle, from concept, design and construction to commissioning, occupancy, modification/renovation and deconstruction. Education and training within the building professions must reflect this complexity, including the specific skill needs at each point in the building's life cycle. These lifecycle considerations include efficient use of energy and water through reduced waste and demand management, improved occupant comfort and health, and upgrading the human-building system interface. In each time period within the building's life cycle, particular segments of the building community must be engaged and have the requisite knowledge to adequately address the unique needs within that time period.

While the Institute focuses primarily on the built environment, we recognize that buildings do not exist in isolation; they rely on connections to other sectors of the economy. Such connections include utilities, finance and manufacturing. Understanding these connections is essential to the design, construction and operation of buildings, so I will focus some of my testimony on illuminating these connections.

Efficiency and conservation methods within buildings should continue to be employed in construction designs. However, the backbone of the nation's electrical and water delivery systems also needs significant repair and improvement. With nearly 60 percent of electricity and 20 percent of water being lost before it ever enters service, significant savings will not be realized until the delivery systems become more efficient and waste is reduced. Aging supply lines need to be replaced to ensure proper delivery of both potable water and water for fire protection. Ten percent of the nation's water distribution system is over 80 years old and 30 percent is between 40 and 80 years old. Nearly 2 trillion gallons of water is lost annually through leaks in water pipes. This annual loss equates to an estimated $1 to $2 billion. Aside from the cost implications, it is estimated that a five percent reduction in water distribution system leakage would save 313 million kWh of electricity and avoid approximately 225,000 metric tons of CO_2 emissions annually.[7] The American Society of Civil Engineers, in a 2009 report, gave the U.S. drinking water and wastewater system a D-. The electrical infrastructure faired only slightly better by earning a D+. Both systems require significant investments in technology and distribution systems simply to maintain their current service, let alone to keep up with growing demands.

According to Congressional Budget Office estimates from 2002, it will take $335 billion over the next 20 years to repair and update water distribution systems and an additional $300 billion to do the same for sewer systems. The process of repairing the nation's crumbling infrastructure can create tens of thousands of long-term American jobs. The United States Conference of Mayors estimates that every job created through rebuilding water systems creates more than 3.6 jobs elsewhere and every dollar invested in water infrastructure adds $6.35 to the national economy.

In an era of constrained water supplies, the very conservative approach in the United States of using potable water for nearly all applications may not be sustainable. Reusing lightly contaminated graywater collected onsite reduces the quantity of potable water consumed by the facility as non-potable supplies replace potable supplies. Additionally, sewer systems receive less water. The same occurs for reclaimed/recycled water, where a portion of the wastewater generated by entire communities is collected, treated and returned to facilities for non-potable reuse. This reduces the influent collected for treatment to potable water standards and also reduces the effluent discharged to the environment. Treatment of non-potable water also is less energy-intensive than treatment to

[7] *The Carbon Footprint of Water*, Bevan Griffiths-Sattenspiel and Wendy Wilson (2009).

potable water standards. Rainwater harvesting also offsets potable water consumption and has the added benefit of reducing the quantity of stormwater needing onsite management.

Interest in the use of non-potable water for various applications has surged in recent years, driven in part by the emergence of new stretch codes and standards, as well as the recognition that water is a finite resource. Numerous applications are available, including water closet and urinal flushing, cooling tower makeup, automatic fire suppression systems, landscape irrigation and fountains. Non-potable water may include rainwater, graywater, reclaimed water and non-potable water from various other alternative sources. Currently, however, there are no federal regulations governing water quality or permissible utilizations for non-potable water. In 2004, the Environmental Protection Agency released EPA/625/R-04/108, *Guidelines for Water Reuse.* While that document is instructive, it is not binding. The *Guidelines for Water Reuse* is currently undergoing an update intended to further streamline it and incorporate the latest findings. The update is slated for completion by October 2012. The regulations on how non-potable water can be used in applications inside and outside of buildings are highly variable throughout the nation. Many states do not even have such regulations. The lack of uniform regulations is currently the greatest impediment to more wide-spread use of non-potable water in buildings and on building sites.

Thermal insulation is routinely used to improve the thermal efficiency of hot water delivery systems. Although specific requirements vary, all major building energy codes currently require some pipe insulation on domestic hot water (DHW) piping. DHW piping insulation requirements have been based on the energy savings associated with reduced heat loss from piping systems. However, thermal insulation also helps conserve water by reducing the time it takes from the initial demand for water (turning on the tap) until the water is delivered to the demand point at the required temperature. A study is needed to quantify the potential energy and water savings associated with increasing the use of pipe insulation.

In conclusion, there must be a national research program directed to understand the complex relationship between energy and water, including production, infrastructure, training and funding. Consistency of approach, consistency of appreciation of value and consistency of mandates are essential elements to ensuring the water / energy nexus is better understood and future decisions are made with an appreciation for the balance between energy and water considerations.

As the entity charged by Congress to provide an authoritative source for findings and advice to the public and private sector on the use of building science and technology to achieve national goals, the Institute is pleased to offer its expertise to the Subcommittee, Congress at-large and federal agencies.