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The Stakes Get Higher: Green Building Challenges for Design and Construction

—John Patelski

Aggressive political initiatives and a new national mindset will increasingly demand a reduced carbon footprint for the built environment. This blossoming agenda offers the design and engineering community opportunities to employ innovative and creative methods.

During the past five years, great progress has been made in sustainable design. New technologies and a far wider array of sustainable materials in the marketplace have all helped to reduce energy use, while lower material costs and higher utility rates have significantly reduced payback times.

However, the stakes are now clearly becoming higher, given that buildings account for approximately 50 percent of all greenhouse gas emissions, according to the American Institute of Architects. And a variety of aggressive initiatives are underway to reduce the carbon footprint of our built environment.

Previously, President Obama has called for an economy-wide cap-and-trade program that can reduce greenhouse gas emissions by 80 percent by 2050. In mid-April, the Obama administration declared that carbon dioxide and five other emissions threaten the planet. This historic shift in the formal approach to climate change at the federal level signals a change that will affect all of our lives. Understanding the potential future regulations and emissions limitations and adjusting facilities and operations accordingly will be key to the future prosperity and in some cases the survival of many businesses.

Legislation has been introduced in the U.S. House of Representatives for a domestic cap-and-trade program. The climate change component of the bill would establish an economy-wide cap-and-trade program to reduce U.S. greenhouse gas emissions to 3 percent below 2005 levels by 2012, 20 percent below 2005 levels by 2020, and 83 percent below 2005 levels by 2050.

Other mandates are coming to bear as well. In 2007, Congress passed the Energy Independence and Security Act containing energy use requirements for federal buildings, including the require-

ment that all federal buildings be carbon neutral by 2030.

The Act also calls for the formation of the Net-Zero Commercial Building Initiative to develop strategies to achieve net-zero energy use in commercial buildings by 2030.

The California Energy Commission requires all residential buildings be zero net energy by 2020 and all commercial buildings by 2030. Zero net energy is defined as "no net purchases from the electricity or gas grid; facility needs are met by energy efficient design and on-site clean distributed energy."

The Building Owners and Managers Association has extended a 7-Point Challenge, which includes decreasing energy consumption by 30 percent across real estate portfolios by 2012. The U.S. Department of Energy indicates that buildings represent 40 percent of U.S. primary energy consumption, with HVAC and lighting comprising a majority of energy use.

The Business Case

We in the design and engineering community must be prepared to respond. Fortunately, new developments in sustainable design and construction make compliance easier, faster, and cost effective — within a framework that includes design excellence. Best of all, it's possible to build a strong business case for sustainable design and construction. We see a number of very positive trends in sustainability:

- It is rapidly moving from mere energy efficiency, being green, and having LEED-certified facilities to carbon neutrality.
- It is moving from individual buildings to the built environment and existing buildings, which currently represent 98 percent of the built environment in a given year.
- Increasingly large numbers of owners and developers see sustainability not only as worthwhile in terms of ROI with improved operational performance and reduced operating costs but also in terms of increasing the value of the asset and creating a healthier and more productive working environment for employees. The ROI for reduced operating costs can be calculated through energy savings. The increased asset value and improved health and productivity savings are difficult to calculate due to lack of available data.

- Sustainable design is being embraced by the industrial and retail sectors, not just the commercial. It has been documented by NASA that productivity drops significantly in the industrial environment for every 1 degree temperature rise above 78 F.

- Soon, consumers as well as building professionals will be able to gauge the energy performance of buildings more easily. A building energy labeling program that uses labels similar to stickers on new cars will be introduced this year by the American Society of Heating, Refrigerating, and Air Conditioning Engineers. The label indicates a scale of energy efficiency, with markers for the designated building alongside typical ratings for similar buildings. This initiative will work with existing programs such as Energy Star. A self-selection process can start initially to differentiate high-performing buildings, potentially leading to legislative requirements for all buildings.

- Governments are increasing their incentives. For instance, the new federal stimulus bill contains an extension for three years of a $13 billion tax credit on the production of clean energy, and President Obama has called for a new national renewable portfolio standard for energy.

- The Department of Energy has established a building technologies program to create designs and technologies for zero-energy homes by 2020 and zero-energy commercial buildings by 2025.

- According to the AIA, with about 5 billion square feet of new construction, 5 billion square feet of renovation, and 1.75 billion square feet of demolition taking place each year, by 2035, three-quarters of the built environment in the U.S. will either be new or renovated. This provides a historic opportunity for creating a major reduction in the greenhouse gas emissions of our built environment.

- There must be a change in mindset to promote good energy practices, such as turning off lights, computers, and other equipment when they are not in use. It sounds simple, but do we have the discipline to do it as we live and work in the built environment?

Reaching Aggressive Goals

A number of methods being employed today can significantly reduce carbon

footprints that will only improve with time.

Minimize environmental impact beginning with site selection. Studying what is offered to the site by the sun, wind, water, temperature, humidity, and earth sets the stage for effective green building design that enhances the overall life cycle performance of the facility. Other factors to consider during the initial site selection include:

- Renovations and additions — in contrast to new construction — benefit the environment by recycling the original structure and site work.
- Locating a project on a reclaimed brownfield in an urban area enables the development to tap into existing infrastructure.
- Choosing an urban location allows users to access public transportation.
- Identify sites with clean utility energy — gas, hydroelectric, renewable or other clean sources of electricity.

Select building materials for sustainability. Choosing building materials can be done with consideration of sustainability. Transport costs and the corresponding environmental impact can be minimized by selecting recycled or local raw materials extracted in an environmentally responsible way and transported short distances to the site. Most construction materials contain recycled materials at current market rate pricing. Commercial steel, for example, typically contains 60 percent to 90 percent recycled content at no additional cost.

Other sustainable design elements include nontoxic finishes for paint, carpet, and furniture, reuse of existing materials, captured rainwater, daylighting, lighting control, high-efficiency HVAC systems, photovoltaic electricity, solar thermal water heating, and low-flow or no-flow plumbing fixtures.

Design the building shell to work with the climate. This can be addressed even in the harshest of climates.

Allowing sunlight in through exterior glazing can reduce the amount of energy used for artificial lighting; sunlight also can be absorbed to influence HVAC loads. Mechanical climate control solutions include passive heating, air-side economizers, and natural conditioning where possible.

Industrial processes throw off excess heat that can be used to heat adjacent office spaces, reducing the need for fossil

fuel energy. Point-of-use water heaters versus storage tanks can cut energy use.

Large roof areas can be used for solar energy electricity or water heating. According to our calculations, photovoltaic electric systems usually run in the range of $8,000 to $10,000 per kW, with roof-membrane systems at about $10 to $15 per square foot.

While the payback for both systems now runs about 30 to 40 years, California, New York, and New Jersey have incentives that, when combined with federal ones, lead to paybacks in the 5- to 10-year range.

Use green roofs. Green roofs can be installed in new construction or as replacements for conventional roofs in existing structures. Restoring high-density sites with vegetated green roofs can reduce heating and cooling loads while avoiding excess heat absorption of the surrounding environment (the heat island effect).

Using several of our recent projects as examples, the installed cost of a green roof was $20 per square foot or a little higher. While the exact payback is difficult to quantify, there have been significant benefits in thermal mass, storm water management, and, if visible to the occupants, aesthetics. For example, our McCormick Place West Hall expansion in Chicago used green roof mass selectively to balance the cost impact with the ability to use the green roof as part of the storm water management strategy for the complex.

However, it is important to note that green roof application becomes cost prohibitive for buildings with large roof areas that lack occupant access. In these cases, a roof membrane with a high solar reflector index may be a better choice.

Consider lighting and daylighting. Both fluorescent and daylighting can significantly reduce a building's energy use and carbon footprint. For instance, while there is a typical 25- to 50-cent per square foot premium for T5 fluorescent lighting, the typical payback is roughly two years.

There are a number of benefits to daylighting, including offsetting of electricity use that can be significantly enhanced through integrated control systems. In addition, because it is a higher quality light, daylight can lead to more productive spaces and healthier environments for employees. Natural light has been documented to improve employee performance.

For retail occupancies, studies have shown that shopping areas with natural light show increased sales over stores without it.

There are a number of design techniques to bring in natural lighting, from skylights and light wells to clerestory walls. In a recent industrial project, skylights for a 600,000-square-foot distribution center cost approximately $750,000, or $1.25 per square foot. Energy savings due to daylighting combined with controls were $110,000 per year, or for 6.8-year payback, or a 12 percent ROI over 15 years of occupancy.

Harvest rainwater. Rainwater harvesting can make sense economically in areas where water conservation is politically sensitive. Buildings operating in desert climates, states with water-rights laws, and areas of recent droughts can often justify the longer payback period associated with this sustainable design element.

Solar shading and thermal devices serve multiple purposes. Solar shading uses evacuated solar tube collectors to shade the sun and also can provide a heating source for all core hot water needs to a major building.

Look to onsite generation. There will also be a new demand for renewable and onsite energy generation. This may cause a shift from focusing on green buildings that rely completely on conventional energy sources to renewable generation onsite. A net-zero energy building will most likely require some form of onsite energy generation such as photovoltaic panels or equivalent solar heating system.

Conclusion

With the increasing attention to climate change and the built environment accounting for 50 percent of greenhouse gas emissions, change is coming, and the design and engineering community need to be prepared to meet it. There are cost-effective means right now to significantly reduce the carbon footprints of our buildings. We need to embrace them.

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