Do you know that America's buildings and their construction account for almost 50% of all the energy consumption and greenhouse gas emissions in this country each year? You hold the key to ensuring that U.S. buildings are good for the economy and the environment ...

Build Better Buildings

A Brighter Future Is Inside . . .

The past 20 years have brought a revolution in electronics, materials, communications, and the way we conduct business and live our lives . . . with one exception: BUILDINGS.

Many houses, offices, schools, and other buildings where we spend about 90 percent of our time do not "perform" any better that those built a generation ago. In fact, the idea that a building should "perform" well is new to many people, even though the substandard performance of a majority of our nation's "built environment" has a real cost which can be measured in environmental pollution, dollars, and our quality of life.

The U.S. building industry has produced remarkable innovations in specific building products, technologies, materials, design tools, and construction methods. Think super-efficient heating/cooling systems, lighting controls, insulating concrete forms, photovoltaic roofing shingles, low-flow and waterless plumbing fixtures, and integrated security systems.

Unfortunately, most building designs do not integrate these advancements to achieve a whole that is greater than the sum of its parts.

Buildings should be better for us, for the environment, and for the economy. And they will be better—we have the knowledge and tools—if policy makers, federal program managers, and industry leaders make a concerted effort to coordinate current programs and focus resources on the "Whole Building," integrated approach to building design and construction. Together we can bring about a long-overdue revolution in U.S. buildings.

See inside to learn how you can make a difference ...

Not the Status Quo:
High-Performance Buildings

Energy

... The Status Quo

- U.S. buildings account for more than a third of the nation's total energy consumption and use two thirds of the electricity generated. Lighting, heating, cooling, and operating inefficient buildings waste vast amounts of energy.
- Only a tiny fraction of energy needs are currently met by generating electricity from clean and renewable sources such as the sun and wind. Few buildings have on-site power generation, such as building-integrated photovoltaics (solar energy systems).

The Future Is Now ...

- ***High-performance*** buildings (which encompass ***sustainable*** and ***green***) are typically 30 to 50 percent more energy efficient than their conventional counterparts because they were designed as a system of interrelated parts—the 'whole building' approach—and are equipped with energy-efficient mechanical, electrical, and plumbing systems. They are *climate responsive*—the local geography and predominant weather patterns inform site selection when possible, the orientation of the building on the site, and materials that will be used to construct it. High-performance buildings work with, not against, local (micro) climate conditions.

- High-performance buildings typically feature *passive-solar design* strategies, which allow buildings to collect, store, and distribute energy from the sun. This significantly reduces the need to purchase energy from nonrenewable sources.
- Energy-efficient buildings make maximum use of on-site renewable power generation. Special roofing materials can double as solar collectors that generate electricity. Utilities are generating power from renewable sources ("green power") such as large-scale solar collectors and wind farms. *Zero-energy* homes and buildings (ZEBs) are energy efficient, produce their own power, and may be able to sell excess power back to the utility which can result in a net-zero annual energy bill. Through government-industry partnerships, researchers and builders are making progress toward more mainstream construction of ZEBs.

The Environment

...The Status Quo

- The power to operate buildings in the United States comes primarily from fossil fuels—coal, oil, and natural gas—which are extracted from the Earth and burned to produce electricity. The combustion of fossil fuels is known to release carbon dioxide, sulfur dioxide, and nitrogen oxide, and buildings are responsible for more than a third of these "greenhouse gas" emissions. The sustained emission and excessive build-up of these gases are intensifying the natural "greenhouse" effect of the atmosphere and changing the climate in ways that may affect weather patterns, sea level, and the land masses that support life.
- Buildings consume about 12 percent of the potable water in this country, and their construction and related infrastructure consume approximately 60 percent of all raw materials used in the U.S. economy.
- Relatively few buildings incorporate the most sustainable and efficient materials and products.

The Future Is Now ...

- Buildings can be designed to use water efficiently and be constructed with sustainable materials.
- Landscaping with indigenous plantings reduces water use.
- Responsible construction waste management also reduces the amount of building materials that end up in landfills.
- Buildings that rely on energy derived from renewable sources—whether directly, as with building integrated photovoltaics, or indirectly, when the utility produces electricity from the sun, wind, and other clean energy sources—are not contributing to greenhouse gas emissions.

Safety and Security

...The Status Quo

- Recent history shows that buildings are both symbols of democracy and targets for hostility. Many are also vulnerable to natural disasters because they are inadequately reinforced.
- Few buildings effectively integrate state-of-the-art security systems, telecommunications, noise control, and energy management systems.

The Future Is Now ...

- Community centers, houses, and other buildings that generate power from off-grid, renewable sources are places of refuge even during grid failure and blackouts.
- While buildings cannot be entirely protected from acts of terrorism or natural disasters, they can at least be made as resilient as possible. A building can be as secure as the specifications and budget dictate, such as through structure reinforcement.

continued...

The Future of High-Performance Buildings ... Is Now

Health and Productivity

...The Status Quo

- Buildings too often contribute to allergies and asthma due to poor indoor air quality. According to the U.S. EPA, the concentration of pollutants may be as much as 100 times higher indoors than outdoors. Children are especially vulnerable because of their small size and early stage of growth.
- New building materials and furnishings that "off-gas" or emit chemicals may be hazardous to our health when ventilation is inadequate.
- Indoor spaces that are too cold, too hot, too drafty, too noisy, or that have obvious signs of mold and moisture may hinder our ability to concentrate on working, teaching, reading, and many other indoor activities.

The Future Is Now ...

- High-performance buildings have superior indoor environmental quality (visual, acoustical, thermal comfort). They are free of contaminants that cause health problems. Research on daylighting—the controlled admittance of natural light into a building that supplements electric lighting and reduces building energy use—shows a compelling correlation to health and well-being.
- To view these studies, please visit **www.SBICouncil.org/buildbetterbuildings.htm**

Affordability

...The Status Quo

- Buildings are unnecessarily expensive. Systems engineering, mass production techniques, and computer-driven efficiencies are just beginning to touch the building industry.
- A NIST report esimates the cost of inadequate interoperability in the U.S. capital facilities industry to be $15.8 billion per year.
- The average household spends about 6 percent of its gross annual income on energy. Low-income households have a higher relative burden, about 15 percent of income. The cost of heating, cooling, lighting, and operating homes represents a significant portion of monthly expenses.
- Consumers typically are driven by first costs rather than life cycle cost (the cost of ownership), which is higher in an inefficient building.

The Future Is Now ...

- Government–industry partnerships are conducting research to standardize measurements and component interfaces in the home building industry. This means shorter onsite construction, less construction waste, and more moderate home prices.
- High-performance school buildings are saving $25,000 and more on their annual utility bills.
- Building operations are getting more efficient as progress is made on "interoperability"—the ability to control different building systems through shared hardware and software.

Communities

...The Status Quo

- Buildings that need repair, rehab, or replacement in a few years after being built undermine the stability of a neighborhood.
- More money spent to power homes and businesses means less money spent on other community goods and services.

The Future Is Now ...

- Homes and buildings that are durable, resilient against fires and wind hazards, resource efficient, and cost-effective are good community citizens for decades.
- Proper orientation of homes, streets, and lots is critical for achieving optimal solar access and encouraging the use of site-generated solar energy.
- Incorporating sustainability principles in community and site planning, such as locating new development on infill sites near schools, shopping, and public transportation, protects the nation's valuable natural resources.
- Less money spent on monthly energy bills provides more discretionary spending for household items, community services, business expansion, new hires, and equipment upgrades.

U.S. Competitiveness

...The Status Quo

- The U.S. imports 62 percent of its energy, while other countries are investing more in renewable energy and energy efficiency technologies, which spurs their economies and leaves them less reliant on foreign energy sources.

The Future Is Now ...

- U.S. investment in high-performance building technologies will employ more Americans, boost the economy, and create economies of scale that reduce the price of these technologies.
- The construction of new homes and buildings is a local activity but has an impact beyond the local community. With the energy they consume and the effect they have on our lives, the millions of existing buildings and new ones built every year clearly represent a strategic national resource.

How Can You Make a Difference?

The Role of the Federal Government

Support a robust U.S. buildings R&D program based on the 'whole building' design approach that:

- Provides sufficient long-term resources for training and education
- Funds collaborative, fundamental, and applied research on whole building performance
- Partners with industry to stimulate demand for high-performance buildings through public awareness
- Supports development of prediction and verification tools for measuring building performance

A Good Start ...

The building industry and the U.S. government have been funding research and development geared toward improving construction products and methods for more than 50 years. At the same time, the utility industry and a number of federal agencies have improved building energy efficiency through innovative partnering and incentive programs. Builders and utilities have teamed up to make homes more efficient, proving that private sector partnerships can drive and transform the market for energy efficiency.

In recent years, it has become clear that a 'whole building' approach is critical to making significant advances in building performance. The U.S. government has taken the lead in creating software tools and information resources that enable designers to balance and integrate the various complex functions of buildings. Government–Industry partnerships are creating innovative solutions.

What's Next?

A coherent, long-term, nonpartisan research and development program on the national level is needed to go the necessary next step. Private industry is the source of amazing innovations that create better buildings, but no one company has enough market share to improve all types of buildings nationwide. A new, *coordinated* U.S. buildings program can bring together isolated building research programs; integrate the full range of advanced building components developed by hundreds of individual companies and organizations; and concentrate the effort of diverse segments of the building industry.

The program should consolidate various federal energy conservation, energy efficiency, solar and renewable technologies, and other related programs into a single, integrated effort with a strong, clear vision about the high-performance buildings in America's future.

The 'Whole Building' Approach

A 'Whole Building' approach to design considers the building as an interactive system of materials and components. Early in the planning and design process, designers simulate—typically with energy-modeling software—how all elements of the structure interact. For example, the amount of natural light brought into a building to improve occupant well-being will affect the electric lighting design, which will affect the heating load on a building, which will affect the size of the mechanical cooling/heating system. The building's long-term operations and maintenance cost (life-cycle cost) is also considered in the goal of high performance.

To learn more about 'Whole Building' design, log onto the Whole Building Design Guide Web site at www.wbdg.org.

Case Study: A High-Performance School Building

K-12 schools currently spend more than $7.8 billion per year on energy. The U.S. DOE estimates that energy costs, when combined with the cost of water, wastewater processing, and trash collection, average out to $175 per student per year. Indoor pollutants such as mold, mildew, dust, and formaldehyde can trigger various allergies and asthma. According to the U.S. EPA, asthma alone accounts for 14 million missed school days each year.

Photo: www.jimschaferphotography.com

A high-performance school reduces utility costs by up to $70 per student, provides superior indoor air quality, and features large amounts of natural daylight, acoustical and thermal comfort, and safety and security.

Clearview Elementary, a 43,000 square foot K-4 school located in Hanover, Pa., is an example of a high-performance school achieved through an integrated, 'whole building' approach to design. The design team considered each building component as part of an interdependent system. Project architect L. Robert Kimball & Associates used light-diffusing, south-facing clerestory windows to maximize daylighting and control heat gain and heat loss; low-VOC paints, adhesives, sealants, and coatings contribute to healthful indoor air; an energy-efficient building shell with augmented roof insulation, insulating concrete forms (ICFs), and triple-glazed windows that eliminate the need for perimeter heating all conserve energy. The design team utilized energy analysis tools to predict future energy savings (59%). To a large extent, the team specified building products that were locally and regionally manufactured. Water-efficient design was achieved in part through landscaping with indigenous grasses that require no irrigation (resulting in 38% reduced water use).

More information on Clearview Elementary and many other schools can be found in SBIC's *High-Performance School Buildings Resource and Strategy Guide*, available at www.SBICouncil.org.

Timeline: Advancements In Building Technology And Design

12,000 BCE Humans build the first shelters.

3000 Romans use glass to trap heat in homes.

500 Mesopotamians make the first brick.

6 Greeks orient streets to bring sunlight indoors.

1200 CE Masons form early trade organizations.

1400 Firebricks and inexpensive chimneys help create a market for coal.

1756 First modern concrete made from cement and pebbles.

1800 Attached greenhouses bring sun warmed air into homes.

1816 First U.S. utility founded.

1824 Portland cement invented.

1850s Prefabricated, modular units used in large-scale construction.

1863 Steel becomes available in bulk.

1902 Air conditioners control indoor humidity and temperature.

1905 Modern plywood is mass produced.

1950s Electricity and gas displace wood in heating homes and offices; Photovoltaic technology born in the United States.

1960s Sustainability emerges as a global concern.

1970s Photovoltaics used in the building sector.

1977 U.S. Department of Energy and Solar Energy Research Institute founded.

1980 Passive Solar Industries Council (PSIC) founded to advance the design, affordability, energy performance, and environmental soundness of U.S. buildings.

1996 PSIC launches *Energy-10* energy analysis software program.

1997 PSIC conceptualizes the Whole Building Design Guide (www.WBDG.org).

2000 PSIC changes its name to the Sustainable Buildings Industry Council (SBIC) to better reflect its mission.

2002 Internet-protocol (IP) based building automation systems become common.

2005 SBIC celebrates 25th anniversary.

High-performance buildings (which encompass green buildings or sustainable buildings) contribute to the health and productivity of their occupants, are cost-effective, and have a minimal adverse impact on the environment. Building designers achieve the goal of high performance when they use a **whole-building, integrated design process** and utilize design tools and energy modeling software that take the guesswork out of creating a high-performance building.

The strength of the U.S. building industry is in its hundreds of thousands of individual builders, designers, product manufacturers, investors, contractors, and others who understand their own "piece of the puzzle" extremely well. But this diversity and fragmentation is also the industry's weakness. None of these individual stakeholders has the resources or incentive to conduct the much-needed research for putting all of these disparate elements of the building process together for the good of all buildings nationwide. Consequently, many buildings still do not perform at their full potential and too often compromise the health of their occupants, the environment, and the economy.

The federal government has an important role in coordinating research that will improve buildings nationwide for years to come.

BETTER BUILDINGS ... A BRIGHTER FUTURE IS INSIDE ...

For more information about SBIC and its members, please contact:

Advancing a 'whole building' approach to design™

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". . . an independent, nonprofit organization whose mission is to advance the design, affordability, energy performance, and environmental soundness of America's buildings."

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