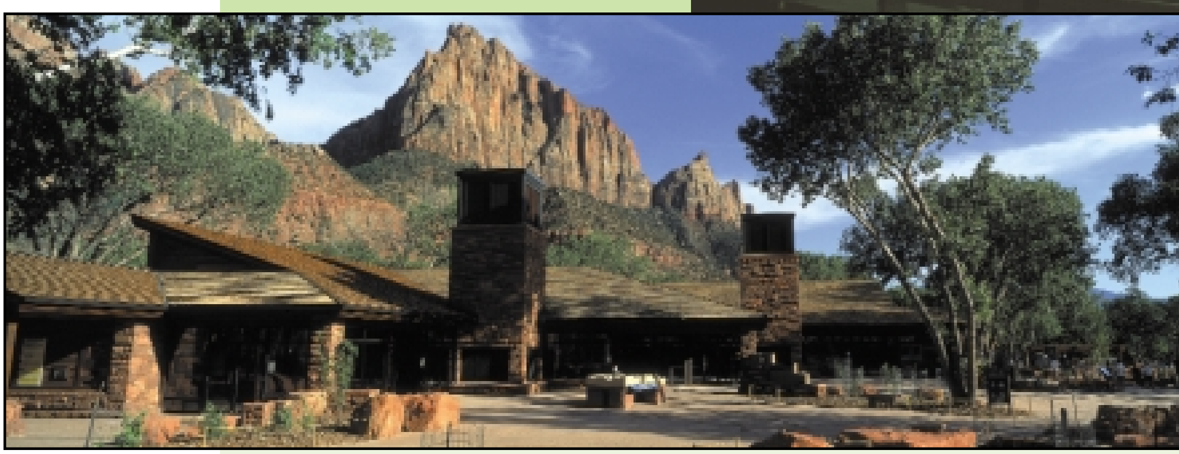
The Business Case for

SUSTAINABLE DESIGN IN FEDERAL FACILITIES

RESOURCE DOCUMENT



U.S. Department of Energy

Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

FEDERAL ENERGY MANAGEMENT PROGRAM

The Business Case for

SUSTAINABLE DESIGN IN FEDERAL FACILITIES

We at the Department of Energy believe there can be a sound business case for the use of sustainable design options, and we encourage all Federal agencies to incorporate these options whenever possible.

– David Garman

Assistant Secretary

Office of Energy Efficiency and Renewable Energy

U. S. Department of Energy

The Federal government has many leaders in this field already, and together we can demonstrate that a sustainable building is healthier, more environmentally sound, operationally and economically viable, and the way we should be doing business.

– John L. Howard, Jr.,

Federal Environmental Executive

October 2003

On the cover: National Institutes of Health, Louis Stokes Laboratories/Building 50, Bethesda, MD
Sandia National Laboratories' Process and Environmental Technology Laboratory, Albuquerque, NM
Zion National Park Visitors Center, Springdale, UT

Preface

"Sustainable design" is becoming a mainstream movement in the U.S. architecture and construction industry, and U.S. government agencies have been both joining that movement and leading the way. In the summer of 2001, the U.S. Department of Energy's Federal Energy Management Program (FEMP) and the U.S. Navy initiated the Interagency Sustainability Working Group as a forum for Federal agency representatives located in the Washington, D.C., area to share sustainable design experiences and information. The government members of this group include:

- Coast Guard
- Department of Agriculture
- Department of Commerce
  - National Oceanic and Atmospheric Administration
- Department of Defense
  - Department of the Air Force
  - Department of the Army; Army Corps of Engineers; Army Environmental Center
  - Department of the Navy; Naval Facilities Engineering Command
- Department of Energy
  - Lawrence Berkeley National Laboratory
  - National Renewable Energy Laboratory
  - Oak Ridge National Laboratory
  - Pacific Northwest National Laboratory
- Department of the Interior
  - Fish and Wildlife Service
  - National Park Service
- Department of State
- Environmental Protection Agency
- Executive Office of the President
  - Office of the Federal Environmental Executive
  - Office of Management and Budget
  - White House Task Force on Waste Prevention and Recycling
- General Accounting Office
- General Services Administration
- Indian Health Service
- National Aeronautics and Space Administration
- Postal Service
- State of California; State and Consumer Services Agency
- Tennessee Valley Authority

The group expressed a strong interest in communicating the business case for sustainable design. In response, FEMP initiated the effort documented in this report, which focuses on providing solid arguments, supported by defensible data, to further justify the application of sustainable design principles in Federal agency construction projects. Sustainable design is a natural extension of FEMP's established role as an energy-efficiency, renewable-energy, and water-efficiency advocate in the Federal sector.

Although the analysis in this document was targeted toward U.S. government facilities, the findings also have relevance to private-sector architects and engineers, developers and contractors, and building owners. In a recent survey conducted by the U.S. Green Building Council, members of the Council said that better understanding the costs and benefits of sustainable design was a high priority. Architectural and engineering firms that promote sustainable design have also expressed a need to communicate the business case.

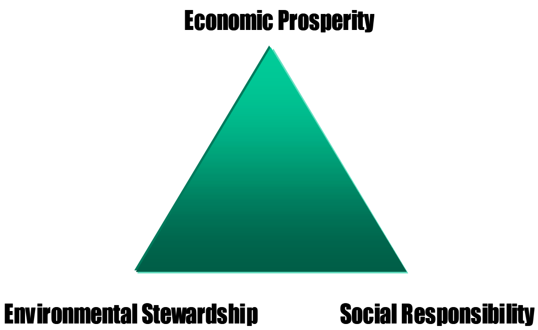
This document is a technical resource report containing cost information, research results, case studies, and other quantitative and qualitative information pertaining to the business case for sustainable design. It serves as a companion document to another shorter publication that summarizes the business case for sustainable design and construction. Both documents can be found on the FEMP website: http://www.eere.energy.gov/femp.

Executive Summary

What is Sustainable Design and Construction?

Sustainability means choosing "paths of social, economic, and political progress that meet the needs of the present without compromising the ability of future generations to meet their own needs."[i] The concept of sustainability includes three key goals, sometimes called the "triple bottom line:"

- **Environmental stewardship –** Protecting air, water, land, and ecosystems and conserving resources, including fossil fuels, thus preserving the Earth's resources for future generations
- **Social responsibility –** Improving the quality of life for individuals, communities, and society as a whole
- **Economic prosperity –** Reducing costs, adding value, and creating economic opportunity for individuals, organizations, and communities.



When designers apply these concepts to architecture, they take a holistic look at all aspects of the design to minimize the use of energy, materials, and natural resources, as well as the environmental impacts of the building and site. Designers also try to maximize the quality of life inside the building and its positive effects on the surrounding community. The principles of sustainable building design and construction include optimizing site potential, minimizing energy consumption, protecting and conserving water, using environmentally preferable products, enhancing indoor environmental quality, and optimizing operational and maintenance practices.[ii]

The Business Case for Sustainable Design and Construction

Many Federal designers and planners embrace the goals of environmental stewardship and social responsibility, but capital budget constraints often stand in the way of smart design choices. Federal managers need hard facts and figures to help articulate the "business case" for sustainable design. Without clear information about the lifecycle costs and other benefits of design alternatives, Federal decision-makers are likely to continue favoring traditional design choices.

This document serves as a resource for people working on Federal and private-sector sustainable construction projects. By providing significant financial evidence from research and case studies, this document can help Federal designers make the case that sustainable design is a smart business choice.

Sustainable Design and Construction in the Federal Sector

The Federal government has been leading by example in the field of sustainable design. Many Federal agencies have developed policies to promote sustainable design concepts, and their buildings are achieving prestigious silver and gold ratings from the Leadership for Energy and Environmental Design (LEED™) rating system developed by the U.S. Green Building Council.[iii] Federal laws and Executive Orders have established goals and provide guidance to building designers in the Federal sector; for example, government agencies are required to apply sustainable design principles and install energy and water conservation measures that have a payback period of less than 10 years. Laws and Executive Orders also mandate that Federal managers use lifecycle cost analysis for all projects. This approach supports the use of many sustainable design features because the annual cost savings from these features over their lifetimes can offset their sometimes-higher first costs. However, because capital budgets are usually preset for Federal construction projects, government-building designers sometimes find it difficult to increase the capital budget to include the incremental first costs of some sustainable design features. Nevertheless, Federal agencies have found many creative ways to stay within their capital budgets while making their buildings "green." In fact, sustainable design does not have to increase the cost of constructing a facility, and in some cases, may actually lower first costs, as well as operating costs.

The Benefits of Sustainable Design and Construction

A growing body of evidence shows that sustainable buildings reap rewards for building owners and operators, building occupants, and society. The business case for sustainable design can be described using the "triple bottom line" framework. The three categories of benefits are shown in the box below.

Economic Benefits
- Lower (or equal) first costs
- Decreased annual energy costs
- Reduced annual water costs
- Lower maintenance and repair costs
- Better productivity and less absenteeism
- Indirect economic benefits to the building owner, e.g., lower risk, ease of siting, and improved image
- Economic benefits to society, e.g., decreased environmental damage costs. lower infrastructure costs, and local economic growth

Social Benefits
- Health, comfort, and well-being of building occupants
- Building safety and security
- Commmunity and societal benefits

Environmental Benefits
- Lower air pollutant emissions
- Reduced solid-waste generation
- Decreased use of natural resources
- Lower ecosystem impacts

At Zion National Park Visitors Center in Utah, designers moved exhibit space outdoors and introduced natural cooling and lighting. The building cost 30% less to build and reduces energy cost by 70% compared with a conventional facility that just meets code.

When designers of the Pennsylvania Department of Environmental Protection's Cambria Office Building first proposed an upgrade to triple-glazed, double low-e windows, the developer balked at the $15,000 increase in cost. However, he was won over when the designers were able to demonstrate that the upgrade would allow them to eliminate the perimeter heating zone for a savings of $15,000, downsize the heat pumps for another $10,000 savings, and increase floor space because of the smaller equipment and ducts for a gain of $5,000 in rent.

Laboratories are energy-intensive. The Process and Environmental Technology Laboratory at Sandia National Laboratories in New Mexico spent just 4% more in their capital budget for energy-efficient technologies, saving enough energy to pay off that investment in about three years, with continued savings for many years to come.

Economic Benefits

Economic benefits of sustainable design can include both capital and operating cost savings, as well as benefits, such as productivity improvements and lower permitting costs, derived indirectly from the very environmental and social benefits that sustainable buildings provide. To realize the full benefits, sustainable design must begin at the conceptual stage of a project and should be developed using an interdisciplinary team that examines integration of, and tradeoffs among, design features. When the team chooses to include sustainable features, often they can downsize or eliminate other equipment, resulting in *lower (or equal) first costs* for the sustainable design. Renovating older buildings, eliminating unnecessary features, avoiding structural over-design and construction waste, and decreasing the size of site infrastructure such as parking lots, roads, and sewers can also reduce first costs while providing environmental and social benefits. Some sustainable features, such as recycled carpet, concrete with fly ash, and no-water urinals, can cost less than their traditional counterparts.

Sustainable design also reduces annual operating costs. Case studies show that energy use can be reduced by as much as 70% by incorporating energy-efficient and renewable energy systems, with payback periods below 10 years.[iv] Water-saving devices such as low-flow faucets and showerheads and no-water urinals can reduce water consumption significantly (e.g., from 2.5 gallons per minute to 1.0 gallons per minute for low-flow faucets). Payback periods for these devices are typically short – from immediate for no-water urinals to less than 3 years for low-flow showerheads.

Another key tenet of sustainable design is increased durability and ease of maintenance. Concrete with fly ash is more durable than normal concrete, potentially decreasing future repair costs; and low-emitting (low-VOC) paint is also reported to be more durable than regular latex paint. Sustainable landscaping typically decreases maintenance costs (e.g., for lawn care, fertilizers, and irrigation) and has a short payback period (e.g., less than a year).

Use of raised floors and underfloor HVAC and telecommunications systems, as well as moveable wall partitions, can reduce the churn cost (cost to reconfigure space and move people within the building) by over $2000 per person moved. Given that an estimated 27% of people in a government building move each year, reducing churn costs can save over $1 million/yr in a large building with 2000 workstations.

Personnel costs in the U.S government far exceed construction, energy, or other annual costs. Sustainable buildings potentially lower absenteeism and increase productivity. A recent study estimated potential annual cost savings on the order of $25,000 per 100 employees resulting from a one-time investment in better ventilation systems of $8000 per 100 employees.[v] Another study estimated that the value of improved productivity (including lower absenteeism) of office workers could be as high as $160 billion nationwide.[vi]

Other indirect and longer-term economic benefits to the building owner include the following:

- **Better worker retention and recruitment.** The environmental image associated with an employer that builds a sustainable building and the improved indoor environment within the building may reduce turnover, improve morale, and help create a more positive commitment to the employer, as well as lower recruiting and training costs.
- **Lower cost of dealing with complaints**. A recent study showed that increased occupant comfort could result in a 12% decrease in labor costs for responding to complaints.[vii]
- **Decreased risk, liability, and insurance rates**. Some insurance companies offer lower rates for buildings with energy-efficiency and other sustainable features. Sustainable buildings also reduce the risk of liability from sick building syndrome and natural disasters.
- **Greater building longevity.** If buildings do not have to be demolished and replaced, the government's construction costs will be lower over the long run. Some strategies for prolonging building use include selecting durable materials, designing photovoltaic-ready roofs, building foundations that will accept additional floors later, and designing with classic and regionally appropriate styles.

When workers at the West Bend Mutual Insurance Company moved into their new building with personal controls for their workstations and other sustainable features, productivity increased 16%.

Some insurance companies offer insurance premium credits when the insured implement selected energy-savings strategies. For example, the nation's largest professional liability insurer – DPIC – offers 10% credits for firms that practice commissioning, and Hanover Insurance offered 10% credits for earth-sheltered or solar buildings on the basis that their fuel-based heating system has fewer operating hours, thus reducing fire risks.

A study of the new headquarters for the Herman Miller furniture company indicates that the new sustainable building had positive impacts on occupants' well-being, job satisfaction, feelings of belonging, and other aspects of work life that affect individual job performance. Productivity measured by the company's own total quality metrics increased when employees moved into the new space,

Picture: Kahujku Ranch, Hawaii

Although some would say that something like a unique ecosystem is "priceless," certain groups within American society do place economic value on, and are willing to pay for, environmental and natural resources. For instance, the Nature Conservancy is planning to invest $1 billion to save 200 of what they call the world's "Last Great Places."

- **Better resale value**. In 1998, the U.S. General Services Administration sold over 1500 properties at a total selling price of about $250 million. Investing in sustainable design features can considerably increase a property's resale value because it lowers annual costs and makes a building more profitable for the new owner.
- **Ease of siting.** Gaining early support from a community can greatly speed up approvals for a project. For example, the developers of Central Market, a store in the town of Poulsbo, Washington, say that their decision to enhance an onsite wetland and offer it to the city as a park not only reduced maintenance costs but also avoided project delays by generating strong community support.[viii]

Benefits of sustainable design accrue not only to the building owner, but also to society at large. For example, energy-efficiency measures reduce public costs from pollution damages. Studies estimate the costs to society of air pollutant emissions to be $100 to $7500 per metric ton for sulfur dioxide (SO_2), $2300 to $11,000 per metric ton for nitrogen oxides (NO_x), and $6 to $11 per metric ton for carbon dioxide (CO_2).[ix] Sustainable development may also reduce taxpayer's costs for municipal infrastructure (e.g., decreased need for landfills, water/sewage treatment plants, and roads) and may foster regional economic growth through emerging businesses associated with sustainable buildings.

Social Benefits

Sustainable buildings can improve the health and well-being of building occupants. Sick building syndrome symptoms can be reduced by increased ventilation, personal control over thermal conditions, improvements in ventilation system maintenance and cleaning, reduced use of pesticides, and good maintenance. Studies also show that building features such as stable and comfortable temperature, operable windows, views out, usable controls and interfaces, and places to go at break time have positive psychological and social benefits. The benefits include reduced stress, improved emotional functioning, increased communication, and an improved sense of belonging.

Certain features of sustainable buildings can also foster occupant safety and security. For instance, improving control of building air distribution systems – including periodic calibration of sensors, adjustment of dampers, and other system maintenance – is essential for rapid response to an emergency and contributes to energy-efficient operation under normal conditions. Tighter building envelopes have the dual benefits of reducing energy losses from infiltration and making it easier to pressurize a building, thus reducing entry of an airborne hazard that was released outside.

> "In the process of renovating the Pentagon, we've found that several of the force protection measures we are taking to protect the Pentagon against terrorist attacks are complementary to our sustainable construction efforts. These are all examples of building security and energy efficiency working hand in hand."
>
> Teresa Pohlman, Special Assistant for Sustainable Construction, U.S. Department of Defense

Buildings that incorporate sustainable features also become models for others to follow and can improve the communities in which they are located. For example, the Herman Miller Corporation's "Green House" regularly provides tours and outreach programs for design and construction professionals as well as for businesses that are planning their own sustainable buildings. Communities may experience better environmental and aesthetic quality of life and less traffic congestion (when sustainable buildings make public transportation and bicycle storage accessible).

Environmental Benefits

Many sustainable design strategies reduce disturbance of the natural environment. Sustainable buildings emit lower levels of air pollutants and CO_2 emissions due to decreased energy use achieved through energy-efficient design, use of renewables, and building commissioning. Waste reduction and reduced strain on landfills can be achieved by storing and collecting recyclables, managing construction waste, using recycled-content materials, eliminating unnecessary finishes, and using standard-sized or modular materials and durable products. Sustainable siting preserves woodlands, streams, and other natural areas. Using rapidly renewable materials (bamboo, cork, wheat straw boards, etc.) and certified wood decreases the use and depletion of long-cycle renewable materials and fosters better forest management and biodiversity.

At the U.S. Environmental Protection Agency campus in Research Triangle Park, the design team justified the choice to spend considerably more to build an aboveground garage instead of ground-level paved parking lot. The team placed a high value on the 15 acres of natural woodlands that would have been destroyed by the paved lot.

The Costs and Benefits of Sustainable Design: A Prototype Building Analysis

During this study, analyses were conducted to evaluate the cost savings associated with various sustainable building features in a "prototype" two-story 20,000-ft^2 building hypothetically located in Baltimore, Maryland.[x] The total construction cost of the base- case building to which the sustainable building was compared was estimated to be about $2.4 million. The cost implications of adding sustainable features to this building were modeled using Energy-10 and DOE-2, supplemented by vendor quotes and other cost estimation techniques. The results are summarized in Table S-1, which also shows which sections of the report discuss each feature.

Although some features such as energy efficiency, commissioning, sustainable landscaping, and storm-water management systems added about $47,000 (2%) to the original first cost of the building, the annual cost savings associated with the sustainable features are significant. Annual energy and water costs were reduced by $5900, and annual maintenance and repair costs for the landscaping and parking lot were reduced by $3600 compared with costs for the base-case building. A reduction in churn costs (by using a raised floor) could lower annual costs by an additional $35,000.[xi] When the societal benefits of reducing air pollution are factored in, the total annual cost reduction could be about $47,000, completely offsetting the first cost increase in the initial year of operation. The first cost increase potentially could be further offset by using sustainable materials such as recycled carpet and concrete with fly ash.

Building a Stronger Business Case for Sustainable Design and Construction

This document presents a sound business case for incorporating the principles of sustainability in the design and construction of Federal facilities. In November 2002, the Federal Energy Management Program hosted a workshop to explore the information that would be needed to make this case even stronger. The participants concluded that collecting data on a wide range of projects using consistent protocols for data collection, reporting, and use would help to more definitively assess the costs of sustainable building projects. They also highlighted the need to develop a better understanding of the health, well-being, and other benefits to building occupants. Because worker productivity is so important, the workshop participants called for a better understanding of how productivity can be measured, especially for "knowledge workers" who do not conduct routine tasks that are easily quantified. The participants concluded that further dialogue is needed on methods to better understand the strategic business advantages of sustainable design.

Table S-1. Summary of First Costs and Annual Cost Savings of Sustainable Features in the Prototype Building Analysis [i]

Feature	First Cost Change	Annual Cost Change	Explanation
Energy-efficiency measures	+$38,000	-$4,300	Results of energy simulation models showed that a 37% reduction in annual energy costs could be achieved by a combination of energy-efficiency measures at a total first-cost increase of about 1.6% of the building cost. The simple payback was estimated to be 8.7 years. See Section 2.2.
Commissioning	+$4,200	-$1,300	Commissioning costs about 2% of the heating, ventilation and air conditioning plus control system cost. It can yield a benefit on the order of 10% of annual energy costs, for a payback period of about 3.2 years. See Section 2.2.
Water-savings measures	-$590	-$330	No-water urinals can have lower first costs than their traditional counterparts because less piping is required, thus lowering first costs for the entire package of water-savings measures. All of the water-savings technologies analyzed have favorable economics, with payback periods ranging from 0.3 to 2.8 years. See Section 2.3.
Sustainable landscaping and stormwater management	+$5,600	-$3,600	Landscaping using natural grasses and wildflowers instead of traditional turf, and a sustainable stormwater management system using porous–surface parking lot paving instead of asphalt, have payback periods of 0.8 and 5.6 years, respectively. See Section 2.4.
Subtotal [ii]	**+$47,000**	**-$9,500**	**5-year payback**
Raised floor system and moveable walls	Negligible [iii]	-$35,000	A raised floor system and moveable wall partitions instead of traditional systems would decrease churn costs significantly with very little additional first costs. See Section 2.5.
Sustainable materials	-$51,000	N.A.	Use of various sustainable materials (concrete with slag content, recycled carpet, low-emitting paint, and certified wood doors) reduced the prototype building's first cost by up to $2.60/ft^2$, lowering the building's cost by about 2%.[iv] See Section 2.1.
Social cost reduction of air pollution reduction	[v]	-$2,000	Annual reductions in emissions from improved energy performance were estimated to be 0.016 tons of SO_2, 0.08 tons of NO_x and 10.7 tons of CO_2, which might be valued as high as $1090 for SO_2, $800 for NO_x, and $107 for CO_2. By including the sum of these societal cost reductions in the payback calculation for the energy measures, the simple payback period would decrease from 8.7 to 6.0 years. See Section 2.8.1.
Total	**-$3,800**	**-$47,000**	

[i] Values were rounded to two significant digits.
[ii] The costs for features included in the subtotal are more certain than those for the features in the rows below.
[iii] Lower cost of air distribution systems, electrical receptacles and other equipment usually offsets the higher cost of the raised floor itself.
[iv] Sometimes the costs of sustainable materials are higher than traditional ones, so the cost reduction for sustainable materials shown in this table should be viewed as less certain than the other values.
[v] The cost is included in energy-efficient measures.

Executive Summary Endnotes

[i] Brundtland Commission. 1987. *Our Common Future*. United Nations World Commission on Economic Development.

[ii] Principles are from the "Whole Building Design Guide" developed by a consortium of U.S. government agencies. See http://www.wbdg.org.

[iii] LEED has four ratings – platinum, gold, silver, and certified. The rating for a building is determined by adding the number of points the building achieves through its sustainable features. See http://www.usgbc.org.

[iv] U.S. DOE High Performance Buildings website. See URL http://www.eere.energy.gov/buildings/highperformance/.

[v] Milton DK, PM Glencross, and MD Walters. 2000. "Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints." *Indoor Air 2000* 10:212-221.

[vi] Fisk WJ. 2001. "Estimates of potential nationwide productivity and health benefits from better indoor environments: an update." In *Indoor Air Quality Handbook*. eds. JD Spengler, JM Samet, and JF McCarthy, McGraw-Hill, New York.

[vii] Federspiel C. 2000. "Costs of Responding to Complaints." In *Indoor Air Quality Handbook*. eds. JD Spengler, JM Samet, and JF McCarthy. McGraw-Hill, New York.

[viii] Rocky Mountain Institute website: http://www.rmi.org/sitepages/pid221.php.

[ix] National Research Council. 2001. *Energy Research at DOE: Was It Worth It?* National Academy Press, Washington, D.C., p.29.

[x] Baltimore was chosen because it has both a moderately high heating and cooling load. A moderately small office building was chosen because that size represents the 75th percentile within the current stock of office buildings in the U.S. government and a similarly large percentage of private-sector buildings. The base-case building used standard construction and met the ASHRAE 90.1-1999 standard for energy efficiency (this is also the baseline for LEED energy-efficiency credits).

[xi] This summary uses the conservative (low) end of the cost-savings range that was estimated.

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Vicki Lee of Lee Scientific Communications in Richland, Washington, served as the editor. Carl Costello and Jennifer Landsman-Ayres of Greening America developed a shorter version of this report (available on the FEMP website: http://www.eere.energy.gov/femp) and provided support for graphics in this longer resource document.

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This report is dedicated to the memory of Fredrik (Rik) Wiant, an active member of the Interagency Sustainability Working Group, who demonstrated his dedication to sustainable design principles during his career at the Army Corps of Engineers.

Acronyms and Initialisms

AC	air changes
ACH	air changes per hour
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
BEES	Building for Environmental and Economic Sustainability
BGE	Baltimore Gas and Electric Company
BIDS	Building Investment Decision Support
CFC	chlorofluorocarbon
cfm	cubic feet per minute
CO_2	carbon dioxide
COP	coefficient of performance
CSC	Customer Service Center
DEP	Department of Environmental Protection
DOE	U.S. Department of Energy
DWP	Department of Water and Power (Los Angeles)
ECM	energy conservation measure
EE	energy efficient
EER	energy-efficiency ratio
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 1992
ESPC	Energy Services Performance Contract
FEMP	Federal Energy Management Program
gpf	gallons per flush
gpm	gallons per minute
GSA	U.S. General Services Administration
HCFC	hydrofluorocarbon
HVAC	heating, ventilation and air conditioning
IFMA	International Facility Management Association
kWh	kilowatt-hour
L/s	liters/second
LEED™	Leadership in Energy and Environmental Design
NERL	New England Regional Laboratory
NO_x	nitrogen oxides
NOI	net operating income
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
O&M	operations and maintenance
PECI	Portland Energy Conservation Inc.
PNNL	Pacific Northwest National Laboratory
ppm	parts per million
psi	pounds per square inch
PV	photovoltaic
RCSOB	Rachel Carson State Office Building
SAD	Seasonal Affective Disorder
SBS	sick building syndrome
SCROB	South Central Regional Office Building
SO_2	sulfur dioxide
TQM	Total Quality Management

TVA	Tennessee Valley Authority
USPS	U.S. Postal Service
UV	ultraviolet
VOC	volatile organic compound
WBDG	Whole Building Design Guide

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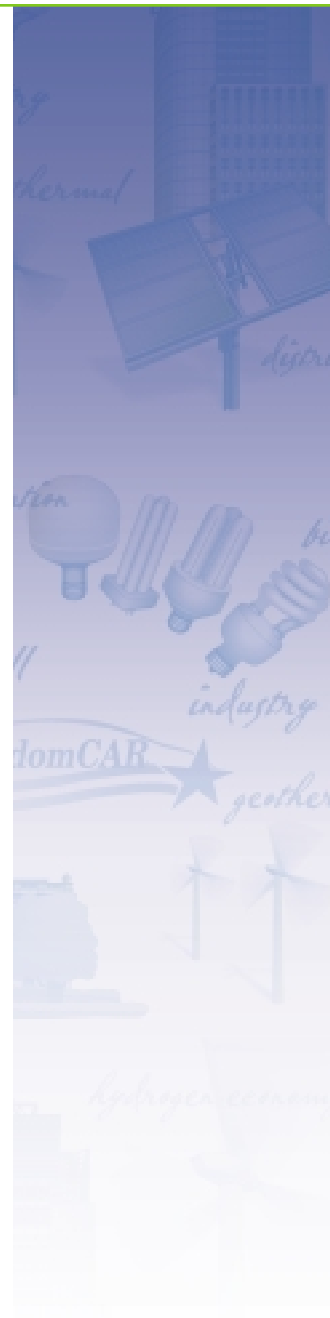
A Strong Energy Portfolio for a Strong America



Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as vital new "energy carriers."

THE OPPORTUNITIES

Biomass Program
Using domestic, plant-derived resources to meet our fuel, power, and chemical needs

Building Technologies Program
Homes, schools, and businesses that use less energy, cost less to operate, and ultimately, generate as much power as they use

Distributed Energy & Electric Reliability Program
A more reliable energy infrastructure and reduced need for new power plants

Federal Energy Management Program
Leading by example, saving energy and taxpayer dollars in federal facilities

FreedomCAR & Vehicle Technologies Program
Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Geothermal Technologies Program
Tapping the Earth's energy to meet our heat and power needs

Hydrogen, Fuel Cells & Infrastructure Technologies Program
Paving the way toward a hydrogen economy and net-zero carbon energy future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Solar Energy Technology Program
Utilizing the sun's natural energy to generate electricity and provide water and space heating

Weatherization & Intergovernmental Program
Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and businesses

Wind & Hydropower Technologies Program
Harnessing America's abundant natural resources for clean power generation

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FEMP works to reduce the cost and environmental impact of the Federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at Federal sites.

Federal Energy
Management Program

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