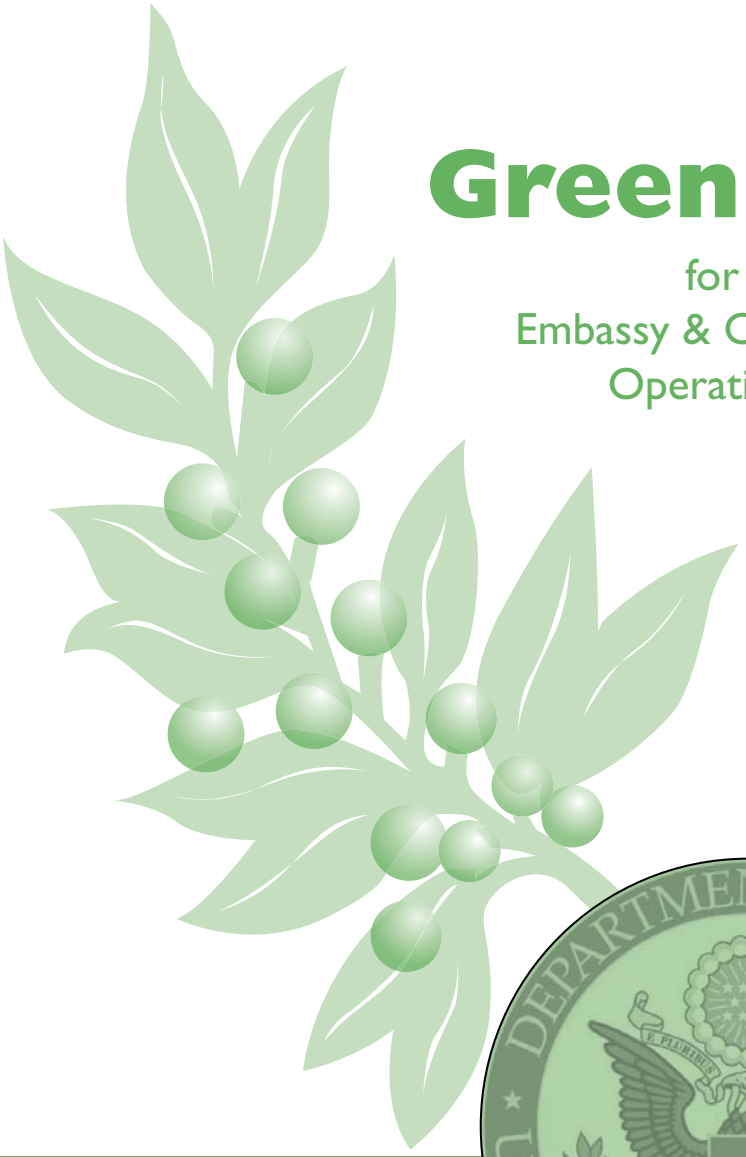
GreenGuide

for Embassy & Consulate Operations



"I encourage our missions to use this timely and valuable guide to address energy and sustainability challenges at our facilities overseas, in response to federal mandates and in support of greater environmental stewardship. Regular adherence to the guidance provided here will allow Overseas Buildings Operations to participate in and further the Department of State's platform of eco-diplomacy."

Patrick F. Kennedy
Under Secretary for Management
Department of State

GreenGuide for Embassy & Consulate Operations

First Edition

GreenGuide
for
Embassy & Consulate Operations

Department of State (**DOS**)

DOS Mission:
Create a more secure, democratic, and prosperous world for the benefit of the American people and the international community.

Overseas Buildings Operations (**OBO**)

OBO Mission:
To provide safe, secure, functional, and well-maintained facilities for the conduct of U.S. diplomacy and the promotion of U.S. interests worldwide.

Energy & Sustainable Design Program (**Green**Team)

GreenTeam Mission:
Support OBO in its role as a leader in high performance and sustainable buildings by incorporating principles of sustainable design and energy efficiency into all building projects.

GreenTeam Guiding Principles:
Achieve high performance in new and existing properties in the following areas:

1. **Site:** Optimize site potential
2. **Water:** Protect and conserve water
3. **Energy:** Minimize nonrenewable energy consumption
4. **Materials:** Use environmentally preferable products
5. **Indoor Environment:** Enhance indoor environmental quality and occupant well-being and productivity
6. **Research & Development:** Advance sustainable technologies
7. **Operations & Maintenance:** Optimize operational and maintenance practices

Preface:

Since 1999, the Department of State's (DOS) Bureau of Overseas Buildings Operations (OBO) has worked to significantly increase the performance of its more than 285 embassies and consulates around the world. Through new construction, major renovation, and systems upgrades, conditions for our Americans overseas have greatly improved. DOS has already moved over 18,573 employees to 60 newly completed facilities, with an additional 30 new compounds under construction, and has substantially renovated over 200 since 2000.

Through the past decade, issues of security have taken priority over energy and sustainability. Recent federal mandates have demonstrated the interconnection of these two concerns. The *Energy Policy Act* 2005, 2006 *Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)*, 2007 *Executive Order 13423 – Strengthening Federal Environmental, Energy; and Transportation Management, and the Energy Independence and Security Act (EISA)* 2007 have required aggressive reductions in consumption of energy and water. EISA has reclassified energy and water as issues of national security. DOS is committed to achieving the targets set by these Federal mandates.

Our diplomatic missions require safe, secure, functional, well maintained, and sustainable platforms for operation. At a time of surging energy prices and increasingly limited access to freshwater resources, conservation is of paramount importance at our facilities. The **Green**Guide *(also available electronically on http://obo.state.gov/index.cfm)* is a timely and valuable tool for Post's implementation of best practice strategies to increase efficiency, reduce consumption, and promote United States Government commitment to conservation through operations.

The Guide provides both a world context for global challenges such as greenhouse gas emissions and climate change, as well as mission-specific tips for systems such as lighting, irrigation, and fleet management, to generate immediate results. In addition to this Guide, OBO's **Green**Team, with support from Patrick Kennedy, Under Secretary of Management, launched a Sustainability Survey, Database, and Report in 2007 to baseline and benchmark facility utility use. This report is updated annually and used to prioritize OBO's capital appropriations for energy- and water-related projects. Together, the Guide and Report provide the State Department a strong framework for successful reductions, compliance with Federal mandates, and stronger American missions.

Top 10 recommendations from OBO's **Green**Team on going **Green!**

1 Transportation: Fleets - Implement a fleet management and carpooling plan, and designate preferred parking spaces to reward high occupancy vehicles.

2 Site: Stormwater - Decrease paved surfaces to the minimum required, to reduce runoff. Implement an Integrated Pest Management Plan to reduce contamination of local waterways by runoff.

3 Energy: Rate Restructuring - Review utility rates with the local power provider to negotiate the best possible rates, fees, and surcharges. Ask about Green Power. Identify and purchase power from green-renewable providers. Keep track of the percentage of Post's total load that is provided from green power.

4 Energy: Audit - Benchmark facility utility use. Complete the OBO Sustainability Survey for Post, Compound, and Building. Individually meter utilities at all buildings. Perform re-commissioning on all major building systems every five years to optimize system performance.

5 Energy: HVAC - Review systems points and set-backs to optimize efficiency. Install workstation occupancy sensors to power down plug-loads during non-use. Turn off all computer monitors and other equipment when not in use at the end of the day. Purchase Energy Star® (or equivalent) equipment and appliances.

6 Energy: Lighting - General lighting levels should be 25-35 foot-candles (269-377 lux) (use artificial lighting to supplement natural daylight to reach this level). Supplement workstations with Light-Emitting-Diode (LED) task lighting. Replace all incandescent bulbs with higher-efficiency compact, low-mercury, fluorescent bulbs, or LED lamps.

7 Water: Irrigation - Meter irrigation water separately from building and HVAC water uses. Replace water-intensive planting with native, drought-tolerant species to minimize the need for irrigation, and consider automated controls for irrigation.

8 Water: Fixtures - Identify and eliminate leaks in plumbing systems, and replace older plumbing fixtures with water-efficient fixtures, waterless urinals, and automatic-shut-off lavatory faucets.

9 Materials: Recycling - Identify and participate in local recycling programs. Use a minimum of 30% post-consumer recycled content for white paper, and have employees set double-sided printing and copying as a default.

10 Indoor Environment: Contaminants - Establish a green-cleaning plan using non-toxic cleaning products, prevent mold growth, minimize dust, install entryway walk-off mats, isolate construction areas, and use low-emitting paints, adhesives, and sealants, etc.

These chapter identification icons represent exemplars of sustainability in the natural world. As basic sustainability principles for the built environment have their roots in effective systems and technologies observed in the plant and animal kingdoms, these icons are used to remind us of sustainability's connection to environmental stewardship.

Transportation

Site

Water

Energy

Materials

Indoor Environment

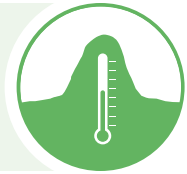


Table of Contents

Introduction 1

Chapter 1 – Transportation 17

Fleet Management 22
Transportation Audit 22
• Policies & Procedures 23
Commuting 26
Practical Application 28

Chapter 2 – Site 31

Landscaping 33
Pollinators 33
Xeriscaping 34
Stormwater 35
Impervious Surfaces 35
Runoff, Erosion, and Sediment Control 35
• Exterior Building Maintenance 36
• Pest Management 37
• Constructed Wetlands 40
Green Roofs 42
Heat Islands 43
Forestation 45
Light Pollution 46
Practical Application 48

Chapter 3 – Water 51

Water Audit 54
Metering 55
Efficient Technologies 56
- Toilets 56
- Urinals 57
- Faucets & Showerheads 59
- Irrigation 60

Water Sources 61
- Rainwater 61
- Wastewater 62

Practical Application 64

Chapter 4 – Energy 67

Rate Restructuring 70
Energy Audits 72
- Getting Started 72
- Office Energy Checklist 76

Energy Management 78
- Load Reduction 79
  - Lighting 79
  - Computers 85
  - Solar Thermal Hot Water 86
- Systems Efficiency 87
  - Building Controls 89
  - Metering 90
  - Commissioning (Cx) 91
  - Commissioning Checklist 93
- Regenerative Systems 94

Renewable Energy Sources 94
• Photovoltaic (PV) 95
• Wind Power 99
Innovative Contracting 102
Energy Savings Performance Contracts 102
Education and Training 104
Practical Application 106

Chapter 5 – Materials 111

Procurement 113
Environmentally-Preferable Building Products 114
Office Products 116
Food Service Products 117
Appliances & Equipment 118
Incandescent Lamps 118
Green Cleaning Products 118
Alternative Materials 119
Fleets 119
Resource Use 120
Reduce 121
Reuse 122
Recycle 122
Proper Disposal 123
Mercury-Containing Light Bulbs 123
Batteries 124
E-waste 125
Construction, Demolition, & Renovation 126
Practical Application 127

Chapter 6 – Indoor Environment 131

Indoor Air Quality 133
- Ventilation 133
- Material Emissions 134
- Isolating Construction Areas 135
- Pollutant & Contaminant Control 135
  - Entryways 135
  - Integrated Pest Management (IPM) 136
  - Cleaning 137
  - Indoor Contaminant Sources 139

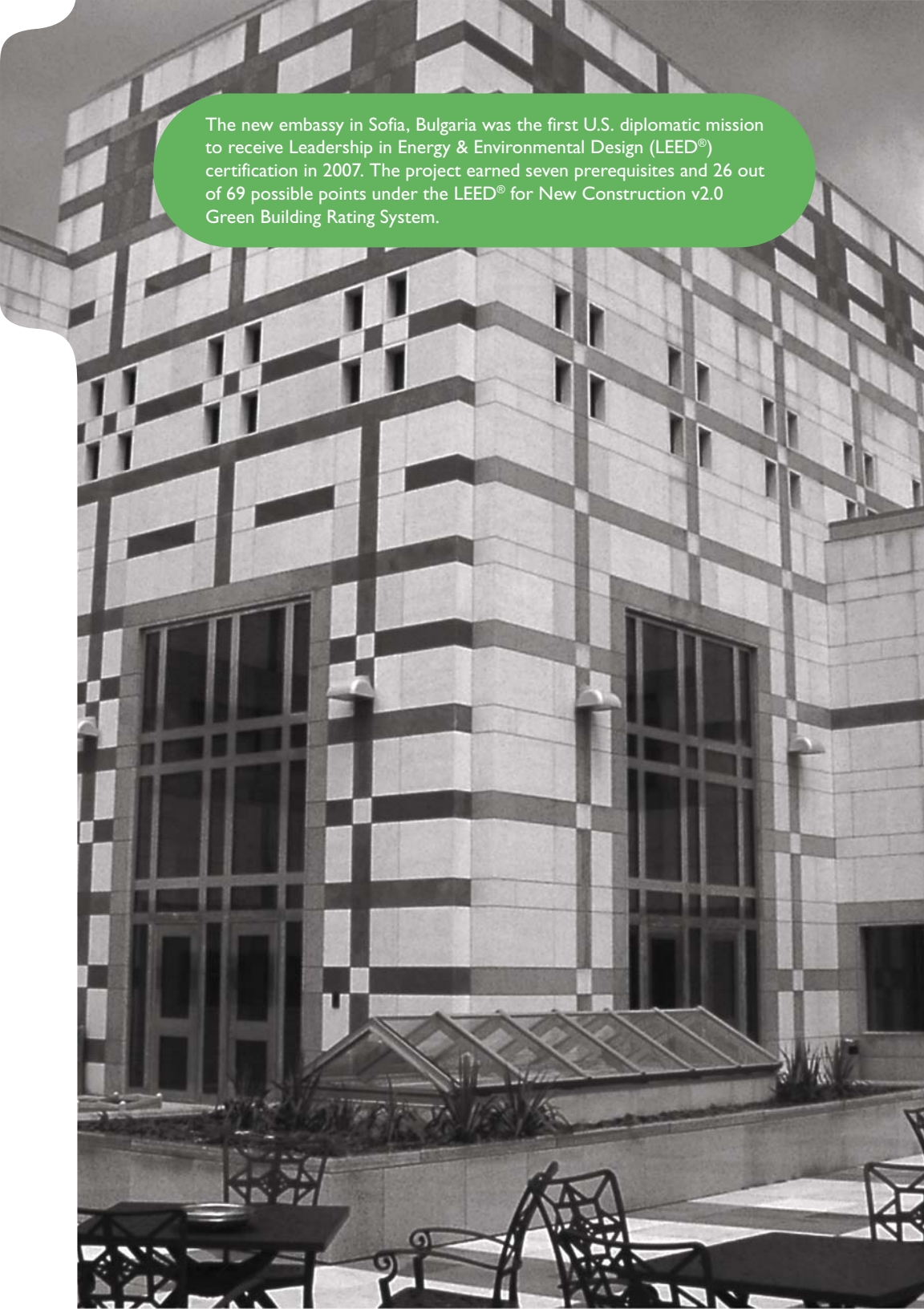
Thermal Comfort 142

Productivity 143
- Daylight & Views 143
- Ergonomics 144

Practical Application 145

Glossary 149

INTRODUCTION



The new embassy in Sofia, Bulgaria was the first U.S. diplomatic mission to receive Leadership in Energy & Environmental Design (LEED®) certification in 2007. The project earned seven prerequisites and 26 out of 69 possible points under the LEED® for New Construction v2.0 Green Building Rating System.

"The United States takes seriously the challenges of energy security and climate change. We are committed to working constructively with our partners abroad to find a new way forward that will reduce greenhouse gas emissions, strengthen energy security, support prosperity and sustainable development, and advance negotiations under the United Nations Framework Convention on Climate Change."

President George W. Bush

Introduction to
GreenGuide for Embassy & Consulate Operations

In the United States alone, buildings account for[1]:

- 70% of electricity consumption
- 39% of energy use
- 39% of all carbon dioxide (CO_2) emissions
- 40% of raw materials use
- 30% of waste output (136 million tons (123 billion kilograms (kg)) annually)
- 12% of potable water consumption

The federal government owns approximately 445,000 buildings with total floor space of over 0.3B square meters (sm) (3B square feet (sf)), in addition to leasing 57,000 buildings comprising 34.7M sm (374M sf) of floor space. These federal buildings account for 37% of the government's total energy use[2]. These structures and their sites affect our natural environment, our economy, and the productivity and health of workers and visitors that use them.

Federal mandates require improved energy performance and the application of sustainable practices for federal facilities to strengthen national security by lessening dependence on foreign oil, reducing global warming, lowering energy costs, creating new jobs, and strengthening our economy. Implementing these mandates requires leadership not only from organizations, but from people. Living green, supporting greening of local schools, participating in community clean-up campaigns, and initiating recycling programs are but a few of the personal actions that lead to energy savings and conservation of precious resources.

Relevant current federal mandates guiding DOS in this work include the *Energy Policy Act of 2005; Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding; Executive Order (EO) 13423: Strengthening Federal Environmental, Energy, and Transportation Management; and the Energy Independence and Security Act (EISA)*, among others.

President Bush signed EISA on December 19, 2007, requiring the following under *Subtitle C – High Performance Federal Buildings:*

- Net-Zero-Energy buildings by 2030
- 55% energy use reduction in new buildings by 2010
- 30% energy use reduction in existing buildings by 2015
- 30% of hot water to be generated by solar energy
- Audits of 75% of facilities for energy & water use every 4 years
- Stormwater runoff to meet predeveloped conditions

EO 13423 was signed by President Bush on January 24, 2007, calling for:

- 15% of federal buildings to comply with requirements by FY15
- 30% reduction in energy use by FY15
- 16% reduction in water use by FY15
- 50% of the 5% renewable energy required by 2010 (*See EPAct 2005, Section 203)* to be from new sources
- 30% post-consumer fiber content minimum in paper products
- Reductions in toxics and solid waste

EISA and EO 13423 mandate that federal agencies conduct their activities in an environmentally and economically efficient and sustainable manner. They set goals in the following areas:

- sustainable buildings
- fleets
- water conservation
- energy efficiency
- renewable energy
- electronics stewardship
- acquisition
- toxic chemical reduction
- recycling
- indoor air quality

EO 13423 supersedes several previous EOs, including 13101, 13123, 13134, 13148, and 13149; and requires widespread use of Environmental Management Systems (EMS) as the framework with which to manage and continually improve federal agencies sustainable practices. The federal government's Office of Management and Budget (OMB) ties these mandates together with the Environmental Scorecard.

Getting to "green" on OMB's Environmental Scorecard requires documenting the following:

- ☑ Submittal of EMS Self-Declaration Protocol and verification of compliance for all appropriate facilities
  - 50% of all facilities meet EMS
- ☑ Comprehensive Affirmative Procurement Program (APP) for green products is in place, including requirements for mandatory and non-mandatory green products in representative acquisitions
- ☑ Agency participates in pilots for new products & green practices, audits compliance annually through the Federal Procurement Data System - Next Generation (FPDS-NG) system, and develops corrective action plans to address shortcomings in preference program
  - Annual audits conducted and corrective actions identified
- ☑ Sustainability program for green buildings that are required to implement EO 13423
  - Requires sustainable design for all new construction and major renovations
  - Sustainability Policy in place
- ☑ Sustainability program for electronic environmental stewardship for promoting the purchase, operation, and use of end of life management strategies for electronic assets
- ☑ Comprehensive Compliance Management Plan (CMP) and a CMP implementation strategy in place

Many of the targets set by these federal mandates can only be met by addressing inefficiencies in existing buildings.

The U.S. Department of State (DOS, State, or the Department) is committed to being a leader in sustainability through design, construction, operations, and maintenance of Embassies and Consulates. The Department, through its OBO, has established a series of policies, programs, and activities to emphasize its commitment to green operations.

The goal of this **Green**Guide is to support Embassy and Consulate personnel as the Department goes "**Green**." It provides specific guidance and defines strategies and technologies for facility managers, general service officers, and management officers to improve, manage, operate, and maintain facilities in a more sustainable manner while achieving compliance with federal mandates and demonstrating commitment to environmental stewardship. In addition, this guide provides a solid basis for personnel to understand green issues and basic opportunities at the global, regional, community, Post, compound, and building levels.

Sustainable facility operations require an internal green team to identify and carry out initiatives with a holistic vision and concrete goals. Sustainable operations require a team approach. Organize a green team of interested and motivated staff to initiate projects, practices, or policies. The recommendations in this **Green**Guide support a proactive approach to operations that put U.S. Embassies and Consulates in a sustainable leadership position and demonstrate and promote environmental stewardship and "eco-diplomacy" in the local community and beyond.

Today, much of the buzz around green buildings centers on new construction. As a design tool, *LEED® for New Construction (LEED®-NC)* has garnered much attention. Lesser known is the *LEED® for Existing Buildings: Operations and Maintenance (LEED®-EB)* program launched in 2007. This tool supports sustainable facilities management by certifying policies and plans for reporting, inspection, and review to ensure high building performance over time. Operation and maintenance of existing buildings typically produce a high percentage of total CO_2 emissions, which is a major cause for global climate change; therefore, addressing building performance issues can make a substantial contribution to reducing global climate change.

Two recently released studies, one by the New Buildings Institute (NBI) and one by CoStar Group[3], a major provider of global commercial real estate information, have validated that third-party certified buildings outperform their conventional counterparts across a wide variety of metrics; including energy savings, occupancy rates, sale price and rental rates. In the NBI study, the results indicate that LEED®-NC certified buildings are, on average, performing 25-30% better than non-LEED® certified buildings in terms of energy use. The study also demonstrates a correlation between increasing levels of LEED® certification and increased energy savings. Gold and Platinum LEED®-certified buildings have average energy savings approaching 50% over conventional construction.

The report also underscores that monitoring a building's ongoing operations and maintenance is equally important. Energy savings under the Environmental Protection Agency's (EPA) Energy Star® building program are similarly impressive: analogous to the Energy Star® appliance program, buildings can also earn an EPA label. The studies noted above document that these buildings use an average of 40% less energy than average buildings, and emit 35% less carbon.

Case Study

Since 1999, OBO has used the internationally-recognized high standards of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System to demonstrate the Department's commitment to sustainable design and construction.

Marking progress, the new U.S. Embassy in Sofia, Bulgaria became the first Embassy to receive LEED® certification in 2007 furthering Secretary Rice's quest for "transformational diplomacy." [4]

The Embassy earned seven prerequisites and 26 out of 69 possible points under LEED® for New Construction v2.0, including noteworthy performance in:

- Use of the building as educational tool
- Remediation of the site, a former brownfield
- Alternative transportation
- 35% reduction in energy consumption
- Ozone protection
- Enhanced indoor air quality
- Tree preservation and enhanced open space

Case Study

In 2008, the second Embassy to attain LEED® certification was the U.S. Embassy Compound in Panama City, Panama, which incorporated a wide range of technologies and strategies from OBO's Energy and Sustainable Design Program (GreenTeam). The project met the seven prerequisites and earned 26 Points.

Noteworthy performance standards were met via:

- 35% reduction in energy consumption
- Strategies that protect the ozone layer
- Demonstration of water efficient landscaping
- Purchase of regional materials from within 75 miles of the project site
- Installation of low-emitting materials
- Monitoring of indoor air quality
- Using the building as an educational tool [5]

The Embassy provides an educational program for occupants and visitors, explaining the integration of security and sustainable design strategies, technologies, and benefits so they may get the most use out of this integrated approach.[6]

OBO has required new Fiscal Year 2008 (FY08) building projects to earn LEED® certification from the USGBC and is seeking to increase the level of achievement to the LEED® Silver level for FY09 projects.

League of Green U.S. Embassies

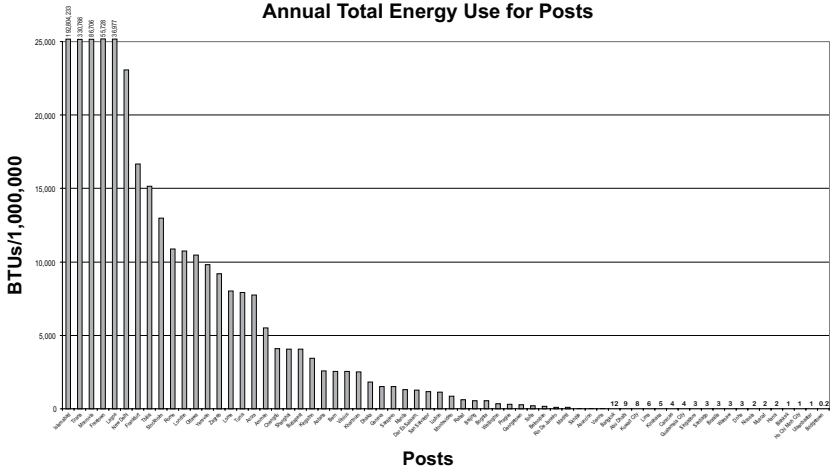
Sustainability leadership is also coming from the League of Green U.S. Embassies (the League), an initiative by Ambassador Michael Wood, of the American Embassy in Stockholm, launched in 2007. By summer 2008, 20 Embassies had already joined the League to lead the challenge of greening our U.S. missions, acting collectively to establish green building practices as a priority. The League collaborates with local governments and private sector greening initiatives. Members have access to a web-portal for sharing best practices, case studies, and energy saving tools, tips, and strategies. OBO supports the League and Posts worldwide through the development of this "**Green**Guide for Embassy and Consulate Operations."

Stockholm, Sweden converted from gas to district heating saving an estimated U.S. $71,000/year and 600,000 tons (544 million kg) of CO_2.

Members of the League pledge to:

- ✓ Provide environmental leadership at our Embassies
- ✓ Increase the use of renewable energy
- ✓ Institute recycling programs at Embassies
- ✓ Establish an energy conservation program
- ✓ Work with the Secretary of State in seeking additional funding for Embassy greening projects
- ✓ Share ideas for improving energy efficiency
- ✓ Cooperate with counterparts on energy efficiency and other strategies for reducing greenhouse gas emissions[7]

To further support Posts in going green, OBO's **Green**Team conducted a Sustainability Survey for data, giving facility managers an opportunity to investigate Post, compound, and building-level sustainability strategies. The survey has set a Fiscal Year 2007 (FY07) baseline for each responding Post (not all Posts have responded to the call for data). This baseline data will enable Posts to evaluate progress in achieving sustainability goals and offer tangible evidence of program success in support of decision making and operational priorities.



The FY07 report from the data collected to date is available for review on OBO's website under "Resources": *http://obo.state.gov/oboweb/obo_downloads/sustainability/Sustainability_Data_508.pdf*. Note that data and information related to Embassy and Consulate facilities must be managed in strict compliance with security protocol.

Using this **Green**Guide is just one step personnel can take to go green. Opportunities abound in green education programs, sponsorship of green awards in-country, co-development of green workshops, participation in the host country's green building council, and utilization of Embassy websites as environmental information resources. For example, the U.S. Embassy in Beijing notes on its website China's *National Sustainable Development Outline* principles and plans, as well as current events, reports, and announcements.

Other countries use their Embassy websites to communicate commitment to sustainability, including the Embassies of Chile, Sweden, Australia, Switzerland, Austria, and Denmark, all of which state their environmental laws and recommendations for green activities by organizations and citizens. The Embassy of Spain posts its "Strategic Plan for Climate Change Science Program"; the French Embassy posts green policies of its country.

Leadership often starts with the generation of "big ideas." Going green requires this kind of thinking…looking for opportunities and creative solutions to complex challenges. The first action step in identifying the best investment strategy for sustainability is an objective evaluation of an organization's current options. This audit should address key categories such as:

- **Transportation**
- **Energy**
- **Site**
- **Materials**
- **Water**
- **Indoor Environment**

This **Green**Guide has devoted a chapter to each of these topic areas.

Examining all these areas holistically–in consideration of facility improvement needs–can enable Embassies and Consulates to realize economies of scale. For some Posts, the most cost-effective approach may be to bundle projects. For Posts looking to roll out green programs incrementally, however, the initial focus is often energy efficiency, since results and paybacks are often immediate. Embracing sustainability requires adoption of a complex system of benefits and trade-offs. Posts are encouraged to explore and adopt technologies and strategies that produce multiple environmental benefits—vegetated roofs/stormwater management, water use reduction/reduced wastewater, green cleaning/integrated pest management, and daylighting/energy optimization. All of these encompass synergies with other systems and disciplines.

Practical application can be found at the end of each chapter using the following four steps that have proven helpful to facilities in going green:

Step 1: AUDIT:

- Determine what the existing conditions are at Post (e.g. transport, stormwater, water, power, waste stream, air quality, or daylighting)

Step 2: SHORT-TERM ACTIONS:

- Identify low or no-cost cost items that can be addressed immediately
- Execute those for immediate results; report successes to engage Post personnel

Step 3: MID- to LONG-TERM ACTIONS:

- Introduce a plan and budget items that require time and money for implementation. *(Note: OBO's* **Green**Team *prioritizes, approves, and funds projects based on need and a maximum payback of 10 years.)*
- Maintain vigilance/attention to implementation opportunities
- Document results—successes and challenges in performance measurement

Step 4: EDUCATE:

- Communicate results, give praise, and develop a program to recognize stewardship and leadership.

Facility management organizations, such as International Facility Management Association, provide online, ongoing training and offer examples in how to achieve each step listed above. The value of training for the facilities management team within the Embassy and for suppliers and vendors can't be overstated. Budgeting for training, use of online training resources, and inclusion of data-gathering/research line-items for post-occupancy evaluations are encouraged, so that verification of successes and challenges are documented and lessons learned. Partnerships that support shared training within security guidelines are also essential and encouraged.

Embassy facility management teams can make a major difference in the impact of U.S. operations on their host countries' environments and local economies, as well as on the lives and health of Embassy personnel. Going green starts with big ideas, short-, mid-, and long-term steps, and strong commitment. OBO is committed to supporting this change and this **Green**Guide is designed to spark action.

Case Study

National Geographic Society Headquarters Complex Washington, D.C., USA

LEED®-EB Silver Pilot Project

The Headquarters Complex is comprised of four interconnected buildings ranging from 20 to 100 years old. The management team embraced the opportunity to "green" the complex and developed a capital budget that included major mechanical system infrastructure upgrades, space consolidation, security enhancements, and building and human resources management systems improvements. Cafeteria equipment was also upgraded or replaced with more efficient models to eliminate CFCs.

Policy development and implementation were key components of this project including green site and building maintenance plans, construction waste management plans, and materials selection policies.

PROJECT GOALS AND RESULTS

The process involved determining the baseline of operations for the complex, then systematically developing and upgrading the entire complex. The challenges were the age of the buildings and the need for several major HVAC system improvements. An Energy Savings Performance Contract (ESPC) was used to implement the HVAC system improvements. This approach allowed $5.5 million of HVAC system improvements to be carried out with a guaranteed energy savings. To respond to the concern of applying LEED®-EB in older buildings, the team used a holistic approach to ensure that emphasis on crucial areas was not overlooked. With more efficient heating, cooling, and interior lighting systems, energy use was reduced by 20%. In addition, water utility expenses decreased by 18%.

Endnotes

1. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718
2. The Federal Commitment to Green Building: Experiences and Expectations http://www1.eere.energy.gov/femp/controlledaccess/pdfs/fgb_report.pdf
3. www.costar.com/news/Article.aspx?id=D968F1E0DCF73712B03A099E0E99C679
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6. Media Note Office of the Spokesman Washington, DC March 27, 2008 U.S., Department of State http://www.state.gov/r/pa/prs/ps/2008/mar/102740.htm
7. Refer to #4

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"The One Big Thing", Embassy of the United States of America, Stockholm, Sweden brochure
http://stockholm.usembassy.gov/Environment/One%20Big%20Thing%20Pamphlet%202007.pdf

CoStar Study
www.costar.com/partners/costar-green-study.pdf

Federal High Performance Buildings Database is available at
http://www.eere.energy.gov/femp/highperformance/

IFMA (International Facility Management Association)
www.ifma.org/

LEED® for Existing Buildings: Operations & Maintenance (LEED®-EB)
https://www.usgbc.org/ShowFile.aspx?DocumentID=3617

LEED® for New Construction (LEED®-NC)
www.usgbc.org/DisplayPage.aspx?CMSPageID=220

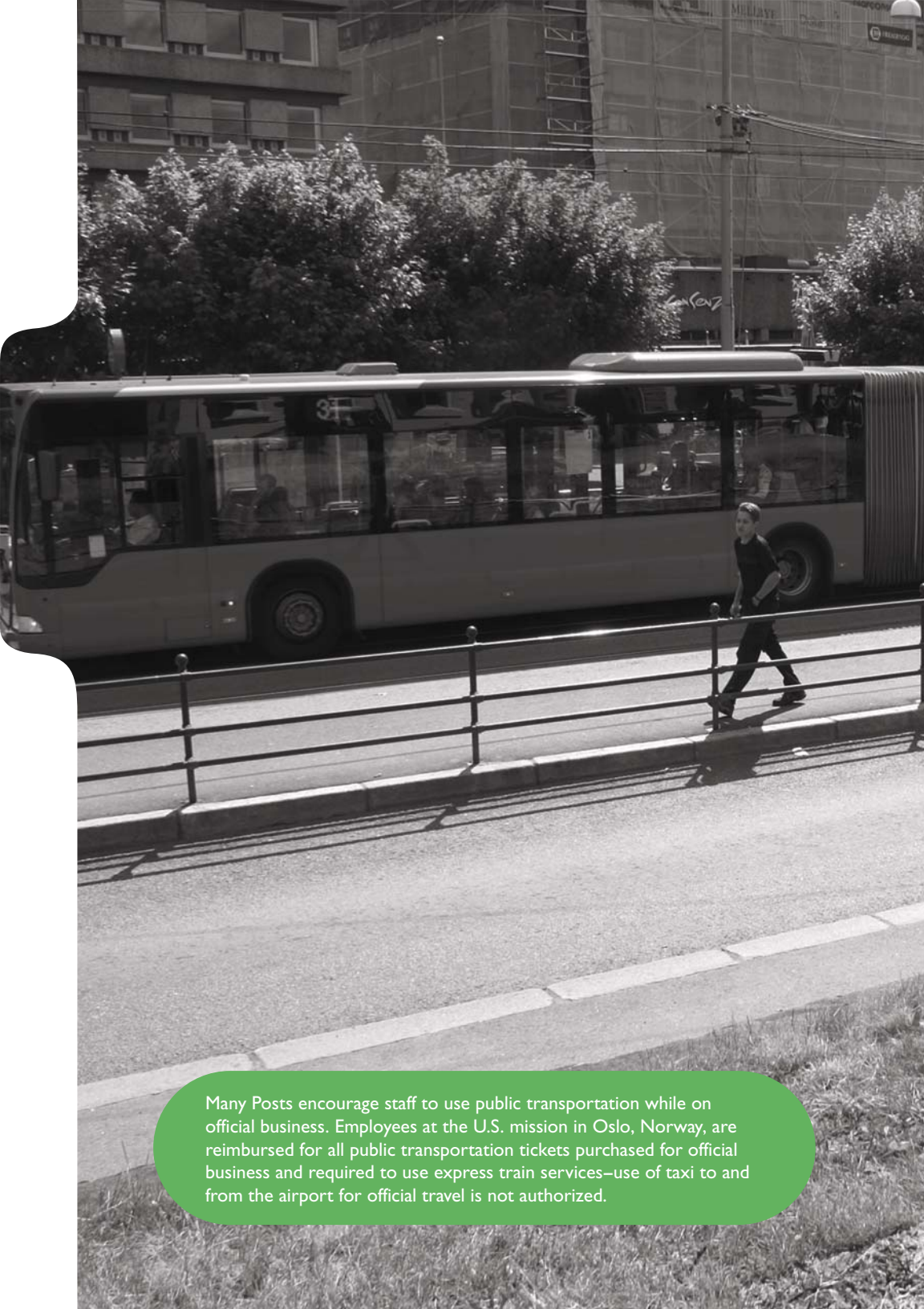
NBI Study was funded by USGBC with support from the U.S. Environmental Protection Agency and can be accessed at
www.usgbc.org/ShowFile.aspx?DocumentID=3930

U.S. Green Building Council
www.usgbc.org

TRANSPORTATION

Ruby-Throated **Hummingbirds** fly 43 kilometers (km) per hour (27 miles per hour (mph)) on their 18.5 hour migration flight across the Gulf of Mexico without refueling.

This is fuel efficiency worth mimicking.



Many Posts encourage staff to use public transportation while on official business. Employees at the U.S. mission in Oslo, Norway, are reimbursed for all public transportation tickets purchased for official business and required to use express train services–use of taxi to and from the airport for official travel is not authorized.

Chapter 1
Transportation

Fleet Management 22

Transportation Audit 22

- Policy & Procedures 23

Commuting 26

Practical Application 28

Transportation

"In 2003, the transportation sector accounted for about 27% of total U.S. greenhouse gas emissions, up from 24.8% in 1990." Emissions increases resulting from transportation sources outpaced all other industries during this time.[1]

Current transportation systems depend largely on nonrenewable, fossil fuel energy sources. An increasing global demand coupled with a depleted supply drives transportation costs continually higher. Renewable energy technologies and increased efficiencies in transportation systems must be developed to reduce the environmental impact of fossil fuel based transportation networks and offset their significant economic impact.

On average, large SUVs produce 40% more climate-threatening carbon dioxide (CO_2) emissions than a fuel efficient car. Large vehicles are likely to remain prominent in the vehicle market for years to come, so improving their fuel economy is essential to reducing the environmental impact of the U.S. auto fleet as a whole. In fact, increasing the low end of the efficiency spectrum is the quickest way to save fuel and reduce CO_2 emissions: raising the fuel economy.[2]

The U.S. Embassy in **Bangkok, Thailand** is located near public transit to better serve the public and staff.

The impact of transportation on the world's economic and environmental future requires a critical evaluation of our transportation choices. Three simple criteria can guide responsible decisions: saving money, protecting the environment, and conserving natural resources.

Oslo, Norway, where on July 14, 2008 local news reported gasoline prices hit a record high of NOK 11.32/liter (U.S. $ 6.68/gallon), has a public bike service. The bike can be used for up to three hours before being returned to any city bike stall.[3]

Related U.S. federal mandates, including E.O. 13149, 13423, EISA, and the OMB Transportation Scorecard, detail prescribed actions for changes leading to sustainability in many areas, including transportation.
Synergy: Introduction

The following are a few of the highlights from these mandates:

Energy Independence and Security Act (EISA) of 2007

- Section 141 amends Section 303 of the Energy Policy Act (EPAct) of 1992 and prohibits federal agencies from acquiring a light duty motor vehicle or medium duty passenger vehicle that is not a low greenhouse gas emitting vehicle.

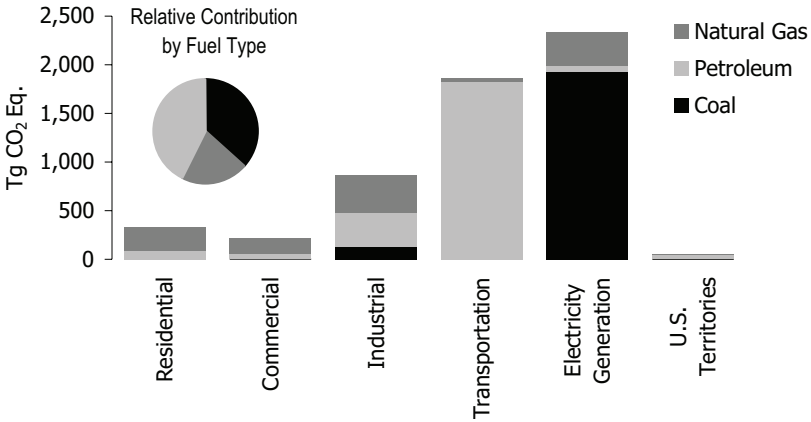
- Section 142 adds Section 400 to EPAct 1992 detailing requirements for mandatory reductions in petroleum consumption by federal fleets of 3 mpg/year.

- Section 246 requires installation of at least one renewable fuel pump at each federal fleet fueling center in the U.S. under the jurisdiction of the head of the federal agency no later than January 1, 2010.

Getting to "green" on OMB's Transportation Scorecard requires DOS to document the following:

- ☑ 75% of new vehicle acquisitions are alternative fuel vehicles (AFVs)
- ☑ 51% of fuel used in AFVs is an alternative fuel
- ☑ Increased average fleet fuel economy by 3 miles per gallon (mpg) over 1999 baseline
- ☑ 20% reduction in fleet petroleum use over 1999 baseline
- ☑ Implementation plan approved by DOE and OMB for meeting Executive Order 13149
- ☑ Provide an updated implementation plan to Senior Transportation Official (e.g. Assistant Secretary)

The goals of a more sustainable transportation sector include increasing fuel efficiencies, improving the health and safety of human beings, accelerating reductions in emissions, and a conscious effort to be part of the local traffic solution instead of contributing to the problem. Posts can make policies and support practices that create immediate as well as long-term local and global impacts.



U.S. 2006 CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type
Note: The electricity generation sector also includes emissions of less than 0.01 Tg CO_2 Eq. from geothermal-based electricty generation

In 2006, the transportation sector was the number one user of petroleum and the number two overall producer of CO_2 emissions.[4]

Case Study

The United States' United Parcel Service has a Skip the Left Turn; Save the Planet Policy

Simply avoiding left turns while driving can significantly reduce environmental impact, as each left turn requires additional idling at intersections while waiting to make the turn. Although this is a small impact for individual drivers, fleet owners can realize significant reductions in fuel costs and traffic accidents.

United Parcel Service (UPS) owns 94,500 trucks and discovered an impact to both its bottom line and resource use by using software to reduce left turns on truck routes. The system also increases efficiency (reducing the number of trucks required to be on the roads), reduces fuel consumption, lowers engine emissions, and lowers operations costs. Collectively, UPS, Roadnet, a division of UPS, and Roadnet's third-party clients are saving over 190 million liters (50 million gallons) of diesel fuel every year.

Fleet Management

With the goals of maximizing efficient use of agency vehicles and reducing maintenance and operating costs of the fleet, consider the following best practices. Post fleet managers should use these strategies where feasible, with the understanding that they are not necessarily applicable to every fleet situation.

Transportation Audit

Conducting an assessment or audit helps in understanding travel patterns of Post personnel and may lead to efficiencies in fleet management. Reducing demand for travel is an obvious step toward sustainability. Decisions to travel, whether across town or around the world, should be based on clear, mission-critical objectives, budget, and opportunities for multiple tasks to be accomplished. Limit travel by utilizing web resources and video- or telephone-conferencing, thereby saving money, reducing physical human stress, and reducing environmental impact. Choose public transit when available and approved by the Post's Regional Security Officer, offset carbon from official air travel, and use car hire and taxi companies that have environmentally-perferable vehicles. These choices help to demonstrate the Department's commitment to sustainability.

Generally, to increase fuel economy and reduce emissions, follow these ten best practices:

1. **Gather riders:** Schedule trips on a common route to serve more than one rider whenever possible.
2. **Plan your route:** Consult a map, internet, or Global Positioning System (GPS) device to determine the shortest and most direct route.
3. **Avoid left turns:** Avoid left turns to reduce idle time and increase safety by reducing crossings of oncoming traffic.
4. **Maintain vehicles:** Check that tires are properly inflated and change oil regularly. Regular maintenance can improve gas mileage.
5. **Drive responsibly:** Make gradual starts and stops and don't drive over the speed limit. Driving style affects gas mileage.

6. **Stop idling:** Practice a "no idling" policy; for stops longer than three minutes, turn the engine off.
7. **Empty the trunk:** Reduce vehicle weight by unloading unnecessary items in the trunk.
8. **Open a window:** Limit use of air conditioning to reduce engine load. Open a window or fresh air vent to naturally cool the car interior—unless driving at high speed, which will tend to reduce gas mileage.
9. **Park in the shade:** Lower vehicle temperature by parking in a shaded area when the vehicle is not in use.
10. **Choose best gas mileage:** Use a vehicle that gets the best gas mileage for long trips.[5]

● Policies & Procedures

Create a written fleet management policy that addresses the following, which may have both short- and long-term effects:

- **Educate:** Place a copy of the Post's policy on a card in every fleet vehicle to communicate with drivers, operators, and passengers. Make the cards easy to understand. Write the policies and procedures in simple terms and provide in both English and local language.
- **Train:** Give new drivers experience through a skills development program to familiarize them with specifics of Post's pollution prevention, wise driving, and non-idling policies.
- **Reward:** Encourage drivers to obtain continuing education and certification to place them in a fleet management leadership role.
- **Use:** Stay within the manufacturer's gross vehicle weight guidelines, so that maximum vehicle efficiencies and safety are achieved. Overloading vehicles stresses body parts and can be dangerous as well as harmful to the vehicle.

- **Procure:**

  - » **Alternatives:** Use electric utility or golf-type carts, when appropriate, instead of licensed vehicles for exclusive on-compound transport.

  - » **Standards:** Establish a vehicle procurement program that uses fuel type and efficiency as discriminators when making purchase decisions to control cost over time. EISA requires fuel economy standards to increase to 35 miles per gallon by 2020 for new cars and trucks. Alternative fuels include electric, ethanol, biodiesel, compressed natural gas, propane, and hydrogen.

Synergy: Chapter 5 Materials/Procurement

- **Manage:**

  - » **Motorpool:** Create a centralized motorpool to minimize fleet size. Motorpools can be made available to all departments on an as-needed basis and sub-pools created, as appropriate, for remote locations or departments with special needs.

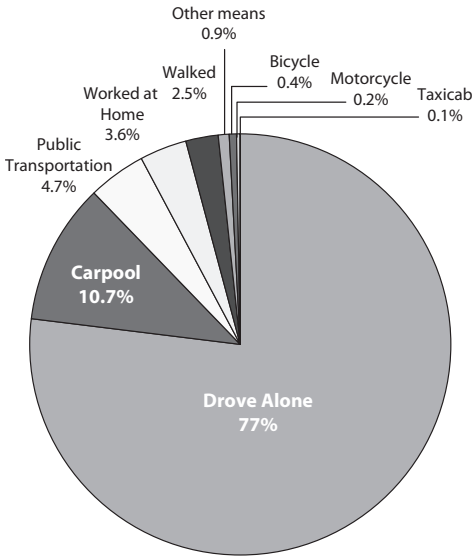
  - » **Leased/Rental:** Use vehicle rental contracts for shared units and for vehicles used infrequently, for special use, or as back-up units, for proven efficiencies. Partner with other U.S. government entities in close proximity to create a joint-use vehicle pool of specialized vehicles, in order to downsize individual fleets.

  - » **Vehicle Disposition:** Transfer high mileage vehicles to on-compound maintenance and grounds departments, where they will not be driven as far. This can extend useful vehicle life by several years.

  - » **Disposal:** Dispose of surplus vehicles promptly in accordance with agency surplus property procedures. Storage of vehicle carcasses on the premises poses safety and environmental hazards. Prepare vehicles for disposal by using the least amount of resources for the best price, noting that timely disposal will also limit depreciation.

- **Maintain & Repair:**
  - » **Schedule:** Adhere to manufacturer-recommended maintenance intervals to support vehicle efficiencies.
  - » **Tires:** Inspect tire air pressure weekly to promote longer lasting tires and fuel efficiency.
  - » **Brakes:** Replace brake pads and shoes before they wear discs or drums.
  - » **Oil:** Change oil and fluid levels at manufacturer-recommended intervals.
  - » **Parts:** Track maintenance as well as vehicle and parts warranties to achieve maximum savings on maintenance and repairs. A good warranty tracking system can prevent paying for repairs or parts that are still covered under manufacturer warranties.
- **Manage Materials:**
  - » **Waste:** Track disposal of all waste. Documenting compliance with environmental standards and local codes is expected and can be performed with a spirit of environmental stewardship and with creative approaches to reuse and recycle.
  - » **Recycle:** Use rebuilt or recycled parts and supplies when possible (recapped tires and re-refined oil, for example), which are usually less expensive than new parts. Particularly for high-mileage vehicles, this may be a preferable maintenance solution.
  - » **Sell:** Find buyers for used batteries, oil, tires, and scrap metal. Firms specializing in recycling these materials help support the local economy.

Commuting



Commuting Method Used In The U.S.[6]

There are multiple benefits to carpooling by Post personnel—fuel savings, reduced vehicle maintenance, reduced parking requirements, community-building, reduced local traffic, and clean air gains. Posts can provide incentives to carpool by dedicating preferred parking spaces for High Occupancy Vehicles (HOV).

The U.S. Embassy, Mexico City, developed the following as guidance for carpooling at Post:

CARPOOL CRITERIA

Preferred parking spaces are dedicated to HOV and the minimum size for an authorized carpool or HOV is three American employees of the Embassy. Post monitors this to ensure that employees assigned to HOV spaces are complying with this requirement. Violations lead to termination of this privilege. Spaces are assigned on a priority basis, based on the number of rides and the total distance traveled (i.e., the largest carpools, traveling the furthest aggregate distances get the highest priority.) [7]

Proven measures that encourage alternative means of transportation include:

Oslo, Norway Bicycle storage rack for Post personnel

- Provide a Guaranteed Ride Home program for commuters who regularly (at least twice a week) carpool, vanpool, bike, walk or take transit to work with a free and reliable ride home when unexpected emergencies arise, or if the employee is required to work beyond regular business hours.
- Make showers and changing rooms accessible for walkers, bikers, and runners.
- Provide secured bicycle storage to encourage alternative transportation use.
- Create a contest to reward staff members with the lowest travel carbon footprint.
- Establish trails and pathways for walkers and joggers within Embassy/Consulate grounds to provide exercise opportunities and support for a healthy lifestyle.
- Encourage carpools and vanpools through preferred parking.

Practical Application

1. **AUDIT**: Measure and baseline fleet management at Post:
   a. Conduct a survey of Post's official vehicles and their use.
   b. Conduct a survey of Post personnel travel and commuting habits.
   c. Document environmentally-friendly strategies already in place.

2. **SHORT-TERM ACTIONS**: Identify low- or no-cost options and measures for immediate consideration:
   a. Use videoconferencing/teleconferencing as a substitute for travel.
   b. Limit staff's local and international travel based on mission critical, scope, budget, and alternatives.
   c. Track official travel miles for both air and vehicle use, and calculate and track the resulting carbon footprint for each employee.
   d. Use car hire and taxi companies that have environmentally-friendly vehicles.
   e. Implement a guaranteed ride home program.
   f. Dedicate preferred parking for HOVs to encourage carpooling.
   g. Provide secured bike storage, showers, and changing areas.

3. **MID- to LONG-TERM ACTIONS**: Identify equipment or projects requiring capital investment.
   a. Optimize fleet size and create a centralized motorpool.
   b. Purchase alternative fuel vehicles.
   c. Establish a fleet management plan.

d. Establish maintenance schedules for all vehicles.

e. Develop program for recycling and proper disposal of vehicles.

4. **EDUCATE**: Develop education programs for staff focusing on personal behavior modifications.

   a. Encourage alternative transportation for commuters by initiating a contest for the lowest carbon footprint.

   b. Develop efficient driving skills and a vehicle maintenance guide/ program.

Endnotes

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SITE

Natural wetland systems have often been described as the "earth's kidneys" because they filter pollutants from water that flows through on its way to receiving lakes, streams, and oceans. Because these systems can improve water quality, engineers and scientists construct systems that replicate the functions of **natural wetlands.**

The U.S. Embassy Kathmandu, Nepal incorporates plant palettes composed of native and adapted species, planted drainage swales, and on-site bio-filtration components.

Chapter 2
Site

Landscaping 33

- Pollinators 33
- Xeriscaping 34

Stormwater 35

- Impervious Surfaces 35
- Runoff, Erosion, and Sediment Control 35
  - Exterior Building Maintenance 36
  - Pest Management 37
  - Constructed Wetlands 40
- Green Roofs 42

Heat Islands 43

- Forestation 45

Light Pollution 46

Practical Application 48

Site

Every action taken to change the condition of Embassy and Consulate sites has an impact on surrounding properties. The cumulative effect of seemingly minor choices in site selection and maintenance can have unintended consequences. Impervious areas such as building rooftops and pavement create a heat island effect on the surrounding climate and lead to increased storm water runoff, causing erosion, contributing to pollution of nearby waterways, and adding to groundwater contamination.

Making informed choices about the land use at DOS facilities demonstrates the federal government's continued desire to be good neighbors to the host country and world beyond.

The landscaping at the U.S. mission in **Bridgetown, Barbados** is climate appropriate.

The primary goals of thoughtful site selection and an effective site management plan are to maintain the natural environment as much as possible while reducing the cost of infrastructure. Conserving natural wetlands and woodlands and implementing sustainable site management practices have long-term benefits to the immediate micro climate and local environment, and also benefit the Post through reduced operations and maintenance costs.

To discover opportunities that may exist for a property, conduct a site audit of existing conditions as a first step. This should include an assessment of the impacts of site operations on the surrounding area and identification of ways to reduce those impacts.
Synergy: Chapter 3: Water/Water Use Reduction

Landscaping

Use of drought-tolerant plants, grasses, and trees that are native or adapted to the region is recommended. Such species have a greater chance of long-term survival, require less irrigation, and help control runoff from the site. Mulching assists in reducing runoff and retaining moisture, thereby reducing the demand for irrigation. Composting trimmings in planted areas results in less need for chemical fertilizers and thus a reduction in runoff contaminated with nitrates and phosphorus that damage aquifers and local waterways.

Abu Dhabi, **United Arab Emirates:** Initial planting of native salt resistant plants was used to the maximum extent practicable for landscaping to reduce the need for irrigation.

Pollinators

Insects and animals that disperse pollen are needed for the production of at least 30% of human food crops, including almost all fruits and vegetables. They are also necessary for many commercial crops such as cotton, chocolate, and coffee, and are therefore important for food and economic security. Globally, pollinators are documented to be in decline, primarily due to pesticides, invasive pests, and loss of habitat. Converting a portion of the facility's landscaped areas to a pollinator-friendly habitat is an attractive way to demonstrate to the host country that the U.S. supports conservation of native plants and pollinators.

Xeriscaping

Xeriscape landscaping is ideal for the **U.S. Embassy Nicosia, Cyprus** and provides a beautiful and responsible alternative to traditional landscape architecture.

Xeriscaping is a landscaping method that uses slow-growing, drought-tolerant plants, thrives with minimal fertilization, is low-maintenance, uses little water, and provides many attractive options. Xeriscaping uses the following seven common-sense gardening principles to save water while creating a lush and colorful landscape[1].

1. **Plan**: design for water conservation and aesthetic appeal
2. **Turf**: limit turf areas to practical and manageable sizes, shapes, and appropriate selection of grasses
3. **Plants**: select native/adapted drought-tolerant species and group plants of similar water needs together
4. **Soil**: amend soils using trimmings, compost, or manures needed by the soil for the types of plants used
5. **Mulch**: use trimmings, compost, or woodchips to reduce evaporation and keep the soil cool
6. **Irrigation**: use underground water-efficient drip systems where possible, water only when needed, do not over-water, and water at night when evaporation rates are lowest
7. **Maintenance**: mow, weed, prune, and fertilize appropriately

Use of potable water for irrigation is discouraged; when irrigation is necessary, underground drip irrigation technology is recommended. Water from non-potable sources such as rainwater, treated wastewater, or mechanical systems' condensate can be captured and reused for irrigation.

Synergy: Chapter 3: Water/Irrigation

Stormwater

Total coverage by impervious surfaces in areas, such as a municipality or a watershed, increases with rising urbanization. Imperviousness is, on average, over 50% of land area in multi-family communities and 70% in industrial and commercial areas. Impervious areas include building rooftops and pavement; a reduction in these types of surfaces allows rain and irrigation water to pass through subsurface ground levels and recharge the groundwater table. Denser landscapes help control rate, quantity, and quality of runoff.

Impervious Surfaces

When planning new construction, limit paved surfaces to the minimum required. For driveways, walkways, and parking areas, consider alternative paving methods that are pervious. Choose gravel, stepping stones, and permeable paving systems that allow rain and irrigation water to percolate into the soil below. This may not be practical in locations where snow removal, the freeze/thaw cycle, groundwater table, or inappropriate soil types are issues. Keep in mind that paving solutions must comply with relevant codes, including the Architectural Barriers Act for handicap access.

Runoff, Erosion, and Sediment Control

EISA requires new projects with a footprint of more than 465 square meters (5,000 square feet) to maintain runoff to pre-developed conditions, including temperature, rate, volume, and duration of flow. Existing facilities should target reductions in stormwater runoff rate and quantity. Excessive runoff may be responsible for land erosion and the addition of sediment to local waterways.

Erosion results in a loss of topsoil that supports plant life and regulates water flow. Topsoil loss may lead to increased need for fertilizers, pesticides, and irrigation. Planting and maintaining groundcover vegetation reduces the potential for erosion.

Nitrogen and phosphorus carried by stormwater runoff contributes to the pollution of waterways and the fostering of algal blooms. For reductions in stormwater runoff, choose strategies that retain or detain storm water:

Effective stormwater management design allows rainwater to percolate and penetrate the ground, recharging the water table at the Embassy in **Istanbul, Turkey.**

- Mulch landscaped areas
- Plant groundcover in non-vegetated areas
- Minimize impervious paving
- Consider vegetated roof alternatives when replacing roofing
- Consider rainwater catchment and reuse for irrigation or non-potable building use
- Use natural drainage swales instead of concrete where possible
- Utilize bio-filtration to passively treat runoff

Exterior Building Maintenance

Material used for cleaning and maintaining building exteriors and site surfaces can impact air and water quality of surrounding areas. Consider simple methods, such as a brush or low-pressure water wash which are frequently safe, effective, and inexpensive. Water of slightly higher pressure or with a non-ionic detergent additive also may be effective. Some alkaline and acidic cleaners can be neutralized to be safely discharged into storm sewers. However, most solvent-based cleaners cannot be neutralized and are categorized as pollutants, and must be disposed of by a licensed transport, storage and disposal facility.[2]

- **Cleaning:** Choose cleaning materials that have the least environmental impact for building and site cleaning activities. (Those with low-volatile organic compound (VOC) levels and not containing chemicals that may harm vegetation, soils, or groundwater). Rainfall can wash potentially harmful cleaning compounds off cleaned surfaces to the ground and off-site.

- **Repairs:** Select paint, sealant, and adhesive products with low-VOC levels for exterior building repairs. VOCs can compromise local air quality and possibly be drawn into the facility.

- **Snow Melt:** In areas where snow or ice are issues, an effective plan that minimizes the use of chemicals, including harmful chemicals such as chlorides, should be developed, communicated to staff, and implemented.[3]

Pest Management

DOS practices Integrated Pest Management (IPM - required by 15 FAM 957.2), which avoid conditions that attract pests (e.g., food, water, harborage). Many pest problems can be solved by non-chemical methods once inviting conditions are eliminated.

Traditionally, pesticides, herbicides, insecticides, or fungicides were applied over large areas, killing not only pests, but other species that are beneficial and keep the pest population in check. Excessive use of a pesticide eventually leads to pest resistance to the pesticide, resulting in a pest population that re-builds and requires another treatment application.

Rachel Carson's 1962 landmark publication "Silent Spring" clearly illustrates the mistakes of traditional pesticide-reliant pest control and the far-reaching damage it causes.

- **IPM Plan:** Pest control is important to protect people from pest-borne disease and to protect buildings and other property from damage. IPM is the best way to control pests and protect the health and safety of employees, maintain facilities, and protect the environment. In some locations, common pests include rodents, reptiles, and larger animals that require capture-and-release techniques.

OBO's Division of Safety, Health, and Environmental Management (OBO/OPS/SHEM) manages the Department's IPM Program for overseas Posts. The *IPM Program Document* is the fundamental

reference on this program and is found on the SHEM intranet site *http://obo.state.gov/opssaf-shem/index.html* along with other IPM implementation tools such as, *http://obo.state.gov/opssaf-shem/PARENT%20PAGES/Publications/IPM/IntranetUpdateIPMSHPU1107tables.pdf*. IPM guidance includes the following:

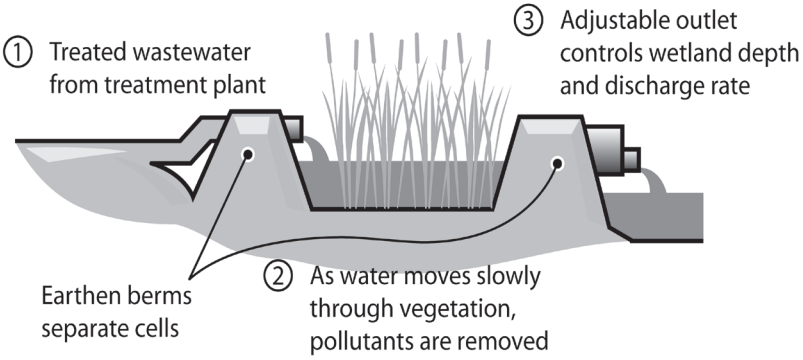
- Know what pests are historically problematic in the area
- Focus on prevention rather than use of toxic chemicals
- Prevent pests from entering facilities: building design should exclude pests from gaining entry, avoid roosting ledges for birds, and channel water away from the building
- Use non cellulose building materials in areas with termites and avoid wood-to-soil contact
- Prevent ponding water by grading to carry run-off away from the building
- Locate plantings away from building foundations
- Choose disease and pest-resistant plantings that are well-suited to the soil, moisture, sun exposure, and climate
- Keep lawns short to avoid hiding places for snakes and rodents
- Prune vegetation preventing contact with the building or overhanging the roofs creating bridges for pests
- Secure building waste in rat-proof containers
- Remove waste frequently from the property
- Fumigate with heat, a method proven to quickly treat items
- Bait with small amounts of pesticide to draw pests to feed and share the poison; a method widely used for ants, cockroaches, and termites in addition to rodents
- Use pesticide only when a need is demonstrated and other methods prove unsuccessful:

- » Gain authorization from the Department if required
- » Use in a limited manner, targeting concentrations of pests
- » Select the safest pesticide for the situation and carefully follow all precautions on the pesticide label as well as general pesticide safety precautions

- Properly diagnosis the problem. Systematic evaluation can eliminate the need for pesticides entirely:
  - » **Termites:** An alleged termite infestation turned out to be sawdust from damaged wood surfaces (Note: termites don't generate saw dust)
  - » **Caterpillars:** The caterpillars shown in this photo were blamed for dead leaves on a neighboring plant. A virus was diagnosed as the cause of the leaf damage. Instead of being killed by a pesticide, these caterpillars became beautiful, rare butterflies.
  - » **Birds:** Over 50 diseases have been associated with birds, their nests, and droppings. Modify roosting/nesting areas of the building and grounds with netting, porcupine wire, noise emitters, or electrified wire.
  - » **Mosquitoes:** The most effective long-term means to reduce mosquitoes is to eliminate stagnant water sources where they breed. Locating all the breeding sites is the key to this solution. Once located, drain the water and prevent it from accumulating by filling in the basin, or making a permanent drain. Also consider stocking the container with larvae-eating fish, covering the surface of the water to prevent female mosquitoes access for laying eggs, or treating the water with a biological larvicide Bt.

• Constructed Wetlands

This low-cost, low-energy option offers odor and vector control by using subsurface flow of wastewater (or stormwater) through a constructed wetland. These engineered natural systems are used for secondary treatment of wastewater and offer immediate payback from energy savings. Periodic maintenance is less than or equal to that needed for other treatment facilities.
The economic benefits of constructed wetlands include:



Constructed Wetland: diagram showing subsurface flow.

- Reduced energy use – payback depends on electricity costs
- 50% reduction in first-cost of package wastewater treatment plant
- Reduced maintenance – periodic, rather than continuous, on-site labor

Although most wetlands are constructed during new facility development, this technology can be aligned with other low-impact stormwater control strategies for existing properties, such as bio-swales, pocket sand filters, or other methods which remove contaminants from rainwater runoff.

Case Study

This constructed wetland at the Embassy in **Nairobi, Kenya** provides secondary wastewater treatment for ~600 occupants using ~95liters/day (25gallons/day) for a total of 57,000 liters (15,000 gallons) per day.

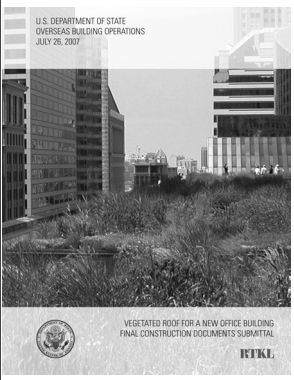
Water quality is a critical concern in Kenya. It is an issue the United Nations Environmental Program has addressed with the application of constructed wetland management techniques. They have applied this technology in two areas–at the inflow of the Nairobi Dam, critical to improving the quality of the surface waters entering the dam, and at the Kenya Wildlife Service headquarters, where a system was designed to recycle 50,000 liters per day to reduce ground water depletion in the Nairobi National Park.

The U.S. Embassy is doing its part to improve water quality in Nairobi by using a constructed wetland for secondary treatment of its wastewater. The system uses microorganisms and plants to breakdown pollutants while sustaining plant life. This reduces treatment infrastructure and blends with the landscape. It is a low cost, low energy option that requires minimal operational attention. Because it is a subsurface flow, constructed wetlands offer odor and vector control.

Green Roofs

Embassies in **Athens, Greece** (left) and **Berlin, Germany** (right) as well as Zagreb, Croatia and Nairobi, Kenya have 'extensive' green roofs.

The economic benefits of green (vegetated) roofs include reductions in runoff, heat island effect, roof maintenance costs, and energy consumption. Green roofs have been shown to reduce heat gain up to 95% and to result in a 25% reduction in summer cooling needs. In addition, they provide a reduction in site stormwater with a 10 to 50% reduction in roof runoff. With a 40-year roof life (instead of 10-15-year), green roofs protect waterproofing membranes and minimize roof maintenance. No permanent irrigation is required if planted with moss, sedums, herbs, and grasses. Due to safety precautions, access to most green roofs is limited to routine maintenance.



Vegetated Roof Study by **OBO**

Currently there are a variety of vegetated roofing systems on the market. The most common systems are extensive (not intensive) systems that are very similar to a ballast roof, with soil depths between 5-20 cm (2-8 inches), weighing 63-146 kg per square meter (13-30 lbs per square foot) when saturated. OBO produced a green roof study that Posts can use to evaluate the feasibility of a green roof in their region. The 18-point checklist contained in the study is useful to understand the key factors required for a successful green roof. The checklist uses the Koppen Climate Classification map as a basis for feasibility and the following factors for consideration: local zoning, climate rating, structural capacity, roof slope, regional availability, wind loads, and existing roof conditions.

Heat Islands

Heat island effect describes the phenomenon of metropolitan areas that are significantly warmer than their rural surroundings. Urban and suburban temperatures are typically 1-6°C (2-10°F) hotter than nearby rural areas, increasing energy use and heat-related illness and mortality.[4] Building rooftops and pavement are largely responsible for these increased temperatures. These low-reflectance surfaces can reach temperatures of 66-88°C (150-190°F) and contribute to the following:

- Increased cooling energy use and higher utility bills
- Higher peak electricity demand, raised electricity production costs, and a potentially overburdened power grid
- Reduced indoor and outdoor comfort
- Increased air pollution
- Accelerated deterioration of roofing materials, increased roof maintenance costs, and high levels of roofing waste sent to landfills.[5]

The following are alternatives to assist in reducing ambient temperatures:

- Use either a highly reflective (high albedo, or "white") or a green (vegetated) roof when replacing a roof (see EPA's Cool Roof program)
- Plant trees adjacent to paved areas and buildings to provide shading
- Provide shade structures over paved areas
- Plan new facilities with structured or underground parking to reduce surface area

Covered parking at the Embassy in **Zagreb, Croatia** protects vehicles and reduces heat island effect.

OBO's Standard Embassy Design (SED) requires shading as specified in the *International Zoning Code Supplement, Chapter 8:*

805.3 PLANTING DESIGN

2. SHADING FROM TREES: Provide shade (within 5 years) on the site's non-roof impervious surfaces, including parking lots, walkways, and plazas such that the sum of the total shaded walk area and shaded parking area equals 30% of the site's non-roof impervious surfaces. Provide tree shaded walks between staff and official visitor parking to Compound Access Control (CAC), from CAC to building units, staff housing, and recreation areas. Shade may be provided by existing or newly planted shade and/or palm trees within 5 years of planting. Newly planted shade trees shall be a minimum of 75 millimeters (mm) in caliper and 4.0 meters (m) tall at time of planting. Palm trees shall be a minimum of 3.5 m to base of fronds at time of planting. To the greatest extent possible, locate trees to shade non-roof impervious surfaces.

Abidjan, Nigeria: Planting design provides tree shaded walks between building units, housing, and recreation areas.

Forestation

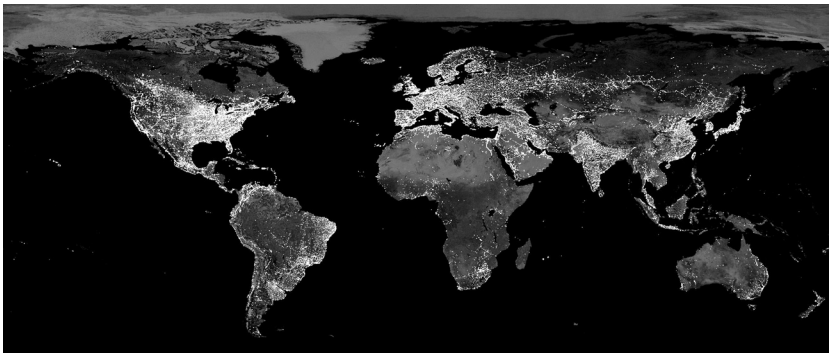
As most countries of the world struggle to keep forests intact and healthy, the value of forestation and reforestation can not be overstated. Forestation is a primary avenue to offset carbon dioxide, with additional benefits of reducing the heat island effect and reducing runoff. Shading parking lots and buildings produces immediate energy savings. An additional benefit is that trees encourage biodiversity by providing a habitat for birds and insects. A forestation program involves planting native shade trees. OBO offers support in reviewing compound site plans to identify appropriate locations for planting additional trees.

Case Study

In **Tunis, Tunisia,** Ambassador Robert F. Godec gathered his staff in February 2008 to break ground on a tree planting project.

At the ground breaking event for a tree planting project at the Embassy in Tunis, Tunisia, Ambassador Robert F. Godec stated, "This excellent project will help improve the environment and the quality of life for everyone here." 170 additional trees, 127 olive and 43 shade trees, were added to the Embassy grounds. The project's main goals are to increase site shading, reduce stormwater runoff, and mitigate greenhouse gas emissions through the trees' natural respiration process, which takes in carbon dioxide. In Tunisia, Olive trees are highly regarded and the environment in general receives conspicuous official support. Landscaping and park improvements are evident throughout Tunis, and the nation's Ministry of the Environment and Sustainable Development sponsors a number of "green" programs, including a national Tree Festival Day. See *STATE Magazine*, May 2008 issue for an expanded article.

Light Pollution



This image of Earth's city lights was created with data from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). Originally designed to view clouds by moonlight, the OLS is also used to map the locations of permanent lights on the Earth's surface.[6]

Light pollution is defined as light that escapes from a property upwards into the night sky or onto adjacent properties. Light spillage may result from exterior or interior lighting that remains on during periods when buildings are unoccupied.

Excess light simply is a waste of energy. The energy to produce excess light increases greenhouse gases which contribute to global warming. Additional problems associated with an excess of artificial outdoor lighting include sky glow interfering with astronomy, detrimental sleep patterns affecting human health and disruption of nocturnal patterns of many species.

Synergy: Chapter 4: Energy/Energy Management/Load Reduction/Lighting

OBO's SED requires light fixtures for parking lots to be shielded ("cut-off") to prevent outfall beyond the property line or beyond limits dictated by security requirements. In addition, non-emergency lighting should be limited to actual hours of use.

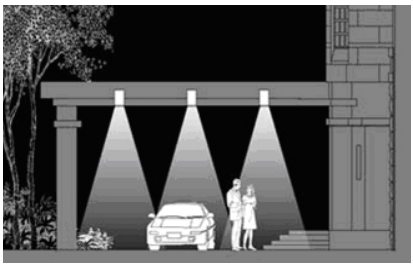
OBO's SED Site Lighting Guidelines require cut-off fixtures of appropriate height.

Photocells are the most common and effective device for turning site lighting on and off. Time clocks can also be used for exterior or interior lighting. Manual controls or overrides are still needed to control special areas such as sallyports or to provide for security-related needs.

Synergy: Chapter 4: Energy/Energy Management/Load Reduction

OBO's SED Site Lighting Guidelines recommended that only lighting required for security purposes remain illuminated during periods when the facility is not in use.

The true value of security lighting depends upon its ability to support the surveillance of the site by the direct vision of the security force and through the secondary vision of the closed-circuit television (CCTV) cameras.



OBO's SED Site Lighting Guidelines prohibit unshielded direct light sources.

Practical Application

1. **AUDIT**: Measure and baseline site features and management at Post:

    a. Conduct a survey to identify current site/landscaping practices.
    b. Document existing environmentally friendly site management practices.

2. **SHORT-TERM ACTIONS**: Identify low- or no-cost options and measures for immediate consideration:

    a. Add vegetation and trees without increasing irrigation to control stormwater and reduce heat island effect.
    b. Replace exotic or high-maintenance plantings with pollinator-friendly plants that are native and drought-tolerant.
    c. Implement xeriscaping principles when re-landscaping.
    d. Mulch landscape beds.
    e. Reduce areas requiring irrigation.
    f. Reduce impervious surfaces where possible.
    g. Develop and implement an effective snow removal policy where appropriate.
    h. Begin an on-site composting area for landscape debris.
    i. Limit exterior lighting to shielded or cut-off fixtures.
    j. Choose exterior building/site cleaning and maintenance materials that have the least impact on the environment.
    k. Develop and implement an integrated pest management plan.

3. **MID- to LONG-TERM ACTIONS:** Identify equipment or projects requiring capital investment:

    a. Choose high-albedo materials for roof replacement to reduce heat island effect or consider a green roof to reduce run-off.
    b. Replace impervious hard-surfaced paving with pervious alternatives.
    c. Replace light fixtures to eliminate light trespass to adjacent properties and night sky.
    d. Regrade to eliminate erosion problems and retain water on-site to recharge the ground water.

4. **EDUCATE:** Develop an education plan for staff and the local community:
   a. Provide signage that describes sustainable features of the site/ landscape.
   b. Partner with the community to establish a tree dedication program.
   c. Organize site tours for the local community.

Endnotes

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2. http://www.nps.gov/history/hps/tps/briefs/brief01.htm#Planning a Cleaning Project
3. http://www.green.ca.gov/EPP/Grounds/Delcers.htm
4. http://www.epa.gov/heatisland/
5. http://www.epa.gov/heatisld/strategies/coolroofs.html
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American Society of Landscape Architects (extensive list of links to resources)
www.asla.org

Center for Watershed Protection
www.cwp.org

Cool Roof Rating Council
www.coolroofs.org

Ecological Restoration
http://ecologicalrestoration.info

Energy Star® Roof Compliant, High Reflectance, & High Emissivity Roofing
www.energystar.gov

EPA Heat Island Effect Web Site
www.epa.gov/hiri/

EPA Office of Wetlands, Oceans & Watersheds
www.epa.gov/owow

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www.epa.gov/greenacres

Green Seal
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International Dark-Sky Association
www.darksky.org.ida/ida_2/index.html

Lawrence Berkeley National Laboratory Heat Island Group
http://eetd.lbl.gov/heatisland/

National Pesticide Information Center (NPIC)
http://npic.orst.edu

Pennsylvania Green Building Operations & Maintenance Manual
www.dgs.state.pa.us/dgs/lib/dgs/greenbldg/greenbldgbook.pdf

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Plant Native
www.plantnative.org

Planting a Pollinator Garden
http://www.garden.org/articles/articles.php?q=show&id=1978

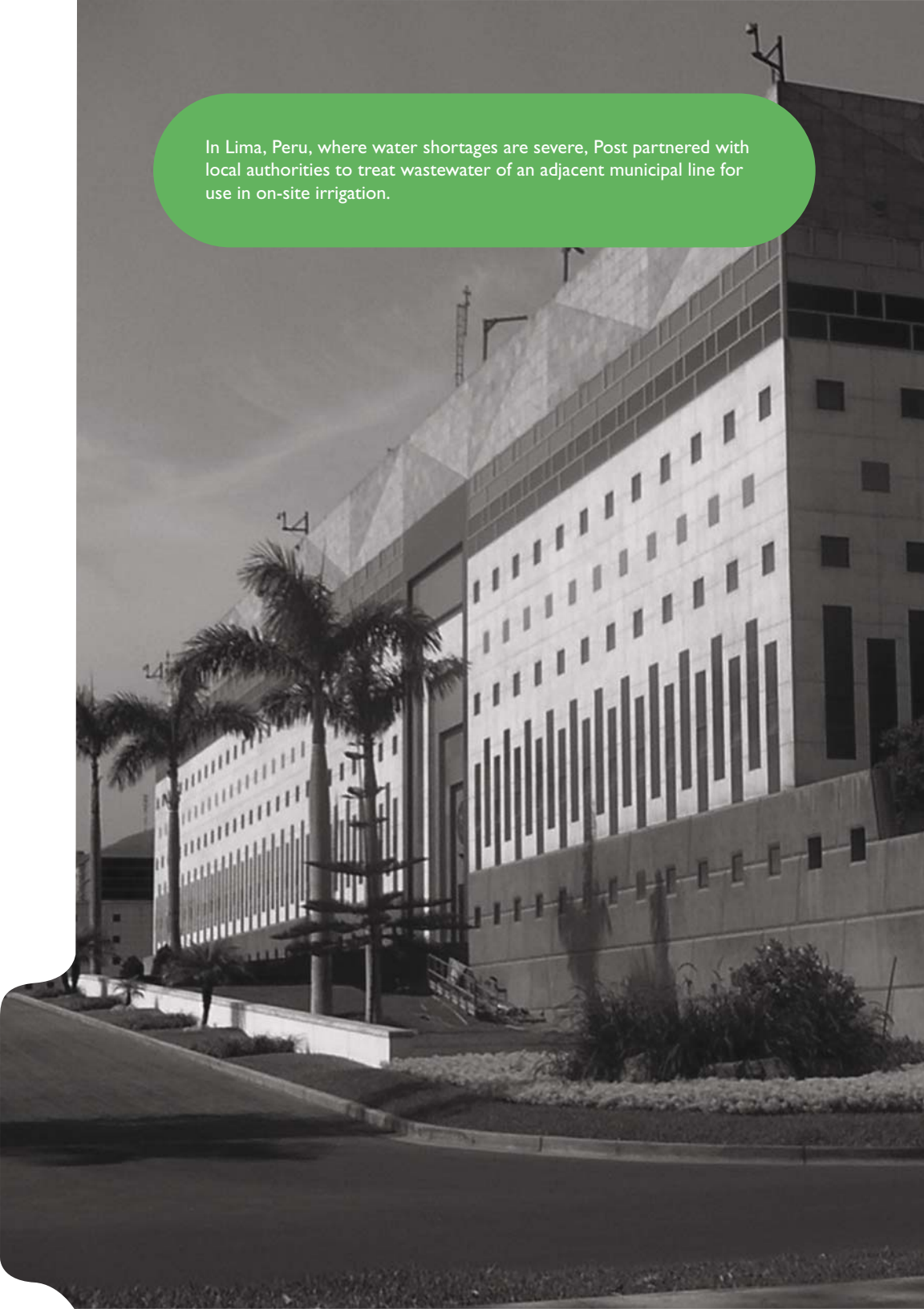
Plants for Pollinators
http://www.pollinator.org/Resources/Pollinator_Syndromes.pdf

Soil and Water Conservation Society
www.swcs.org

Stormwater Manager's Resource Guide
www.stormwatercenter.net

WATER

The **Saguaro** is the ultimate water harvester, absorbing as much water as possible when it rains. The trunk and arms are pleated like an accordion and can expand or contract with the amount of water taken in. **Saguaro** roots extend to a diameter of 30 m (100 ft) (for a 15-m-high (50-ft-high) **Saguaro**) at a depth of only inches. Tiny hairs absorb even concentrated drizzle or mist.



In Lima, Peru, where water shortages are severe, Post partnered with local authorities to treat wastewater of an adjacent municipal line for use in on-site irrigation.

Chapter 3
Water

Water Audit 54

Metering 55

Efficient Technologies 56

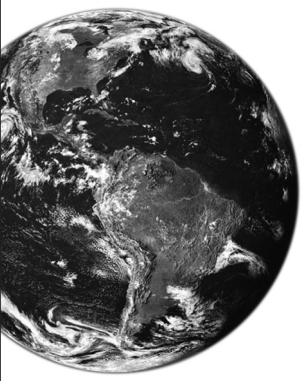
- Toilets 56
- Urinals 57
- Faucets & Showerheads 59
- Irrigation 60

Water Sources 61

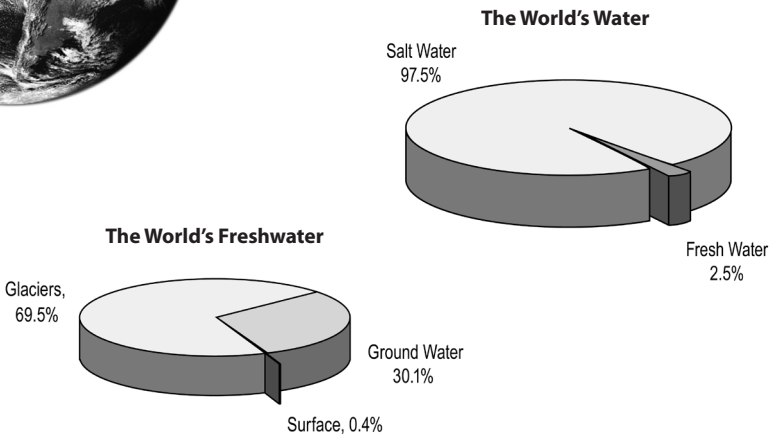
- Rainwater 61
- Wastewater 62

Practical Application 64

Water



From space the Earth is seen as a blue planet, because 70% of it is covered with water. However, 97.5% of all water on earth is salt water, leaving only 2.5% as fresh water. Of this 2.5%, nearly 70% is locked in ice at the North and South poles and another 30% is deep below the ground. Only .4% is accessible on the surface.



Water is a finite resource. There is debate in the scientific community as to whether the freshwater on earth came from comets, asteroids, or from water deep in the earth released by volcanoes; but we do know the amount we have is finite. The earth does not produce more water. The water molecules in our bodies today may have been in the bodies of dinosaurs, may have traveled down the Nile, or may have been in a cloud a week ago.

More than half of humanity will be living with water shortages within 50 years. Severe water shortages will affect 4 billion people by 2050.[1]

Increased pollution is damaging ecosystems and the health, lives, and livelihoods of those without access to adequate, safe drinking water and basic sanitation.[2]

Countries with the lowest fresh water availability per person (surface water and groundwater) are Kuwait, United Arab Emirates, Bahamas, Qatar, Maldives, Libya, Saudi Arabia, Malta, Singapore, and Jordan.[3]

For many countries agriculture is the primary use of fresh water resources; whereas in the U.S., the greatest percentage of fresh water is consumed for domestic, industrial, commercial, and other uses. Only a small percentage of fresh water extracted is consumed through evaporation, transpiration, or incorporated into products or crops; the rest is used, treated, and discharged into bodies of water. Frequently this leads to pollution of our water ways through the introduction of bacteria, nitrogen, heavy metals, toxins, and other contaminants.

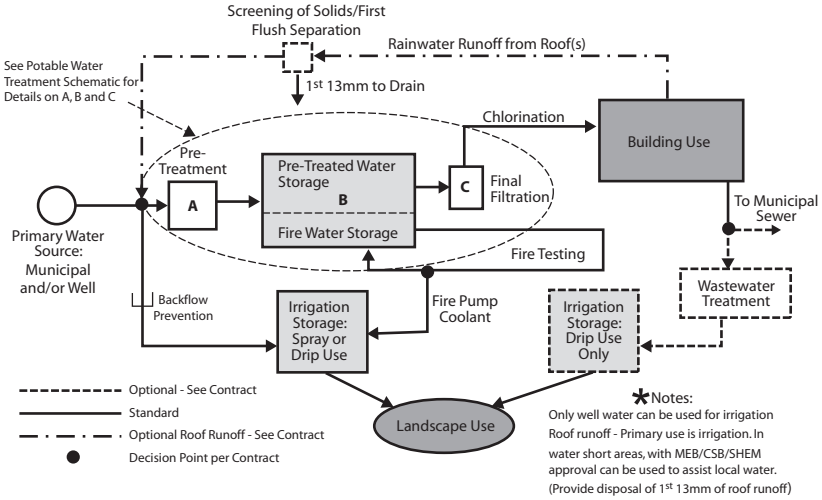
While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold.[4] This increase in water usage translates into increased operating and maintenance costs. It also means increased demand on the municipal infrastructure of water supply and waste treatment facilities, where they exist. To help mitigate the increasing demand on fresh water supplies, it is necessary to identify alternative sources and water-saving technologies that can be readily implemented.

Synergy: Chapter 2: Site/Stormwater

EO 13423 requires federal buildings to reduce water consumption 2% per year or 16% by 2015. Water efficiency measures in commercial buildings can easily reduce water usage by 30% or more.[5]

Water Audit

The first step toward increasing water efficiency is to have a clear understanding of how water is being used at each facility. Conducting a water audit to measure and benchmark current use identifies opportunities for savings.



Typical Water Systems Diagram of an Embassy or Consulate Compound

A water audit should include a thorough examination of all on-site water piping to determine conditions and identify leaks. Early detection of problems can save Post a significant amount of money and time. A water audit should include the following seven steps:

1. **Create a log-sheet**: per month and year for each Post compound
2. **Record total water used**: use utility bills to check accuracy against the main water meter per month and per year; these numbers establish the baseline water use for the compound
3. **Record subtotal use at each meter:** per building at a minimum; if each building does not have a meter, this is the first action item
4. **Quantify unmetered uses:** identify and estimate unmetered uses; metering these uses is the second action item, and if the irrigation system and HVAC process water are not separately metered, then these are additional action items

5. **Quantify discrepancies:** subtract Item 3 from Item 2; this is the balance of water that is unaccounted, which may indicate leaks or other loss
6. **Identify measures to reduce water use & loss:** define both short and long term action items to reduce water consumption
7. **Benchmark subtotal use:** divide item 2 by the number of Full-Time-Equivalents (FTE) served; this can be broken out per building or for the entire compound, if individual building metering is not yet implemented

Benefits of a water audit include improved knowledge and documentation of the distribution system, including problem and risk areas. The audit is a valuable tool to manage resources by understanding how the facilities use water. The audit also creates a benchmark, documenting Post's water use over time and providing a baseline for comparison of progress on current or future conservation efforts in response to federal mandates.

Metering

Meter readings are critical to accurate tracking of water use, and proper metering allows Posts to monitor the impact of improvement measures over time. Sub-metering offers a means of further identifying how water is used. Where practical, metering at the following points should be implemented:

- Compound or site
- Each individual building
- Irrigation systems
- Process water use for HVAC or other cooling system

Each Post compound should have a meter at the main water supply point, whether it is a municipal line, well pump, or other source. Additionally, each Post should install a meter at the connection point of each building, irrigation system, and HVAC water connection to allow for accurate consumption tracking. A monthly and annual log of the readings from each meter should be compiled to identify changes and system anomalies and compare to utility billing for accuracy. Select a meter that can communicate with the existing or future Building Automation System (BAS). A BAS is an example of a distributed control system. Building automation describes the functionality provided by the control system, which is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical, lighting, and security systems in a building.

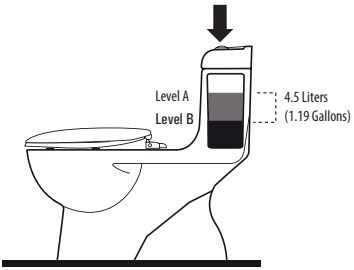
Efficient Technologies

Installation of water-efficient bathroom fixtures, toilets, urinals, and faucets can provide significant water savings (20-30% or more) over standard models. Communicate water conservation goals and educate staff to encourage maximum benefits from fixture use.

Toilets

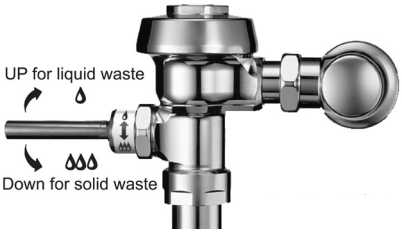
Toilets account for almost half of a typical building's water consumption.[6]

Choose dual-flush toilets, waterless urinals, and automatic/low-flow faucets to reduce water consumption. Most conventional toilets are gravity-fed, single-flush toilets and require 6 liters (L) (1.6 gallons (gal)) per flush; whereas high efficiency toilets (HET) require less than or equal to 4.8 L (1.28 gal) and dual-flush toilets require 3-3.8 L (0.8-1 gal). OBO recommends HET or dual-flush toilets to reduce domestic water consumption when replacing outdated toilets.



Dual-Flush (tank) Toilet – dual buttons/ levers allow for two flushing modes.

Dual-Flush (tank-less) Toilet – the flushometer allows a full or half flush by pulling up or pushing down on the lever.

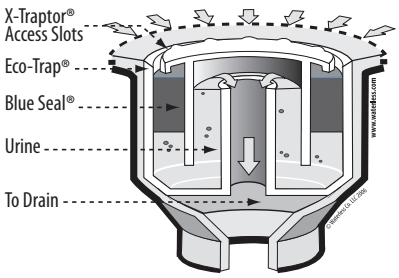


Urinals

Waterless urinals use a cartridge located in the urinal that houses lightweight, biodegradable oil. The oil allows the heavier urine to pass through and down the drain while sealing off and preventing odors from escaping into the space. Using water to clean waterless urinals can wash away the oil seal. Using a spray disinfectant and rag to wipe the fixture clean is recommended.

Advantages of retrofitting with waterless urinals instead of standard urinals are as follows:

- Domestic water costs related to urinals are reduced by 100%.
- Installed cost is less than that of a standard urinal.
- The only maintenance required is replacement of cartridges four to five times per year.



Cross Section of Eco-Trap®

OBO has funded the replacement of over 300 existing urinals and 100 toilets for an estimated total water savings of 34M L/year (9M gal/year). OBO has also required waterless urinals in the SED for new Embassy and Consulate compounds since 2003. Waterless urinals are a low-cost, low-maintenance retrofit that significantly reduces domestic water consumption. Installation of waterless urinals has reduced water consumption by 600,000 L (158,400 gal) annually at the U.S. Embassy, London, England.[7]

The following are few of the many Posts where urinals have been replaced with a waterless type: 30 in San Salvador saving 9.8M L/yr (2,600,000gal/yr), 57 in Manila saving 5.3M L/yr (1,400,000gal/yr), 20 in Islamabad saving 3.1M L/yr (830,000gal/yr), 23 in Amman saving 2.3M L/yr (620,000gal/yr), 55 in Cairo saving 1.8M L/yr (480,000gal/yr), and 26 in Lima saving 1.6M L/yr (430,000gal/yr).

Case Study

Most of the 8-9 million urinals in the U.S. average 11.4 liters per flush (Lpf) (3 gallons per flush (gpf)), while new models use only 3.8 Lpf (1.0 gpf). Individual water savings varies depending on use. However, in a small office building with one urinal and 25 males working 260 days a year, a waterless urinal can save 73,815 L (19,500 gal) annually in lieu of a 3.8 Lpf flush (1.0 gpf) urinal. As a replacement for an 11.4 Lpf (3.0 gpf) urinal, a waterless urinal can save 221,446 L (58,500 gal) of water annually.

The Bureau of Reclamation at the Glen Canyon Dam Visitors Center, Lake Powell, Arizona, USA installed three waterless urinals and, due to very high usage, saved an estimated 853,610 L (225,000 gal) per year. This allowed the Bureau to avoid a planned, $600,000, on-site sewage treatment expansion and demonstrates how this technology lowers water use and sewage.[8]

Faucets & Showerheads

OBO has required low-flow and automatic faucets for over a decade, and recommends no delay for the shut-off timing. Both aerating and non-aerating, low-flow faucets can provide a smooth, laminar stream of water at half of the flow rate of a conventional faucet.

- **Touchless Controls:** Infrared sensors detect motion and activate plumbing fixtures. Water use is minimized while hygiene is improved.
- **Low-flow showerheads:** Narrow spray jets and an increased mixture of air in the water, reduce water flow while simulating the feel of a conventional showerhead.

	Water Consumption			
Plumbing Fixture	Conventional		Water Efficient	
Urinal	3.78 Lpf	1.0 gpf		
Waterless			0 Lpf	0 gpf
Toilet	6.056 Lpf	1.6 gpf		
Gravity-fed, Single-flush			4.2 - 4.9 Lpf	1.1 - 1.3 gpf
Dual-flush (half flush)			0.3 - 4.2 Lpf	0.8 - 1.1 gpf
Dual-flush (full flush)			4.9 - 6.1 Lpf	1.3 - 1.6 gpf
Pressure-assist			4.2 - 4.5 Lpf	1.1 - 1.2 gpf
Power-assist			4.2 - 4.9 Lpf	1.1 - 1.3 gpf
Faucet	9.463 Lpm	2.5 gpm		
Low-flow			1.9 - 4.7 Lpm	0.5 - 1.2 gpm
Automatic Shut-off			1.9 - 4.7 Lpm	0.5 - 1.2 gpm
Showerhead	9.463 Lpm	2.5 gpm		
Lowflow			3.8 - 9.1 Lpm	1.0 - 2.4 gpm

'Conventional' fixtures above represent maximum flows established by the 1992 National Energy Policy Act. Older fixtures (pre-1992) may exceed water consumption listed in table.

Irrigation

OBO's SED requires underground water-efficient irrigation systems, and planting to reduce the quantity of water used for irrigation. Chapter 8 of the OBO Supplement to the *International Zoning Code* requires the following regarding source water for irrigation.

SECTION 02810 - IRRIGATION SYSTEM

1.2 SYSTEM PERFORMANCE REQUIREMENTS – C. Water Consumption: Through the use plant selection and irrigation system efficiency, water consumption for the irrigation system shall be less than 50% from the LEED® Baseline Case. For purposes of calculations, the project Design Case shall include both city domestic water supply as well as treated or untreated well water, but not stormwater or gray water.

The following are techniques recommended to reduce irrigation water consumption:

- Reduce areas requiring irrigation by choosing gravel, stone, or mulch.
- Use drip irrigation to provide more efficient support to landscaped areas than spray techniques such as sprinkler systems. Drip irrigation utilizes a network of pipes, tubes and emitters or micro-sprinklers to irrigate plantings and minimize the use of water and fertilizer. The system allows water to slowly infiltrate the root zone directly below the ground surface. System emitters have a typical flow rate of 3.8-15 L (1-4 gal) per hour, which is more efficient than a typical sprinkler irrigation system.[9]
- Install water-efficient irrigation fixture heads.
- Select native or adapted drought-tolerant plants for landscaping.
- Group plants based on irrigation requirements.

- Use controls such as timers or sensor-based controls for quantity control.

- Retrofit irrigation systems to use rainwater or treated wastewater effluent.
  Synergy: Chapter 2 Site/Landscaping/Xeriscaping

Water Sources

Rainwater

Rainwater catchment systems offer a means of additional water savings for irrigation or for use in plumbing fixtures. Rainwater may be captured in tanks or cisterns and then treated and used as supply for non-potable uses or even, in cases of extreme water shortage, for potable use.

The feasibility of rainwater harvesting in a particular location is highly dependent upon the amount and intensity of rainfall. Other variables, such as catchment area and type of catchment surface, usually can be adjusted according to the facility's needs. As rainfall is usually unevenly distributed throughout the year, rainwater collection methods best serve as a supplementary water source. The viability of rainwater harvesting systems is also a function of the quantity and quality of water available from other sources, the cost of water from other sources, facility size and per capita water requirements, and available budget. Decision makers must balance project cost against available budget, including economic benefits resulting from conserving water supplied from other sources.

Chesapeake Bay Foundation Headquarters, Annapolis, Maryland, USA collects rainwater for reuse in the building after treatment. This LEED® Platinum building uses 67% less water than a standard office building of similar size, occupancy, and use.[10]

Rainwater systems' maintenance is generally limited to annual cleaning of the storage tank and regular inspection of filters, gutters, and down spouts. Maintenance typically consists of the removal of dirt, leaves and other accumulated materials. Such cleaning should take place before the start of the major rainfall season or forecasted storm event. Storage is usually in an underground, surface, or elevated tank. Elevated storage has the advantage of gravity feed. Ground level tanks require additional care to avoid damage and contamination by people and animals and may require fencing.

Wastewater

A reduction in the amount of water consumed results in an automatic decrease in the amount discharged. Lowering the level of water discharge lowers energy and operational costs for on-site or local water treatment facilities, and can further lower utility fees for sanitary sewer discharge. Some municipalities offer incentives for reduced water use and discharge. These programs target decreasing the capital investments required to serve potable water demand and wastewater treatment.

Reuse of treated wastewater for irrigation instead of discharging it off-site is a low first-cost strategy that results in a short payback period, depending on water and sewer costs. There is also an ongoing reduced operating cost attributed to the on-site irrigation source and negligible additional maintenance to the irrigation system. By reusing treated wastewater, groundwater and/or municipal water is saved.

Synergy: Chapter 2 Site/Stormwater/Constructed Wetlands

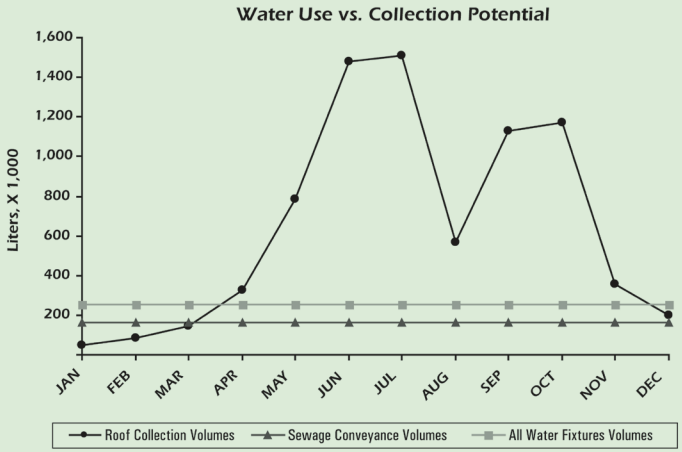
Case Study

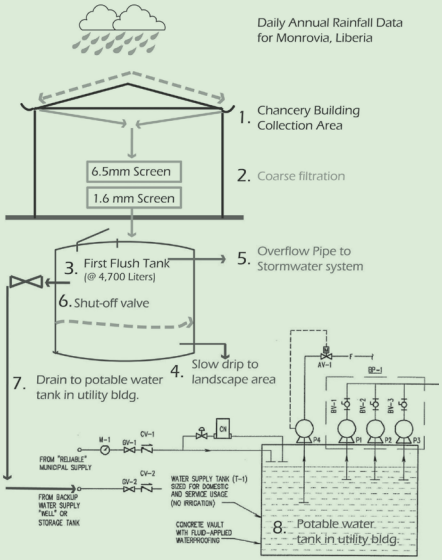
The sustainability consultant, Paladino & Co., Inc. prepared seven technical studies for the new Embassy project in Monrovia, Liberia. The rainwater collection study offered a prime example of how a resource abundance approach can be used to rethink a design solution to provide a more sustainable project and lower the total cost of ownership for DOS.

Monrovia's climate offers an abundance of rainfall, nearly 200 inches of rain per year. This coupled with the estimated long-term costs of water delivery led the team to investigate the feasibility of rainwater harvesting. The project site has no access to a water well or municipal supply and therefore would require water to be trucked to the facility from a local stream at a cost of roughly six cents per liter.

The consultant considered annual rainfall as compared to water use at the Embassy. As seen in the chart below, rainfall collected from the Chancery roof alone could be enough to offset 100% of water needed to flush toilets and/or supply 100% of all water consuming fixtures.

After running a calculus based water balance model to optimize the roof collection area, tank size, and the use of low flow water fixtures (37% savings versus the standard Energy Policy Act 1992 requirements), it was determined that the project could virtually eliminate the need to truck in water.





Key system components include connecting the Chancery roof to a first flush tank (to reduce sedimentation generated during the dry season), routing the collected rainwater to the standard water treatment and storage tanks, and routing overflow to the stormwater pond located nearby for periods of excessive rainfall.

Through implementing this strategy, a Net Operating Income of more than $180,000 per year is achieved with an added operations and maintenance cost of roughly $8,000 to maintain the more complex system, and first-cost increase of roughly $40,000 to purchase additional piping and the first-flush tank. Using these parameters, life cycle calculations indicate this system would pay-back within the first three months of operation and provide a Net Present Value greater than $3.3 million for a 25 year analysis period.

Practical Application

1. **AUDIT:** Measure and baseline Post's water use:
   a. Conduct a survey of all water uses of each compound and building.
   b. Document existing water saving practices.

2. **SHORT-TERM ACTIONS:** Identify low- or no-cost options and measures for immediate consideration:
   a. Fix leaks.
   b. Reduce irrigated areas.

c. Use alternative cleaning methods such as sweeping paved areas instead of hosing them down.
d. Replace existing older fixtures to reduce consumption, using:
    i. Dual-flush toilets.
    ii. Waterless urinals.
    iii. Low-flow faucets and shower heads.

3. **MID- to LONG-TERM ACTIONS**: Identify equipment or projects requiring larger capital investment:
    a. Install drip-irrigation.
    b. Collect rainwater for irrigation.
    c. Reuse treated wastewater effluent for irrigation.
    d. For new construction projects, consider a gray water system for toilet flushing and irrigation.

4. **EDUCATE**: Develop a communication and education plan for staff:
    a. Communicate water conservation goals.
    b. Provide signage explaining water-saving fixtures and devices.
    c. Promote water conservation through incentives to staff.
    d. Provide personal tips for saving water at home.

Endnotes

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ENERGY

The enormous **solar power** potential of the Southwest - comparable in scale to the huge hydropower resource of the Northwest - will be realized. A desert area 16.1 kilometers (km) (10 miles) by 24.1 km (15 miles) could provide 20,000 megawatts of power, and the electricity needs of the entire United States could theoretically be met by a 260 km^2 (100 $mile^2$) photovoltaic array.

The U.S. Embassy, Geneva, Switzerland, has a building-integrated photovoltaic system with net metering that produces an average of 270 kilowatt hours of power a day and approximately $60,000 worth of electricity a year.

Chapter 4
Energy

Rate Restructuring 70

Energy Audits 72

- Getting Started 72
- Office Energy Checklist 76

Energy Management 78

- Load Reduction 79
  - Lighting 79
  - Computers 85
  - Solar Thermal Hot Water 86
- Systems Efficiency 87
  - Building Controls 89
  - Metering 90
  - Commissioning (Cx) 91
  - Commissioning Checklist 93
- Regenerative Systems 94
- Renewable Energy Sources 94
  - Photovoltaic (PV) 95
  - Wind Power 99

Innovative Contracting 102

- Energy Savings Performance Contracts 102

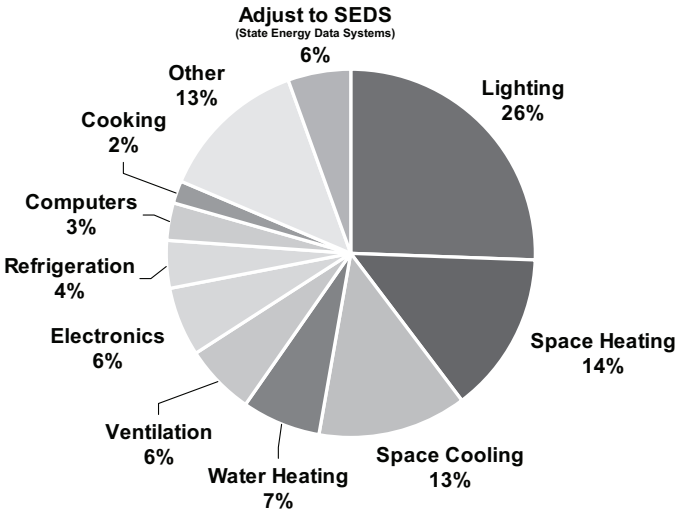
Education and Training 104

Practical Application 106

Energy

Office buildings produce 17% of CO_2 emissions[1] and consume up to 25% of the commercial electricity[2] used in the United States. U.S. facilities overseas, often built to American standards, contribute similarly. By seeking opportunities to use renewable forms of energy and to improve efficiency in the use of resources, every person and Post can minimize the negative impacts of consumptive actions and contribute to a sustainable level of resource use.

Typical Office Building Energy Consumption by Use
(varies by climatic region)



Total Energy Consumption: 17.40 Quadrillion Btu
Excludes buildings energy consumption in the industrial sector.[3]

Buildings' primary energy uses are environmental controls (26% for lighting and 40% for HVAC) which therefore provide the greatest opportunities for savings. The remaining energy uses–computers and electronics at 9%, cooking and refrigeration at 6%, and water heating at 7%–are controlled by users and procurement managers. More energy-efficient equipment is becoming more readily available, and the use of this equipment is a significant contributor to overall building performance.

DOS performed a benchmarking analysis using the Building Owners and Managers Association (BOMA) unit costs for utilities. The results determined that 24% of the 164 Posts analyzed exceeded the threshold value for O&M costs for 2006.[4]

The federal government's Office of Management and Budget (OMB) has introduced a requirement to benchmark and track energy usage at all government facilities.

To get to "green" on OMB's Energy Scorecard, DOS must document the following:

- ☑ Reduce energy intensity (kWh/sf (MJ(megajoule)/sm)) in standard buildings by 30% compared with 1985, and that energy intensity is on track for 35% reduction by 2010
- ☑ Reduce energy intensity (kWh/sf (MJ/sm)) in all facilities by 1% compared with 2003, and that energy intensity is on track for 20% reduction by 2015
- ☑ Use at least 2.5% renewable energy for facility electricity use
- ☑ Reduce petroleum use in standard buildings by 50% compared with 1985
- ☑ Follow procurement guidelines for mandatory energy efficient products and services as required by EPAct 2005
- ☑ Require 100% of new buildings to be 30% more efficient than American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2004 (non-residential buildings) or 2004 International Energy Conservation Code (residential buildings)

Effective energy use begins with a reduction in demand load, followed by optimization of the performance of technical systems to meet operational needs; then supplement loads with on-site renewable power where feasible. Facilities should begin to self-evaluate in conjunction with OBO's energy and data gathering effort to audit energy usage for each building, and benchmark the use against industry standards. This analysis is needed to identify facilities that will benefit most from specific Energy Conservation Measures (ECMs) or Energy Savings Performance Contracts (ESPCs), as discussed in this chapter. There are a number of no- or low-cost measures that can greatly reduce energy usage, energy costs, and carbon emissions.

Rate Restructuring

Posts may leverage opportunities to negotiate utility rates for better efficiency and savings. Facility management teams should explore demand charges and peak usage charges with utility providers and opportunities to save money by scheduling energy-intensive activities during off-peak hours. Utility providers can help the facility management team understand the choices available. Forming a working, collaborative partnership with the local utility providers can help to identify opportunities that save energy production demands for the utility provider and optimize energy savings for the Post. These are the first steps of an intensive energy audit, and are also a low-cost approach to addressing utility costs before initiating equipment replacement or construction projects.

Many facilities may be eligible to have their periodic utility bill calculated in two or more different ways, reflective of their energy usage and pattern. A Post's usage category is usually determined by its recent history of peak power demand and total energy consumption. By modifying its energy usage pattern, a Post may qualify for an alternate rate schedule (method of bill calculation).

Electric utility bill amounts may be composed of the following four additive cost components:

- **Fixed Charge:** These administrative charges often include meter reading costs, and other recurring charges unrelated to the Post's specific energy consumption; and peak power demand quantities.

- **Energy Charge:** These are utility costs directly related to the Post's energy consumption and may include the cost of fuel used to generate power for the Post, as well as the Post's share of the generating facility's operating and maintenance expenses.

- **Peak Power Charge:** This is the prime factor in determining the size of the utilities' generation and distribution facility and system. The total peak demand on a power provider determines its plant's overall investment cost; this cost is typically passed along proportionally, based on the peak power demanded by each customer.

- **Power Factor Penalty:** A penalty is assessed when power used by a facility does not match the utility company's requirements for its system. The power factor is primarily affected by electronic loads (computers, lighting, and controls) or inductive loads (motors). A penalty is assessed when the power factor drops below a level pre-determined by the utility provider. The greatest factor contributing to low power factor is poorly maintained systems. The best way to counteract this problem is with a comprehensive energy audit and, if necessary, properly engineered systems to mitigate poor power factor.

Energy Audits

Comprehensive utility audits collect utility information to better understand and inform energy users. An audit or survey inspires and assists facility personnel in achieving the goal of saving energy. This is the starting point for sponsoring further investigation and action. Information gathered should include data from available sources, such as the local utility company, library resources, Internet resources, and other facility-generated ideas. Below is a brief overview of the type of information to be gathered by an energy audit. This information can be tailored to a specific facility's requirements. Note that additional information concerning the geographical area or cultural patterns is also useful.

For reference, the average annual energy intensity for office buildings across the United States is 858.96 kBtu/sm (79.8 kBtu/sf), and the average cost is $17.76/sm ($1.65/sf). Of the total energy consumption, 66% is for electricity and 34% is for natural gas and other fuels. This translates to 166.84 kWh/sm (15.5 kWh/sf) of electricity and 2.91 therms/sm (0.27 therms/sf) of natural gas.

Getting Started

Perform an energy audit of the condition and operation of each system and major components of each system on a regular basis (quarterly is ideal, every 6 months acceptable, and annually is a bare minimum).

Energy Tips for High-Performance O&M[5]

Create a checklist to record and track audit results for Post-specific equipment. The essential HVAC elements to be audited are as follows:

- **Unitary Equipment:**
  - » **Refrigerant:** Charge is as specified
  - » **Coils:** Evaporator coil and condenser coil are clean and in good condition

- » **Controls:** System operates correctly in response to temperature settings and doesn't cycle on-off inappropriately for climate and indoor environment
- » **Air:** Temperature of supply air is at 12.7°C (55°F), return air at 26.6°C (80°F)

- **Air Handlers:**
  - » **Ventilation:** System brings in the amount of outdoor air shown in the plans or specifications meeting minimum ASHRAE standards for building type
  - » **Filters:** Filters are in place and in clean condition, and level of efficiency is as specified by the equipment manufacturer
  - » **Condensate:** Pans drain properly and are clean
  - » **Economizers:** Dampers operate appropriately and set-points are as specified by the equipment manufacturer

- **Chillers:**
  - » **Refrigerant:** Charge is as specified
  - » **Condenser:** Barrel tubes are clean and should be checked at least every three years
  - » **Water:** Temperature (T) entering and leaving are as specified. Look for delta-T between the two and seek ways to increase it; the larger this delta-T, the less pumping energy. Delta-T should be in the minus 12.2°C to minus 6.6°C (10-20°F) range
  - » **Pumps:** Operating schedules should conform to chiller schedules; consider Variable Frequency Drives (VFD) to minimize pump flow needed to meet flow and Delta-T requirements

- **Boilers:**
  - » **Temperature:** Set-point is as high/low as possible to maintain occupant comfort, and reset works to keep heating hot water at the lowest temperature needed to meet heating needs
  - » **Burner:** Flame is blue and even, and controls and/or electronic ignition are functional
  - » **Combustion:** Controls of larger systems perform as specified
  - » **Burner:** Efficiency checked annually with combustion gas analyzer
  - » **Circulating pumps:** Operate only as needed
- **Controls:**
  - » **Automation:** Verify that automatic sequences of operations programmed into the controls system are still in force (i.e. that the system hasn't been put into "manual mode", overriding the function of the automatic controls)
  - » **Calibration:** Verify calibration of temperature sensors, pressure sensors, and flow sensors
- **Ductwork:**
  - » **Leaks:** Check exposed ductwork for leakage (often evidenced by black discoloration in the vicinity of the leak)
  - » **Insulation:** Ensure supply air ducts are well-insulated
  - » **Connections:** Ensure concealed duct branches are connected to diffuser, not just blowing into the ceiling plenum

- **Domestic Hot Water:**
  - » **Water Heaters:** Temperature set-point is as low as possible
  - » **Burner:** Flame is blue and even and electronic ignition are functional
  - » **Boilers:** Temperature set-point is as specified and as low as possible. Ensure combustion controls operate as specified (larger systems)
  - » **Re-circulating Systems:** Verify pump, electronic controller (button, thermostat timer, or motion sensor), and zone valves are calibrated and operational
  - » **Tempering Valves:** Verify valve is operational and heat trap, if installed, is functional
- **Building Envelope:**
  - » **Shading:** Verify operable shading devices (louvers, shades, awnings, etc.) are in good condition and are used daily as needed to reduce solar loads in the cooling season and allow sun into the building in the heating season
  - » **Insulation:** Verify that levels are R-30 at roof and R-19 for walls, and are continuous and uninterrupted with sealed seams.
  - » **Vapor Barrier:** Verify the barrier is continuous and on the warm side of the insulation
  - » **Sealant:** Verify cracks and joints are properly and continuously sealed or caulked, and that sealant is in good condition
  - » **Glazing:** Verify operable windows are shut when outdoor conditions increase HVAC system load

The U.S. Department of Energy (DOE) also provides a checklist for use in energy audits of office buildings.

DOE - Energy Efficiency and Renewable Energy (EERE) Federal Energy Management Program (FEMP)

Office Energy Checklist[6]

5-1 The following is a simple checklist of energy conservation/efficiency measures to use at the office. This document is also available as a printable flyer for download

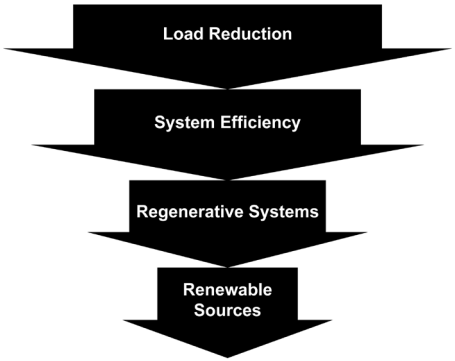
- ☑ Replace incandescent lights with **compact fluorescent lights (CFLs)** for desk lamps and overhead lighting. Using CFLs instead of comparable incandescent bulbs can save about 50% on lighting costs. CFLs use only one-fourth the energy and last up to 10 times longer.
- ☑ Switch off all unnecessary lights. Use **dimmers, motion sensors, or occupancy sensors** to automatically turn off lighting when not in use to reduce energy use and costs.
- ☑ **Turn off lights** when not in use.
- ☑ Use **natural lighting** or **daylighting**. When feasible, turn off lights near windows.
- ☑ Use **task lighting**; instead of brightly lighting an entire room, focus the light where needed, to directly illuminate work areas.
- ☑ Use energy efficient **ENERGY STAR®** products.
- ☑ Close or adjust window blinds to block direct sunlight to reduce cooling needs during warm months. **Overhangs or exterior window covers** are most effective to block sunlight on south-facing windows.
- ☑ In the winter months, open blinds on south-facing windows during the day to allow sunlight to naturally heat the workspace. At night, close the blinds to reduce heat loss at night.
- ☑ **Unplug equipment** that drains energy when not in use (i.e. cell phone chargers, fans, coffeemakers, copiers, desktop printers, radios, etc.).
- ☑ Turn off **computers and monitors** at the end of the work day, if possible. Turn off monitors when left for extended time periods.
- ☑ Turn off photocopiers at night or purchase new copiers with a low standby feature. Purchase printers and fax machines with power management

feature and use them.

- ☑ Coordinate with vending machine vendor to turn off advertising lights.
- ☑ Have a qualified professional perform an **energy audit**. Check with local utility companies for names of auditors.
- ☑ Clean or change furnace filters once a month during the heating season.
- ☑ Check furnace ducts for disconnects or leaks.
- ☑ Ensure HVAC ductwork is well-insulated.
- ☑ Ensure adjustable speed drives are operating properly.
- ☑ **Insulate water heater**, hot water piping and tanks to reduce heat loss.
- ☑ Install low-flow toilets and shower heads.
- ☑ Verify the **energy management system (EMS)** switches into setback mode during unoccupied hours. Also, time clocks and computer controls may need adjustments after power outages or seasonal time changes.
- ☑ Install **meters** to track energy use.
- ☑ Visit **Businesses Can Save Energy this Winter with Help from EPA and ENERGY STAR®** for 5 steps to save energy this winter. The steps are based on lessons learned from ENERGY STAR® business and organization partners.
- ☑ **Save paper**. Photocopy only when needed. Always use the second side of paper, either by printing on both sides or using the blank side as scrap paper.
- ☑ **Collect and log utility bills**. Separate electricity and fuel bills. Target the largest energy consumer or the largest bill for energy conservation measures.
- ☑ **Carpool, bike, or use mass transit** when commuting to work.
- ☑ To save gas: drive the speed limit, accelerate and decelerate slower, and make sure tires are pumped up.
- ☑ Use coffee mugs instead of disposable cups.

Energy Management

The most effective sequence for pursuing energy efficiency and reduction is illustrated by the graphic below: [7]



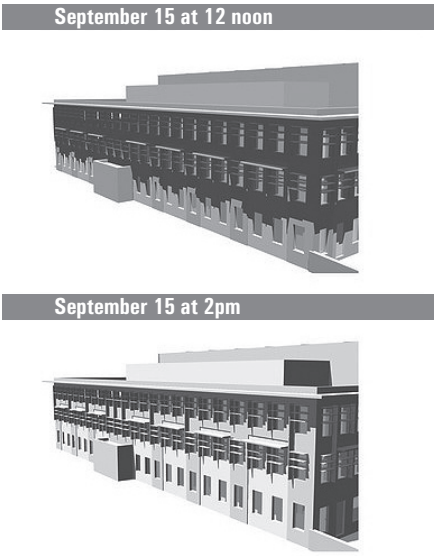
- **Load Reduction:** Identify every possible means to reduce energy use. Look for load reductions in lighting, heating, ventilating, cooling, and plug loads. Implement an aggressive procurement policy that makes energy efficiency a priority criterion. Consider energy use characteristics when purchasing all electronics, including task lighting, Information Technology (IT) support systems, vending machines, and appliances.

- **System Efficiency:** Ensure current systems are the most efficient in serving operational requirements, once loads have been reduced. Meter energy usage to support identification of immediate problems that need to be addressed, as well as to validate the strategies that are working. Re-commission systems on a regular basis to verify equipment is operating as intended.

- **Regenerative Systems:** Identify ways to use "waste" energy from one system to supplement another in order to reduce overall energy use. Labeled "regenerative," this approach could include using waste heat from the cooling system to preheat domestic hot water, or using waste heat from a combined heat and power system to power a secondary system.

- **Renewable Sources:** Seek to serve the remaining energy load with renewable energy produced on-site from solar, wind, wave, biomass, or bio-gas. Using support by OBO through the Energy and Sustainable Design Program, develop on-site renewable power sources. Track opportunities offered by the local utility provider for default renewable power (green power) purchases and identify additional opportunities through the private sector.

Load Reduction



The design team for the new Embassy in **Port-au-Prince, Haiti** optimized external shading devices to reduce solar gain.

Lighting

Natural daylight is the human eye's preferred source of illumination. Maximizing interior use of natural daylight reduces demand for lighting power. Work spaces and community spaces can be organized to take advantage of or reduce daylight as appropriate. New facilities utilize exterior shading devices coupled with interior light shelves to maximize the penetration of daylight in office buildings. These techniques can be implemented in existing facilities as well with thoughtful consideration and solar design simulation. Specific technologies in energy reduction for interior lighting include both basic and advanced daylight harvesting controls, lighting types, and uses.

Implementation of a lighting load control strategy can have a great impact on energy savings, especially when multiple strategies are used in concert.

Utilizing the correct light and lamp for the application:

- **Fixture Replacement:** First, consider replacement of inefficient lighting with newer, more efficient forms. Replacement of incandescent lighting with fluorescent lighting can have great effect on energy consumption in an office environment. The U.S. Embassy in London reported an energy consumption savings of 82.5% per fixture after replacing incandescent with compact fluorescents.[8] Procurement of energy efficient lighting systems presents the greatest opportunity for reducing energy demands.
  Synergy: Chapter 5: Materials and Chapter 6, Indoor Environment

- **Appropriate Light Levels:** Proper lamping for the task is paramount; and the first step is to promote a policy of using no higher wattage lamp than is necessary. Look for opportunities to downsize lamps in accent lighting, down lighting, and task lighting. Replacement of a 100-watt lamp with a 75-watt lamp has little effect on human vision; however, over a year in an 8-hour office environment, that equates to a savings of approximately 80kWh (288 MJ) of electricity.

LED task lights

- **High Efficiency Lighting:** LED (Light Emitting Diode), is growing in availability and affordability. The selection of LED lighting alone has proven to lower operational costs and reduce the need for relamping. LEDs typically use 75% less energy than that a normal incandescent light source and last 25 times longer.[9] They do not contain mercury found in compact fluorescent lights. LED light is whiter and more pleasing to the eye, and can produce equivalent illumination even with lower footcandle output.

Reduction of lighting used:

- **General versus Task Lighting:** Reduce ambient ceiling lighting and increase point-of-use task lighting. Use a minimal number of fluorescent overhead fixtures to maintain general illumination levels at approximately 30 foot-candles (323 lux), coupled with adjustable task lighting at the work area.

- **Manual Lighting Control:** The simplest control scheme is to turn off (or down) lights when they are not needed. Turn lights off in unoccupied rooms, rooms with sufficient task lighting or rooms that benefit from significant natural lighting.

- **Automatic Lighting Controls:** Occupancy sensors can yield considerable savings by ensuring that building services only operate when someone is using the area. Sensors can reduce demand by 50% or more.[10] These sensors, which are usually infrared and/or ultrasonic, are most effective in areas that are infrequently occupied, or in small areas such as offices and conference rooms. As sensor technologies have evolved, combinations of different sensor technologies into single devices has increased reliability and reduced instances of false shut-downs. The following are the primary types of occupancy sensor controls that are suitable for fast response services such as lighting. Note that not all sensors are security-approved for all building locations.

  - » **Passive Infra-Red (PIR) sensors** are electronic devices that measure infrared radiation emanating from objects in their field of view. This energy is invisible to the human eye, but can be detected by electronic devices designed for such a purpose. The term 'passive' in this instance means the PIR does not emit energy of any type, but merely accepts incoming infrared radiation.

  - » **Ultrasonic sensors**, also known as transducers as they both send and receive signals, are electronic devices that work on a principle similar to radar. These sensors evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively.

» **Microwave sensors** are electronic devices that generate and receive microwaves. These are commonly used in automatic doors and are able to provide good directional and spatial coverage.

» **Timers** are devices ranging from simple time clocks to advanced controls used to regulate the lighting in large areas. If the office is shut down completely at night, a timer can ensure the lighting is turned off, leaving minimal night lighting for security and emergency navigation.

» **Photo sensors**, originally designated for control of exterior lighting, now have indoor applications where they control lighting in a room based on the amount of natural light entering from outside. They can reduce lighting costs by 20% and can easily be combined with occupancy and/or time clock controls.

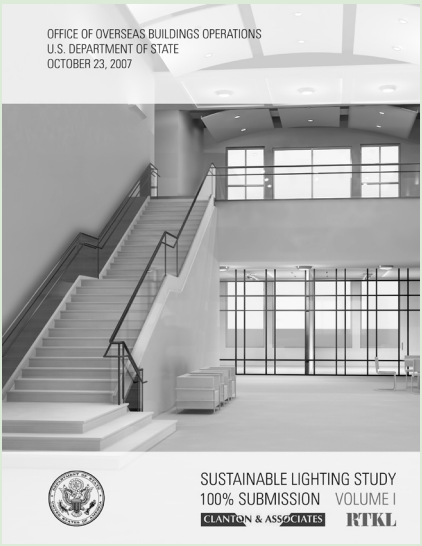
» **Advanced controls** are combinations of sensors, timers, and controllers to regulate an entire building (or large area) based on preset points. These controls can use photo sensors with dimmers (daylight harvesting for effective utilization of natural light), occupancy sensors, and timers to ensure lights are off when not needed.

These techniques have been identified in studies executed by OBO. One such study, the Sustainable Lighting Study performed by Nancy Clanton, Clanton & Associates of Boulder, CO., identified opportunities for new facilities and guidance for existing facilities as well. *(See Case Study on page 83)*

Energy costs should take into account savings realized due to daylight and manual dimming, occupancy sensors, and energy management systems. Peak power demand in most climates occurs during the sunniest days when daylight is the most available. If the peak demand can be lowered through the use of automatic controls, then the energy costs can be considerably lower.[11]

Case Study

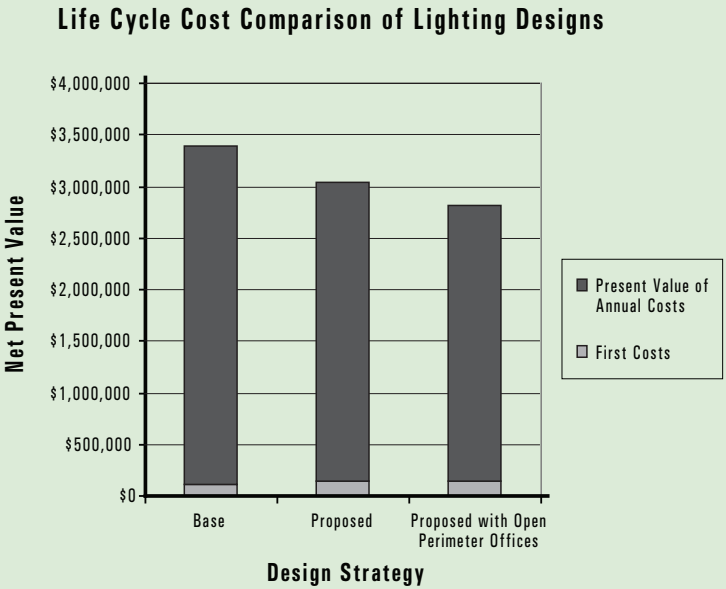
Using a whole-building design process, OBO's Sustainable Lighting Study details strategies for improving interior building lighting efficiency. Replacement and relamping of lighting equipment are inherent in maintenance costs. The study's recommendations from the "Lighting Equipment Selection" are summarized as follows:



Lamps, ballasts, and controls must be selected based on their application, maintenance requirements, reliability, and life span. Things to consider when selecting these items are as follows:

- **Lamps:** require additional selection criteria related to their compatibility with other fixtures, energy consumption, and replacement costs. Though poor quality lamps may be available locally, they may have lower life expectancies, poorer color qualities, and higher operating costs.
  - » Match existing lamp type for color temperature and color rendering index
  - » Match lamp type as close as possible in order to assure ballast and control compatibility
  - » Do not install instant start lamps, since their life is shortened when controlled by occupancy sensors
  - » Group re-lamp whenever possible versus spot re-lamping
  - » Energize fluorescent lamps for 100 hours at full intensity before dimming

- **Ballasts:**
  - » Match existing ballast type as close as possible in order to assure lamp and control compatibility
  - » Do not install instant start ballasts since this limits control opportunities
  - » Employ control schemes
- **Controls:**
  - » Install simple to understand and low maintenance controls
  - » Install occupancy sensors in appropriate/recommended areas such as offices, meeting rooms, and rest rooms
  - » Maintain consistency of lamp and ballast type controlled



The chart above is an example—using an Open Perimeter Office Design—of a comparison of net present values among a base case, proposed design, and Open Perimeter Office Design. It shows a small increase in first cost can reduce significantly the present value of annual cost. Other sustainable lighting strategies can produce similar or greater life cycle cost savings, based on site, function, and building design.

Computers

The global economy has shifted from paper-based to digital information management. Data centers, facilities that primarily contain electronic equipment used for data processing and communications networking, have become common and essential to the functioning of business, communications, academic, and governmental systems. Individual computers also consume significant energy and are often left on unnecessarily over night or for days on end without use. Conscious system operators are installing software applications to surf their network systems for such offenders and turn them off remotely. DOE has piloted these types of systems and reports significant energy savings. For example; the Embassy in Santiago, Chile, where power costs ~$.20/kWh ($.72/MJ), has realized a 6% reduction on its utility bill, resulting in an estimated savings of $36,000/year. This was accomplished by using software to automatically shutdown OpenNet workstations. When Personal Computers (PCs) are left unattended, the system goes into an energy saving standby mode.

Forecasts indicate that unless energy efficiency is improved beyond current trends, the federal government's electricity cost for servers and data centers could be nearly $740 million annually by 2011, with a peak load of approximately 1.21 gigawatts (GW).[12]

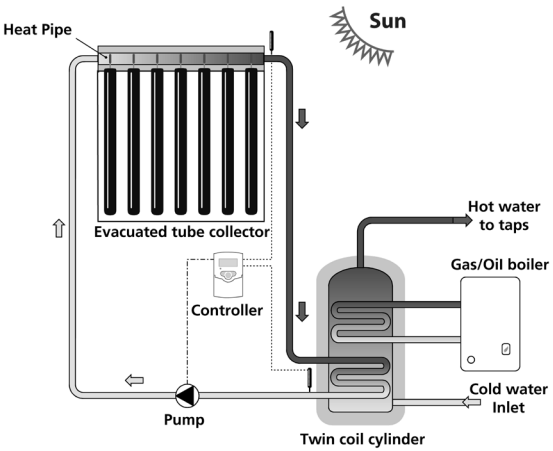
To further reduce energy consumption at individual workstations, remote service can reduce energy consumption from 60w to 6w per station by supporting only the LCD monitor, keyboard, and mouse. This technology, termed, thin-client or lean-client, is an application or system that accesses a remote server by way of a local network. Client computing depends primarily on the central server for processing activities, and mainly focuses on conveying input and output between the user and the remote server. In contrast, a thick or fat-client does as much processing as possible and passes only data for communications and storage to the server. Many thin-client devices run only web browsers or remote desktop software, meaning that all significant processing occurs on the server. However, recent devices marketed as thin-clients can run complete operating systems.

Solar Thermal Hot Water

In **Abuja, Nigeria,** this roof-mounted solar thermal hot water system reduces the energy load of the Embassy.

Solar thermal water heaters are easy to install. Energy savings is the primary economic benefit. The payback can be as short as one year, depending on local energy costs. This technology works in most climates, not just hot, sunny environments, to achieve effective results. Building roof space is utilized to install thermal panels to collect radiation from the sun to heat water. In its most common and simplest form, a black water tank is located on the building roof. More technical installations are very efficient and can eliminate the need for electric or gas water heaters.

Systems are available in two types: a) active systems that constantly recirculate water or heat-transfer fluid (used in colder climates) in an indirect circulation system, and b) passive systems that do not circulate fluid and offer three different technology options—flat-plate (such as those used in swimming pools), integral collectors (such as those used for any pre-heat tank system) and evacuated tubes. With



Evacuated Tube - Solar Thermal Hot Water Diagram

their ability to produce near-boiling temperatures, evacuated tube collectors are particularly effective for kitchen applications, which require higher temperature water for sanitization.

These technologies are quickly and easily implemented, and are more suitable for residential and commercial kitchen applications. In residential applications, the highest demand for hot water is for showers and cleaning (such as laundry). OBO has installed systems in Abuja, Amman, Bamako, Brasilia, Dar es Salaam, Katmandu, Niamey, Santiago, Tanzania, and other locations. These systems are usually locally available and are relatively inexpensive. OBO has a program to support the installation of these systems, and recommends that Posts explore their cost benefit and local market for possible suppliers and installers.

Synergy: Introduction

Systems Efficiency

Every facility manager faces the challenge of providing appropriate levels of heating, cooling, ventilating and lighting for distinct and varying needs throughout large buildings. Creating 'zones' in a building allows separate time, temperature, and ventilation control for these areas. Consider zoning where different occupancy patterns, solar exposure, temperature requirements, or space usage is evident (particularly where top floors are poorly insulated).

Significant cost savings can be achieved through an ongoing HVAC system controls review. The integration of common best practices to day-to-day operations helps optimize HVAC performance efficiency. Consider installing an enhanced automated control system along with compatible control equipment on building mechanical and electrical systems. The HVAC, lighting, fire and smoke detection, and security systems can all be integrated into one automated control system. Enhanced automation allows for greater zone control by continuously monitoring and adjusting lighting and HVAC equipment based on occupant densities and environmental factors. This allows load curtailment during peak times when utility

rates are highest. Enhanced automation also decreases occupant complaints arising from poor indoor air quality, since zones rarely fall outside of control set points. Problems that do arise are detected and rectified quickly, often before occupants have noticed. Because equipment is optimized and operated in coordination with the full system, equipment life is extended and downtime for repair and maintenance is minimized.

Other effective tools to reduce HVAC operating costs may only deal with the system indirectly. Before undertaking expensive retrofits, investigate ways to reduce heating and cooling loads. Lighting retrofits, building envelope improvements, and use of energy efficient office equipment all reduce heat load. These measures precede making HVAC upgrades. Implementation of these measures allows the size of the HVAC system to be minimized while ensuring optimum building systems operate efficiently with minimal impact on the environment.

Rome, Italy: Fire Pump Room

There are a number of equipment installations that can increase efficiency of the overall system. Typically, new equipment selection can include certification by Energy Star®, an EPA program to promote the purchase of energy-efficient equipment. Other equipment is available that uses advanced technology to increase its efficiency, including Variable Frequency Drives (VFD) that regulate the frequency of power to a motor to regulate speed, electronic lighting ballasts, and mechanical equipment. Another energy efficient type of equipment is a Magnetic Levitation (MagLev) bearing chiller, which utilizes magnetic bearings to levitate the motor shaft, significantly reducing the friction experienced from traditional bearings and greatly increasing the efficiency.

Case Study

On Earth Day 2007, the U.S. Embassy in Tokyo became the showcase of a new energy efficient technology when the world's first large-tonnage, air-cooled, MagLev chiller was installed. OBO contracted with Cosmopolitan Corp. of Columbia, Maryland, USA to install the 2,520-kilowatt (720 tons of cooling) air-cooled chiller plant. The plant consists of a dozen 210-kW MagLev chiller modules on the roof of the Embassy. OBO expects the $2.8M project to pay for itself in less than 10 years.

MagLev compressors are very quiet due to the lack of reciprocating mass and the extremely fine balance achieved through digital controls. The reduced friction increases efficiency and longevity of their parts.

- **Building Controls**

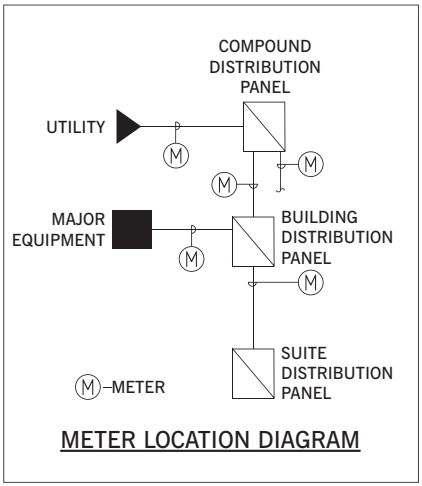
Newer building control systems are a computerized network of electronic devices which are designed to monitor and control mechanical, lighting, and other systems in the building.

A Building Automation System (BAS) core functionality maintains the building climate within a specified range, provides lighting and cooling/heating based on an occupancy schedule, monitors system performance and device failures, and provides notifications to building engineering staff. The BAS is typically managed by the facility manager.

Energy savings and improved occupant comfort can be achieved by monitoring and adjusting building systems in response to internal conditions. Conditions that are usually controlled by the BAS include temperature, light levels, humidity, and carbon dioxide levels. Where older style systems use individual room thermostats, the BAS maintains temperature set points of rooms, which can be adjusted based on occupant requirements and/or requests.

Metering

Metering of electricity, water, and gas for each building larger than 200 square meters is required on all federal facilities as a best management practice. By October 1, 2012, all federal buildings are required to be individually metered, per EPAct 2005, Section 103 Metering Requirements, to support efficient energy use and cost reduction. Section 103 requires hourly intervals and daily reporting for all federally owned and leased facilities.



METER LOCATION DIAGRAM

Metering helps manage energy use and cost, verify equipment operations, support decisions, benchmark facilities, verify utility bills, and understand costs. The metering installation must meet EPAct 2005 requirements as specified by OBO's SED requirements.[13] This includes the provision of additional meters for each building, suite, and specialty system or major equipment. OBO recently initiated a program to address existing facilities that are not equipped with metering in accordance with EPAct 2005. The goal of this effort is to standardize metering requirements and provide guidance for facilities to install proper metering for water, electricity, gas, and fuel.

Metering efforts and ongoing documentation of meter readings inform and help prioritize funding for ECMs and ESPC contracts. OBO compiled energy and water usage data through its Sustainability Survey distributed to all facilities in November 2007. The resultant database report shows Posts ranked by energy and water use and cost. The report graphs results by totals, unit rate, per square meter, and per full-time-equivalent (FTE) personnel. This report allows Posts to evaluate their standing in relation to other Posts of their region and the overall mean.

Synergy: Introduction

Metering locations for electricity, water, and fuel/gas shall be in compliance with EPAct 2005 as noted below:

- **Electricity:**
  - » Individual building feeds: Individual designated suites
  - » Large mechanical equipment (chillers, air handling units, boilers, and/or water heaters)
  - » Large individual feeders over 100kW in size
- **Water:**
  - » Individual building feeds (swimming pool or cafeteria)
  - » Service water: Large mechanical equipment (chillers)
  - » Irrigation feeds
- **Gas/Fuel:**
  - » Generators
  - » Boilers
  - » Water heaters

Meters can be installed at relatively low cost, and their installation require minor design effort.

● Commissioning (Cx)

As defined by ASHRAE, commissioning is a "quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems and assemblies meets defined objectives and criteria."[14] Typically, this process occurs during design and construction.

Retro-commissioning or Re-commissioning (R-Cx) is a similar process in its goal of verifying that systems perform as closely as possible to defined performance criteria. R-Cx typically occurs after systems have been in operation for at least one year. Best practice recommends R-Cx every 5 years.

Cx and R-Cx processes are valuable tools to ensure that building systems are operating properly. Both Cx and R-Cx offer facility managers a direct, tangible means of supporting business objectives and provide a benchmark by which to measure a building's operational performance.

- R-Cx generally focuses on three issues:
  - » safety and security
  - » occupant comfort
  - » energy use and savings

The decision to perform R-Cx might arise from a failure to maintain space temperature or humidity requirements, an unexplained dramatic increase in energy use, or upcoming modifications to systems requiring performance data that does not exist.

- The economic benefits of R-Cx are:
  - » increased system optimization
  - » increased energy efficiencies
  - » identification of operating/control/maintenance problems, including reduced premature equipment failure

The process aids in long-term planning and budgeting. With typical office building operating costs of $0.54 cents to $4.30 cents per square meter, R-Cx often has an initial investment payback of one to four years.

To determine systems requiring a minimum R-Cx effort, facility managers should first schedule R-Cx for systems related to health and life safety such as fire suppression and alarms and security/ emergency lighting. Facility managers should also schedule R-Cx and regular testing for systems critical to a facility's mission. These would include systems that are immediately detrimental to operational costs and the need for capital expenditure should they fail. Examples of such systems include HVAC systems and power systems. Post should compile and maintain Cx & R-Cx documentation. One straightforward method of documentation is a checklist.

The following is a sample checklist as recommended by DOE that can be tailored by Post according to their specific systems:

Commissioning Activities and Documentation Checklist[15]

- ☑ **System Requirements:** List and describe the system requirements and basis of design intent with performance criteria.
- ☑ **Commissioning Plan:** Create the commissioning plan as early in the design phase as possible, including the management strategy and list of all features and systems to be commissioned.
- ☑ **Bid Documents:** Integrate commissioning requirements in the construction bid and contract documents. Designate the Construction Specifications Institute (CSI) Construction Specification (1995 version) Section 01810 in Division 1 for general commissioning requirements. Use the unassigned Sections 01811 through 01819 to address requirements specific to individual systems. Notify the mechanical and electrical subcontractors of Division 15 and 16 commissioning requirements in Sections 15995 and 16995.
- ☑ **Functional Performance Test Procedures and Checklists:** Develop functional performance test procedures or performance criteria verification checklists for each of the elements identified in the commissioning plan.
- ☑ **Commissioning Report:** Complete a commissioning report for each identified component, equipment, system, or feature, including the results of installation observation, start-up and checkout, operation sampling, functional performance testing, and performance criteria verification.
- ☑ **Training:** Assemble written verification that training was conducted for appropriate personnel on all commissioned features and systems.
- ☑ **Operation and Maintenance Manuals:** Review operation and maintenance manuals for completeness, including instructions for installation, maintenance, replacement, and start-up; replacement sources; parts list; special tools; performance data; and warranty details.
- ☑ **Recommissioning Management Manual:** Develop an indexed recommissioning management manual with components such as guidelines for establishing and tracking benchmarks for whole building energy use and equipment efficiencies, recommendations for recalibration frequency of sensors, list of all user adjustable set-points and reset schedules, and list of diagnostic tools.

Inspectors can use this type of checklist during initial R-Cx work to ensure they review, test, and verify items of concern. Facility managers can easily convert it into a spreadsheet of action items to address and confirm, and then file as a primary document that is available for future reference. The checklist may also be used for ongoing Cx to ensure consistent data collection.

Often the internal facility management team can set up the process and perform many of the required tests; however, it may be necessary to contract with outside building system professionals.

Regenerative Systems

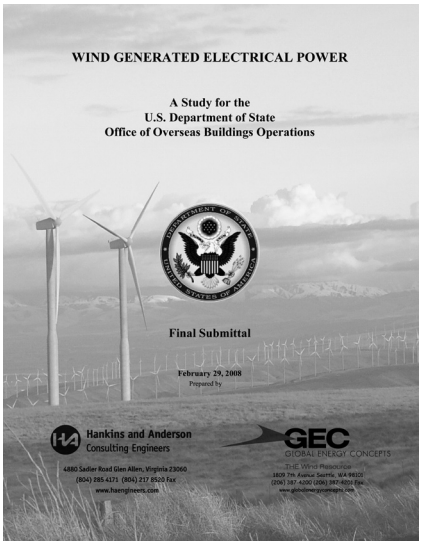
Regenerative systems use identifiable waste streams as a fuel source for another system. The most prominent example of this, used in some DOS facilities, is the capture of waste heat from generators to heat water for multiple purposes. Often considered co-generation, the effective use of a wasted commodity can have significant impact on efficiency and savings at a facility.

Another form of regeneration is use of the earth's naturally stable temperature to transfer heat to the advantage of the facility. This technology, when properly designed into a system, can pre-heat or pre-cool depending on the need using geothermal (earth temperature) sources to cool water for air conditioning systems, cool air for fresh air intake, and heat water for supplemental heat. The U.S. housing in Seoul, Korea has installed a geothermal heat pump that circulates hot water from the cooling system in the summer, and cold water from the heating system in the winter, through the ground. Water exits the ground loop at consistent 12°C (54°F) year-round increasing system efficiency.

Renewable Energy Sources

Renewable energy sources are becoming more and more economical to install and operate, which provides financial savings benefits and

power independence. The most notable point regarding renewable energy sources is that the source is always available and free, regardless of the market or political environment. Depending on the Post's utility costs, these systems can pay for themselves quickly by reducing utility expenses. An added benefit of renewable energy is the reduction of carbon emissions from traditional generation sources.



Renewable energy sources include solar, wind, biomass, landfill gas, ocean (tidal, wave, current and thermal), geothermal, municipal solid waste and new hydroelectric generation capacity. See EPAct 2005, Section 203. Due to the size of OBO facilities, the primary focus is on PV and wind.

● Photovoltaic (PV)

Photovoltaic energy is produced by exciting electrons in typically silicone-based panels. Once these electrons begin to move, electricity is produced. Panels (typically 1 square meter in size) are arranged in arrays and can be located on roof structures, or as free-standing arrays. Free-standing arrays may be used to provide solar shading for windows, walkways, and parking areas. Arrays may also be installed vertically on the face of buildings or on the ground. The power produced by the array is Direct Current (DC), similar to battery power, and must be converted to Alternating Current (AC) for use in the facility. This is accomplished with inverters that intelligently change DC power into AC, and feed this power into the facility power distribution system.

- **Systems:** panels, inverters, and mounting—are modular and able to be phased, dependent on availability and funding. There are two common types of PV installations, battery and grid-connected.
  - » **Battery** systems charge batteries at DC and the batteries are available for use during the day or night.
  - » **Grid-connected** systems connect directly to the power system of the facility and supplement the base source of power (utility or generator) to reduce the need for that source. Because of the high maintenance needs of batteries, only grid-connected systems have been installed or planned for OBO facilities to date.

The economic benefit of a PV system is that the array generates on-site power with no fuel cost. Payback periods for new construction, depending on utility/fuel costs that have been documented with OBO; current OBO project selection criteria requires a maximum of 10 year payback cycle. As industry efficiencies improve, the subsequent payback periods will decline.

On-site power generation increases security through independence and control of the power source, which is a major benefit to the Post.

In the event the PV system produces more electricity than the facility needs, surplus power can be sold back to the utility. This is considered a net-meter installation, and the utility can pay for the power at standard utility rates or pay a premium for the "green power" to provide incentives for the use of renewable energy sources, as established in some countries in Europe.

OBO has installed PV arrays at the U.S. Embassies in Geneva, Switzerland and Abuja, Nigeria, and is actively planning installations in Kigali, Rwanda and Athens, Greece.

OBO did a preliminary investigation of the feasibility of PV at Posts with reported power rates and created a Project Prioritization Listing. This preliminary prioritization listing of PV installations ranks Posts on the basis of shortest payback period according to OBO's current understanding of Post's electricity generation costs and solar opportunities. A portion of the listing is shown here:[16]

PV Project Prioritization Listing

Rank	FY NEC	Post	Country	kW PV	Project Cost (Total)	Annual Savings	Simple Payback (Years)	Utility Rate $/kWh[a, b]
1	10	N'Djamena	Chad	300	$3,085,000	$1,955,088	2	$1.21
2		Abuja - NOX	Nigeria	125	$1,085,000	$671,104	2	-
3		Rangoon	Burma	250	$2,585,000	$671,882	4	-
4	09	Monrovia	Liberia	500	$4,085,000	$1,106,718	4	-
5	10	Santo Domingo	Dominican Republic	500	$4,085,000	$1,043,485	4	$0.40
6	05	Kigali	Rwanda	419	$4,275,000	$973,385	5	$0.45
7	05	Port-Au-Prince	Haiti	339	$4,390,000	$889,466	5	-
8	06	Harare	Zimbabwe	569	$4,637,000	$863,245	6	$0.15
8		Windhoek	Namibia	750	$6,085,000	$1,083,239	6	$0.40
9	06	Djibouti	Djibouti	569	$4,637,000	$821,817	6	$0.40
10	07	Ouagadougou	Burkina Faso	569	$4,637,000	$770,991	6	$0.40
11	07	Johannesburg	South Africa	569	$4,637,000	$767,662	6	$0.30
12		Kabul	Afghanastan	250	$2,085,000	$344,801	6	-
13		Athens	Greece	404	$2,711,000	$557,506	6	$0.12
14	09	Valletta	Malta	105	$925,000	$142,267	7	$0.30
15	06	Beirut	Lebanon	569	$4,637,000	$706,291	7	$0.30
16		Freetown	Siera Leon	500	$5,085,000	$747,574	7	-
17		Frankfurt	Germany	33	$299,500	$49,648	7	$0.14
18	06	Khartoum	Sudan	347	$2,861,000	$402,951	7	$0.40
19	08	Juba	Sudan	1000	$11,085,000	$1,569,768	7	-
20		Dushanbe	Tajikistan	300	$3,085,000	$402,110	8	$0.25
21	09	Malabo		200	$1,685,000	$220,673	8	-
22		Managua	Niceragua	569	$5,775,000	$705,489	8	$0.20
22	06	Brazzaville	Congo	569	$4,637,000	$549,338	9	$0.15
23		Phnom Penh	Cambodia	198	$2,065,000	$240,313	9	-
24		Conakry	Guinea	300	$2,485,000	$289,633	9	-
25		Luanda	Angola	250	$2,585,000	$297,859	9	$0.25
26		Munich	Germany	33	$299,500	$40,349	9	$0.21
27		Lome	Togo	384	$3,925,000	$430,337	9	$0.30
28		Berlin	Germany	33	$299,500	$38,191	10	$0.14
29		Dusseldorf	Germany	33	$299,500	$38,191	10	$0.14
27		Bonn	Germany	33	$299,500	$38,191	10	$0.14
28		Stuttgart	Germany	33	$299,500	$38,191	10	$0.14
29		Leipzeig	Germany	33	$299,500	$38,191	10	$0.14
30		Lagos	Nigeria	250	$2,585,000	$275,841	10	-
31	11	Dakar	Senegal	500	$4,085,000	$431,849	10	$0.20
32		Ulaanbaatar	Mongolia	250	$2,585,000	$257,663	10	$0.16
33	10	Asmara	Eritrea	347	$2,861,000	$283,497	10	$0.30

a. "-" means that the Post is not connected to a power grid

b. Posts with relatively low rates have very frequent or extended outages that make them dependant on power generated on-site

Case Study

U.S. Embassy, Geneva, Switzerland, a building-integrated photovoltaic (BIPV) system with net metering, is producing an average of 270 kWh (972 MJ) of power a day and approximately $60,000 worth of electricity a year. The total installed size of the system is 118kW.

At the time of completion, this was the largest photovoltaic array ever undertaken by the U.S. Government overseas. In 2003, Ambassador Kevin E. Moley, then U.S. permanent representative to the United Nations in Geneva, and his staff found themselves confronted with two problems: the building's concrete façade was crumbling, and Post's energy costs were mounting dramatically as electricity rates soared and the dollar declined. The PV panels help protect the façade and prevent further deterioration, as they generate clean electricity and lower energy costs. The electricity produced is sent directly into Geneva's electricity grid (instead of storing it in batteries for use on-site) and the local power utility purchases it at a preferential rate established to encourage renewable energy production.

The U.S. Embassy in Abuja, Nigeria received the next largest, strictly roof-mounted, installation of PV. Recently completed, the system produces 100kW of power and reduces the power demand on the utility, or from the on-site generators. Abuja was selected for a PV installation due to its electricity use and cost, and abundant sun in equatorial Africa. The system covers the roofs of the utility buildings and CACs, as well as a portion of the Chancery. Because of the high power costs, this system will payback in less than 3 years. The savings directly benefit the Post in the form of reduced energy costs.

Wind Power

Another abundant, on-site, renewable resource is wind. Use of on-site wind to generate power has proven to have beneficial payback, depending on utility/fuel costs and actual wind speeds. It has been used as a supplement to prime power sources and as a strategy to reduce electrical use during peak load conditions.

Low initial cost and low maintenance requirements make wind turbines attractive and of little impact on operations budgets. The system consists of a wind turbine installed on a large open area on the Post.

As with any other alternative energy generation source, wind can provide power independence and control, and is therefore viewed as a means to increase security.

OBO has a five step process for installing wind power generation at Posts:

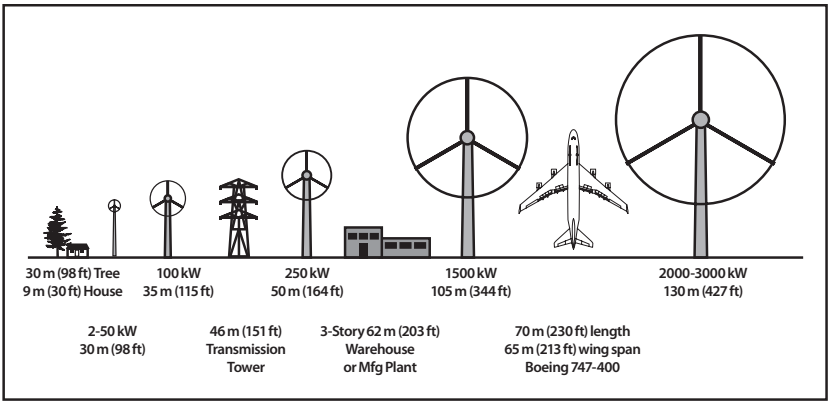
1. **Feasibility:** Post completes the 19-point checklist (See list below).
2. **Site Location:** Post works with OBO to determine the most feasible location for the turbine given site conditions.
3. **Data Collection:** OBO funds the erection of an on-site anemometer—to measure wind speed and direction—such as the one erected for the U.S Embassy in Managua, Nicaragua. The anemometer at this Post was placed on an existing communication tower, adjacent to the site, to log wind data to determine the feasibility of installing a future wind turbine.
4. **Estimate Payback:** After one year of monitoring, Post estimates the investment cost and calculates the payback period of the proposed installation, using the data collected by the anemometer. Currently, as with PV, a minimum of 10-year payback must be achieved for funding consideration.
5. **Funding:** An ESPC or appropriations are identified to fund the project.

OBO produced a comprehensive study to evaluate wind-generated electrical power as a renewable resource for Posts around the world. This study evaluates available wind generation technologies; provides an analysis with nineteen screening criteria; and contains additional information including wind maps, product evaluations, lifecycle-cost-analysis (LCA), and turbine manufacturer product data. The wind ranking criteria score provides OBO a mechanism for prioritizing sites for potential wind generation.

	Wind Ranking Criteria	Possible Points
1	Land Availability	25
2	Cost of Electricity	25
3	Strength of Wind Resource	25
4	Quality of Wind Resource Information	5
5	Terrain	5
6	Surrounding Obstructions	5
7	Accessibility	5
8	Availability of Heavy Equipment	5
9	Local O & M Capacity	5
10	Surrounding Obstructions	5
11	Height Restrictions	5
12	Soil Conditions	5
13	Severe Operating Conditions	5
14	Social Acceptability	5
15	Avian Conflicts	5
16	Aviation Conflicts	5
17	Telecommunications Conflicts	5
18	Blade Soiling Conditions	5
19	Grid Stability	5
	Total Possible Score	155

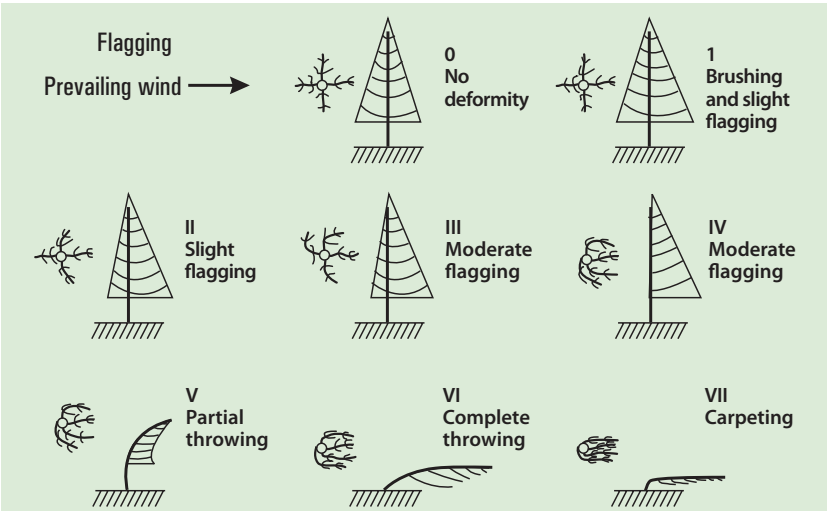
[17]

Wind turbine sizes are classified as residential-scale, industrial-scale and utility-scale. The OBO study evaluated three industrial-scale turbine sizes, small (<10kW), medium (15-60kW), and large (100–250kW) for general feasibility and LCA. The large turbines are most likely to be viable for DOS facilities, depending on land availability, height restrictions, and social acceptability. Local wildlife experts need to be informed that the turbines have not shown significant affects on bird or bat migratory or normal movement patterns.



Comparison of wind turbine sizes with common objects

Currently OBO is gathering wind resource data to determine the optimum locations to implement large-scale wind projects.



Griggs-Putnam Index of Deformity

Index	I	II	III	IV	V	VI	VII
Wind mph	7-9	9-11	11-13	13-16	15-18	16-21	22+
Speed m/s	3-4	4-5	5-6	6-7	7-8	8-9	10

Foliage flagging is an indication of wind availability and speeds. It is used to gather wind data to establish the feasibility of wind power at Posts.

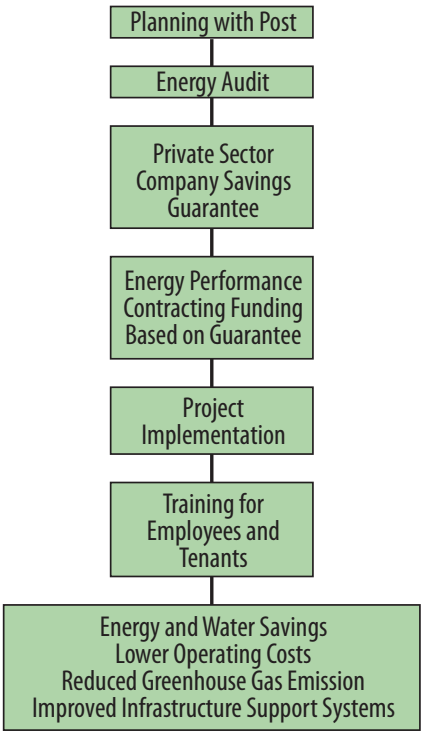
Innovative Contracting

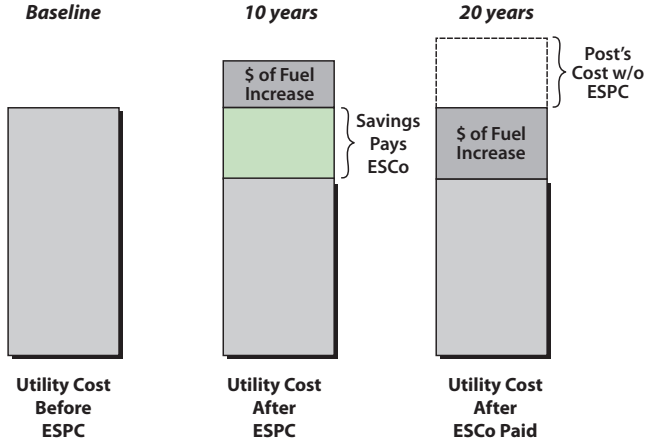
Energy Savings Performance Contracts (ESPCs)

ESPCs are specifically recommended in EISA as an alternative method of project funding and authorized under EPAct 2005, Section 105. ESPC is a no-upfront-cost contracting method supported by the DOE/EERE/FEMP. The project contractor incurs the cost of implementation of ECM and is paid, over a period of time, from resultant energy, water, wastewater, and/or other operational savings.

The process begins with the Energy Service Company (ESCo) conducting a comprehensive audit and identifying improvements that potentially save energy and/or water at the facility. This audit produces a list of all possible ECMs and specific items requested by OBO for evaluation. The list is evaluated based on payback, and is bundled together to meet the savings requirements of the contract and to address any other non-energy-related items that can be rolled into the price and construction. Non-energy related construction with little or no payback, such as deferred maintenance, can be added to the contract and can be funded by the savings of the ECMs. The ESCo then designs and constructs a retrofit project that reduces the Post's utility costs and is paid by these savings generated by the project over a long-term contract. After the contract ends, the cost savings accrue to the Post. The maximum contract term allowed by FEMP is 25 years.

How an ESPC typically works





Examples of OBO ESPC projects implemented at Posts include:

- Mexico City: Lighting, motors and controls
  1999- $0.58M 9-yr contract
- Seoul: Geothermal heat pumps
  2001- $12.5M 19-yr contract
- Santo Domingo: Lighting and controls
  2005- $0.72M 10-yr contract
- Dhaka: Gas Turbine generators
  2007- $0.72M 11-yr contract

As utility and operational expenses rise, and funding sources decline, this project funding method becomes increasingly valuable. Other federal agencies, such as; DOE, Department of Defense, Bureau of Prisons, and General Services Administration, have implemented broad ESPC programs for funding both ECM and rehab/new construction projects.

Education and Training

Ongoing professional development is required of all Embassy personnel who work to improve operations and maintenance of a facility. Ambassadorial leadership and the skills of facility managers, General Service Officers, and Management Officers are specifically critical to the effective use of energy at each Post. All staff can make a contribution to energy savings in the workplace. By including energy efficiency as an essential component in facility management team training and in policy decisions, this priority can be established and reinforced throughout the year.

Facility-run incentive programs, such as the green-team formed by the Embassy in Helsinki, Germany, are most effective because they include a cross section of personnel and meet monthly to review and make recommendations to green the Embassy and residences. These green-teams can encourage initiatives like a "best green idea of the month" to spur ideas from Embassy personnel and be provocative in identifying and implementing energy efficiency strategies. Post leadership can be recognized through award programs or other local programs within the country.

Abuja, Nigeria: Facility Management staff training is specifically critical to the effective use of energy at every Post.

Case Study

The U.S. Embassy in Lisbon, Portugal is committed to reducing the Mission's carbon footprint and improving energy efficiency. Post staff have formed an eco-team called, "Lisbon Eco-Friendly Action Forum (LEAF) to manage, educate, and incentivize conservation activities.

What LEAF is doing for the Embassy:

- Replacing fleet vehicles with hybrid or more fuel efficient models
- Implementing OBO 1997 Energy Audit recommendations (14 of 25 complete)
- Monitoring HVAC set points to optimize system (72°F (22°C)(heating high) and 68°F (20°C)(cooling low))
- Installing 50% more efficient new boilers
- Purchasing 50% more efficient compressors (also quieter)
- Purchasing only Energy Star® appliances (or European equivalent)
- Replacing wall mounted lights with 65% more efficient lights
- Evaluating replacement of fluorescent lamps with five times more efficient LED lights
- Replacing incandescent lights in residences, rented and owned by the Embassy, with five times more efficient CFL lamps
- Installing motion detector light switches in all offices
- Establishing an effective recycling program
- Placing recycling bins and bags in offices and hallways on every floor
- Disposing of segregated materials properly

LEAF Tips for conserving at the office:

- Print and copy on both sides of the paper
- Recycle paper, containers, glass, and batteries
- Turn off monitors and printers at night
- Notify Facilities Maintenance about problems – leaky faucets, cracked doors/windows

Practical Application

1. **AUDIT:** Measure and baseline energy use and cost at Post:

   a. Conduct an audit to identify inefficiencies in energy use and ways to reduce demand for energy.

   b. Complete the OBO Sustainability Survey: Post, Compound, and Building Level Surveys.

   c. Explore Energy Management Systems as support tools.

2. **SHORT-TERM ACTIONS:** Identify low- or no-cost options and measures for immediate consideration to optimize systems performance:

   a. Review potential rate structuring opportunities and benefits.

   b. Implement a policy stating that energy efficiency is a priority criterion in selecting equipment and appliances for use within facility.

   c. Occupancy Sensors – Install workstation occupancy sensors to power down plug-loads during non-use.

   d. Turn-off computers and monitors when not in use.

   e. Use the most efficient light source for lighting fixtures and clean lighting fixtures for optimal light output.

   f. Adjust general lighting levels to 25-35 foot-candles (269-377 lux) (use artificial lighting to supplement natural daylight to reach this level) and supplement workstations with LED task lighting.

   g. Replace all incandescent lamps with higher efficiency, low-mercury, CFL lamps.[18]

3. **MID- TO LONG-TERM ACTIONS:** Identify equipment or projects requiring capital investment:

   a. Metering:

      i. Review federal requirements for compliance with 2012 deadlines.

      ii. Determine metering requirements on a site-by-site and building-by-building basis.

      iii. Develop and set specific energy and water conservation goals.

      iv. Determine data and equipment needs.

   b. Re-commissioning:

      i. Set a R-Cx plan for implementation through facility management, OBO, or outside consultation.

      ii. Perform R-Cx on all building systems every five years to optimize system performance. OBO can provide guidance on a re-commissioning plan.[18]

      iii. Allow BAS to automatically control equipment. Monitor and adjust system set-points and set-backs to optimize efficiency.[18]

   c. Regenerative Systems:

      i. Actively participate in design project planning for retrofits.

      ii. Plan, budget, and schedule upgrades that increase efficiencies.

      iii. Know the specific climate and environment, and look for savings opportunities with new technologies, such as economizers.

d. Renewable Energy

i Identify and purchase power from green-renewable providers.

ii. Keep track of the percentage of facility's total load provided from green power.

iii. Explore options to provide power independence through on-site wind and PV systems.

4. **EDUCATE:** Develop education programs for staff focusing on personal behavior modifications to reduce energy use and cost.

a. Change occupant behavior through increased awareness. Posts have reported reduced use through distribution of energy bill information. For example, trends in energy use, comparisons of one tenant to others or a mean, or simple reminders to conserve.

b. Develop energy efficiency as an integrated theme in facility management team training.

c. Investigate incentive programs to spur ideas from Embassy personnel regarding identification and implementation of energy- efficiency strategies.

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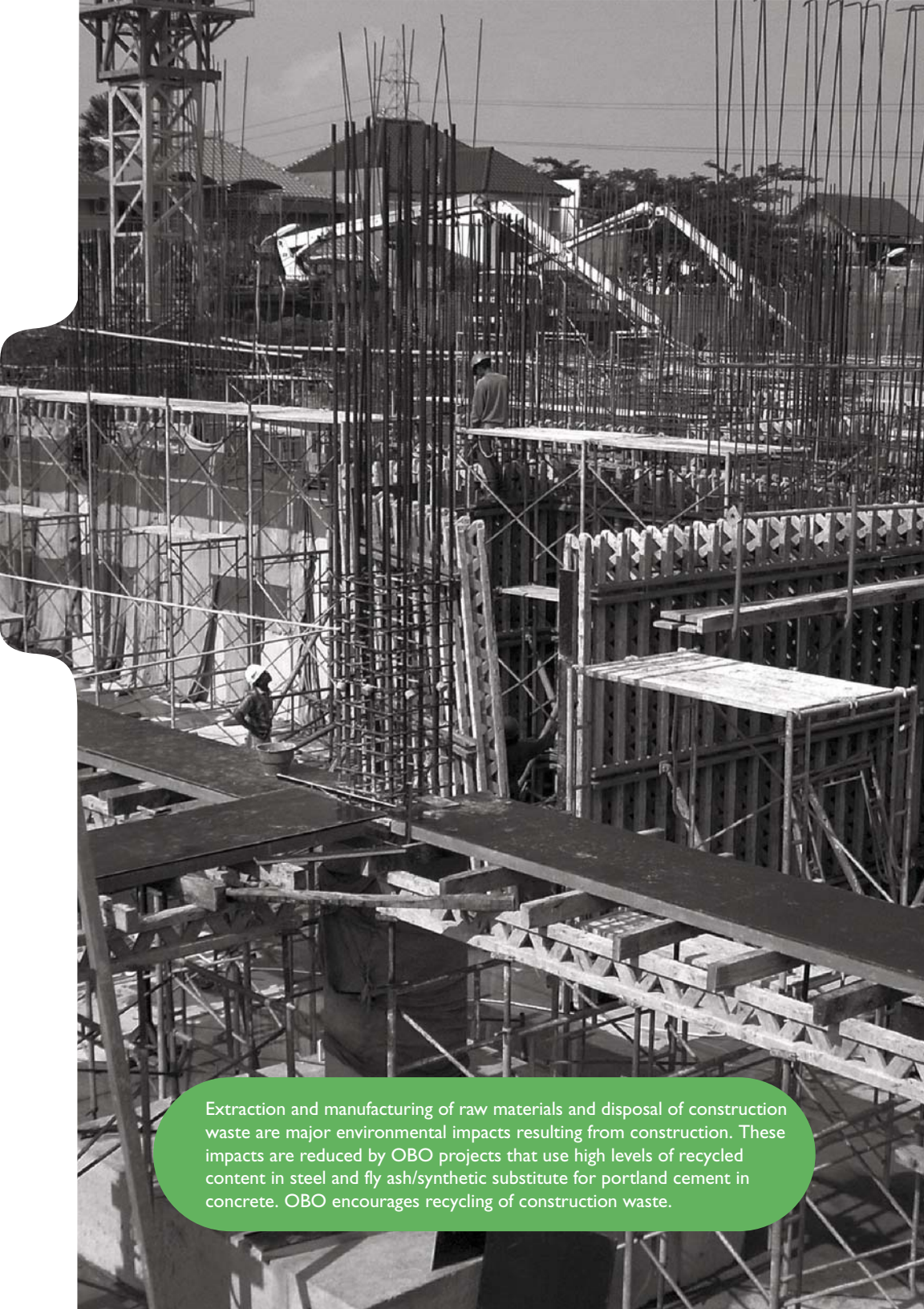
www.BCxA.Org

MATERIALS

The **gecko** can support his entire body with one toe. Biomimicry scientists are studying the microscopic hairs (setae) of the **gecko's** toes as a model for developing the first dry, self-cleaning adhesive.



Extraction and manufacturing of raw materials and disposal of construction waste are major environmental impacts resulting from construction. These impacts are reduced by OBO projects that use high levels of recycled content in steel and fly ash/synthetic substitute for portland cement in concrete. OBO encourages recycling of construction waste.

Chapter 5
Materials

Procurement 113

- Environmentally-Preferable Building Products 114
- Office Products 116
- Food Service Products 117
- Appliances & Equipment 118
- Incandescent Lamps 118
- Green Cleaning Products 118
- Alternative Materials 119
- Fleets 119

Resource Use 120

- Reduce 121
- Reuse 122
- Recycle 122

Proper Disposal 123

- Mercury-Containing Light Bulbs 123
- Batteries 124
- E-waste 125
- Construction Demolition & Renovation 126

Practical Application 127

Materials

"...material flows on the planet [as] biological and technical nutrients."[1]

In their book "Cradle to Cradle", authors Michael Braungart and William McDonough suggests that living and man-made resources, when shaped into usable products, should function within the same closed-loop life cycle so they can be fully and easily recycled, not down-cycled or end up in landfills. This represents a growing sentiment that products used daily should be considered first for their ultimate use when consumers are finished with them—focusing on cradle-to-cradle, rather than cradle-to-grave, life cycles. Using these types of ideas as a baseline for purchase decisions, government agencies around the world have developed guidance that considers manufacturing processes and waste streams in their procurement plans.

Green Procurement:
The purchase of products or services less-toxic and harmful to our health and environment than other available products or services on the market.[2]

The construction of the American Embassy in **Abidjan, Cote d'Ivoire,** used high levels of recycled materials and practiced recycling of construction waste.

Procurement

Materials used to construct, maintain and operate a facility should be chosen with consideration of their associated environmental impacts and should comply with EPA's Comprehensive Green Purchasing Program *http://www.epa.gov/oppt/epp/pubs/greenguides.htm*. Greening initiatives should be managed by a comprehensive team that includes representation by those responsible for the procurement of materials, supplies, energy, and equipment.

Materials selection plays a significant role in sustainable building operation because of the environmental and health consequences associated with their life cycle, embodied energy, and carbon footprint; including extraction, processing, transportation, use, and disposal. These activities can pollute water and air, destroy native habitats, and deplete natural resources. Environmentally responsible procurement policies can significantly reduce these impacts. When purchasing materials and supplies, consideration should be given to the relative environmental, social, and health benefits of the available choices. For example, materials containing recycled content expand markets for recycled materials, slow consumption of raw materials, and reduce quantities of waste disposed of in landfills. Use of local materials supports local economies while reducing transportation impacts. Cleaning and other chemical products with fewer health and environmental impacts lead to a healthier workforce and a cleaner environment.[3]

A sustainable facility operation plan requires policies and procedures that guide the procurement process. A successful plan targets waste reduction and selection of less harmful materials and supplies, thereby reducing the overall impact of the facility on the environment.

Environmentally-Preferable Building Products

When choosing high-quality, durable building products and supplies for construction, operations, maintenance and repair, the following list of desirable characteristics provides guidance:

- Give priority to materials extracted, fabricated, and manufactured within a maximum 805-km (500-mi) radius of the facility
- Procure high recycled-content and recyclable materials. See EPA's recommendations for recycled content
- Use bio-based or rapidly-renewable resources. See USDA's recommendations for bio-based fuels, compost, materials
- Reuse products to reduce the waste stream
- Choose items that do not contain toxic or harmful substances
- Use products that do not compromise indoor air quality
- Select products comprised of salvaged materials
- Find wood products made from wood certified by the Forest Stewardship Council (or from sustainably-managed forests)

Consideration also should be given to the embodied energy (total amount of energy consumed) of the final product, including the extraction of raw materials used to make the product, the assembly and manufacture of the product, and the transport and delivery process to final point of use.

Case Study

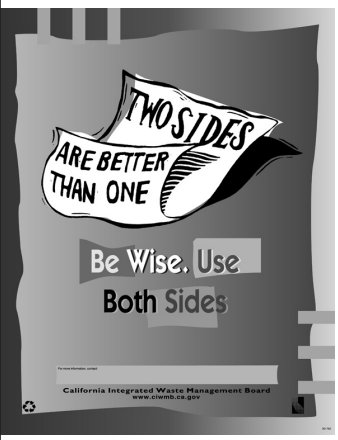
The new Embassy compound in Panama City, Panama earned both LEED® certification points of Materials & Resources (MR) credits MR 5.1 and 5.2 for using locally extracted, processed, and manufactured materials. 22.6% of the total $10.3M construction cost for the project's raw materials came from sources within 75 miles of the project site, supporting the local economy and reducing greenhouse gas emissions from transporting these materials.

Local materials included concrete, plaster, earthwork, pavement, and landscaping. Aggregate, cement, sand, and water for concrete and plaster were extracted from the Chagres area. Trees and palms were regionally grown at nurseries in Chorrera and Panama City. Mulch, shrubs, ground cover, soil, planting mix, gravel, turf-sod, and turf-mulch were grown in a nursery in Penonome. Here is a summary of the project's raw materials:

Total NOB Material Costs	$10,329,501
Total Regional Materials: Extracted, Processed & Manufactured	$2,334,180
Percentage of Total Regional Materials	22.6%
LEED® MR 5.1: Minimum 10% Regional Materials Used	One Point
LEED® MR 5.2: Minimum 20% Regional Materials Used	One Point

Office Products

Is the zero waste office possible? Today the goal of zero waste is more of a journey than something that can be readily achieved. However, just as building products are being evaluated in consideration of their attributes, office products that have less impact on health and the environment should be given favorable status.



The single largest volume office supply used in most offices is paper. Choosing 30% post-consumer recycled-content paper, as specified in federal procurement policy, in lieu of conventional paper, saves natural resources. An effective paper recycling program reduces the cost of paper waste.

Setting office printers/copiers to default on double-sided copies saves on paper consumption. Isolation of high-volume units supporting better indoor air quality, and recycling of toner cartridges, have become standard practice.

Synergy: Chapter 6: Indoor Environment/IAQ/Pollutant & Contaminant Sources

Green products are easier to find in large chain stores that are capitalizing on green sales. In 2003, Office Depot launched its Green Book, a catalog of 1,300 environmentally preferred products which now contains more than double that number. Even more products are available on Office Depot's Buy Green online store section. The company offers items in various shades of green: for instance, paper containing anywhere from 10% recycled to 100% post-consumer paper.[4]

Similar programs exist throughout many supply chains world-wide, providing an increasing source of green products. For example, the office furniture and carpet sectors have made great strides in recent years to create new products that have less impact on the environment and to have attributes that support a healthy work

environment. The efforts of these major manufacturers and others are well-documented. Refurbishing programs support the reuse of salvaged materials, and new products are increasingly being manufactured using recycled and recyclable materials.

Food Service Products

The food service industry, more than any other, has embraced the "disposable age". In today's office environment, disposable packaging and containers for food and drink products abound in lunchrooms, cafeterias, meeting rooms, offices, and workstations. Although in some locations aluminum cans and plastic bottles are being recycled, a large percentage of waste, from both packaging and food service, enters the waste stream.

For example, in the U.S., over 30 billion single serving bottles of water were purchased in 2006. Less than 20% were recycled. Bottle manufacturing required 17 million barrels of oil, produced 2.5 million tons (2.3 billion kg) of carbon dioxide, and used 3 times the amount of water in the actual bottle. Adding transportation, the total energy used is the equivalent of 50 million barrels of oil, enough to power 3 million cars annually.[5]

The installation of a point-of-use filtered water system can easily reduce the need or desire for bottled water in the workplace. Pitchers or carafes may be used in meeting spaces in lieu of drinks served in individual containers, and employees can be encouraged to use their own personal, reusable cup.

One option for reducing waste is to use non-disposable dishes, glassware and utensils. If selected, this option requires energy and water for washing the items. Another option is to choose biodegradable disposable items, such as those made from sugarcane or cornstarch.

A composting operation may be used for the elimination of food scraps, paper, landscape trimmings, wood chips, manure, etc. The resultant materials may then be used for fertilization of planted areas on the site.

All means of eliminating waste associated with food service have economic benefits. By diverting them from the waste stream, disposal fees are reduced.

Synergy: Chapter 2: Site/Landscaping/Xeriscaping

Appliances & Equipment

When purchasing replacement appliances, computers, copiers, printers, and other equipment, choose those with an ENERGY STAR®-label or equivalent rating. See EPAct 2005, Section 104. These appliances consume less energy, and are thus less expensive to operate and have less of a carbon footprint.

Synergy: Chapter 4: Energy/Energy Management/Load Reduction

Incandescent Lamps

Eliminate the use of all incandescent lamps. Initiate a Toxic Material Source Reduction program that targets reduced mercury in lamps, specifically commonly-used fluorescent tubes. When specifying or replacing mercury content lamps for indoor or outdoor applications, choose lamps below 100 pico-grams per lumen hour, on weighted average. Consider LED (low-emitting diode/solid state) fixtures. Note statistics on energy savings and note that they can be used to replace task lighting.

Synergy: Chapter 4: Energy/Energy Management/Load Reduction/Lighting

Green Cleaning Products

While green cleaning is discussed in detail in Chapter 6, in regards to procurement, it is important to establish guidelines for purchasing products based on their green characteristics and how they can contribute to an overall sustainable procurement strategy.

Synergy: Chapter 6: Indoor Environment/IAQ/Pollutant & Contaminant Control

Alternative Materials

To reduce the environmental impacts of materials acquired for operations, maintenance, and upgrade to buildings, consider alternative materials to reduce resource depletion and environmental impacts.

The environmental burden of the harvesting, manufacturing, consuming and disposing of materials varies by material type. Environmentally preferred materials have potential to mitigate this burden relative to conventional materials. Different categories of environmentally preferable products address different aspects of sustainability.[6]

Alternative materials include salvaged materials, recycled content materials, materials made from rapidly renewable resources, materials containing certified wood, and those that are produced locally or regionally. In choosing these materials, it is important to ensure that they are durable and perform well for their intended use.

Synergy: Chapter 6: Indoor Environment/IAQ/Pollutant & Contaminant Control

Fleets

Although issues associated with fleet management are thoroughly discussed in Chapter 1, procurement of vehicles is mentioned here in relation to their use of fossil fuels and the emissions they produce. In considering alternatives for vehicle replacement, it is recommended that long-term environmental impact and cost of operation be considered. Vehicles powered by engines that utilize gasoline/electric hybrid, natural gas, or electric technologies are recommended over those powered by standard internal combustion. Where these vehicle types are not readily available, consideration should be given to relative fuel efficiency.

Synergy: Chapter 1: Transportation/Fleet Management

Resource Use

The environmental impact of buildings is, to a great extent, the result of waste generated both during construction and ongoing operations. Waste disposal through landfill operations and incineration has negative environmental consequences. Management of materials leaving a facility should target a reduction in volume and proper handling of toxic or potentially harmful waste.

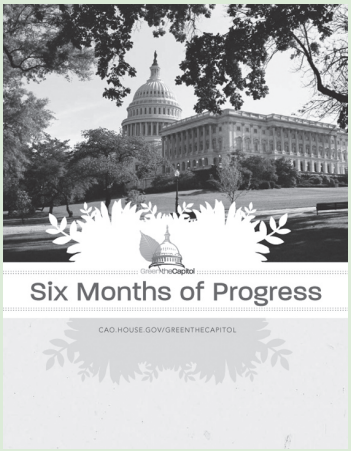
The EPA's three key strategies for waste reduction are (1) source reduction, (2) reuse and (3) recycling.[7]

Source reduction is at the top of the EPA's hierarchy of waste reduction techniques because it reduces all impacts of the material life cycle, including the supply chain, use, recycling, and waste disposal. Reuse ranks second because reused materials do not become waste or produce the environmental impacts associated with the recycling processes. Recycling ranks third – it does not deliver all the benefits of source reduction or reuse, but it does divert waste from landfills and incinerators and reduces the need for virgin materials.[8]

An effective building operations plan must include policies and procedures that describe responsible waste management. In addition, waste management plans require a review of the procurement procedures discussed earlier in this chapter. Procurement policies work in tandem with waste reduction goals to target reduction and the specification of less harmful materials and supplies. The overall goal is to reduce the impact that buildings impose on the environment.

Case Study

Green the Capitol



The House of Representatives is going carbon neutral, using 100% biodegradable cornstarch and sugarcane food containers and utensils in their cafeteria, 100% post-consumer paper products, and a pulper (giant garbage disposal) to reduce food waste by 50%. The pulper extracts water and composts waste into mulch to be used by local schools. This system has already diverted 118 tons from landfills in the four months it has been operating. Their paper choice saves 29,000 trees, 13.25M liters (3.5M gallons) of water, 181,437kg (400,000 lbs) of waste, and eliminates 351,534kg (775,000 lbs) of greenhouse gases a year. By consolidating computer servers, they plan to save 40-70% on computer operation energy in the next three years. They also plan to cut the cost of lighting the Capital Dome by 50%, by switching to LED lights.[9]

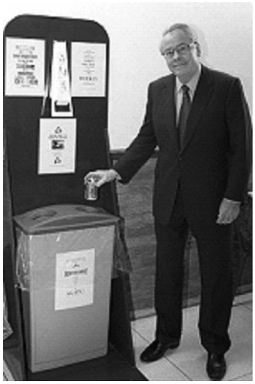
Reduce

The first step in source reduction is to conduct an audit of the current ongoing waste stream to establish a building waste baseline. The audit should identify total waste by volume or weight, with subtotals for recyclables including paper, glass, plastics, cardboard, and metals. Opportunities for reduction or diversion of materials in each category should be identified, and a joint approach should be implemented that considers procurement procedures. Understanding waste production patterns of the building(s) and site is critical to identifying the most appropriate path to reduction.

Attention to procurement reduces the amount of material brought to the facility and waste leaving the facility, with economic benefits on both ends. Less waste means a reduction in disposal fees and a reduction in materials being sent to the landfill or being incinerated. Where source reduction is not possible, consider reuse or recycling.

Reuse

Strategies for reuse in facility operations may vary from one Post location to another, depending on the processes that occur in each. Reuse strategies focus on the elimination of materials from the waste stream. Some examples include reusable dishes, glasses, and utensils in lieu of disposable items; use of reusable trash bags in lieu of plastic disposable; or refurbishing and reuse of furniture and fixtures. All of these are part of an effective waste stream reduction plan.



American Embassy in London recycling program
Ambassador Tuttle leads the way in recycling aluminum cans in the Embassy's cafeteria.

Recycle

Not all Posts have municipal or third-party recycling systems available, but when they are, establishing a program is a leadership opportunity. At a minimum, the following materials should be part of an effective recycling program: paper, glass, plastics, cardboard, and metals.

Storage and collection of materials requires a review of the methods used to collect waste (generally handled by custodial staff), as well as a dedicated area where recyclables can be separated and held until they are picked up. Where on-site space is limited, the use of a third-party recycler with more frequent pick-ups is an acceptable alternative to on-site methods. Contracts can be executed to provide sorting and recycling services off-site.

Economic benefits of recycling are reduced disposal fees and the inherent value of the recycled materials that contribute to offsetting the cost of collection, removal, and disposal.

Proper Disposal

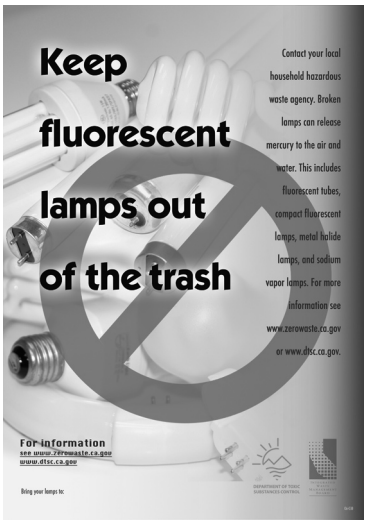
Mercury-Containing Light Bulbs

Human activities are responsible for an increase in the global distribution of mercury, through operation of coal-fired power plants, combustion of other fossil fuels, and disposal of mercury-containing products, including fluorescent lamps. (See Procurement of Lamps above.)

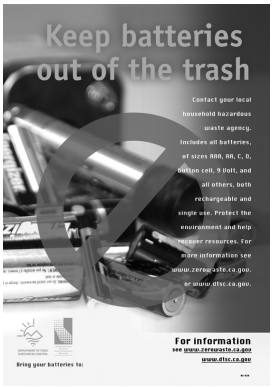
The Resource Conservation and Recovery Act (RCRA) regulations govern the transportation, storage, and disposal of hazardous wastes that contain mercury. Mercury wastes are governed under EPA's Land Disposal Restrictions (LDR) Program. EPA has designated some widely-generated hazardous wastes, including certain batteries, pesticides, mercury-containing equipment and lamps, as "universal wastes".

Standard fluorescent lamps are used to light 90% of lit commercial floor space in the United States.[10]

Other mercury-containing lamps used in buildings include compact fluorescent and high intensity discharge (HID) sources. The mercury in these lamps allows for high-energy efficiency and long life compared to other lighting options. Although currently there is no known method for completely eliminating mercury in fluorescent lights while maintaining energy efficiency, manufacturers have continuously reduced the amount of mercury in lamps. Lamp consumers can further this trend by requesting and purchasing lower mercury content lamps.[11]



Synergy: Chapter 4: Energy/Energy Management/Load Reduction/Lighting



Batteries

Another source of toxins commonly found in buildings is used batteries containing heavy metals such as mercury, lead, cadmium, and nickel, that if disposed of improperly will lead to pollution of land and waterways. Recycling of all batteries is required as part of an effective facility recycling program.

Dry-cell batteries include alkaline and carbon zinc (9-volt, D, C, AA, AAA); mercuric-oxide (button, some cylindrical, and rectangular); silver-oxide and zinc-air (button); and lithium (9-volt, C, AA, coin, button, rechargeable). On average, each person in the United States discards eight dry-cell batteries per year.

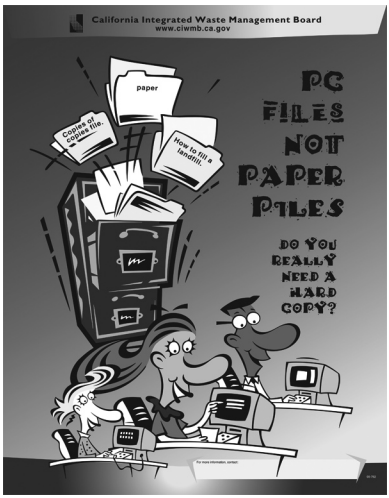
- **Alkaline and Zinc-Carbon:** Alkaline batteries are everyday household batteries used in flashlights, remote controls, and other appliances. Some reclamation companies now exist to process these batteries.
- **Button-Cell:** Most small, round "button-cell" type batteries found in items such as watches and hearing aids contain mercury, silver, cadmium, lithium, or other heavy metals as their main component. Button cells are increasingly targeted for recycling due to the value of their recoverable materials, small size, and easy handling relative to other battery types.
- **Rechargeable:** The Rechargeable Battery Recycling Corporation (RBRC), a nonprofit public service organization, targets four kinds of rechargeable batteries for recycling: nickel-cadmium (Ni-CD), nickel metal hydride, lithium ion, and small-sealed lead. Its "Charge Up to Recycle!" program offers various recycling plans for communities, retailers, businesses, and public agencies.[12]

Some counties and cities have hazardous waste collection programs. Posts should contact local officials to find out if a program is available, and when and where collections are held.

E-waste

According to a recent issue of the USA Today, electronics manufactured in 1997 had an average lifespan of 4-7 years. Today the average lifespan for most electronic equipment is 2 years. The environmental impact of the disposal of computer equipment is often overlooked. Computers are made up of more than 1,000 different materials, many of which are highly toxic, such as chlorinated substances, toxic gases, toxic metals, biologically active materials, acids, plastics, plastic additives, and in some cases, lead.

The good news is that computers are composed mostly of parts that are totally recyclable. The metal casing on the CPU itself is usually either aluminum or sheet metal, which can be melted down and reused to make more computers. Motherboards are mostly plastic and contain some hazardous materials that can all be retrieved in an environmentally-friendly method. Other materials that are considered hazardous can also be collected and reused in new computers. Security of data is of utmost importance at all Posts, and compliance with disposal regulations is required.



DOS' donation of used computer parts can also contribute to the marketplace: New computers can be made from old parts or recycled materials instead of having to mine for new raw materials, thus minimizing production costs.

Construction, Demolition, & Renovation

Diversion of recyclable construction and demolition materials not only saves space in landfills, but also reduces the rate of natural resource consumption. In many locales the following materials may be recycled: soils, site-clearing debris, concrete, asphalt, cardboard, paper, plastics, clean wood, and metal. Investigation of local recyclers will determine which materials are acceptable for recycling. Construction waste recycling will generally pay for itself and may be negotiated with building contractors during normal contract negotiations. Economic benefits include avoidance of disposal fees and recovery value of recycled materials.

The construction of the U.S. Consulate in **Mumbai, India,** uses high levels of recycled materials and practices recycling of construction waste.

Development of an effective Construction Waste Management Policy for future renovation activity requires quantification of land-clearing, demolition, and construction materials to be diverted from landfills. A reasonable diversion target is 50%, but a greater percentage provides even greater benefits. Documentation of quantities diverted is required to verify the effectiveness of the program, but this task is generally delegated to project contractors.

Construction and demolition activities generate enormous quantities of solid waste. The U.S. EPA estimated that 123,377M kg (136M tons) of construction and demolition debris (versus 190,509M kg (209.7M tons) of municipal solid waste) were generated in 1996, 57% of this was from non-residential construction, renovation, and demolition. This equates to 1.27kg (2.8 lbs) per capita, nationwide.

Commercial construction generates between 0.9-1.3kg (2-2 1/2 lbs) of solid waste per square foot, most of which can potentially be recycled.[13]

Practical Application

1. **AUDIT**: Measure, baseline, and benchmark materials use at Post:
   a. Conduct a waste stream audit.
   b. Document existing environmentally friendly materials use.
2. **SHORT-TERM ACTIONS**: Identify low- or no-cost options and measures for immediate consideration:
   a. Meet with chief procurement officer to discuss options for modifying purchasing procedures to integrate green purchasing concepts:
      i. Consider options for paper content.
      ii. Purchase recycled content food service utensils and supplies.
      iii. Purchase recycled content janitorial supplies.
      iv. Purchase environmentally-preferable cleaning supplies.
   b. Meet with solid waste vendor to discuss options for identifying opportunities for enhanced recycling:
      i. Consider options for paper reuse.
      ii. Consider composting organics and food waste.
      iii. Develop a policy and program on e-waste disposal in compliance with Post security measures.
   c. Identify locations within the facility for recycling/composting operations.
3. **MID- to LONG-TERM ACTIONS**: Identify equipment or projects requiring capital investment:
   a. When replacement is required, purchase Energy Star®-rated office equipment and appliances.
   b. Purchase environmentally-preferable cleaning equipment.
   c. Initiate a purchasing program to purchase low-mercury content lamps and initiate take-back program with vendor.

d. Follow OBO's construction demolition waste management program on future renovation projects.

e. Follow OBO's standard specifications for building products that favor environmentally-preferable products.

4. **EDUCATE**: Develop an education program for staff that communicates procurement goals and waste management procedures:

a. Offer community outreach that informs the community of procurement and waste management processes at the Post.

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www.informinc.org/wasteatwork.php

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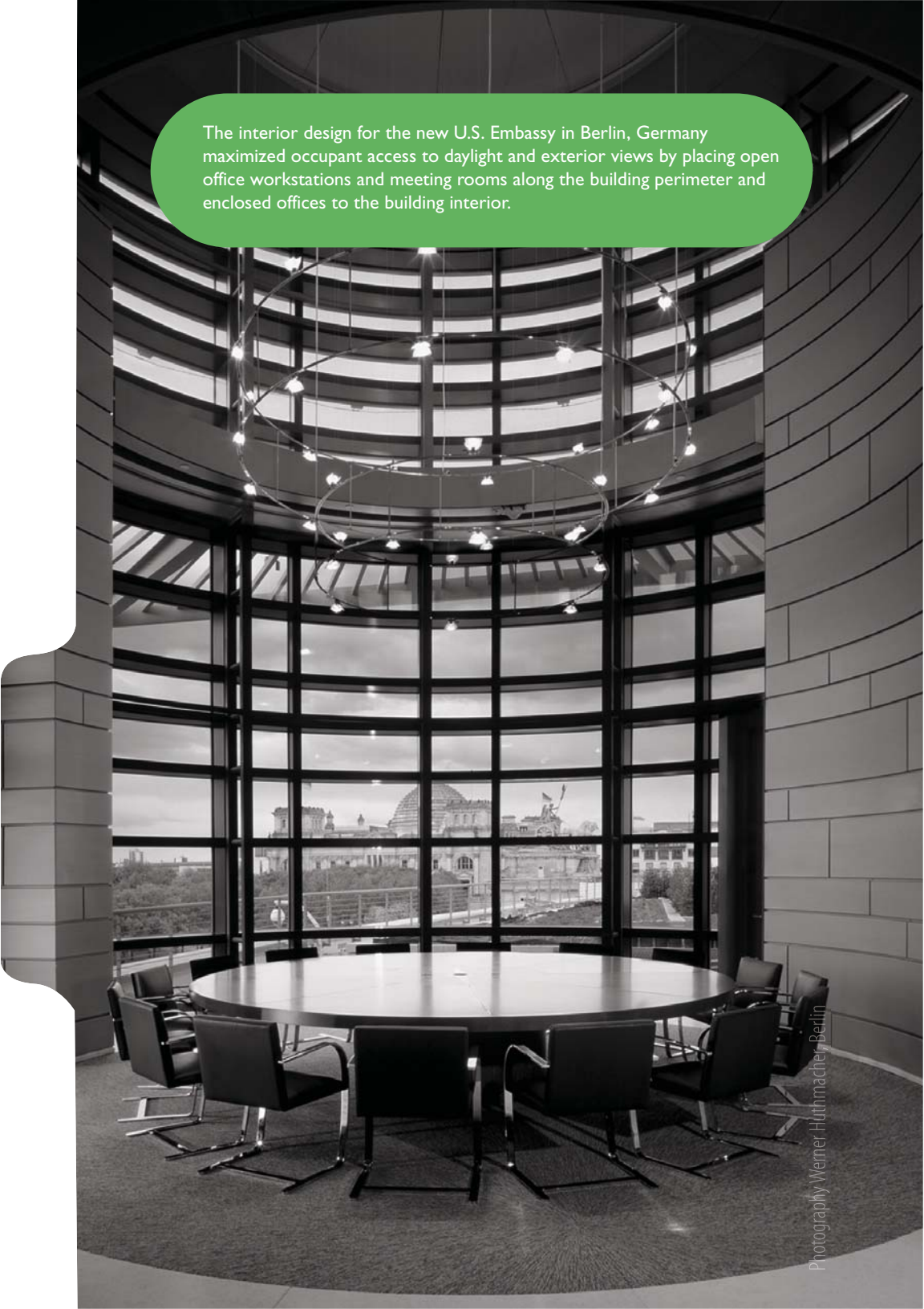
www.aqmd.gov/prdas/brochures/Super-Compliant_AIM.pdf

INDOOR ENVIRONMENT

Termites design their structures to perfectly balance the desert's raging heat of the day and bitter cold of the night, naturally ventilating their environment to an even 25.6°C (78°F).



The interior design for the new U.S. Embassy in Berlin, Germany maximized occupant access to daylight and exterior views by placing open office workstations and meeting rooms along the building perimeter and enclosed offices to the building interior.

Photography Werner Huthmacher, Berlin

Chapter 6
Indoor Environment

Indoor Air Quality 133

- Ventilation 133
- Material Emissions 134
- Isolating Construction Areas 135
- Pollutant & Contaminant Control 135
  - Entryways 135
  - Integrated Pest Management (IPM) 136
  - Cleaning 137
  - Indoor Contaminant Sources 139

Thermal Comfort 142

Productivity 143

- Daylight & Views 143
- Ergonomics 144

Practical Application 145

Indoor Environment

Sick Building Syndrome and outbreak of Legionnaire's disease generated headlines in the 1980's and 1990's, linking building environments to health problems among building occupants. The timing was the result of a "perfect storm" of changes in the building industry: increased off-gassing (or emissions) of chemical compounds from furnishings and finishes, a decrease in natural air infiltration due to advances in building sealing and vapor barriers, and a reduction in outdoor air ventilation to save energy during the energy crisis of the 1970s.

The indoor environment is a dynamic interaction between climate site, building systems, and activities conducted in the building. Occupants' perception of an acceptable indoor environment is also complex, and many factors such as odors, light, thermal comfort, ventilation, noise, vibration, ergonomics, and stress come into play. The majority of these factors can be controlled by the building design and systems, and by proper operations and maintenance. Potential sources of indoor air contaminants include building materials and furnishings, moisture, processes and activities within the building, and outdoor sources. A building that is well-designed for the activities performed within, used for its intended purpose, and well-operated and maintained, minimizes indoor environmental problems and enhances worker productivity and occupant well-being.

The occupants of the Embassy in **Sofia, Bulagria** experience superior indoor air quality via the use of high efficiency particulate air (HEPA) filters, humidity control, separate ventilation for rooms with high chemical emissions, and a CO_2 monitoring system.

One of the Top Ten Recommendations from OBO's **Green**Team on going green pertains to the indoor environment. This recommendation includes the establishment of a green cleaning plan using non-toxic cleaning products; prevention of mold growth; minimization of dust; installation of entryway walk-off mats; isolation of construction areas; and the use of low-emitting paints, sealants, and coatings.

Indoor Air Quality

Ventilation

Ventilation is the process of mixing recirculated indoor air with outside air. In a building with sealed windows and mechanical ventilation, this is accomplished by ducting outdoor air to the air handling unit. Ventilation may also be accomplished by opening windows. A building without sufficient outside air may smell and feel stuffy. High CO_2 levels are an indication of insufficient ventilation. Even though CO_2 occurs naturally in the atmosphere at low concentrations, elevated levels correlate to human activity, and can indicate poor Indoor Air Quality (IAQ) concerns. As a result, CO_2 sensors can be used as a means of monitoring air quality. Outside air is not synonymous with fresh air. Ducted outside air must be filtered before it can be circulated throughout the building.

Employ the following guidelines to optimize ventilation effectiveness:

- Establish minimum balance of indoor to outdoor ventilation rates as defined by ASHRAE 62.1 – 2004. Minimum outdoor air required in commercial office space is 17 cfm (0.008 cubic meters per second (m^3/s)) per person, based on both occupancy and density.
- Install Minimum Efficiency Reporting Value (MERV) 11, activated carbon filters to reduce particles and Volatile Organic Compounds (VOC) from outside air. Replace filters every three months or per manufacturer's recommendations
- Test and adjust the ventilation system to maintain prescribed ventilation and exhaust rates. A slight positive pressure will keep outside pollutants from migrating indoors.
- Verify that exhaust fans for kitchen, bathrooms, janitor closets, high-volume print/copy areas, and disintegrator rooms are vented to the outside and operate properly. Also vent clothes dryers outdoors.
- Install CO_2 sensors to monitor air quality. If CO_2 levels rise above 900 ppm, modulate the ventilation air flow to ensure the reading decreases to acceptable levels.

- Confirm that ducted intakes are 3 meters above grade and 3 meters from noxious sources such as vents, chimneys, plumbing vents, streets, alleys, parking lots, and loading docks.

- Seal all ducts to prevent air leakage and contaminants from entering and circulating throughout the building.

Synergy: Chapter 4: Energy/Energy Management/Systems Efficiency/ Building Controls

Material Emissions

Many building products contain compounds that have a negative impact on indoor air quality and the earth's atmosphere. The most prominent of these compounds, VOCs, contribute to smog generation and air pollution, and can harm the health of building occupants indoors.[1]

VOC Limits	
Architectural paints, coatings, primers on walls and ceilings	
Flats	50 g/ L
Non-Flats	150 g/ L
Floor Coatings	100 g/ L
Clear Wood Finish	
Varnish	350 g/ L
Lacquer	550 g/ L
Stains	250 g/ L
Sealers	
Waterproofing Sealers	250 g/ L
Sanding Sealers	275 g/ L
Other	200 g/ L
Anti-corrosive and anti-rust paints	
Interior ferrous metals	250 g/ L

OBO requires wet-applied finishes such as adhesives, paints, coatings, and sealants—as well as carpets and carpet tiles—to be low- or no-VOC.

Agriproducts are typically low-VOC materials for use in interior spaces, and are readily available. Wood products containing urea formaldehyde should be avoided.

Isolating Construction Areas

Before renovations begin in an occupied building, a construction isolation plan must be developed. During demolition, either seal affected registers or protect the HVAC system by installing MERV 8 filters on the return registers in the construction area. Isolate and install construction dust barriers surrounding the work area. If possible, exhaust 100% of the air to the outside and keep a slight negative pressure with respect to adjacent occupied areas. Protect materials from weather exposure and keep the construction area clean. If possible, schedule activities with high pollutant potential during off-peak hours.

Pollutant & Contaminant Control

- **Entryways**

People entering buildings track contaminants indoors on their shoes. These particles may soil or damage flooring, or can become airborne and enter the building ventilation system. Trap shoe-borne contaminants using entryway systems such as walk-off mats and permanently-installed cleanable floor gates. Capturing these contaminants at building entrances can reduce the cost and need for building materials maintenance. Another benefit of these entryway systems is a reduced need for potentially toxic cleaning products. These entryway systems do require some maintenance and periodic cleaning to ensure that they continue to perform their function.

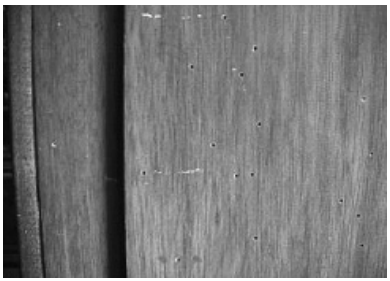
Integrated Pest Management (IPM)

Each year, 1 billion lbs (454 million kg) of conventional pesticide (based on active ingredient only for interior and exterior applications) are applied in the United States. More than 20,000 different products contain pesticides with over 620 different active ingredients.[2]

IPM is Departmental policy for overseas Posts per 15 FAM and as detailed in the program guidance. IPM focuses on eliminating the conditions that attract pests, though judicious use of authorized pesticides is permitted.

Synergy: Chapter 2: Site/Landscaping/Stormwater/Runoff, Erosion, and Sediment Control/Pest Management

By focusing on prevention and elimination of conditions that attract pests through proper cleaning and regular maintenance practices, the need for pesticide treatments is greatly diminished or eliminated. Today, it is rare that a pesticide application is needed indoors, other than small amounts of ant or cockroach gel baits. However, commercial kitchen and waste management operations remain big challenges for eliminating conditions that attract pests.



In a classic example, fumigation with methyl bromide, used to treat wood-boring beetles in the door frame shown in this photo, was determined to be unnecessary. The holes left in the wood showed that the beetles were a variety present prior to installation in the building. Once the beetles had left the wood, no pesticide application, particularly a risky and costly fumigation, was needed.

Cleaning

Cleaning commercial buildings consumes 6 billion lbs (2.72 billion kg) of chemicals annually, most of which are derived from non-renewable resources and pose significant threats to human and environmental health.[3]

Green cleaning products protect environmental health and indoor environmental quality. Unlike conventional cleaning products, they contain no carcinogens or chemicals that may cause reproductive health problems or irritate the eyes or skin, and contain reduced concentrations of VOC that diminish indoor air quality. Green cleaning products minimize the introduction of pollutants into buildings without compromising product performance or maintenance budget.[4]

- **Products:** OBO recommends the use of Green Seal-certified cleaning products. These products have been tested for toxicity, biodegradability, air quality degradation, and their potential to negatively impact human health and the environment.

  Green Seal-certified content products are priced similarly to their conventional counterparts. These products are now readily available from most janitorial supply vendors. Even large name brand manufacturers have introduced "green line" products. These products often have a citrus, oxygen, soy, or other biodegradable base vehicle. The following criteria may be used to evaluate and qualify alternative cleaning products:

  » Use Green Seal GS-37 certified standard cleaning products

  » Use products that meet California Code of Regulations maximum allowable VOC levels for flooring, such as carpet cleaners, floor finishes or stripers

  » Use disposable janitorial paper products and trash bags that meet the minimum requirement of the U.S. EPA's Comprehensive Procurement Guidelines

» Construct a matrix to assist in the evaluation of alternative products and provide a quick comparison of product attributes, applicable standards, and relative cost/value metrics

- **Equipment:** When existing equipment is in need of replacement, consider the following guidelines:

  » Use vacuum cleaners that meet Carpet & Rug Institute "Green Label" Testing Program – Vacuum Cleaner Criteria and that are capable of capturing 96% of particulates 0.3 microns in size, and that operate with a sound level less than 70dBA

  » Select hot water extraction equipment for deep cleaning carpets capable of removing sufficient moisture such that carpets can dry in less than 24 hours

  » Use powered maintenance equipment including floor buffers, burnishers and automatic scrubbers equipped with vacuums, guards and/or other devices for capturing fine particulates, and that operate with a sound level less than 70dBA

  » Choose automated scrubbing machines equipped with variable-speed feed pumps to optimize use of cleaning fluids

  » Use active microfiber technology to reduce cleaning chemical consumption

  » Select ergonomically-designed power equipment to minimize vibration, noise, and user fatigue

  » Specify equipment with rubber bumpers to reduce potential damage to building surfaces

Synergy: Chapter 5: Materials/Procurement

With appropriate isolation of chemical storage and mixing facilities, building occupants are better protected from inadvertent exposure to hazardous materials. Janitorial equipment is an often overlooked source of volatile emissions and should be stored in isolation to reduce occupant exposure.[5]

- **Storage:** Particularly when green cleaning products are not used, reduce the risk of exposure of building occupants to potentially harmful chemicals and contaminants, cleaning supplies, and materials by storing them in closed containers within locked janitorial closets. Construct or retrofit closet walls with deck-to-deck partitions, sealed penetrations, negative pressure, and direct exterior exhaust.

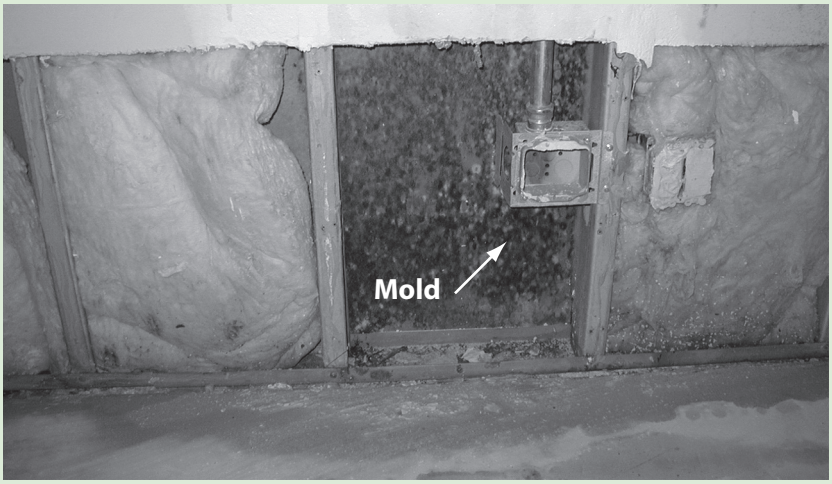
Indoor Contaminant Sources

OBO's Division of Safety, Health and Environmental Management (SHEM) has compiled practical guidance in a checklist format. The following are some of their recommendations:

- **Mold:** Moisture is the most important factor influencing mold growth. Although ubiquitous, excessive mold growth indoors can cause discoloration and odor problems, damage building materials, and trigger allergic reactions in susceptible individuals:
  - » Remove dry water-damaged areas and items within 24-48 hours.
  - » Fix leaky plumbing or other sources of water.
  - » Wash mold off hard surfaces with detergent and water, and dry completely.
  - » Replace absorbent materials (such as ceiling tiles, drywall, and carpet.) that become moldy.

This inspector investigated mold infestation resulting from a toilet that overflowed in the unit above while the resident was away for two weeks.

Case Study



Dushanbe, Tajikistan: During construction of modular components for the New Embassy Compound (NEC) in Dushanbe, precipitation entered the building through numerous roof leaks and other penetrations. The water followed a circuitous route, often within the walls, and pooled on the floors. Opening the walls revealed mold growth in the interior sides of the drywall, sometimes with no indication from the exterior. The roof leaks were stopped and the building was closed in from the elements. Mold cannot be removed from drywall; hence, an extensive amount of drywall was removed and replaced.

Belize City, Belize: Mold was discovered on the exterior metal surfaces of a fan-coil air conditioning unit in an office in the existing Chancery in Belize City. High humidity caused condensation resulting in mold growth on various surfaces in the room. Maintenance protocol did not include cleaning these surfaces. The equipment manufacturer insisted that mold growth should not have occurred. Openings in the building envelope continually allowed humid air to enter the space. Despite air conditioning, the room remained humid. Materials that could not be cleaned of mold were discarded and walls were sealed to prevent regrowth of mold.

- **Asbestos:** Asbestos is commonly found in older facilities and was a material that was widely used in a number of building components due to its resistance to heat, electricity, and chemical damage, and due to its sound absorption qualities and tensile strength. A known carcinogen, asbestos was banned in 1980 from use in building materials in many countries, but can still be found in previously manufactured and installed insulation, fire protection board, roofing, siding, and other building products. Although not harmful in an undisturbed state, effective management is essential to protect asbestos-containing building material from damage. Each overseas Post has an asbestos management plan listing any locations of asbestos-containing materials in its facilities, and procedures for how to manage it in place. Review and follow Post's asbestos management plan or contact SHEM for assistance.

- **Radon:** Radon is a significant contaminant that can affect indoor air quality, particularly where ventilation is deficient. Radon gas from natural sources can accumulate in buildings, typically in basements. Since radon is colorless, odorless, and tasteless, testing is prudent, especially in buildings in regions with geology prone to hot spots and where occupants spend considerable time in the basement. Remediation may require ventilation and/or sealing of floor and/or wall penetrations.

- **Environmental Tobacco Smoke:** Smoking in Federal buildings is prohibited by Executive Order 13058 – *Protecting Federal Employees and the Public from Exposure to Tobacco Smoke in the Federal Workplace*. Second-hand smoke can still be drawn into buildings.

Outdoor smoking area of **Istanbul, Turkey**.

The following procedures are recommended:

» Provide designated outdoor smoking areas located a minimum of 15 meters from any building entrance or air intake.

» Include benches and proper receptacles in designated smoking areas.

Thermal Comfort

The most prevalent complaint concerning the indoor office environment is thermal comfort. This critical component of occupant satisfaction is a product of not only environmental conditions (e.g. temperature, humidity, air flow, and radiant temperature), but also personal preferences, metabolism, activity, and attire. Frequently, in central air-controlled systems, individual control is not an option.

ASHRAE 55, *Thermal Comfort Conditions for Human Occupancy*, identifies indoor thermal environmental ranges that are acceptable to approximately 80% of occupants when attired appropriately for the climate and season. Humidity should be maintained between 30 to 60% for occupant comfort and to avoid mold growth.

Acceptable Ranges of Temperature and Relative Humidity[7]

Relative Humidity	Winter Temperature	Summer Temperature
30%	20.3°C – 24.4°C (68.5°F - 76.0°F)	23.3°C – 26.7°C (74.0°F - 80.0°F)
40%	20.3°C – 24.2°C (68.5°F - 75.5°F)	23.1°C – 26.4°C (73.5°F - 79.5°F)
50%	20.3°C – 23.6°C (68.5°F - 74.5°F)	22.8°C – 26.1°C (73.0°F - 79.0°F)
60%	20.0°C – 23.3°C (68.0°F - 74.0°F)	22.2°C – 25.6°C (72.5°F - 78.0°F)

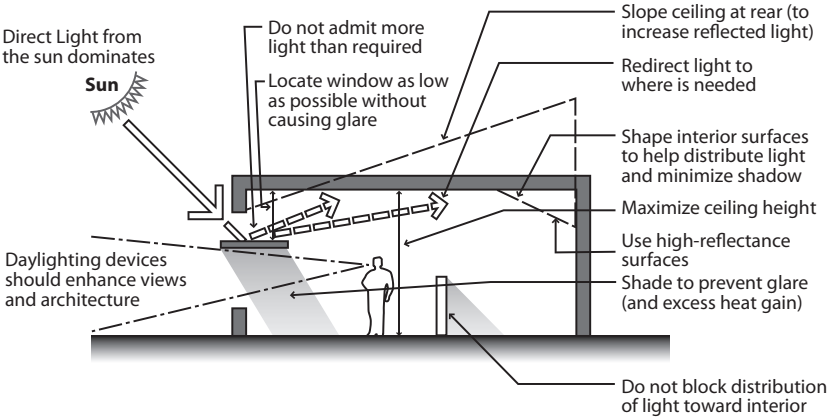
Note: Applies for persons clothed in typical summer and winter clothing, at light, mainly sedentary activity.

Installation of automated controls to maintain temperature and humidity levels in a zoned fashion within the facility assists in achieving a greater level of satisfaction among occupants.
Synergy: Chapter 4: Energy/Energy Management/Systems Efficiency/Building Controls

Productivity

The indoor environment impacts the health and productivity of individuals working within a facility. The cost of operating a facility is a mere fraction of the cost of the overall operation, especially when one considers salaries, benefits, and general health of personnel. Therefore, productivity must be a major factor when making decisions that affect the indoor environment. Even a small improvement in productivity may result in overall significant cost savings in a mission's operations.

Daylight & Views



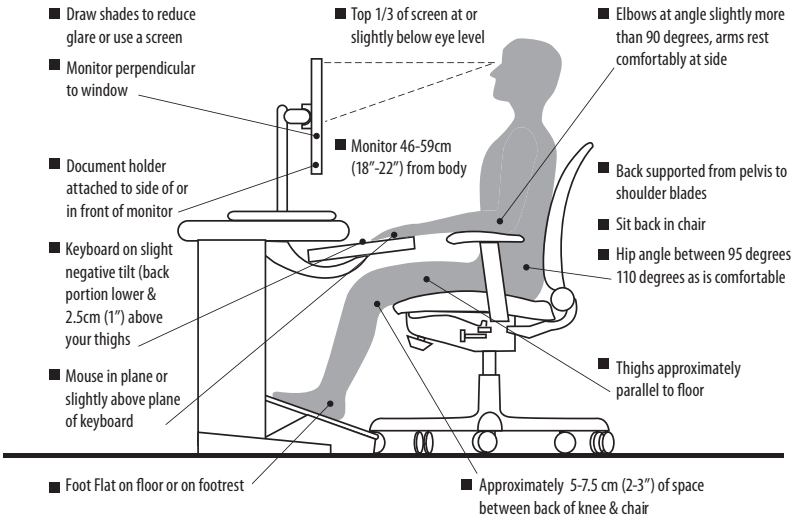
Daylighting Strategies for a Direct Light Source[8]

New standards redistribute closed office space away from the perimeter window walls to maximize shared access to daylight. This amenity has led to recognition that satisfaction in the workplace–and even productivity–may be enhanced through the use of sustainable design parameters. In addition to increased daylight and views and worker comfort and satisfaction, this strategy reduces the need for supplemental electrical lighting, and can therefore reduce operating costs.

Synergy: Chapter 4: Energy/Energy Management/Load Reduction/Lighting

In the development of a space renovation plan, consideration should be given to bringing additional daylight into interior spaces and maintaining a direct line of sight to the outdoors for a maximum number of offices and workstations. Options to consider include reorganizing closed office space to the interior of the building, adding transoms to solid walls, installing light shelves, and painting walls in a light-reflective paint. Daylight dimming of interior spaces may also assist in creating an equally distributed lighting level.

Ergonomics



Ergonomics is the scientific discipline concerned with designing according to human needs. In the workplace, ergonomics is primarily concerned with the quality of the workspace; with particular emphasis on posture, movement, accessibility, and sight. Ergonomic design tailors the workplace and the task to the individual. It accounts for equipment, tools, and work methods; as well as an individual's size, strength, and capabilities. Workplace ergonomic measures often include adjustable features such as

seating, desks, keyboard and mouse trays, and monitor arms to allow tailoring to an individual's size and range of motion. The result is enhanced health, and productivity of individuals.

Practical Application

1. **AUDIT:** Develop an Indoor Environment profile of the building structure, function, and occupancy:

   a. Refer to Section 4 of *Building Air Quality A Guide for Building Owners and facility managers.*

   b. Document any environmentally friendly indoor conditions.

   c. Review Post's Asbestos Management Plan and ensure awareness and proper management of asbestos-containing materials present.

   d. Check for indoor environmental hazards, e.g. mold, VOCs, etc.

2. **SHORT-TERM ACTIONS:** Identify low- or no-cost cost options and measures for immediate consideration:

   a. Reduce pollutants entering building by installing and maintaining walk-off mats, grills, or grates.

   b. Review the products used for housekeeping and maintenance to identify green alternatives to standard products.

   c. Develop a low environmental impact cleaning policy.

   d. Revisit the existing pest management policy and use of pesticides. Mitigate underlying conditions attracting pests.

3. **MID-to LONG-TERM ACTIONS:** Identify equipment or projects requiring capital investment:

   a. Purchase low impact cleaning equipment once existing equipment has reached the end of its useful life.

   b. Develop an IAQ concern response plan that addresses and monitors temperature, relative humidity and moisture.

c. Install CO_2 sensors in highly occupied areas and main return ducts.

d. Use OBO's Sustainable Lighting Study as basis for interior lighting strategy development and implementation.

e. Provide adjustable seating, desk, keyboard and mouse trays, monitor, etc. to minimize physical stress on staff. Repetitive motions conducted in awkward or strained positions can cause injuries over time.

4. **EDUCATE:** Develop a staff education program that targets the identification of health and productivity benefits resulting from good IAQ. Empower occupants to recognize and respond to potential problems.

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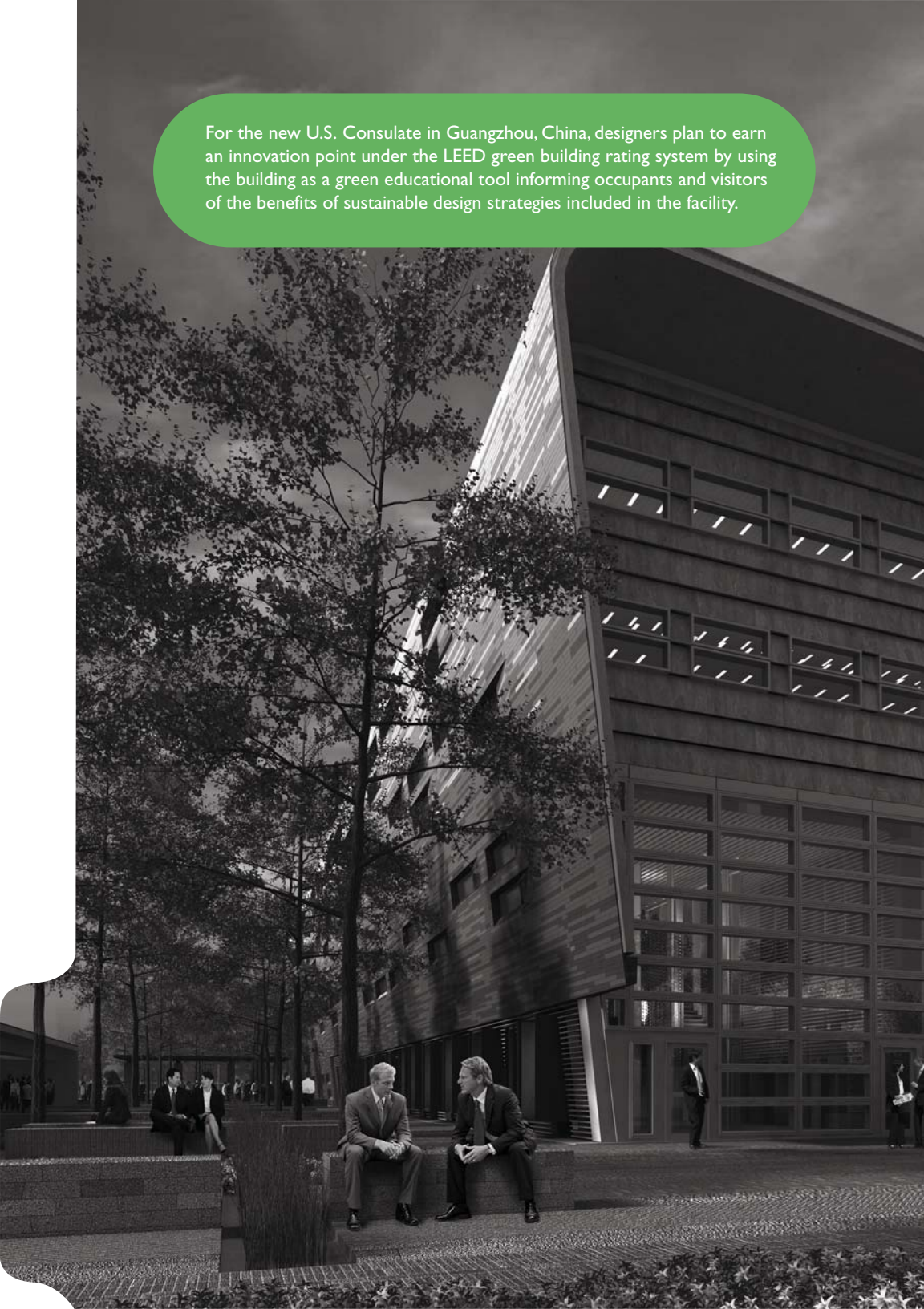
GLOSSARY



For the new U.S. Consulate in Guangzhou, China, designers plan to earn an innovation point under the LEED green building rating system by using the building as a green educational tool informing occupants and visitors of the benefits of sustainable design strategies included in the facility.

Glossary

Albedo
Synonymous with solar reflectance (see below).

Audit
An in-depth analysis of a building's capacity to support current and future program needs. Typical systems examined include structure, mechanical, electrical, lighting, plumbing, building envelope, site drainage, hazardous materials (asbestos, lead, etc.), and life safety. In the context of sustainability, audit typically refers to analysis of existing HVAC, electrical, and lighting systems and their energy use.

Asbestos
Asbestos is a naturally occurring mineral fiber once widely used in a variety of building materials and products because of its useful properties: good thermal and acoustical insulation, chemical and thermal stability, and high tensile strength. Intact, undisturbed asbestos-containing materials generally do not pose a health risk. These materials may become hazardous and pose increased risk if they are damaged, are disturbed in some manner, or deteriorate over time and release asbestos fibers into building air. When asbestos fibers are inhaled into the lungs, they can cause lung cancer, mesothelioma and asbestosis. Since the mid 1980s, use of asbestos has been banned in many countries.

Biomass
The biological material used as a substitute for carbon-based fossil fuels. Biomass power uses a variety of technologies, including a direct-fired system, where burning the biomass heats water and generates steam that turns a turbine; and co-firing, in which biomass replaces some of the coal in a coal plant.

Biomimicry
A relatively new science that studies nature, its models, systems, processes, and elements and then imitates or takes creative inspiration from them to solve human problems sustainably.

Building Area
The sum total of all enclosed floor space from each floor under the roof of a structure.

Building Automation System (BAS)
A centralized computerized network to control devices that monitor the operation of a building's mechanical, electrical, lighting, and security systems in order to optimize efficiency of the systems.

Building Footprint
The shape and measurement of the site area occupied by a building perimeter or horizontal roof projection. In the context of sustainability, the smaller the footprint, the less intrusion on existing environmental systems and habitats.

Carbon Footprint
The total calculation of greenhouse gas emissions produced as a result of human activity, measured in CO_2 output.

Carbon Offset
A conceptual tool in response to carbon footprints, carbon offsets are financial instruments that mitigate carbon emissions through the development of alternative projects such as solar or wind energy or reforestation. Although there are six primary categories of greenhouse gases, carbon offsets are measured in metric tons of carbon dioxide-equivalent (CO_2e). One carbon offset represents the reduction of one metric ton of carbon dioxide, or its equivalent in other greenhouse gases. There are two primary markets for carbon offsets. In the larger compliance market, companies, governments, or other entities buy carbon offsets in order to comply with caps on the total amount of carbon dioxide they are allowed to emit. In the much smaller voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use, and other sources.

Certified Wood
Wood derived from sustainably managed and harvested forests. Certification requires an accredited, independent, "third-party" certifier to evaluate both forest management activities (forest certification) and the tracking of forest products (chain-of-custody certification).

Closed Loop
This term most commonly refers to conditions where a building system does not rely on matter exchange outside of the system. The opposite being an open loop where outside material to support the building system is needed. A sanitation system which aims at closing the nutrient and water cycle, often referred to as ecological sanitation systems or closed loop systems.

Cogeneration (Combined Heat and Power, or CHP)
The use of a heat engine or a power station to simultaneously generate both electricity and useful heat. Conventional power plants emit the heat created as a by-product of electricity generation into the environment through cooling towers, flue gas, or by other means. CHP or a bottoming cycle captures the by-product heat for domestic or industrial heating purposes, either very close to the plant, or—especially in Scandinavia and eastern Europe—for distribution through pipes to heat local housing.

CO_2 Sensor
An instrument designed to detect the level of Carbon Dioxide (CO_2) gas in indoor air. In HVAC applications, CO_2 sensors are used to control the amount of outdoor ventilation air introduced into a building to dilute indoor air contaminants of indoor origin.

Commissioning (Cx)/Recommissioning or Retro-commissioning (R-Cx)
A process of testing and balancing a system in the field to ensure compliance with design intent, and increase system efficiency and performance, as well as testing the interdependency of the system with other systems (i.e., testing adequate performance of the HVAC system with the fire protection system). Cx applies to new buildings; existing buildings undergo R-Cx to fine-tune performance.

Start-up of a building includes testing and adjusting HVAC, electrical, plumbing, and other systems to assure proper functioning and adherence to design criteria. Commissioning also includes the training of building representatives in the use of the building systems.

Constructed Wetlands
An artificial marsh or swamp created to provide secondary treatment of wastewater or primary treatment of storm water runoff, or sewage treatment, as well as to provide habitat for wildlife.

Cool Roof
Cool roof materials have two important surface properties: a high solar reflectance—or albedo—and a high thermal emittance. Solar reflectance is the percentage of solar energy that is reflected by a surface. Thermal emittance is defined as the percentage of energy a material can radiate away after it is absorbed. Benefits of cool roofs include reduced building heat-gain and reduced heat-island-effect.
See *http://www.epa.gov/heatisld/strategies/coolroofs.html*.

Daylighting
Illumination that is provided by light from the sun, as opposed to that from an artificial light source. Daylighting can be enhanced by the addition of interior light shelves that bounce light deeper into the space. Daylight can also be harvested by adding controls that dim or turn-off artificial lights when light levels are met by natural daylight.

District Cooling
(e.g. Chilled Water) A system of cooling commercial and residential buildings from a centralized location. Frequently, large cooling towers provide chilled water to cool neighborhoods and offices through district cooling.

District Heating
(e.g. Steam) A system of distributing heat generated in a centralized location to applications including commercial or residential buildings. Frequently, cogeneration plants provide heat for neighborhoods and offices through district heating.

Embodied Energy
The total amount of energy consumed in all phases of a product or material or service life, from material extraction and harvesting to final assembly and construction, transportation and delivery to point of use, deconstruction and ultimate disposal.

Environmental Management System (EMS)
A set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.

Ergonomics
The scientific discipline concerned with designing according to human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. There are five aspects of ergonomics: safety, comfort, ease of use, productivity/performance, and aesthetics. Ergonomics is one aspect of indoor environmental quality

Full-Time-Equivalent (FTE)
The number of employees assigned to work an eight-hour shift or combination of part-time employees that would equal an eight-hour shift (e.g., two-part-time employees that work four hours per day would equal one FTE). Visitors should also be added to the total of FTE for a

building according to their duration of stay (e.g., four visitors that have an average stay of two hours each would equal one FTE).

Green Cleaning Products
Cleaning products that are as effective as traditional products, but that do not contain harsh ingredients such as volatile organic compounds (VOCs), which can have adverse health effects. Examples of green cleaning alternatives include citrus-based solvents, baking soda, and vinegar.

Green Power
See Renewable Energy.

Green (Vegetated) Roof
A building roof that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane. An extensive green roof is covered in a thin (5-20cm) layer of soil and low vegetation such as sedums; an intensive green roof has a deeper soil base (30-90cm) with trees, shrubs and grasses. Green roofs control stormwater run-off, reduce the heat-island-effect, provide insulation to reduce energy consumption, and filter pollutants out of the atmosphere.

Green (Open) Space
Area designated to remain free of development. Such places include parks, plazas, gardens, ponds, and wetlands. Green spaces can provide areas for camping, hiking, walking, biking, and habitats for wildlife.

Greywater
Sometimes spelled **graywater, grey water** or **gray water** and also known as **sullage**, a non-industrial wastewater generated from domestic processes such as dish washing, laundry and bathing. Greywater comprises 50-80% of residential wastewater. Greywater is distinct from blackwater in the amount and composition of its chemical and biological contaminants (from feces or toxic chemicals). Greywater gets its name from its cloudy appearance and from its status as being neither fresh (white water from groundwater or potable water), nor heavily polluted (blackwater). Wastewater containing significant food residues or high concentrations of toxic chemicals from household cleaners etc. may be considered "dark grey" or blackwater.

Heat Island Effect (or Urban Heat Island Effect)
The condition experienced by urban areas with higher temperatures than surrounding areas, due to absorbed solar radiance of dark surfaces such as roads, roofs, and other paving.

HEPA (High Efficiency Particulate Air) Filters
This type of air filter can remove at least 99.97% of airborne particles 0.3 micrometers (μm) in diameter. Particles of this size are the most difficult to filter and are thus considered the most penetrating particle size (MPPS). Particles that are larger or smaller are filtered with even higher efficiency. HEPA filters are composed of a mat of randomly arranged fibers.

Indoor Air Quality (IAQ)
The result of the interaction between the site, climate, building system (original design

and later modifications in the structure and mechanical systems), construction techniques, contaminant sources (building materials and furnishings, moisture, processes and activities within the building, and outdoor sources), and building air quality as influenced by occupants.

Impervious Surfaces
Surfaces that reduce infiltration of precipitation on the ground plane and increase runoff are impervious to varying degrees. The imperviousness of a site can be calculated by the types of surfacing (asphalt, pavers, grass, shrubs, slope, etc.) and their corresponding coefficients of runoff.

Integrated Pest Management (IPM)
A policy and management program to control pests using a combination of tactics that control what attracts and/or facilitates access of the pests and reduces the pest population. Appropriate pesticides may be used judiciously. Detailed information on the Department's overseas IPM program is found at
http://obo.state.gov/opssaf-shem/PARENT%20PAGES/Publications/IPM/ipm.htm

Light Emitting Diode (LED)
A semiconductor diode that emits incoherent light when power is applied. This effect is a form of electroluminescence. LEDs are often used as small indicator lights on electronic devices and increasingly in higher power applications such as flashlights and area lighting. The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be infrared, visible, or ultraviolet. LEDs can also be used as a standard building light source. LEDs use $1/10^{th}$ the power of conventional lighting to produce the same amount of light, with a life expectancy of 10,000 hours, or up to five times the life of conventional lighting. LEDs produce a greater amount of heat during operation than do conventional lighting systems

LEED® (Leadership in Energy and Environmental Design)
An internationally adopted and recognized green building rating system developed and administered by the U.S. Green Building Council.
See *www.usgbc.org/leed*.

Light Pollution
Interior or exterior lighting that is directed upward to the sky or trespasses off the property. Light pollution disrupts natural habitats and can cause adverse health effects, in addition to obscuring the stars for city dwellers, and interfering with astronomical observatories.

Low Environmental Impact
Having an acceptably small impact on soil contamination, air and water pollution, noise pollution, local ecology, and geology, as determined by the Environmental Protection Agency (EPA).

Methyl Bromide (MeBr)
An odorless, colorless gas that has been used as a soil fumigant and structural fumigant to control pests across a wide range of agricultural sectors. Because MeBr depletes the stratospheric ozone layer, the amount of MeBr produced and imported in the U.S. was reduced incrementally until it was phased out in January 1, 2005, pursuant to the *Montreal*

Protocol on Substances that Deplete the Ozone Layer (Protocol) and the Clean Air Act.

Minimum Efficiency Rating Value (MERV)
A 1-16 scale developed by the American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE), MERV measures the effectiveness of air filters at capturing particulate matter ranging from 0.3 to 10 microns. Higher MERV values correspond to a greater percentage of particles captured.

Municipal Water
Water provided by the local public sector through reservoirs, piping, and water treatment, including water extracted from on-site wells. In some instances municipal water may not be potable as provided, but must be treated on-site for use as building or compound domestic water supply.

Polychlorinated Biphenyl (PCB)
This family of 209 organic compounds with 1 to 10 chlorine atoms attached to biphenyl which is a molecule composed of two benzene rings each containing six carbon atoms. The chemical formula for all PCBs is $C_{12}H_{10-x}Cl_x$. PCBs were used as coolants and insulating fluids for transformers and capacitors, stabilizing additives in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils, flame retardants, hydraulic fluids, sealants (used in caulking, etc), adhesives, wood floor finishes, paints, de-dusting agents, and in carbonless copy paper. PCB production was banned in the 1970s due to the high toxicity of most PCB congeners and mixtures. PCBs are classified as persistent organic pollutants that bioaccumulate in animals.

Photosensor
A device that measures light intensity, usually to activate a switch that engages artificial lighting when the light level falls to a preset limit. Used to turn on exterior lighting when the sun goes down, or, in conjunction with daylight harvesting, to turn off interior lighting when there is adequate daylight.

Photovoltaic (PV)
A process that uses specially constructed panels in arrays to absorb the sun's energy and convert it into electrical current. There are two types of PV systems, grid-connected and battery-connected. Battery-connected systems use excess power produced by the PV panels during the day to charge batteries for use at night, or when the sun is not producing enough to meet the load. Grid-connected systems are integrated into the electrical system of the building and any excess power produced is sold back to the utility. State Department facilities are typically grid-connected.

Pollinator Friendly Habitat
An outdoor ecosystem that specifically attracts the nectar-feeding organisms such as butterflies, hummingbird moths, honey bees, and hummingbirds found in a specific area. The human food chain relies on the productivity of pollinators, thus it is to our benefit to provide these organisms food/water/shelter/space to support their survival.

Potable Water
Water meeting EPA's quality standards to serve as drinking water, whether or not it is used as

such. Although many water sources are utilized by humans, some contain disease vectors or pathogens and cause long-term health problems when ingested if they do not meet certain water quality guidelines. Sources of potable water can include rainwater, wells, or municipal water systems, though some may require treatment.

Radon

Radon is a radioactive gas resulting from the natural decay of uranium commonly found in soils. Radon can enter buildings through cracks and other holes in building foundations. The amount of radon that escapes from the soil into the indoor air depends on the weather, soil porosity, soil moisture, and the relative pressurization of the building. Radon can accumulate in buildings and reportedly causes 21,000 lung cancer deaths per year in the United States alone.[1] Radon is the second most frequent cause of lung cancer, after cigarette smoking, and radon-induced lung cancer is thought to be the sixth leading cause of cancer death overall.

Rainwater Harvesting

The collection of rainwater to increase soil moisture levels, recharge ground water table, mitigate urban flooding, improve groundwater quality, supply building water, or for irrigation purposes. In the context of sustainability, rainwater harvesting is a strategy used to reduce reliance on municipal water sources for building, process, and irrigation water uses. Rainwater requires treatment prior to use as potable water.

Recommissioning or Retrocommissioning

See Commissioning

Regenerative Systems

Building systems that take lessons from nature and go beyond sustainability. Regenerative systems revitalize the underlying systems—both cultural and natural—so that all can work efficiently and in concert to achieve and maintain a healthy environment.

Renewable Energy (Green Power)

Power generated through the use of natural energy resources—those that do not use fossil fuels or other one-use materials. Examples include solar, wind, wave, hydroelectric, geothermal, and bio-fuels. Renewable energy from indefinitely available resources and whose generation has zero/negligible environmental impacts is considered "green power", whether through reduced emissions or minimal environmental disruption. Utilities buy and sell green power at a premium.
See *http://www.epa.gov/oaintrnt/greenpower/basics.htm*

Sick Building Syndrome

A term sometimes used to describe situations in which building occupants experience acute health and/or comfort effects that appear to be linked to time spent in a particular building, but where no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be spread throughout the building.

Solar Reflectance (Albedo)

The ratio of the reflected solar energy to the incoming solar energy over wavelengths of approximately 0.3 to 2.5 micrometers. A reflectance of 100% means that all of the energy striking a reflecting surface is reflected back into the atmosphere and none of the energy is

absorbed by the surface. White surfaces have the highest albedo.

Sustainability
The term, in its environmental usage, refers to the potential longevity of vital human ecological support systems, such as the planet's climatic system; systems of agriculture, industry, forestry, fisheries; and the systems on which they depend. In recent years, public discourse has led to a use of "sustainability" in reference to how long human ecological systems can be expected to be usefully productive. Sustainability has been defined as meeting the needs of the present without compromising the ability of future generations to meet their needs, and typically includes environmental, social, and economic considerations. In the context of facilities, sustainability consists of implementing energy- and water-saving measures; and being responsible in the specification and procurement of materials, in the quality of the indoor environment, and in operation and maintenance practices.

Unitary Equipment
Factory-packaged, refrigerant-based heat pumps that are available in a number of application categories that include: packaged terminal heat pumps (PTHP), closed water loop heat pump systems, ground-coupled (Closed-Loop) systems, ground water-source heat pumps, and large unitary air- and water-source heat pumps.

Variable Frequency Drive (VFD)
A system for controlling the rotational speed of an electric motor by controlling the frequency of the electrical power supplied to the motor. A VFD reduces the amount of power needed to operate a motor at slower speeds when the full speed is not needed, optimizing efficiency.

Volatile Organic Compound (VOC)
Carbon compounds that vaporize (evaporate) at room temperatures. Examples of such compounds include gasoline, paint, paint thinners, adhesives, and cleaning solvents. In high concentrations, these compounds have been proven to have adverse effects on human health; elimination of VOCs is an integral part of IAQ management and healthy indoor environmental quality. Compounds that evaporate from the many housekeeping, maintenance, and building products and furnishings made with organic chemicals. In sufficient quantities, VOCs can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment; some are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans. At present, not much is known about what health effects occur at the levels of VOCs typically found in a building's air quality.

Wastewater
Any water that has been adversely affected in quality by human contamination, whether industrial or residential. Also called "blackwater".

Xeriscaping
Landscaping that incorporates the following seven basic principles: planning and design, soil analysis, practical turf areas, appropriate plant selection, efficient irrigation, use of mulches, and appropriate maintenance. Because application of these principles results in water savings, in common usage, xeriscaping refers to the practice of using native or adapted plants that require no supplemental irrigation, from the Greek "xeri", or "dry".

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