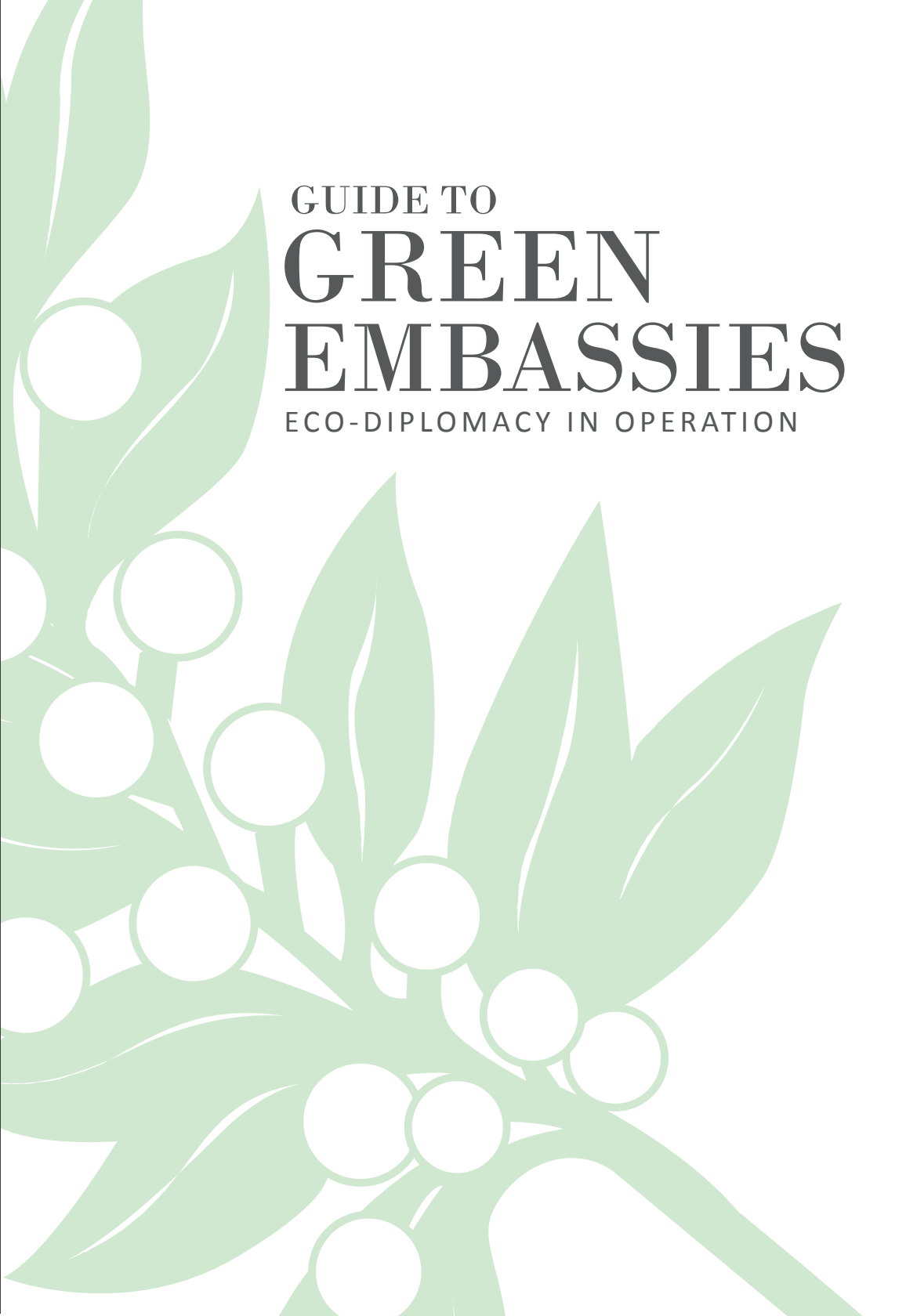
GUIDE TO GREEN EMBASSIES

ECO-DIPLOMACY IN OPERATION



GUIDE TO
GREEN EMBASSIES
ECO-DIPLOMACY IN OPERATION

U.S. Department of State Mission

To create a more secure, democratic, and prosperous world for the benefit of the American people and the international community.

Greening Council Mission and Guiding Principles

To improve the Department's environmental footprint and increase efficiencies, by harnessing expertise in policy, management, and public diplomacy from grass roots to senior management, in order to cultivate and institutionalize sustainability efforts, measure and report progress, and challenge others by fulfilling our environmental commitments and highlighting our successes.

- Implementing best practices in design, construction, and operation of facilities
- Leveraging information technology to support high performance and efficiencies
- Minimizing energy consumption and increasing cleaner energy use
- Using environmentally preferable products and reducing waste streams
- Protecting and conserving water
- Optimizing ecosystems services
- Enhancing indoor environmental quality to support occupant well-being and productivity
- Advancing U.S. efficient, clean energy and sustainable technologies and services

Bureau of Overseas Buildings Operations Mission

To provide safe, secure, and functional facilities that represent the U.S. government to the host nation and support our staff as they work to achieve U.S. foreign policy objectives. The Department's facilities should represent the best in American architecture, design, engineering, technology, sustainability, art, culture, and construction execution.

Foreword

A Message from the Secretary

I am very pleased to endorse the second edition of the ***Guide to Green Embassies*** *Eco-Diplomacy in Operation* (the *Guide*).

U.S. Secretary of State Kerry

Image Source: U.S Department of State

This new edition expands on the success of the initial *Guide*, continuing the environmental sustainability leadership of former Secretary of State Hillary Clinton and the efforts initiated by Under Secretary for Management Patrick Kennedy—the U.S. Department of State's Senior Sustainability Officer. Both of these inspired leaders deserve my thanks and appreciation for the foundation they established. New to this second edition is a chapter on residential strategies, as well as information throughout the *Guide* on staff engagement. These additions are priorities that I support to build on the Department's sustainability leadership.

The *Guide* provides comprehensive and useful information for mission staff—at every level—to fully integrate into their daily practices, both on a personal and professional basis. The *Guide* is organized in a hands-on way so that mission staff can take immediate action to green their homes and offices.

This second edition will be key to achieving the Department's sustainability goals and inspiring the global community.

John F. Kerry
Secretary of State

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Introduction

The Case for Change

According to the U.S. Environmental Protection Agency (EPA), the earth's average temperature has risen by 0.8 degrees Celsius (° C) (1.4 degrees Fahrenheit (° F)) over the past century and is projected to rise another 1.1–6.4° C (2.0–11.5° F) by 2100.[1] The Intergovernmental Panel on Climate Change (IPCC) 2013 report states, "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."[2] The IPCC also says the building sector has more potential to deliver quick, deep, and cost effective greenhouse gas (GHG) mitigation than any other. Energy consumption in both new and existing buildings could be cut by an estimated 30-50% by 2020 through readily available technologies, design, equipment, management systems, and alternative generation solutions. This can be funded through investments that quickly payback and result in significant environmental, social, and economic benefits.

In the context of complex international dynamics and evolving energy prices, as well as limited access to clean freshwater and a growing depletion of finite natural resources, environmental stewardship is critical. This is particularly true given the impact of the building sector and the breadth of the federal government's real estate portfolio. The U.S. government owns approximately 445,000 buildings with a total floor space of over 300 million square meters (m^2) (3.23 billion square feet (ft^2)) and leases approximately 57,000 buildings with a total floor space of over 34.7 million m^2 (374 million ft^2). These buildings account for 37% of the government's total energy use.[3] The U.S. Department of State (the Department) is responsible for more than 7 million gross m^2 (75.3 million gross ft^2) in 19,000 facilities, supporting U.S. embassy missions in 190 countries. In October 2013, Secretary of State John Kerry said:

> …the energy used to power buildings accounts for about one third of all global energy demand and regrettably almost 40 percent of all of our associated CO_2 emissions….by greening our embassies, we are really taking one other important step in the effort to try to contribute to a larger effort with buildings around the world…our embassies ought to also reflect the very best of American design architecture, and they ought to reflect our commitment to sustainability and to technology. They are the model of American innovation in this field and they reflect our deep commitment to responsible environmental stewardship.[4]

Since 1999, the Department's Bureau of Overseas Buildings Operations (OBO) has worked to increase the performance of its 275 embassies and consulates

around the world to provide safe, secure, functional, and sustainable platforms from which to conduct diplomacy. OBO has improved conditions for Americans overseas through new construction, major renovations, and systems upgrades, and moved more than 30,000 employees to 108 new and over 200 renovated facilities. While issues of security and required maintenance take priority over energy and sustainability, recent federal performance goals have demonstrated the interconnection of these concerns.[5] Providing and maintaining sustainable buildings, grounds, and operations allows OBO to effectively demonstrate the intersection of security and sustainability as it literally and figuratively builds the foundation for eco-diplomacy.

Federal Performance Goals	
Executive Order (EO) 13514	• Report a comprehensive annual inventory of GHG emissions. Inventory shall include purchased energy, employee travel and commuting miles, solid waste disposal, and wastewater treatment. • Reduce energy intensity by 30% by 2015 using 2007 baseline. • Reduce potable water consumption intensity by 26% by 2020 using 2007 baseline (2% per year). • Reduce irrigation water intensity by 20% by 2020 using 2010 baseline (2% per year). • Divert 50% of non-hazardous solid waste by 2015. • Ensure that 95% of new contracts require sustainable products and services.
EO 13423	• Ensure that 15% of real property assets are sustainable for buildings larger than 464 m^2 (5,000 ft^2) by 2015. • Reduce fleet fossil fuel consumption by 30% by 2020 using 2005 baseline.
Energy Independence and Security Act (EISA)	• Increase alternative fuel use by 10% each year. • Provide one renewable fuel pump per fueling center by 2010.
Energy Policy Act (EPAct)	• Conduct a feasibility study by 2013 to determine whether the 7.5% renewable energy use target can be achieved.

Underpinning OBO's work, the Department's Greening Diplomacy Initiative (GDI) provides a broad internal framework for the Department's sustainability implementation. GDI challenges the Department to lead by

example, requiring environmental stewardship in both policy and practice. Eco-diplomacy policy and practice foster shared values between nations that are committed to reducing their GHG emissions, conserving natural resources, and increasing biodiversity.

Eco-diplomacy is the practice of conducting international relations by facilitating and advancing a shared commitment to conserving natural resources through sustainable operations and responsible environmental stewardship.

Through tangible 'bricks and mortar,' our embassies and consulates demonstrate America's commitment to mending and improving the relationship between the built and natural environments while simultaneously promoting U.S. initiatives worldwide and demonstrating America's values and best practices in sustainability.

Call to Action

The U.S. government has called for federal facilities to strengthen national security by lessening dependence on foreign oil, thereby strengthening the U.S. economy, lowering energy costs, creating new jobs through new technologies, and reducing global warming.

Empowering Leaders

A successful response to this Call to Action requires leadership from organizations and individuals at all levels. From Post Green Teams to Chiefs of Mission (COMs), everyone has a role and responsibility to make important contributions. Diplomatic leaders can forge partnerships with local peers and other diplomatic leaders to raise awareness of, and take action on, sustainability challenges. Post management, as well as the Post Green Teams and green champions, can generate and implement ideas, raise awareness, and foster support and action.

Five steps for posts to begin their journey toward eco-diplomacy:

Step 1 Join the League of Green Embassies (the League) (visit *http://www.leagueofgreenembassies.org* for more information).

Step 2 Ensure that a Green Team is organized and empowered to lead. Review strategies and resources in the Using This Guide chapter.

Step 3 Develop a sustainability improvement plan. Use the *Guide* to identify strategies, timelines, and funding sources.

Step 4 Define and incorporate sustainability objectives that align with federal performance goals into post's strategic plans and annual staff evaluations.

Step 5 Submit green success stories for annual GDI awards, to recognize staff and promote best practices (visit *www.state.gov/green* for more information).

By leveraging its unique opportunity of global reach and model facilities, the Department can harness the intelligence, resourcefulness, and commitment of its personnel to integrate innovative, high-impact strategies into its daily operations.

> We, the people, still believe that our obligations as Americans are not just to ourselves, but to all posterity. We will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations. Some may still deny the overwhelming judgment of science, but none can avoid the devastating impact of raging fires, crippling drought, and more powerful storms.
>
> The path towards sustainable energy sources will be long and sometimes difficult. But America cannot resist this transition; we must lead it. We cannot cede to other nations the technology that will power new jobs and new industries; we must claim its promise. That's how we will maintain our economic vitality and our national treasure—our forests and waterways, our crop lands and snow-capped peaks. That is how we will preserve our planet, commanded to our care by God. That's what will lend meaning to the creed our fathers once declared.
>
> President Barack Obama
> 2nd Inaugural Address, January 21, 2013

Endnotes

[1] *US EPA (2012). Climate Change Basics*. U.S. Environmental Protection Agency. *http://www.epa.gov/climatechange/basics*

[2] *Climate Change 2013: The Physical Science Basis—Summary for Policymakers.* Intergovernmental Panel on Climate Change, 2013. *http://www.climatechange2013.org/images/uploads/WGI_AR5_SPM_brochure.pdf*

[3] *The Federal Commitment to Green Building: Experiences and Expectations. http://www1.eere.energy.gov/femp/pdfs/fedcomm_greenbuild.pdf*

[4] *Secretary Kerry Delivers Remarks to the D.C. Greening Embassies Forum.* The U.S. Department of State. *http://www.youtube.com/watch?v=QUneIlBgmDg*

[5] *Crosswalk of Sustainability Goals and Targets.* Federal Energy Management Program, U.S. Department of Energy. *https://www1.eere.energy.gov/femp/pdfs/sustainabilitycrosswalk.pdf*

USING THIS GUIDE

The *Guide's* icons represent exemplars of sustainability in the natural world. As basic sustainability principles for the built environment have their roots in the planet and animal kingdoms, these icons are used to remind us of sustainability's connection to environmental stewardship.

The **olive** branch, a symbol of peace and prosperity in classical myth, also exemplifies the benefits of tending natural resources. An **olive** branch can be offered as a diplomatic act of good will; an **olive** tree that is nurtured can thrive and bear fruit for a thousand years.

The new U.S. Embassy Sofia was the first U.S. diplomatic mission to receive Leadership in Energy and Environmental Design (LEED®) certification, in 2007. The Department now has 20 diplomatic facilities certified and another 32 registered.

Image Source: U.S. Department of State

USING THIS GUIDE

USING THIS GUIDE

User Guidance

The Guide to Green Embassies (the *Guide*) is a tool to support embassy and consulate personnel in achieving sustainable goals for buildings, grounds, and operations. By adopting the best practices detailed in the *Guide*, missions build stronger foundations for eco-diplomacy through demonstrating America's commitment to environmental stewardship in ways that are tangible to host country visitors, citizens, and leaders. Sustainability is also an ideal way to highlight American ingenuity and leadership in cleantech, energy efficiency, renewable energy, and high-performance, sustainable solutions.

The *Guide* provides guidance and defines strategies for Chiefs of Mission (COMs), post management staff, and post green champions—formally organized into Post Green Teams or not—to improve and manage facilities in safer, more secure, functional, efficient, reliable, and sustainable ways. By implementing these guidelines, post staff can contribute to the Department's progress in achieving federal performance goals; in building awareness, knowledge, and skill capacity overseas; and in strengthening our missions as platforms for eco-diplomacy.

The many federal performance goals and Department directives guiding our sustainability objectives can create a complex regulatory environment. To assist posts in understanding how internal and external directives combine and align common goals, the *Guide* is organized into six chapters based on environmental impact categories: Transportation, Site, Water, Energy, Materials, and Indoor Environment. An additional chapter, Residential, includes specific applications related to impact areas at home. Together, these focus areas create a roadmap that identifies policies, best practices, and specific strategies to implement. Further, by organizing chapters into these categories, the *Guide* focuses on performance outcomes, creating a vision for a preferred future that allows posts to capitalize upon opportunities presented by federal reduction targets and to proactively create change.

The chapters seek to answer the following questions, many of which address challenges that posts face regularly:

- **Transportation:** How can posts manage fleets, air travel, and transportation options to reduce greenhouse gas (GHG) emissions?

- **Site:** What options exist for posts to manage, improve, and demonstrate sustainable landscape and irrigation practices to enhance biodiversity?
- **Water:** How can posts reduce annual water consumption and costs while managing stormwater to protect water resources?
- **Energy:** How can posts reduce annual energy consumption and costs, decrease reliance on fossil fuels, and increase use of renewable sources of energy?
- **Materials:** What options exist for posts to reduce procurement impacts, reduce waste, and support local and regional business?
- **Indoor Environment:** How can posts enhance and maintain healthy and productive work environments for their occupants?
- **Residential:** What are the unique opportunities for posts to manage and implement changes at residential facilities that address the same impact areas identified in the *Guide* for non-residential facilities?

Additionally, significant guidance has been added to this chapter and within each chapter to assist post management and green champions with occupant behavior and staff engagement strategies.

Chapter Introductions

Each chapter begins with federal performance goals that specifically address the chapter's environmental impact area. The chapter then identifies and provides global context for factors and agents driving change in its unique impact area. A Profile section provides information about how these drivers influence the built environment, and describes how the topic can be divided into smaller pieces that can more easily be addressed. These pieces can then be used to identify how management modifications, improvement upgrades, renovations, and behavior changes can help posts, the Bureau of Overseas Buildings Operations (OBO), and the Department achieve higher performance.

Though not all strategies contained in the *Guide* may be addressable or immediately applicable at all posts, the goal is to facilitate the implementation of as many strategies as possible. Thus,

Chapters are individually tabbed and designed to provide consistent information for ease of use

1. Table of Contents
2. Strategy Matrix
3. Introduction and Impacts
4. Resources
5. Strategies
   - Audit Strategy
   - Impact-Area-Specific Strategies
   - Case Studies
   - Staff Engagement

the second half of each chapter introduction proposes both a preferred approach to identifying and prioritizing strategies as well as a description of special considerations that may influence post's planning and management decisions. Additionally, the chapter highlights anticipated benefit from strategy implementation. The Practical Application section helps posts account for their unique cultures, regional climate conditions, and specific development patterns, as well as the age, size, and systems of their facilities.

Strategies

The majority of chapter content is devoted to specific strategies. Although each impact area chapter's list of strategies varies, these chapters begin with an 'Audit' strategy and conclude with a strategy entitled 'Staff Engagement.'

A general explanation of different strategy types follows:

- **Audit strategies:** The first step in identifying the best sustainability investment plan is an objective evaluation and benchmarking of existing conditions. Conducting an audit is a high priority; having the facts about existing conditions helps identify the combination of impact-area-specific strategies that best assists posts in reaching and documenting progress toward desired goals.
- **Impact-area-specific strategies:** Each chapter of the *Guide* includes strategies specific to the chapter's impact area. While the *Guide* does not provide an exhaustive list, the range of strategies included allows most posts to identify one or more high-value strategies that can be successfully implemented.
- **Strategy-specific case studies:** Case studies in each chapter demonstrate the potential of specific strategies by describing examples of successful implementation. Strategy-specific case studies are located immediately after the strategies to which they apply, enabling comparison between the two.
- **Staff Engagement strategies:** The last strategy in each chapter is entitled Staff Engagement. This strategy is a compilation of key occupant behaviors that can improve performance at little or no cost, along with practical applications that post management and green champions can use to implement engagement programs. General information about facilitating behavior change is provided later in this chapter.

Regardless of type—audit, impact area-specific, or staff engagement—the strategies are designed to provide information in a standardized format for ease of use and comparison. That format is as follows:

Each strategy begins with a matrix, describing in both text and icons information on benefit, time, investment, and required team members. The

matrix should be used initially to identify strategies warranting further review, to provide estimates for typical implementation, and to serve as a starting point for post discussions. The actual level of benefit received from, or actual time or cost invested in, implementation of a strategy can vary based upon site-specific factors.

- **Benefit:** Each strategy in the *Guide* can provide multiple benefits, which are summarized in the matrix. Most of these include some type of operational savings (e.g., energy, water, operating expenses), while others can benefit building occupants (e.g., improved air quality, natural light, ergonomics, or biophilia) or the greater environment of the host country (e.g., eco-diplomacy efforts to be a good neighbor).

  ★ ☆ ☆ ☆ Modest benefit

  ★ ★ ☆ ☆ Medium benefit

  ★ ★ ★ ☆ Significant benefit

  ★ ★ ★ ★ Major benefit

- **Time:** Each strategy identified in the *Guide* takes time to conceive, plan, implement, and measure. While unique post conditions affect the time it takes to complete and generate benefit from the strategy, the following guidelines have been provided based on prior post experiences with similar project implementation. The following scale is used to define the estimated time required. When a strategy includes a range of potential time frames, the icon represents the lower end of the range.

  One month or less

  Six months or less

  18 months or less

  More than 18 months

- **Investment:** The absolute cost of implementing a strategy varies depending on the size of the system or upgrade, the size of facility, and the type of technology selected, among other factors. To assist posts in identifying typical costs associated with the strategy (beyond the labor cost of staff time), the following scale is used to define the estimated investment:

  $ $ $ $ Little or no funding required
  $ $ $ $ Funding from annual operations budget
  $ $ $ $ Funded through special funding allotment
  $ $ $ $ Significant level of funding required

- **Team Members:** Within strategy matrices, the first member listed—in bold—is typically best suited to lead the strategy. Those who follow need to be informed, consulted, or engaged.

  The list below defines acronyms for potential team members necessary to ensure optimal implementation for each strategy, but is by no means comprehensive or indicative of everyone involved.

  - Bureau of Overseas Buildings Operations (OBO)
  - Chief of Mission (COM)
  - Commissioning (Cx) Agent
  - Community Liaison Office/Officer (CLO)
  - Energy and Sustainable Design Unit (ESD or OBO Green Team)
  - Facility Management/Manager (FM)
  - Financial Management Office/Officer (FMO)
  - General Services Office/Officer (GSO)
  - Human Resources (HR)
  - Information Management Office/Officer (IMO)
  - Management Office/Officer (MO)
  - Planning and Real Estate (PRE)
  - Post Occupational Health and Safety Officer (POSHO)
  - Public Affairs Office/Officer (PAO)
  - Regional Security Office/Officer (RSO)
  - Safety, Health, and Environmental Management (SHEM)
  - Test and Balance (TAB) Contractor

Following this matrix is a brief context overview for the strategy that outlines why the strategy is worth pursuing and how it can factor into a larger sustainability picture.

Additional Resources

At the end of the chapter are directions to additional resources and web links that offer more detailed information. These resources, noted by book icons (📖 Resources), appear throughout the *Guide* to indicate the existence of additional resources on specific topics. Readers can access these resources by visiting *http://www.state.gov/obo/green/greenguiderefs/index.htm*. Online readers may also click on the link located in the Resources section at the end of each impact area chapter.

Case Study: Awards Program

Ulaanbaatar, Mongolia

The Greening Diplomacy Initiative (GDI) Award was created by the Greening Council in an effort to strengthen the Department's sustainability efforts. The Department's personnel were encouraged to submit success stories on the GDI Success Stories website. Winners were chosen based on outstanding success stories that aligned with GDI Guiding Principles objectives and the Department's Agency Sustainability Plan.

Criteria included:

- Reduces the Department's environmental footprint
- Increases the use of environmentally preferred products
- Illustrates office or post greening collaboration with host nations
- Is transferable to other offices, or posts, or nations
- Has been integrated into the Department's training efforts

In 2010, U.S. Embassy Ulaanbaatar won the first ever GDI award for the following achievements:

- Carbon footprint calculation—first U.S. embassy
- Formation of Green Team in the Embassy—including LES staff
- Weekly green tips—in the community newsletter
- Water conservation—well drilling, resulting in 16.94% savings in water bills
- Recycling—resulting in 22% savings in trash expenses and 110 cell phones donated to Cell Phones for Soldiers Phone Card program
- Electrical improvements—switch to compact fluorescent lamps (CFLs) and rewiring to smaller grids, resulting in 33.74% energy savings
- Environmentally safe cleaning products—switch to environmentally friendly products

U.S. Deputy Secretary of Energy Poneman speaks about 'Building a Sustainable Energy Future' in Mongolia

Image Source: U.S. Embassy Ulaanbaatar

Organizing for Sustainability

Post Green Teams

Forming Post Green Teams or harnessing the enthusiasm of individual green champions is an effective way to implement sustainability strategies that require input, coordination, and dedication from stakeholders with a broad range of expertise and backgrounds. Sustainable operations require team efforts by committed groups of informed and engaged internal staff with holistic visions and concrete goals, who identify and implement appropriate projects, practices, and policies. An effective, inclusive approach helps ensure that everyone is working toward the same goals, and allows personnel across multiple offices to share the responsibilities.

U.S. Ambassador Thorne makes remarks at a green embassy event in Rome

Image Source: U.S. Embassy Rome

Following is a list of suggested steps that posts can take to form successful Green Teams. Consult OBO's Green Team Toolkit for additional resources.

1. **Gain upper management endorsement and support.**

   The Introduction to the *Guide* includes five steps that COMs can follow to begin the journey toward eco-diplomacy. Note that step two is "Ensure that a Green Team is organized and empowered to lead."

   As volunteer team members may be operating outside of their professional roles and responsibilities, obtaining upper management's

endorsement and support is especially important for successful Post Green Teams. Teams who receive endorsement and support gain authority that they otherwise may not have: to meet, to establish team goals, to gather and disseminate information, and to make recommendations about implementation of policies and practices.

2. Identify leaders.

A Post Green Team's success depends in large part upon the credibility and effectiveness of its leadership and the degree to which leaders can engender support for the team's initiatives.

Leadership responsibilities may include the following:

- Organizing, convening, and leading regular team meetings
- Encouraging subject matter experts, representatives, and partners to remain engaged as they balance demands of their official work responsibilities
- Building and leveraging relationships with key stakeholders throughout the mission and with other Department and external entities in order to build momentum
- Leading Post Green Team interactions with staff, sections, team members, and management; coordinating with OBO's ESD; and raising awareness about the Department's platform of eco-diplomacy
- Managing and measuring overall progress and results of Post Green Team initiatives and reporting successes and challenges to leadership

3. Identify other team members and partners.

The results of Post Green Teams also depend upon the enthusiasm and knowledge of their members, as well as the breadth and depth of their reach. Ideally, Post Green Team members represent as wide a variety of post sections and offices as possible, and bring expertise in subject matter related to one or more of the impact areas in the *Guide*. It is important that members bring enthusiasm, that they understand the necessity of the team's success, and that they are willing to dedicate time and effort to performing their roles and to producing results.

Just as with the team leadership, Post Green Team members typically embody a personal commitment to sustainability values aligned with the Department's Greening Council and the established guiding principles of eco-diplomacy as represented by the Department's GDI. Post Green Team members model this personal commitment through their daily behavior.

A member's responsibilities may include the following:

- Making and keeping commitments to fellow Post Green Team members to model sustainability by consistently demonstrating sustainable actions
- Sharing ideas for strategies to meet Post Green Team goals
- Identifying achievements, opportunities, and challenges within team member's own sections or offices, and sharing this information with the Post Green Team
- Implementing strategies specifically related to their subject matter expertise in support of federal performance goals

4. Form the team.

Once Post Green Team leadership, team members, and partners have been identified, the team can meet to establish their group norms and roles. These may include:

- Establishing a team purpose by defining the Green Team's primary goal, mission statement, and guiding principles; and ensuring that the mission statement is post-specific and well aligned with the Department's mission statement, as well as with host country challenges and opportunities
- Defining the team structures by identifying specific team member roles and responsibilities
- Establishing the team process by defining meeting times, meeting agenda standards, creating standards for communicating with other group members between meetings, and setting standards for the creation and distribution of meeting minutes

U.S. Embassy San Salvador beach cleanup

Image Source: U.S. Embassy San Salvador

5. Continue building the team.

In addition to holding regularly scheduled meetings, Post Green Teams can benefit from conducting wider annual meetings to invigorate their visions, revisit their mission statements, reestablish team goals for the upcoming year, and revisit existing strategies. These meetings should be

open to broader groups of interested staff to educate, build awareness, and engage staff. During these meetings, it may be determined that some goals and strategies should be replaced, while others—such as ongoing energy efficiency training during orientation—should remain indefinitely.

Keys to Post Green Team Success

There are several best management practices that can help Post Green Teams manage expectations of mission leaders, inspire post personnel, advocate change, and contribute to success.

Following are the key actions to success gleaned from experienced Post Green Teams:

1. Gain knowledge of post's context.

Post Green Teams should be aware of, and understand as well as possible, the contexts within which they operate. The quality of the information maintained by the team can determine the level of certainty with which the teams can execute change.

In order to better understand system characteristics—including existing conditions; geographic context; climate; and financial, time, and policies constraints—Post Green Teams can undertake the following tasks:

- Conduct audits for each of the *Guide*'s impact areas.
- Discuss audit results as a team.
- Identify areas of special interest and priority to post, such as local climates, resource availability, and resource costs.
- Identify Post Green Team and post constraints, such as budgets and key team member availability to contribute and complete strategies. Include short-, mid-, and long-term constraints.

2. Select meaningful strategies.

There is no one-size-fits-all approach to achieving

Some potential questions to ask during the goal selection process

- Does the goal align with GDI's Guiding Principles and the environmental imperatives of the host country?
- Can achieving this goal help demonstrate eco-diplomacy?
- Does the goal contain a specific impact area, performance target, deadline, and link to federal performance goals?
- Is the goal measurable, so that staff can monitor, manage, and report their progress?
- Is the goal realistic, so that team members and partners can see their own success striving to reach it?

performance improvements at posts. Some posts may have significant impacts related to energy and water consumption, while other posts' biggest impacts may be related to their transportation profiles. Posts should use the *Guide* to identify their top two or three impact areas and focus on those areas first to gain momentum and success. To bring focus to those top-priority impact areas, Post Green Teams should begin with audit and staff engagement strategies; doing so can give teams greater understanding of the issues related to those topics and help them begin to shift occupant behavior toward achieving federal performance goals.

Begin by reading the chapter introductions, using post's unique characteristics to rank the chapters from most significant to least. Next, use the audit results and Priority Selection Criteria included in each chapter's introduction to identify the two to three strategies within the highest ranked impact areas to implement. Consider which strategies can be implemented by the skills of Post Green Team members, and which can create operational savings with quick payback.

Although many potential strategies are included in the *Guide*, it does not provide an exhaustive list of strategies for meeting any goal. There are other possible strategies beyond what is written within. Seek unique opportunities to motivate others and produce results.

3. Develop an implementation plan.

Strategies provided in the *Guide* do not provide all the information that Post Green Teams need to create an implementation plan; however, teams can use the Investment and Time metrics contained within each strategy as starting points for discussion. In the implementation plan, Post Green Teams should identify which strategies can be executed in the short term so that the team can begin to develop patterns of success. Include, too, strategies that span multiple years and achieve significant benefit.

While various levels of detail are possible, at a minimum, plans should:

- Record the goals and targets.
- Establish current baselines for performance to measure against progress and success.
- Document the selected strategies and how they reinforce established goals. Use worksheet planning tools to document the planning processes.
- Document and verify progress, success, and barriers to implementation. See Figure 2 for an example of how Post Green Teams might document their plan.

- Incorporate lessons learned and modify the plan accordingly.

4. Implement, measure, and communicate results.

Successful implementation, good project management, measurement and reporting of progress, and tracking progress against project goals are activities that are critical to a Post Green Team's success.

Some activities unique to Post Green Teams include the following:

- Start a Post Green Team webpage. Websites can be an excellent way to share success stories, gain feedback, and raise awareness. U.S. Embassy Beijing notes on its website (see: *http://beijing.usembassy-china.org.cn*) 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. U.S. Embassy Madrid includes its 'Strategic Plan for Climate Change Science Program,' while U.S. Embassy highlights posts green policies of its host country.
- Connect with other Post Green Teams. The strategies contained within the *Guide* are a compilation of those that have been successfully implemented at posts around the world. Consider documenting your experiences in implementing strategies—perhaps using a format similar to the one used in the *Guide*—and sharing information with posts in neighboring countries. Membership in the League of Green Embassies is one of the best ways to benefit from and contribute to the sharing of greening successes.
- Apply for awards. The Department offers several ways to gain recognition for performance improvements and sustainability policies and programs that help achieve federal performance goals. GDI offers posts the opportunity to share their successes via an interactive, web-enabled map of Greening Success Stories. Annual GDI awards celebrate leaders around the globe who successfully implement sustainability initiatives. (see: *http://www.state.gov/m/pri/gdi*)

Figure 1: GDI awards celebrate green successes

Image Source: U.S. Department of State

Figure 2: Sample planning worksheet

Green Team Planning Worksheet

Year: 2013 **Post:** New Delhi, India

Goals

Refer to the *Guide* Introduction to identify federal performance goals that can be adopted by post. Consider your host country to identify environmental goals and requirements that are unique to your post and that may further the Department's platform of eco-diplomacy.

1. Reduce energy intensity by 30% by 2015 using 2007 baseline.
2. Divert 50% of non-hazardous solid waste by 2015.
3. Reduce potable water consumption intensity by 26% by 2020 using 2007 baseline.
4. Reduce fleet fossil fuel consumption by 30% by 2020 using 2005 baseline.

Goal	Strategies	Benefits	Investment	Time
1	*Energy audit*	*N/A*	*$2,000*	*40 hrs*
1	*Re-commissioning (Re-Cx)/Retro-commissioning (Retro-Cx)*	*~10% less energy use*	*$6,000*	*120 hrs*
1	*Energy education*	*~10% less energy use*	*$1,000*	*20 hrs*
2	*Waste management*	*60% diverted*	*$2,500*	*50 hrs*
3	*Water audit*	*N/A*	*$2,000*	*40 hrs*
3	*Metering*	*N/A*	*$5,500*	*10 hrs*
3	*Efficient plumbing fixtures*	*~20% less water use*	*$20,000*	*10 hrs*
3	*Water education*	*~10% less water use*	*$1,000*	*20 hrs*
4	*Fleet management policy*	*~15% less fuel use*	*$15,000*	*100 hrs*
	Totals	*See notes*	*$55,000*	*410 hrs*

Notes

- Energy use reduced by ~20% (in kilowatt-hours (kWh)) over 2007.
- Hazardous solid waste (by weight) reduced by 12% over 2012 and 20% diverted.
- Potable water consumption reduced by 6% over 2007.
- Fleet fuel consumption reduced by 15% over 2005.

Influencing Occupant Behavior

Behavior Principles

Although people interact with buildings daily, many tend to identify sustainable facilities with physical features, such as alternative energy systems, water-efficient fixtures, or recycled carpet. The perceptions seem to be that:

- Building designers are responsible for building performance.
- Building performance is established primarily prior to occupancy.

These perceptions are inaccurate. Building design effectiveness and efficiency are largely influenced by, and dependent on, those who operate and occupy the building. In fact, building performance and a significant proportion of building resource use are driven directly by operational and occupant habits that are often completely independent of the building design. In many cases, these habits have a larger impact on building performance than does the initial building design.

Some aspects of building performance are controlled primarily by building operators, maintenance staff, or controls programmers. Other aspects are controlled primarily by building occupants, who are seldom in a position to recognize their direct impact on building performance.

For example, heating, ventilating, and air conditioning (HVAC) fan energy use is an element of building design, but its effectiveness and efficiency is limited by building operational habits (e.g., filter maintenance). Similarly, lighting controls are elements of building design, but occupant habits (e.g., turning lights off) determine effectiveness and efficiency. In some cases, such as with temperature setpoints, building design elements can be impacted both by operational and occupant habits (e.g., setting schedules and prohibiting individual space heaters and fans).

To maximize benefits from occupant behavior related to building performance, leadership is needed to foster change. Such leadership need not be formal; it can come from change agents and influencers throughout the organization.

Post Green Teams can make a major difference in the impact of U.S. operations on their host countries' environments and local economies, as well as in the lives and health of embassy personnel. The Department is committed to supporting this change, and the *Guide* is designed to spark action.

Typically, a sustainability journey is a multi-disciplinary and interdepartmental effort involving psychology, observational and social research, marketing, communication, organization change, infrastructure design, and regulation. Such complex efforts require special leadership skills. The following pages are devoted to providing the means and methods to help sustainability leaders at all levels at post address these needs by guiding them through three stages of organization behavior change: personal, social, and structural.

Personal

It can be challenging to bring about lasting personal behavior change.

Following are strategies that leaders can use to strengthen their personal efforts to model sustainable behavior:

Make a personal commitment. Making and keeping sustainability commitments to oneself is the basis of making and keeping such commitments to others. The process of making a personal sustainability commitment includes some of the same steps that Post Green Team leaders, members, and partners take in establishing their team.

U.S. Ambassador Jones taking the Green Pledge

Image Source: U.S. Embassy Amman

Steps to assist in making a personal commitment include:

1. **Clarify your personal purpose in pursuing a more sustainable life.**

   Ensure that your purpose is well-aligned with both the Department's Agency Sustainability Plan and the Greening Council's Charter and Guiding Principles.

2. **Understand your own sustainability values.**

   Identify the perspective you bring to work and your community every day.

   The following is a sample of questions that you can ask yourself to uncover your own motivations for change:

   - How are your personal interests connected with environmental, social, and economic sustainability issues? For example, someone passionately interested in economic prosperity may want to obtain a deeper understanding of how saving resources equates to saving money. Those passionately interested in personal health may want to obtain a deeper understanding of how sustainable food systems, access to healthy outdoor environments, and clean air affects their personal health and those around them. Those who are concerned about social equity may want to obtain a deeper understanding of how climate change or water quality can impact resource conflicts and major populations.
   - What is your personal sustainability impact? For example, you might want to calculate your personal carbon or water footprint (or both). You might also want to quantify the cost of personal expenses related to sustainability, such as home utilities or commuting costs, and note how these costs have changed over time.

3. **Set personal sustainability goals.**

   Ensure that the goals align with your personal purpose and context. Use the information gathered in earlier steps to identify areas where your purpose, interests, and constraints can enable and motivate you to make a positive contribution in addressing big sustainability challenges.

Change personal habits. Other people cannot know our intentions; they can only interpret how we behave. In order to influence their colleagues, Post Green Team members must first model desired behavior. Using your personal commitment, identify some simple sustainability habits that you can easily adopt. Once you've mastered these new habits, identify new, more challenging habits. Create and build momentum and ultimately your mastery of personal behavior change can allow you to lead by example and inspire others to do the same.

Gain knowledge. The body of sustainability knowledge is expanding daily, so continuing sustainability education and knowing the facts are essential strategies for a sustainability leader and behavior change agent. This education may include information in one of two general topic areas: raising awareness and developing skills.

Following are some suggestions specifically related to sustainability education:

- Organize or participate in lunch-and-learn sessions at post. These could be designed to develop new technical skills for small groups of post staff or to raise awareness about new sustainability challenges for larger groups.
- Consider offering a variety of brief sustainability education sessions in conjunction with new employee orientation. These sessions could help new staff identify specific sustainability challenges and opportunities presented at post, as well as raise awareness about how they can help address them. Separate sessions could be offered to post staff families to help them adjust to local sustainability issues in their new homes.
- Take advantage of online professional education through organizations such as the International Facility Management Association (IFMA). Online training from reputable organizations is a high-quality and low-carbon alternative to classroom training.
- Encourage partnerships that support shared training, within security guidelines. Don't overlook the value of training for suppliers and vendors, who may be interested in learning about such resources.
- Investigate formal education. Universities and colleges around the world are now offering courses remotely that address sustainability through social, environmental, and economic lenses. These resources can be valuable both for raising awareness and for skill development by all members of the post community.

According to Climate Outreach and Information Network: A Practitioners guide to the psychology of sustainable behavior, a person has to identify a goal (e.g. drive less), a behavior in pursuit of that goal (e.g. get the bus to work on Fridays) and the situation that will trigger the behavior (e.g. having enough time to catch the bus).

Social

The most effective change agents understand the power that human beings hold over one another. Adopting new behavior may feel inherently unsafe. The social stage of organizational behavior change involves using a fundamental understanding of human social behavior to facilitate a shift in group behavior toward sustainability.

Influence the influencers. Within any group, the praise, acceptance, and approval of some people are generally seen to be more valuable than that of others. These socially powerful people—the group's thought leaders—are well-connected and well-respected.

Rather than focusing on transforming the behavior of everyone in the group directly (an ambitious goal), a sustainability and behavior change leader can focus instead on shifting the opinions and behaviors of social leaders. In fact, one of a sustainability champion's most important roles is to facilitate strategic discussions that include these thought leaders.

Instead of asking, "How can I make post share my passionate concern for energy and water efficiency?", a sustainability champion may want to consider asking, "How I we help our thought leaders solve the urgent problems they already face through a sustainability lens?". A thought leader's personal concerns may have strong ties to sustainability issues; finding those connections may enable sustainability champions to persuade the thought leader of the value of sustainability and of systems-based thinking. Thus, by acquiring a deep understanding of thought leaders and their real needs, and by addressing those needs with sustainability solutions, sustainability leaders may be able to leverage behavior shifts in entire groups.

Shift social norms. Social norms are group-held beliefs about how members should behave in a given context. These beliefs reflect a group's deeply held shared values. Although green champions may have strong desires to change the world, most people prefer incremental improvement and strongly resist any change that is perceived to challenge their values.

Provided they have been able to gain the support of the group's thought leaders, sustainability leaders may be successful in fostering widespread behavior change through any number of actions, including the following:

- **Raising awareness.** Make explicit the connection between sustainability and safer, more secure, functional, and efficient buildings. Experiment with informal outreach activities.
- **Being clear.** When implementing strategies that impact post staff, make sure to communicate goals to staff members affected by the change. Consider using a variety of communication tools, such as

Table 1: U.S. Consulate General Guangzhou staff behavior change commitments

I pledge to:	Number of pledges
Eat meat at most three days a week	548
Limit my showers to five minutes	330
Recycle all plastic bottles I use	825
Join an environmental organization	516
Plant a tree	631
Build a compost bin	132
Ride my bike to work every day	553
Total:	**3,535**

Data Source: U.S. Consulate General Guangzhou

email, SharePoint sites, online newsletters, posters, fliers, internal print publications, and allowable social media such as Facebook and Twitter. When asking others to take action, provide the most simple, easiest instructions possible.

- **Soliciting feedback.** Use surveys to ask post staff about issues relevant to effective operations and their well-being. Ask for personal perspectives on how well specific sustainability challenges are being addressed, or how well teams are collaborating to solve complex, systemic challenges. Ask people to share what sustainability means to them and what they wish it would become. Do not neglect to follow through: lack of follow-through is a significant demotivating force. Examine the aggregated results, decide on a strategic response, and provide updates to those who offered feedback.
- **Demonstrating respect.** Listen with focused curiosity and interest. Ensure that your nonverbal and verbal communication reflects your willingness to better understand and to learn from others. Be on time for meetings, and allow ample time for others to share their thoughts so they have an opportunity to dig deep. Encourage people to find ways to connect sustainability to their personal goals.
- **Sharing success stories.** Stories are our best tools to communicate; the best stories are short, emotional, surprising, concrete, and believable. Success stories, and especially personal success stories, offer people an opportunity not only to connect with the storyteller, but also to gain new insights about how sustainability can benefit them personally.
- **Jumping on the bandwagon.** Provide opportunities for group members to participate in activities with their peers. Develop lists of global and local sustainability initiatives and special dates, such as Earth Day, and organize special activities around the theme. Organize group trips to neighboring green buildings or manufacturing facilities.
- **Asking questions.** Provocative and truly investigative inquiries can open minds and shift perspectives of others who control results and the keys to change.

To celebrate Earth Week, the Guangzhou Green Team partnered with Bike Guangzhou to ride around Bio Island

Image Source: U.S. Consulate General Guangzhou

- **Making it fun!** When possible, use humor, include refreshments, and create a casual atmosphere. Introduce game-like processes that enable small groups to engage in friendly competition with other, similar groups. Implement a 'best idea of the month' contest.

Structural

In discussing the structural component of influencing occupant behavior, we step away from human factors—personal and social—and focus on how to harness the power of non-human elements. Structural components support shifts in personal and group behavior. These include physical signals—what people touch, see, and otherwise perceive through their senses—as well as the formal and informal processes through which people work. Examples of structural components include policies, procedures, building technologies and systems controls, incentives, awards, and feedback mechanisms.

Refine incentives. Creating effective incentive programs can be challenging. Many well-intentioned programs inadvertently backfire. The most successful programs tend to be implemented after personal and social components have been addressed, for those who are already motivated to change and who already have the social support necessary to do so.

Following are some guidelines for establishing sustainability incentive programs:

- Ensure that incentives support staff in their personal context. Consider whether incentives encourage behavior that is already aligned with professional performance goals. If so, it may be valuable to document sustainability leadership and performance to support feedback during formal evaluation processes.
- Create incentives that support staff in their social context. Consider whether incentives dignify participants in the eyes of others or whether they have the potential to cause embarrassment.
- Set incentives that are valuable to their intended recipients, both to individuals and to their social groups. Consider recognizing outstanding sustainability leadership and performance with dignified, public praise. This may include physical awards and partnerships with local organizations within the host country. Possibilities for smaller incentives may include recognition at 'all hands' meetings or other 'town hall' type events. Details matter; the value of a certificate of recognition may depend upon the job title of the person whose signature appears on it.
- Consider implementing programs that provide rewards only if performance targets are met. Receiving valued rewards can be good motivators, but people may be more motivated by the potential loss of rewards.

Change the physical environment. For better or worse, much of our behavior is influenced by environmental forces. As a result, this resource, one of our most powerful sources of influence, is seldom engaged as an agent of change. Perhaps we more often identify goals, notice behavior that prevents us from achieving our goals, and focus on how to change people—the personal and social component—rather than their environment.

Thus, we may miss subtle opportunities. Sometimes the size or design of a chair can make a person more comfortable and, consequently, more productive or communicative. Sometimes the size of a room can make a person feel confined and less likely to continue working on a task. Similarly, a change in the physical environment where someone lives or works may cause them to behave in more sustainable ways. The powerful, and often undetected, influence of the physical environment presents good opportunity to shift occupant behavior. *Things* don't resist change, and many of them are inexpensive.

Many physical adjustments are included in the chapter strategies.

Following are some additional suggestions for creating a physical environment that supports your goals:

- Ensure that the physical environment sends a message that aligns with your goals. For example, if one of your objectives is to encourage building occupants to provide more timely reports about building maintenance issues, then ensure that building maintenance staff are accessible to building occupants for feedback. One way to do this is by placing their office in a visible location. Another is to ensure that processes and technologies—such as email addresses—are in place to make communication easy and simple.
- Stage the physical environment to make sustainable behaviors easy and convenient for occupants. One way to do this is by setting appropriate defaults. For example, set occupancy sensors to turn the lights off, not on (when occupants need to turn the lights on, they can do so manually) or set toilets to flush less water

Organic food fair hosted by the U.S. Consulate General Guangzhou Green Team

Image Source: U.S. Consulate General Guangzhou

when the handle is pushed down, the default direction, in a dual-flush toilet.

- Create a physical environment that invites opportunities for passive education and instruction. Provide cues to remind people of the behavior that you're trying to influence. For example, install point-of-use signage, such as at hand-wash sinks, that provides information about how many liters (L) of water are consumed for every ten-second interval of use. Monitoring devices, such as those that keep continuous energy consumption records, provide valuable feedback to building occupants. For example, make building-energy-use dashboards that show occupants their current use as compared to an average (e.g., average of all post buildings).

In honor of the 42nd anniversary of Earth Day, the U.S. Consulate General Chennai launched a new recycling program and showed support by wearing green

Image Source: U.S. Consulate General Chennai

Resources

This list of resources that can support sustainability efforts. Some are internal to the Federal Government, the Department, and OBO, while others are public. All of these tools can be used by Post Green Teams to support their work in achieving sustainability goals.

Greening Diplomacy Initiative
The Department of State
http://www.state.gov/r/pa/pl/156053.htm

Launched by Secretary of State Hillary Clinton in 2009, the goal of Greening Diplomacy Initiative (GDI) is to improve the environmental sustainability of the Department's global operations. Advanced by the Department's Greening Council, GDI challenges the Department to develop and implement policies and actions that lessen its overall environmental footprint, reduce costs, and ensure sustainability remains at the forefront of U.S. foreign policy.

The League of Green Embassies
http://www.leagueofgreenembassies.org

Primarily composed of U.S. embassies, the League of Green Embassies (the League) is a global network of over 100 U.S. and foreign diplomatic missions formulating a common agenda for energy efficiency, renewable energy, and water conservation. Access to all diplomatic missions concretely illustrates the power of connecting environmental stewardship with political will to advance a platform of eco-diplomacy. Member embassies pledge to introduce innovative solutions, influence individuals and institutions in host countries, and play an important role in mobilizing public action, by:

- Providing environmental leadership at embassies
- Working with appropriate government officials in seeking additional funding for embassy greening projects
- Cooperating with counterparts and sharing ideas on energy conservation and other strategies for reducing GHG emissions
- Promoting reliance on increased use of renewable energy
- Instituting recycling programs at embassies

The League website is a forum to promote best practices, discuss common challenges, and connect solution providers to organizations seeking energy- and water-saving innovations.

Green Team Toolkit
Bureau of Overseas Buildings Operation
http://obo.m.state.sbu/greenteam/pages/green-team-toolkit.aspx

The Green Team Toolkit is an online resource developed to complement the *Guide* and further support staff engagement. With over 150 green teams, this 'one-stop-shop' is intended to unify the Department's GDI messaging, facts, and branding of eco-diplomacy for posts' greening champions. This set of prepared tools, tips, templates, and formalized guidance from management allows Post Green Teams to focus on results and benefits. The Toolkit provides practical information regarding Green Team start-up, organization, and communication techniques, as well as how to plan and execute successful community events, implement actions to produce tangible results, and recognize peers for their greening success.

Utility Management, Analysis, and Reporting Tool

Bureau of Overseas Buildings Operations
http://obo.m.state.sbu/greenteam/pages/utilitymanagement.aspx

In 2007, OBO launched the Utility Data Portal to support reporting from posts on federal performance goals. In 2013, to provide more advanced tools for utility management and analysis, OBO deployed the Tririga Real Estate Environmental Sustainability (TREES) database to all posts.

TREES provides graphic feedback for over 22 metrics focused on energy and water cost and consumption, as well as GHG emissions. Baseline and annual data entered into the system enable posts to better manage building performance, compare performance with like buildings in similar climate zones, and evaluate progress in achieving sustainability goals.

Using TREES, OBO continues to achieve new breakthroughs by using information technology (IT) to measure and manage the performance of the Department's global portfolio. Figure 3 showcases OBO's Utility Dashboard, an interactive tool offering insights into utility consumption, costs, comparisons, and trends against targets. The Dashboard is available to all the Department's personnel, offering the ability to drill down from a high-level view of worldwide performance to a low-level view of building performance.

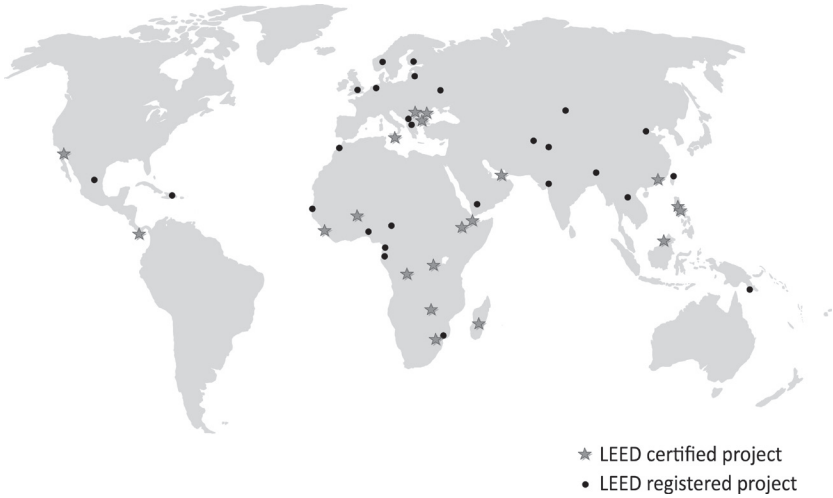
Leadership in Energy and Environmental Design
U.S. Green Building Council
http://www.usgbc.org

LEED for New Construction (LEED®-NC) provides a base for sustainable operation and maintenance. In 2008, the Department committed to

certifying new U.S. embassy and consulate construction through LEED-NC. In addition to the current list of 20 LEED certified U.S. diplomatic missions, the Department has over 30 projects registered with the U.S. Green Building Council. (see http://www.state.gov/obo/green/leed/certified/index.htm)

LEED for Existing Buildings: Operations and Maintenance (LEED® EB:OM) supports sustainable facilities management by certifying policies and plans for reporting, inspection, and review to ensure high building performance over time. Posts can demonstrate progress in green building by obtaining LEED EB:OM certification for main facilities (contact OBO for assistance) and by holding a press briefing to share this success publicly.

Figure 2: LEED® certified and registered U.S. diplomatic facilities, October 2013



LEED Level	U.S. Embassy or Consulate
Gold	Brazzaville, Bujumbura, Dubai, Manila, Monrovia
Silver	Antananarivo, Guangzhou, Lusaka, Ouagadougou, Valletta
Certified	Addis Ababa, Bandar, Belgrade, Bucharest, Djibouti, Johannesburg, Manila, Panama City, Sofia, Tijuana
Registered	Abuja, Beijing, Bishkek, Cotonou, Dakar, Helsinki, Islamabad, Jakarta, Kabul, Karachi, Kyiv, London, Malabo, Maputo, Mbabane, Mexico City, Monterrey, Moscow, N'Djamena, Nouakchott, Oslo, Podgorica, Port Moresby, Pristina, Rabat, Riga, Sana'a, Santo Domingo, Sarajevo, Taipei, The Hague, Vientiane

Data and Image Source: Bureau of Overseas Buildings Operations

TRANSPORTATION

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

That is fuel efficiency worth mimicking.

U.S. missions in Beijing, Canberra, Dakar, Helsinki, Kampala, Kathmandu, and many others are reducing greenhouse gas (GHG) emissions while saving on fuel consumption by investing in hybrid and electric vehicles, including the Chevy Volt, the Nissan Leaf, Mahindra REVA electric vehicles (MREV), and three-wheeled Safa Tempos.

Image Source: U.S. Embassy Kathmandu

TRANSPORTATION

Transportation

Federal Performance Goals

Resource Consumption:

- 20% reduction in petroleum use in vehicle fleets by 2015 compared to 2005 baseline

Alternative Fuels:

- 95% of fuel used in non-waivered alternative fuel vehicles (AFVs) is alternative fuel
- 75% of new vehicle acquisitions to be AFVs
- 10% annual increase in alternative fuel consumption as projected from the 2005 baseline

Chapter Overview

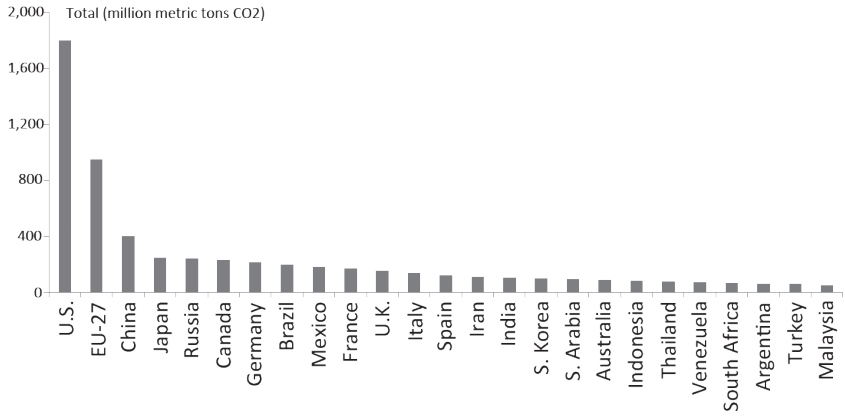
Current transportation patterns generate significant economic, social, and environmental damage. Globally, transportation consumes more than half our liquid fossil fuels, emits almost one-quarter of our energy-related carbon dioxide (CO_2), generates more than 80% of the urban air pollution in developing countries, results in more than 1.2 million fatal traffic accidents annually, and produces chronic traffic congestion.[1]

Collectively, the top 25 countries contributing to atmospheric CO_2 from transportation account for 88% of global emissions (Figure 1). These numbers include ground, rail, maritime, and aviation transport. Currently, approximately 80% of CO_2 emissions from transportation are the result of ground travel; however, the GHG emissions produced by air travel are believed to cause more damage to the ozone layer than ground transportation, due to jet fuel combustion occurring at higher elevations.[2]

Current transportation systems depend largely on nonrenewable fossil fuel energy sources. The increasing global demand from both developed and developing nations, coupled with dwindling supply, may continue to drive transportation costs higher unless we move to alternative transportation modes and the use of renewable fuels. To reduce the environmental impact

of fossil fuel-based transportation networks and offset their significant economic impact, governments around the world are investing in renewable-fuel transit and conducting ongoing research into increasing efficiencies in transportation systems.

Figure 1: Top transportation CO_2 emitters include the U.S., the European Union (EU), and China, 2006



Data Source: World Resources Institute

Within this context, no one would dispute that mobility is vital for U.S. diplomats and officials as they work to implement successful U.S. relations with the international community. However, each post should consider the carbon impact of travel when convening and attending meetings. Sometimes new technology can serve as a reasonable and successful substitute for face-to-face meetings. For example, in 2012 the Department hosted over 33,000 digital video conferences. When large meetings are required, consider the guidance provided by the U.S. Environmental Protection Agency's (EPA's), Green Meetings and Conferences Policy. (See Resources: Green Meetings) The keys are balancing effective transportation with environmental stewardship, via alternative transportation and communication strategies, and the adoption of new technologies as they are developed.

Goals of a more sustainable transportation program include increasing fuel efficiencies, improving human health, meeting and exceeding emission reduction goals, and working toward solving local traffic solutions. Posts can demonstrate eco-diplomacy by creating policies and implementing practices that support transportation emission reduction goals of their host countries.

Transportation Profile

The primary mode of transportation to and from Department of State (the Department) facilities varies greatly based on whether post's location is urban, suburban, or rural. Other factors that determine types of transportation used to access post facilities include the locations of buildings in relation to airports, populations served, and staff residences, as well as availability and security of mass transit, air pollution concerns, or high incidence of violent crime. In the United States, 83% of all trips are made by private vehicle, and 79.5% of commuters drive to work alone;[3] however, commuter patterns for posts are likely to mimic those of the local population. Cities with large, dense populations are more likely to have a transit mode profile that reflects walkability and access to public transit.[4]

Table 1: Annual percent of U.S. transportation trips by mode

Mode of Transportation	1995	2001	2009
Private Vehicle	89.3	86.4	83.4
Bus	3.0	2.8	3.3
Rail	0.6	0.6	0.6
Air	0.1	0.1	0.1
Walk	5.5	8.7	10.4
Bike	0.9	0.8	1.0
Other/Unknown	0.5	0.6	1.1
TOTAL	**100.0**	**100.0**	**100.0**

Data Source: U.S. Department of Transportation

Considering the goals of maximizing efficient use of government vehicles and reducing maintenance and operating costs of the fleet, post fleet managers should use this chapter's strategies wherever feasible, with the understanding that they are not necessarily applicable to every fleet situation. Consult with the RSO to determine the optimal transportation modes for post, including mass transit and other commuting alternatives.

For posts located in one of the highest-emitting countries (see Figure 1), all transportation strategies included in this chapter should be considered. Fleet upgrades, environmentally-sensitive transportation options, and alternative commuting practices can all contribute to significant reductions of the mission's total GHG emissions.

Considerations

Facilities should begin by determining the commuting habits and work-related travel patterns of post staff, as well as the fuel efficiency of fleet vehicles. An audit can provide intelligence on how to prioritize transportation strategies.

Figure 2: A Mexico City public transit study helped inform the new Embassy's design and location

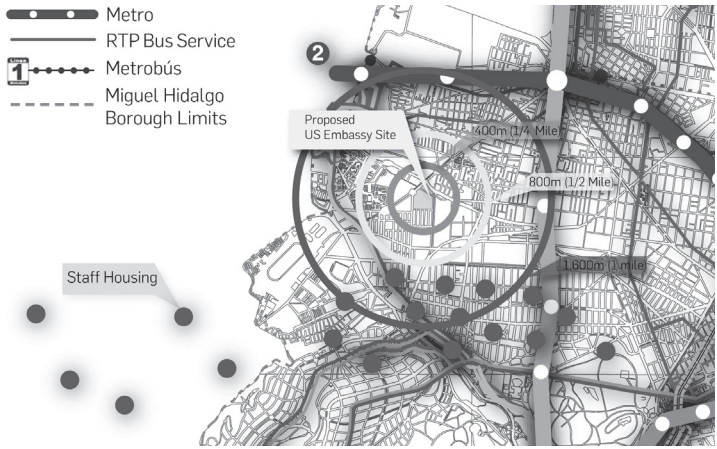


Image Source: WSP Flack + Kurtz

After audit completion, the most effective sequence for pursuing an overall reduction in environmental impact due to transportation is as follows:

1. **Load reduction:** Alternatives to driving to work include telecommuting, carpooling, shuttles, bicycling, walking, and use of public transit. Virtual meetings can reduce air travel by post staff. By reducing single-passenger commuting and unnecessary fleet and air travel, posts can significantly reduce GHG emissions without implementing any improvements to vehicles.
2. **Fuel efficiency:** Inefficient fleet vehicles should only be used when required for a specific task. Additionally, post should implement a fleet replacement plan to phase out vehicles with low fuel economy. Educate post personnel on best practices for maintenance and driving.
3. **Renewable fuel sources:** Consider AFVs that use electric, ethanol, biodiesel, compressed natural gas, propane, and hydrogen. Before purchasing, ensure that these vehicles can be serviced by post or host country, and that they are cost-effective solutions.

Strategy Selection Factors

Once posts have examined commuting patterns and fleet fuel efficiency, they can factor in their unique characteristics to help prioritize strategies. Consider the following:

- **Low-density location:** Posts located in suburban or rural environments can benefit from use of commuting programs that reduce single-occupant vehicles. Additionally, these posts are likely to experience greater use of fleet vehicles for off-site meetings and events.
- **Health and safety:** Where air pollution, risk of violent crime, or other safety issues are prevalent, commuting alternatives are less likely to be accepted or applicable. Posts in these areas should focus on improving fleet efficiency and examining opportunities for telecommuting, carpooling, and other behavior change strategies.
- **Single passenger commuting >50%:** If more than half of staff is composed of single-passenger commuters, supporting and incentivizing alternative commuting methods could make a significant impact.
- **Large vehicle fleet:** Posts with large fleets can experience the greatest benefit from optimized vehicle fuel efficiency, particularly if many of the vehicles have fuel efficiencies lower than 6 kilometers per liter (km/L) (15 miles per gallon (mpg)).

Priority Selection Criteria	Low-density location	Health and safety	Single passenger commuting >50%	Large vehicle fleet
Audit	All posts			
Commuting	●		●	
Fleet Management	●	●		●
Staff Engagement	All posts			

Case Study: Walk/Bike to Work Day

Foreign Service Institute, Arlington, VA

Walk to Work Day

Both staff and students at the Department's Foreign Service Institute (FSI) participated in National Walk to Work Day in April 2012, and promoted the event by holding a Walk to Work sign while they walked.[5] The event was organized by the FSI Wellness Committee, which encourages activities that contribute to the health and wellness of FSI employees.

FSI employees participated in Walk to Work Day, 2012

Image Source: State Magazine, July-August 2012

Bike to Work Day

FSI employees have been actively engaged in Bike to Work Day since 2009. During the 2012 event, an estimated 12,000 people, including FSI employees, rode bikes to work in Washington, D.C. To support the event and encourage participation, the Institute allowed riders to use the showers and lockers in the Foreign Affairs Recreation Association gym free of charge. Under Secretary for Management Patrick Kennedy, the Department's Senior Sustainability Officer, addressed and praised cyclists before they rode a 7.4 kilometer (km) (4.6 mile (mi)) circuit of the National Mall.

Strategies

Strategy	Benefit	Time	Investment
Audit	★★★★	🕐🕐	$
Commuting	★★	🕐🕐	$$
Fleet Management	★★★	🕐	$$$
Staff Engagement	★★★★	🕐	$

Dunaföldvár Mayor Nagy breaks ground for Hungary's largest alternative fuel, bio-ethanol production facility, while U.S. Ambassador Kounalakis, U.S. Embassy Budapest, observes

Image Source: State Magazine, July-August 2012

Audit

Benefit ★ ★ ★ ★	Provides in-depth knowledge of post's transportation infrastructure and occupants' travel practices, and identifies measures to reduce transportation carbon emissions
Time	One week for planning, two to four weeks to implement a commuting survey, and two to four weeks to complete the audit and write a report
Investment $ $ $ $	No financial investment required
Team Members	**Post Green Team** | GSO, FM, RSO

Transportation audits can clarify travel patterns of post personnel and may lead to improved efficiency in fleet management, increased adoption of alternative commuting options, and reductions in work-related travel. A balanced audit includes a review of government-owned and -maintained vehicles, air and automobile travel requirements, staff commuting habits, and availability of transportation modes.

Transportation accounts for 27% of total U.S. energy consumption, and over 90% of transportation energy use is petroleum.[6]

Data collection for government vehicles allows posts to assess the current fuel efficiency of their fleets, devise plans for improvements, implement operational and strategic initiatives to save fuel and money, and suggest recommendations for improvements into future fleet procurement policies.

For each official vehicle, confirm or obtain the following:

- Make, model, year, fuel type, and annual distance driven
- Fuel efficiency
- Maintenance schedules, records, and costs

Similarly, a review of work-related travel can quantify the financial and environmental consequences of high-impact activities, such as air travel. Collect information about method of travel, distance traveled, typical routes taken, travel time, public transit usage, and carpool/vanpool usage.

Commuting habit surveys provide baseline information about current practices and allow posts to identify opportunities for energy and financial savings. Ideally, this information is collected well in advance of strategy implementation. The surveys also should identify post staff who use public transit effectively, so that they can be recognized as leaders and share best practices and tips with people who commute via single-occupant vehicles.

Practical Application

1. **Work** with post's fleet manager to update documents pertaining to post's official vehicles and their use.
2. **Conduct** a survey of post personnel travel and commuting habits. Calculate distance traveled to each home in post's housing pool.
3. **Determine** whether post is served by safe, reliable public transit. If so, check with the RSO for permission to use mass transit, and identify the nearest transit stops and routes that serve each stop in relation to residences and typical meeting locations.
4. **Determine** whether biking to post is feasible, based on road conditions and health and safety factors. Establish whether post has showers, changing rooms, and secure storage to support bicycle transit.
5. **Determine** whether alternative vehicle fueling or charging stations exist locally.
6. **Identify** technologies and resources available to enable teleconferencing, video conferencing, and telecommuting.
7. **Document** environmentally-friendly, transportation-related strategies and policies already in place, such as preferred parking spaces for carpool vehicles.
8. **Use** inventory data, survey results, and other information to identify opportunities to reduce post's transportation-related GHG emissions, such as replacement of high emission vehicles.
9. **Compile** findings and recommendations into an audit report that can be used to inform post's fleet management and commuting policies, as well as residential leasing practices.

Commuting

Benefit ★★☆☆	Reduces fossil fuel consumption and GHG emissions from post staff commuting, improves staff health, and reduces parking demand at post facilities
Time 🕐🕐🕑🕑	Two to three months to select bicycles and bicycle racks, one to three months to install bicycle infrastructure and carpool signage, and three to six months to develop and implement education and programs
Investment $ $ $ $	Bicycles and bicycle racks, parking lot signage, and transit passes
Team Members	**FM** | GSO, CLO

Commuting by single-occupant vehicle is associated with financial cost, unproductive travel time, and GHG emissions. Supporting and incentivizing alternative commuting methods such as bicycling, carpooling, walking, and public transit can benefit both post and staff. Posts can reduce parking demand, limit the impact on local traffic, increase community engagement, and decrease emissions. Staff benefits include fuel savings, reduced vehicle maintenance, improved health, and increased productivity.

Three hours of biking per week reduces the risk of heart disease and stroke by 50%.[7]

To encourage alternative commuting modes including mass transit, carpooling, walking, and cycling, posts can provide infrastructure and incentives such as:

- Preferred parking for high occupancy vehicles (HOVs)
- Secure bicycle storage, showers, and changing rooms
- A bike share program that enables post residents and staff to borrow bicycles for short trips for free or for a nominal fee
- Staff residences located near mass transit, where available, and if in compliance with security and housing pool requirements

Incentives and programs could include:

- Partially or fully subsidized transit passes
- Guaranteed ride home program for commuters who carpool, vanpool, bike, walk, or take transit; the program should provide a free and reliable ride home (e.g., taxi) in emergencies or after hours
- Educational programs or materials that encourage staff to use alternative commuting strategies (see Transportation: Staff Engagement)

Practical Application

1. **Check** with the RSO regarding allowable alternative commuting options.
2. **Dedicate** preferred parking for HOVs and carpools.
3. **Provide** bicycle commuting facilities.
4. **Work** with the GSO to secure residential leases proximate to post facilities and mass transit options, if mass transit is allowed by the RSO (see Residential: Green Leasing).
5. **Establish** a guaranteed ride home program.
6. **Implement** a bike share program.
7. **Work** with the GSO to establish a transit pass subsidy.
8. **Coordinate** with the CLO to provide alternative commuting education.

U.S. Ambassador Eacho encourages sustainable transportation by taking Embassy staff to ride the city of Vienna's Eco Bus

Image Source: U.S. Embassy Vienna

Case Study: Bike Share Program

Department of State, Washington, D.C.

Benefit	Reduces vehicle emissions, increases health benefits for staff, and demonstrates environmental leadership
Time	Three weeks to solicit quotes from dealers and purchase bikes and adjunct equipment
Investment	Approximately $8,300, including 10 bikes, two bike racks, helmets, lock and key sets, odometers, and monthly maintenance
Team Members	**FM**

Employees at the Department have many options when traveling in the Washington Capital region, including motor pool vehicles, organization vehicles, Department shuttles, taxis, mass transit (i.e., the Metro bus and rail system), walking, and now, loaner bicycles. The Department provides 10 bicycles free of charge to Department employees and contractors as a healthy and environmentally-friendly alternative means of transportation.

To participate in the program, which is managed by the Administration Bureau's FM Section, participants must sign an agreement and acknowledgement of responsibility. Bicycles are stored and locked at dedicated racks in the Harry S Truman Building (HST) garage and participants check out and return the bicycles through the FM office during business hours. Outside of business hours, participants may place keys in a lockbox near dedicated racks.

The program expanded in 2010, with four of the bicycles being relocated to a Department annex building to fulfill demand outside of HST. Since its inception, 298 employees and contractors have enrolled, riding nearly 9,650 km (6,000 mi) and precluding almost five tons of CO_2 that would have been generated through driving.

A sample of the bicycles offered for loan at HST

Image Source: U.S. Department of State

Fleet Management

Benefit ★★★☆	Reduces fossil fuel consumption, GHG emissions, and fleet operations and maintenance (O&M) costs
Time 🕐🕐🕐🕐	One to three months to develop and document fleet management policies
Investment $ $ $ $	Potential increase in purchase prices of replacement vehicles
Team Members	**FM** | GSO, CLO

Sustainable fleet management incorporates strategies to reduce vehicle distance traveled, improve fuel economy and maintenance, train drivers to develop green driving habits, and plan for efficient vehicle replacement. Reducing travel demand is an obvious first step toward fleet management. Optimizing the size, vehicle mix, maintenance, and use of official vehicles can also reduce petroleum consumption and GHG emissions, extend vehicle life, and reduce operating costs.

The Department operates a fleet of close to 15,000 administrative and law enforcement vehicles that consumed nearly 23 million gasoline-equivalent liters (L) (6 million gallons (gal)) of fuel in fiscal year 2012 (FY12). The Department is working to increase alternative fuel use in its fleet.

To improve fleet fuel efficiency:

- Adhere to manufacturer-recommended maintenance intervals.
- Stay within the manufacturer's gross vehicle weight guidelines to improve fuel efficiency, safety, and vehicle life.
- Match vehicle size to task. When appropriate, use electric utility or golf-type carts for transport within the facility grounds.
- Train and encourage green driving habits to improve fuel efficiency (see Transportation: Staff Engagement).

For resource-efficient fleet maintenance:

- Use rebuilt or recycled parts and supplies when possible.
- Decide whether to retain older, high-mileage vehicles. If so, repurpose them for on-site maintenance and grounds use.
- Find local buyers to recycle used batteries, oil, tires, and scrap metal.

Fleet replacement plans should:

- Consider the availability of AFVs, alternative fueling stations, spare parts, and specialized maintenance in the host country, in conjunction with 14 FAM 438.2 tier descriptions.
- Replace least-efficient vehicles first to achieve the greatest fuel savings.
- Minimize motorpool fleet vehicle size and use of special-use vehicles.
- Use fuel type, fuel economy, and life-cycle cost as purchase criteria for new vehicles.
- Match new vehicle sizes to post needs.
- Consider acquiring AFVs such as plug-in hybrid (PIH), flex-fuel (e.g., ethanol blends up to E85), electric, ethanol, biodiesel, compressed natural gas, propane, and hydrogen.
- Use alternative fuels in conventional vehicles, such as biodiesel in diesel vehicles, where feasible.

By using electric car charging stations, U.S. Embassy Dakar saves $82 in gas daily

Image Source: U.S. Embassy Dakar

Practical Application

1. **Review** the transportation audit report for recommendations.
2. **Engage** the MO and post's fleet manager to implement or improve policies and practices that can reduce fleet vehicle miles traveled, operate post's existing fleets more efficiently, and improve resource-efficient vehicle maintenance and disposal practices.
3. **Develop** or improve a vehicle replacement plan to improve fleet efficiency, based on the FAM requirements for the applicable tier, and cost comparison analysis.
4. **Modify** existing policy documents to include proposed best practices and implementation plans for fleet management and purchases.

Staff Engagement

Benefit ★ ★ ★ ★	Reduces transportation costs and vehicle emissions
Time 🕐 🕐 🕐 🕐	One to two months to develop education materials and install signage; and regularly scheduled short training sessions
Investment $ $ $ $	Preparation and printing of training materials and signage
Team Members	**Post Green Team** | Fleet Manager, Drivers, PAO

The following key behaviors can have a large effect on post's transportation emissions. They can be implemented by staff at all levels and throughout all departments.

Encourage post personnel to:

- Use alternative transportation modes and strategies.
- Select the most appropriate vehicle for the task.
- Drive responsibly: obey speed limits, avoid sudden acceleration and breaking, and eliminate idling for periods over two minutes.
- Combine trips when possible.

The Department has a no-idling policy. Drivers are required to turn off engines when parked for longer than two minutes.

Practical Application

1. **Review** general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Provide or create a map, guide, or tour of post and nearby amenities, such as bicycle racks, showers, bike paths, and alternative fueling stations. Provide links to local transit schedules and resources to help staff select more fuel-efficient personal vehicles.
   - Hold training sessions to familiarize staff and drivers with teleconferencing and video conferencing tools,[8] and with fuel-efficient driving practices. Topics for a green driving training session

could include trip preparation (route planning, vehicle selection, and removal of unnecessary, heavy objects from the vehicle), vehicle assessment (proper tire inflation and compliance with manufacturer weight guidelines), driving style (idling, stopping, starting, and speed), and comfort (using windows and vents and parking in the shade).

3. **Create** social involvement opportunities.
   - Use metrics such as official travel miles for air and vehicle use and encourage small teams to compete to see which team can achieve the largest percent reduction per team member, year over year.
   - Initiate annual 'Green Driver' and 'Green Commuter' awards, and publicly recognize the winners.
   - Establish a bike to work day or month, in collaboration with PAO and host country events.

Bike to Work Day at U.S. Embassy Santiago

Image Source: U.S. Embassy Santiago

4. **Implement** structural components.
   - Include information in post welcome kits that provides personalized instructions for public transit commuting from assigned residences.
   - Place small cards in each fleet vehicle with a list of driving policies and best practices, both in English and in the local language(s).
   - Offer a variety of vehicle options to ensure that post staff can select the right-size vehicles for their tasks.
   - Create carpooling sign-up lists and boards to connect potential ride-sharers.
   - Initiate alternative transportation commuter incentive programs.
   - Develop recommended route maps that aim to avoid left turns in order to reduce idle time and increase safety by reducing crossings of oncoming traffic. (Avoid right turns in countries where cars are driven on the left side of the road.)

Resources

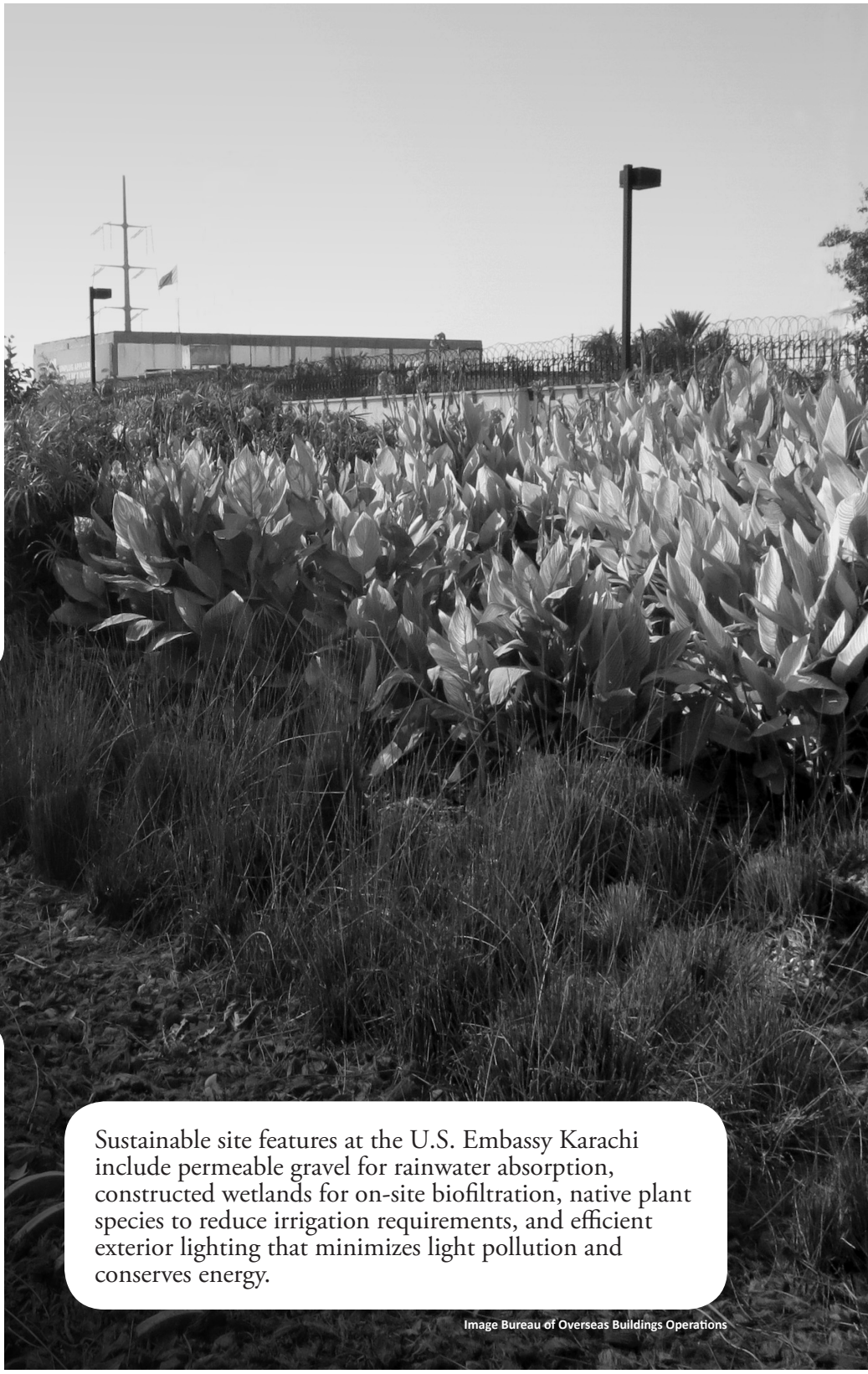
📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.htm#transportation*

Endnotes

1. *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.* United Nations Environment Programme. *http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf*
2. *Transport, Energy and CO_2.* International Energy Agency. *http://www.iea.org/publications/freepublications/publication/name,3838,en.html*
3. *Means of Transportation by Selected Characteristics: 2009.* U.S .Census Bureau. *http://www.census.gov/hhes/commuting/files/2009/means_of_transportation.pdf*
4. *2013 Pocket Guide to Transportation.* Research and Innovative Technology Administration, U.S. Department of Transportation. *http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/pocket_guide_2013_1.pdf*
5. *'Walk and Bike to Work Days Held,'* p.30, State Magazine, July-August 2012. Department of State.
6. *Sources of Greenhouse Gas Emissions.* U.S. Environmental Protection Agency (EPA). *http://www.epa.gov/climatechange/ghgemissions/sources.html*
7. Bike To Work. *http://www.biketoworkinfo.org*
8. *Green Meetings.* EPA. *http://www.epa.gov/oppt/greenmeetings*

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**.



Sustainable site features at the U.S. Embassy Karachi include permeable gravel for rainwater absorption, constructed wetlands for on-site biofiltration, native plant species to reduce irrigation requirements, and efficient exterior lighting that minimizes light pollution and conserves energy.

Image Bureau of Overseas Buildings Operations

SITE

SITE

Federal Performance Goals

Irrigation:

- Reduce irrigation water intensity by 20% for existing and by 50% for new buildings from 2010 baseline by 2020 per Executive Order (EO) 13514

Integrated Pest Management:

- Implement Integrated Pest Management (IPM), as managed by OBO's SHEM, required by 15 FAM 957.2, and described in OBO's IPM Program Document

Stormwater:

- Manage stormwater runoff to pre-developed conditions per the Energy Independence and Security Act (EISA)

Chapter Overview

By 2050, it is expected that 70% of the world's population may be living in urban communities.[1] This increasing global urbanization may continue to have environmental and social impacts beyond the city limits, but the extent of those impacts is difficult to predict. Cities and towns create external demands for food, water, power, transportation, and waste disposal.[2] Burdens placed on local and global ecosystems by urban demands can include elevated air temperatures; air, soil, and water pollution; increased incidence of disease and chronic health conditions; loss of animal and plant species; and higher levels of atmospheric carbon.

Embassy and consulate sites present opportunities to ensure that host country citizens can have a positive first impression of the United States. Post grounds that respect the natural ecosystems, enhance biodiversity, and incorporate technological innovations can demonstrate leadership in wise use of resources, providing tangible examples of eco-diplomacy. This is especially important in developing countries that may be struggling to balance natural resource management with economic growth.

Posts that maintain a healthy, functional, and preserved ecosystem help protect water resources, control erosion, regulate pests and disease, provide

nutrient storage and recycling, assist in pollution breakdown and absorption, contribute to climate stability, increase habitats, decrease building energy use, and increase resilience to natural disasters.

Integration of native and adapted species, low-impact development, and stormwater management into the landscape design of diplomatic sites offers a highly visible opportunity for the mission to demonstrate American best practices in sustainability.

Figure 1: Air temperature variation by land use type

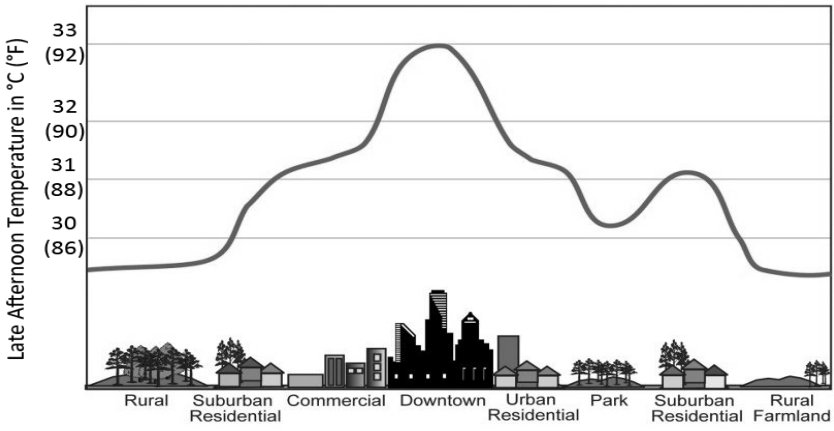


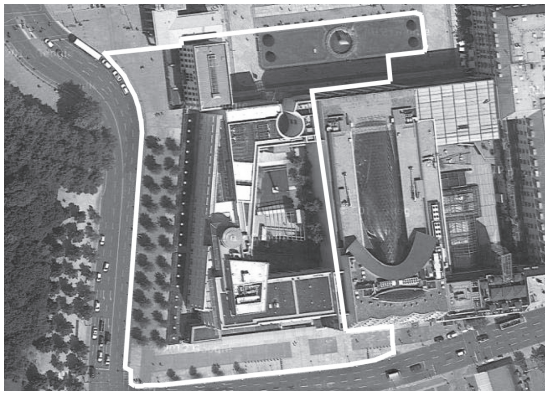
Image Source: U.S. Environmental Protection Agency

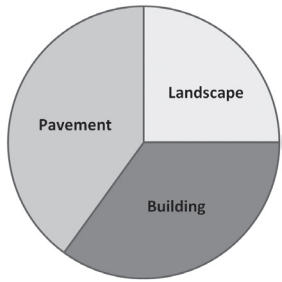
Evidence of heat island effect is another compelling reason to preserve the natural landscape of diplomatic sites. The concentration of heat-absorbing surfaces within urban areas, such as asphalt paving or darkly colored roof areas, produces higher temperatures than surrounding suburban and rural areas (Figure 1).[3] Resultant increases in local temperatures have negative environmental and health impacts.

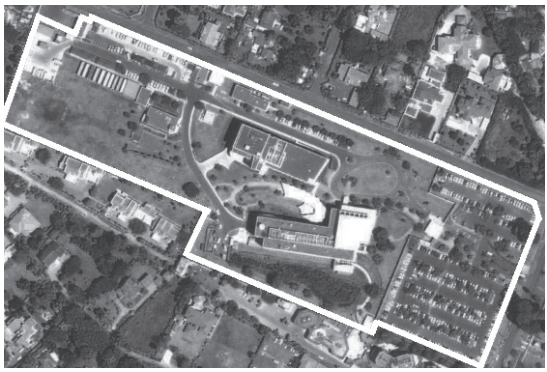
Site Profile

Post sites may be composed of many elements, including buildings, landscaping, stormwater management infrastructure, parking, roadways, patios, and sidewalks. Site configuration varies dramatically from post to post, as illustrated by the comparison of U.S. Embassy Berlin and U.S. Embassy Nairobi in Figure 2. Variations in proportions of site elements, total land area, permeability of surfaces, and types of materials result in significantly different maintenance and operational needs. Therefore, the existing site composition is a significant driver of an appropriate site management solution.

Figure 2: Aerial views of U.S. Embassy Berlin (top) and U.S. Embassy Nairobi (bottom)







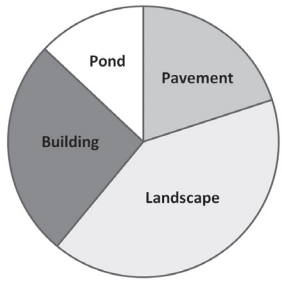


Image and Data Source: Google Earth

For example, compact sites with high proportions of built and impervious surface coverage, including U.S. Embassy Berlin, may be best served by structural solutions, such as green roofs or pervious pavement. Posts with expansive landscaping, similar to U.S. Embassy Nairobi, are prime candidates for low-impact development strategies that use ecological processes, such as bioswales and constructed wetlands, to minimize impact on the surrounding area and reduce resource demand.

The post facilities team should conduct audits to understand existing site composition, conditions, and maintenance practices. After assessing sites, the most effective sequence for pursuing site performance improvement is as follows:

1. **Reduce loads:** Non-native plantings, lawn areas, and extensive areas of hardscape can unnecessarily increase site water loads, thereby requiring increased stormwater management. Establish xeriscaping strategies and reduce hardscape areas to decrease both irrigation demands (see Water: Irrigation) and runoff.
2. **Choose lower-impact alternatives:** IPM, green exterior maintenance and cleaning, and sustainable landscaping practices include low-impact techniques that require less water, fuel, and time to implement than conventional, unsustainable practices. Identify strategies to reduce site runoff through stormwater detention techniques. Additionally, low-impact site strategies can improve air and water quality of surrounding areas.
3. **Consider on-site treatment:** Posts can reduce the burden on their host country's municipal water treatment and conveyance systems through rainwater collection from roofs, retention in cisterns or tanks, green roofs, treatment for reuse, and discharge into groundwater tables. These techniques can minimize or even eliminate the need to connect to municipal water or rely on well water systems. These strategies can also reduce negative impacts from stormwater runoff.

Strategy Selection Factors

In order to determine the most appropriate site strategies, Post Green Teams should identify the contexts of the regional habitats in which their embassy compounds are located, and then consider which of the following characteristics are applicable:

- **Urban location:** Posts in high density areas are likely to have significantly higher ratios of hardscape to landscape, a situation that tends to generate greater quantities of stormwater runoff and contributes to the heat island effect that impacts the host country and ultimately the greater region.
- **Lack of infrastructure:** Posts should routinely implement low-impact development strategies to retain, infiltrate, and treat stormwater on-site. These strategies are particularly important for posts located in developing regions that lack infrastructure to mitigate stormwater.
- **Significant annual rainfall:** Posts located in areas with moderate or heavy annual rainfall should work to integrate pervious surfaces and natural stormwater detention techniques to manage site runoff and reduce erosion. These locations should also consider harvesting rainwater for reuse (see Water: Rainwater Harvesting).
- **Arid climate:** In dry climates, posts should undertake landscaping

strategies that include drought-tolerant native and adapted plant species to conserve water and support the local ecological environment. Consider opportunities for reducing hardscape, and increase shading to reduce heat islands.

- **Extensive landscaped areas:** Posts that manage an extensive landscaped area, including posts where the site area is more than twice as large as the building footprint, should explore IPM solutions, examine landscaping practices, and undertake low-impact exterior maintenance. Consider constructed wetlands for tertiary on-site wastewater treatment (WWT) and infiltration opportunities. Also, consider reducing lawn areas to a minimum to reduce irrigation demands.

Priority Selection Criteria	Urban location	Lack of infrastructure	Significant annual rainfall	Arid climate	Extensive landscaped areas
Audit	All posts				
Exterior Maintenance			●		●
Integrated Pest Management	All posts				
Landscaping		●	●	●	●
Runoff, Erosion, and Sediment Control	●	●	●		
Heat Island Mitigation	●			●	
Staff Engagement	All posts				

Case Study: Wildlife Habitats

Geneva, Switzerland

The U.S. Mission to the United Nations in Geneva was the first U.S. Department of State (the Department) facility to be certified as a wildlife habitat by the National Wildlife Federation®.[4]

The Mission's garden staff and Green Team implemented several changes in the existing gardens in order to meet National Wildlife Federation's requirements for sustainable horticulture and habitat development. Changes included minimizing the use of water and fertilizer and maximizing native plants, particularly those friendly to bees, butterflies, and other pollinators. In addition, staff used mulch, compost, and chemical-free fertilizer. To promote and protect wildlife habitat, the Mission provided for wildlife seeds, fruits, berries, and other food sources; roosting locations; water sources such as birdbaths and ponds; thickets, rock piles, and other cover; and places for wildlife to raise young, including mature trees and host plants for butterflies. The Green Team even organized a workshop for the Mission's children, who made birdhouses that staff placed in the trees on the Mission's five-acre grounds.

Mission Geneva customized the Wildlife Habitat Certification to address their specific site. Ecologists or local wildlife specialists provided guidance and expertise to ensure that various species' needs were met. For more information about the program, visit: *http://www.nwf.org/How-to-Help/Garden-for-Wildlife.aspx*.

The U.S. Mission to the United Nations in Geneva is a Certified Wildlife Habitat™

Image Source: State Magazine, May 2010

Strategies

Strategy	Benefit	Time	Investment
Audit	★★☆☆	🕐🕐🕐🕐	$$$$
Exterior Maintenance	★☆☆☆	🕐🕐🕐🕐	$$$$
Integrated Pest Management	★★★☆	🕐🕐🕐🕐	$$$$
Landscaping	★★☆☆	🕐🕐🕐🕐	$$$$
Runoff, Erosion, and Sediment Control	★★☆☆	🕐🕐🕐🕐	$$$$
Heat Island Mitigation	★★☆☆	🕐🕐🕐🕐	$$$$
Staff Engagement	★★★☆	🕐🕐🕐🕐	$$$$

Xeriscaping practices at U.S. Consulate General Ciudad Juarez

Image Source: U.S. Consulate General Ciudad Juarez

Audit

Benefit ★★☆☆	Identifies no- and low-cost strategies to improve operational efficiency and reduce environmental impact on the site
Time 🕐🕐🕐🕐	One week to survey the site and compile an audit report
Investment $ $ $ $	No financial investment required
Team Members	**FM** | Post Green Team

Site management affects the sustainability of exterior areas, indoor environments, and the environment of the surrounding region. Unlike water and energy audits, site audits cover a broad range of current practices and environmental conditions related to stormwater, landscaping, and maintenance.

Landscaped grounds of U.S. Embassy Monrovia

Image Source: Thierry Rosenheck, OBO

Post Green Teams should review the strategy selection factors for post's location to determine the particularly relevant elements of a site audit and focus efforts on assessments related to the most applicable strategies. For example, posts located in dense urban environments are less likely to receive benefit from a review of plants and irrigation practices, whereas posts with significant rainfall would benefit from a review of stormwater management systems. For each relevant strategy, use the audit to evaluate impacts on site operations and to identify potential impact reduction measures.

Some elements of a site audit are best performed at night. An after-dark audit allows identification of light pollution sources as well as nocturnal wildlife that could become pest problems.

Practical Application

1. **Contact** the teams or people responsible for post site operations and engage them in the site audit.
2. **Identify** and focus efforts on the site audit elements that are most relevant to post.
3. **Evaluate** site landscaping (see Site: Landscaping) and hardscaping.
   - Quantify landscaped spaces by area and percentage of total site.
   - Identify the types of plants installed and note whether each species is native, drought-tolerant, habitat-providing, or a food crop.
   - Document maintenance and irrigation practices, irrigation system conditions, equipment used, and products applied, such as mowers, mulches, fertilizers, and pest control treatments (see Water: Irrigation).
4. **Evaluate** heat island and stormwater runoff impacts (see Site: Runoff, Erosion, and Sediment Control and Heat Island Mitigation).
   - Quantify hardscaped spaces by area and percentage.
   - Identify the color and type of each hardscaped area, maintenance practices, and products used for cleaning and snow removal.
   - Identify stormwater management systems or structures in use on-site, as well as their maintenance requirements.
   - Note whether storms typically result in significant runoff from the site and, if so, locations where runoff causes erosion or flooding.
5. **Assess** the type and application of products used for building exterior and landscape maintenance, including pest management (see Site: Exterior Maintenance and Integrated Pest Management).

- Collect maintenance records for exterior building and landscape maintenance, including pest management treatments.
- Identify products used, such as paints, sealants, cleaners, pesticides, de-icing agents, fertilizers, and fungicides.
- Assemble relevant material safety data sheets (MSDS) for each product used.

6. **Review** applicable strategies and identify measures to increase efficiency and sustainability of site management, based on the audit results. Categorize opportunities as no- or low-cost, short-term, or mid- or longer-term initiatives.
   - Consider no- or low-cost improvements such as product substitutions, repair of malfunctioning parts, schedule changes, or lamp replacement.
   - Propose a schedule for mid- or longer-term strategies, such as replacing light fixtures, expanding permeable site surface area, or improving irrigation systems.
7. **Document** existing and proposed site management measures in a report.

Landscape design at U.S. Embassy Phnom Penh enhances natural areas with indigenous plants

Image Source: U.S. Embassy Phnom Penh

Exterior Maintenance

Benefit ★ ☆ ☆ ☆	Increases worker safety, improves environmental quality of post sites and surrounding areas, and improves indoor air quality (IAQ)
Time	One to three months to review audit results and develop purchasing and maintenance plans
Investment $ $ $ $	Purchase of alternative products during regular reordering
Team Members	**FM** | GSO, Post Green Team

Materials and equipment used for cleaning and maintaining building exterior and site surfaces can impact air and water quality of surrounding areas. Some alkaline and acidic cleaners can be neutralized and safely discharged into storm sewers. However, most solvent-based cleaners, such as pine-oil products, cannot be neutralized, are categorized as pollutants, and must be disposed of by a licensed transport, storage, and disposal facility.[5]

Rainfall can wash potentially harmful cleaning compounds off cleaned surfaces and onto the ground and off-site into local waterways. Volatile organic compounds (VOCs) in exterior cleaning and maintenance products can compromise local air quality and can potentially be drawn into buildings through openings and air intakes. Runoff containing phosphorus, nitrogen, and other chemicals found in fertilizers and cleaning products contributes to the growth of the algal blooms that create hypoxic (low oxygen) or 'dead' zones in estuaries and coastal areas, where marine life cannot survive.

Of an estimated 400 such dead zones located around the world, the Gulf of Mexico hypoxic zone is one of the largest, at approximately 17,000 square kilometers (km^2) (6,600 square miles (mi^2)), which is roughly the size of Massachusetts.[6]

Select cleaning products that have the least environmental impact for building and site cleaning activities, such as Green Seal certified products.

Consider using the following:

- Water-based products rather than solvents for cleaning, paints, sealants, and adhesives
- Exterior paints, sealants, and adhesives that meet Green Seal® standard

for Paints and Coatings GS-11 (see Indoor Environment: Contaminant Reduction)

Undertake site maintenance practices that are environmentally safe:

- Use simple methods, such as a brush or low-pressure water wash. Water of slightly higher pressure or with a non-ionic detergent additive also may be effective.
- Minimize use of resource-intensive or polluting maintenance equipment, such as pressure washers and gas-powered mowers. Use only as necessary to maintain safe and operable surface conditions.
- Use hand tools rather than power tools where feasible, such as rakes rather than leaf-blowers or push rather than gas-powered mowers.
- When replacing equipment, consider electric, low-decibel, energy-efficient, and water-efficient models.
- Avoid environmentally-damaging products, such as salt or calcium chloride, where snow or ice removal is required. Select environmentally preferable de-icing chemicals, such as magnesium chloride, potassium acetate, and potassium chloride. Use a small amount of de-icer to prevent icing, rather than a large amount to treat existing ice.

Alternative fuels can power a variety of site equipment, such as this propane-powered lawn mower

Image Source: North Central Texas CoG, NREL 17541

Practical Application

1. **Review** results of the site audit related to cleaning and maintenance products and practices.
2. **Include** exterior maintenance products in post's green cleaning procurement and use policies. Choose environmentally-sensitive cleaning products. Replace solvent-based cleaners with environmentally-safe alternatives (see Indoor Environment: Green Cleaning).
3. **Implement** environmentally-safe cleaning practices.
4. **Create** a plan to replace maintenance equipment with lower-impact alternatives as items reach the end of their useful life.
5. **Develop** a plan to communicate new cleaning and maintenance procedures to the appropriate post staff (see Site: Staff Engagement).

Integrated Pest Management

Benefit ★★★☆	Controls pests, protects the health and safety of employees, maintains facilities, and protects the environment
Time 🕐🕐🕐🕐	One to two months to create an IPM plan, one year for plan establishment, and ongoing review and assessment after establishment
Investment $ $ $ $	New IPM measures such as bird mesh and pest-proof waste bins
Team Members	**FM** | GSO, FMO, Gardeners, SHEM

Effective pest control protects people from pest-borne disease, and shields buildings and other property from damage. Pesticide, herbicide, insecticide, and fungicide application leads to pests developing resistance to those products; negatively impacts other beneficial species; pollutes soils, air, and water bodies; and causes human health issues.

Pest problems aren't just inconvenient. Cockroach allergens—proteins in cockroach feces, saliva, and decomposing body parts—can cause allergies and asthma attacks.[7]

The goal of IPM is to reduce risk to both human health and the environment. The Department's IPM program emphasizes controlling factors that could invite pests, preferably using non-chemical methods to reduce pest populations. If pesticides are required, they must be authorized by the Department through the OBO's SHEM. Methods include reducing the prevalence of pests through prevention, self-help measures that post personnel can implement independently without engaging the SHEM IPM team, and application of EPA-registered and SHEM-authorized pesticides, if necessary. A typical IPM plan includes identification of problem pest species, pest-prevention measures, monitoring and reporting systems, occupant self-help programs, communication protocols, action thresholds for pest populations, pest control methods and priorities, documentation methods, and inspection schedules.

Include the following best practices in post's IPM program:

- Verify that pests are the cause of the problem rather than a symptom.
- Use pesticides as a last resort. Prevention is the first course of action.

- Obtain SHEM approval when pesticides are needed and use the least toxic pesticide in the smallest possible quantity, targeting concentrated areas of pests.
- Use pruning and pest-resistant plantings, and locate new vegetation away from the building to reduce bridges that allow pests to access the building.
- Keep lawns short to avoid hiding places for snakes and rodents.
- Use netting or mesh to discourage roosting birds.
- Secure building waste in insect- and rodent-proof containers.
- Eliminate stagnant water to reduce mosquitoes, and consider stocking ponds with larvae-eating fish.
- Use heat treatment rather than chemical fumigation of enclosed areas.
- Provide information to all post personnel on self-help pest control methods as indicated in the IPM Program Document (see 🕮 Resources: The IPM Program Document).

At U.S. Embassy Zagreb, tall vegetation is located away from the building to discourage pests

Image Source: U.S. Department of State

Practical Application

1. **Consider** any pest management recommendations included in the site audit report.
2. **Review** SHEM's IPM Program Document, available on the OBO intranet, for specific requirements and methodologies (see 🕮 Resources: The IPM Program Document).
3. **Identify** the IPM team members.
4. **Document** conditions that historically have attracted problematic pests and employ prevention techniques.
5. **Work** with post's IPM team to develop a plan, or update post's plans to meet the requirements of the IPM Program Document. Include proposed schedules and self-help measures.
6. **Implement** the plan.

Landscaping

Benefit ★★☆☆	Reduces stormwater runoff volume and water use for irrigation, improves stormwater runoff quality, promotes biodiversity and pollination, and reduces atmospheric carbon
Time 🕐🕐🕐🕐	One to three months to implement low-impact maintenance procedures and six to 18 months to change or add landscaped area
Investment $ $ $ $	Vegetation selection and planting and installation of automated irrigation systems (if necessary) for new or modified landscaping
Team Members	**FM** | OBO, Gardeners

Sustainable landscaping incorporates native or adapted plants, grasses, and trees. The practice requires less irrigation and maintenance, offsets carbon dioxide (CO_2), promotes biodiversity by providing wildlife habitat, provides erosion control, controls stormwater runoff, and reduces heat island effect. Xeriscaping is a specific landscaping method that uses slow-growing, drought-tolerant plants that thrive with minimal fertilization.

To the extent possible, group plants with similar irrigation needs (see Water: Irrigation). Irrigation systems should be carefully selected and zoned to further minimize water consumption.

Post grounds may be able to support regional endangered species by converting portions of the facility's landscaped areas to pollinator-friendly habitats that include native, flowering plants; nesting areas; and shelter for bees, butterflies, bats, hummingbirds, and other pollinators (see 🕮 Resources: Pollinator Friendly Practices).

Pollinator insects and animals are needed for the production of at least 30% of human food crops, including almost all fruits and vegetables.[8]

Low-impact maintenance can further reduce irrigation and chemical fertilizer demand, decreasing stormwater runoff volumes that can pollute or degrade the quality of local aquifers and waterways.

Include low-impact maintenance strategies, such as the following:

- Mulch landscape beds and potted plants to reduce evaporation and keep

the soil cool, where appropriate.

- Designate an on-site composting area for landscape trimmings.
- Amend soils with trimmings, compost, and manure as required by the soil for the types of plants used, in place of chemical fertilizers.
- Use low-impact equipment for landscape maintenance.
- Dispose of yard waste on-site and leave grass clippings on lawns.
- Add large-canopy shade trees to reduce evaporation and increase privacy. Take care not to encroach on perimeter 'clear zone' or breach non-climb perimeter or building conditions.
- Allow native grasses to go dormant in the winter, and reduce watering to minimum levels during the summer.

Practical Application

1. **Review** the site audit report for opportunities to improve landscaping and landscape maintenance procedures.
2. **Work** with FM to plan and implement low-impact maintenance practices. Incorporate low-impact maintenance procedures and upgraded site elements into the site maintenance plan.
3. **Consult** with OBO and local landscape architects for appropriate landscape species, irrigation system improvements, and xeriscaping practices.

The grounds of U.S. Embassy Kampala

Image Source: U.S. Department of State

4. **Implement** water-efficient irrigation (see Water: Irrigation). Consider non-potable water sources for irrigation (see Water: Rainwater Harvesting and On-site Wastewater Treatment).
5. **Reduce** site areas requiring irrigation by replacing high-maintenance plants with native or drought-tolerant species, and consider xeriscaping.
6. **Specify** and install vegetation and trees that do not require irrigation, that provide shade, and that are pollinator-friendly (see Site: Runoff, Erosion, and Sediment Control and Heat Island Mitigation).

Case Study: Native Planting

Cape Town, South Africa

Benefit	Preserves endangered species habitat, decreases potable water consumption, and reduces greenhouse gas (GHG) emissions
Team Members	**OBO** | Design Consultants, FM, Gardeners

The U.S. Consulate General in Cape Town, South Africa, made particularly good use of native plants to reduce irrigation demands, beautify their site, and preserve local endangered species, including the leopard frog, which makes its home in the Westlake River.[9]

Landscape architects specified using only indigenous plants, which are attractive and perform well under local conditions. The plants selected help prevent soil erosion, even on steeply graded slopes. Erosion control was a major challenge, as the Westlake River runs through the Consulate site.

The results of the Consulate's landscape efforts included decreased potable water consumption for irrigation, increased biodiversity, and reduced GHG emissions and the overall carbon footprint of the United States Government. The Department is demonstrating eco-diplomacy through landscape design that promotes native habitat.

Native plants foster endangered wildlife species at U.S. Consulate General Cape Town

Image Source: State Magazine, April 2012

Runoff, Erosion, and Sediment Control

Benefit ★★☆☆	Minimizes quantity and rate of stormwater runoff, which reduces site erosion and potential contamination of water bodies
Time 🕐🕐🕐🕐	One to three months to implement no- and low-cost tactics, six to 12 months to establish new plantings, and one to two years for longer-term site upgrades
Investment $ $ $ $	Vegetation selection and planting and installation of permeable surfaces
Team Members	**FM** | OBO

Stormwater runoff can cause soil erosion and sedimentation of local waterways. Erosion results in loss of topsoil, which regulates water flow and is essential for plant life. Topsoil loss may lead to increased need for fertilizers and pesticides to maintain plant material. In turn, the use of increased fertilizers and pesticides pollutes rivers, lakes, and oceans. Site sediment also pollutes and degrades aquifers and local waterways by adding high concentrations of total suspended solids and toxins.

Runoff prevention strategies are particularly important to implement at posts that experience large storm events or high volumes of annual precipitation. Existing erosion control measures should be protected and reinforced to prevent breaches and damage during new construction or major renovations to buildings, landscapes, or hardscapes. Strategies may include temporary installations of hay bales around inlets, silt fences at the boundary of disturbed soils, and gravel at construction vehicle entrances and exits.

Runoff from erosion has impacts far from the site of origin. The sediment produced can clog fish gills and suffocate aquatic habitats.[10]

Consider the following landscape plan components to reduce the quantity and speed of runoff and minimize associated erosion:

- Use compost and mulch in planted areas to protect exposed soils.
- Add small-scale bioretention areas, such as planter boxes or tree wells.

Longer-term initiatives for on-site stormwater retention and detention include:

- Rainwater harvesting for larger-scale irrigation or potable water use (see Water: Rainwater Harvesting)
- Site regrading to eliminate steep slopes and retain water on-site
- Natural bioswales to treat runoff passively instead of concrete curbs, gutters, and culverts, which concentrate and exacerbate site runoff
- Biofiltration to treat runoff passively
- Replacement of hardscape with permeable surfaces, such as gravel or pervious pavement, to increase infiltration and recharge groundwater
- Installation of vegetated roofs and rain gardens to control runoff

Figure 3: Bioswales, or 'rain gardens,' passively treat stormwater runoff

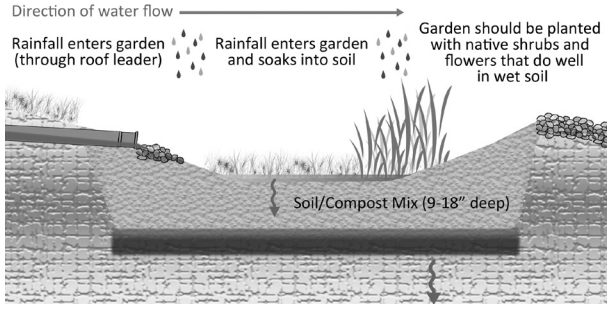


Image Source: City of Gallatin

Practical Application

1. **Review** the site audit report to identify any major concerns and recommendations for improvements. Implement recommended no- and low-cost tactics.
2. **Use** groundcover such as mulch, compost, or vegetation to protect exposed soil between other landscape plants and to stabilize loose soil, especially on slopes (see Site: Landscaping).
3. **Install** splash blocks where rainwater from buildings drains to the site at ground level, use rainwater barrels for catchment and diversion to landscaped areas, or implement small-scale bioretention (see Water: Irrigation).
4. **Work** with OBO civil engineers and landscape architects to prioritize and implement longer-term site upgrades.
5. **Incorporate** upgraded site elements into the site maintenance plan, and monitor site runoff to measure success of implemented initiatives.

Heat Island Mitigation

Benefit ★★☆☆	Decreases load on heating, ventilating, and air conditioning (HVAC) systems, thereby reducing associated utility charges; provides shade for comfort; promotes human health; promotes biodiversity; and helps control stormwater runoff
Time 🕐🕐🕐🕐	One to two years for plant establishment; major retrofits or structural additions should be part of a larger capital project
Investment $ $ $ $	Installation of plantings or architectural shade structures, and replacement of existing roof or paved areas
Team Members	**FM** | FMO, OBO

Heat island effect is the phenomenon whereby metropolitan areas are significantly warmer than their rural surroundings due to the amount of paved area and buildings that have replaced vegetated and permeable surfaces. Dry and unshaded urban surfaces absorb solar gain and re-radiate heat into the atmosphere, elevating air temperatures. For example, low-reflectance building rooftops and pavement can reach temperatures of 66–88 degrees Celsius (° C) (150–190 degrees Fahrenheit (° F)),[11] warming the local area (see Figure 1). As urban densities, areas, and populations increase, this issue may become of greater concern.

Heat islands can contribute to the following:

- Risks to human health, including heat-related illness and mortality[12], as well as species loss
- Reduced indoor and outdoor comfort
- Increased cooling energy use and higher utility bills
- Higher peak electricity demand and raised electricity production costs
- Higher intake air temperatures for building conditioning systems
- Increased air pollution from increased energy to cool building interiors
- Accelerated deterioration of roofing materials, increased roof maintenance costs, and higher levels of roofing waste sent to landfills[13]

OBO's design criteria for new projects require shading and high-albedo (reflective or 'cool') materials on site surfaces and roofs. Various heat island

mitigation strategies can also be implemented around existing buildings and are particularly beneficial in locations with extended cooling seasons.

Consider the following strategies:

- Installing native, drought-tolerant species, with shade provided within five years (see Site: Landscaping)
- Working with OBO landscape architects to identify appropriate locations for planting additional trees, taking care not to breach anti-climb walls and building conditions and without encroaching into the perimeter 'clear zone' (see Site: Landscaping)
- Where energy costs and solar insolation values are high, installing solar energy generating systems, such as photovoltaics (PV) or solar thermal, at shade structures and canopies (see Energy: Photovoltaics)
- Resurfacing with high albedo materials (see 🕮 Resources: Energy Star®)
- Installing green roofs (see 🕮 Resources: Cool Roofs and Emissivity and Vegetated Roof Study)
- Replacing asphalt or other dark surfaces with permeable, open-grid pavers or light-colored materials

Practical Application

1. **Review** site plans to identify opportunities for planting shade trees or plants around paved areas.
2. **Consult** with OBO or a local landscape architect or nursery to select and plant the appropriate species for shading.
3. **Evaluate** whether shade structures or canopies are appropriate for the site.
4. **Work** with OBO to select high solar reflectance roofing materials.
5. **Evaluate** the feasibility of permeable, open-grid pavers or light-colored materials as a replacement for asphalt or other dark surfaces.
6. **Develop** a plan to undertake regular maintenance, at least every three years, of all high-reflectance surfaces to ensure that they are clean. Maintain vegetated roofs for planting and structural conditions.

U.S. Consulate General Johannesburg uses a combination of white roofing material and light-colored paving to reduce heat island effect

Image Source: U.S. Department of State

Staff Engagement

Benefit ★★★☆	Instills land conservation as a fundamental value and motivates building occupants to adopt behaviors and habits that conserve soil and protect water resources
Time	One to two months to develop education materials and install signage; and regularly scheduled short training sessions
Investment $ $ $ $	Preparation and printing of training materials and signage
Team Members	**Post Green Team** | PAO

Sustainable site management practices encompass a range of topics, from rainwater retention and landscaping to pest management. Many of the strategies are structural in nature and require implementation by FM staff; however, there are a variety of behavioral activities that can easily be undertaken by general post occupants.

The People's Garden Initiative encourages the U.S. Department of Agriculture to develop community gardens around the world, teaches sustainable gardening practices and nutrition, and shares produce with neighbors and food banks.[14]

Encourage post personnel to:

- Prohibit pouring or dumping harmful chemicals into building plumbing or facility storm drains.
- Use hand tools, such as rakes and shovels, rather than power equipment, such as leaf-blowers and snow-blowers, whenever possible and practical.
- Help maintain the site and avoid pest infestations by closing garbage lids, picking up garbage, and not feeding wildlife.
- Report problems on-site, such as oil spills in parking lots, standing water, or poorly-timed exterior lights, as soon as noticed.
- Organize post community planting projects on mission grounds.
- Hold an education session on rain gardens.
- Initiate or participate in a community clean-up day.
- Coordinate with the local international school to start a vegetable garden.

Members of the Lisbon Eco-Friendly Action Forum (LEAF) begin a community garden on-site

Image Source: U.S. Embassy Lisbon

Practical Application

1. **Review** general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Coordinate local garden tours.
   - Provide information about beneficial and harmful insects.
   - Host gardening classes with a focus on native plants and urban farming.
3. **Create** social involvement opportunities.
   - Create a community garden and have social harvest days.
   - Initiate a 'Green Site Champion' annual award that receives public recognition.
   - Collaborate with PAO to organize social events such as on-site or community cleanups and tree plantings.
   - Organize events around the following partial list of relevant annual United Nations observances:
     - March 21: International Day of Forests
     - March 22: World Water Day
     - April 22: Earth Day

- Last Friday in April: Arbor Day
- May 9-10: World Migratory Bird Day
- May 22: International Day for Biological Diversity
- June 5: World Environment Day
- June 8: World Oceans Day
- June 17: World Day to Combat Desertification and Drought
- October 22: World Energy Day

4. **Implement** structural components.
   - Install signage near storm drains, perhaps with the likeness of a beloved local species that is endangered by poor water quality.
   - Install educational signage on-site that highlights attractive features such as butterfly-friendly landscaping.
   - Distribute information providing self-help guidance for common pest management problems and IPM solutions.
   - Ensure that post staff has clear instructions on protocol and contact information to report site related issues.
   - Create opportunities for small teams to contribute or compete with one another, perhaps by offering a prize for the best new solution to a post site sustainability challenge.

Wandsworth Mayor Cooper and U.S. Deputy COM Stephenson plant a tree at the American Gardens in Wandsworth, England

Image Source: U.S. Embassy London

Resources

📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.html#site*

Endnotes

1 *Urbanization and Health.* World Health Organization (WHO). *http://www.who.int/bulletin/volumes/88/4/10-010410/en*

2 *Effects of Urbanization Extend to the Global Scale.* National Science Foundation. *http://www.nsf.gov/news/news_summ.jsp?cntn_id=111079*

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5 *Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings.* National Park Service, U.S. Department of the Interior. *http://www.nps.gov/history/hps/tps/briefs/brief01.htm#Planning%20a%20Cleaning%20Project*

6 *Hypoxia 101.* EPA. *http://water.epa.gov/type/watersheds/named/msbasin/hypoxia101.cfm*

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8 *Using Farm Bill Programs for Pollinator Conservation.* U.S. Department of Agriculture, 2008. *http://plants.usda.gov/pollinators/Using_Farm_Bill_Programs_for_Pollinator_Conservation.pdf*

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10 *Stormwater Runoff Control.* EPA. *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4*

11 *Heat Island Effect: Basic Information.* EPA. *http://www.epa.gov/heatisland/about/index.htm*

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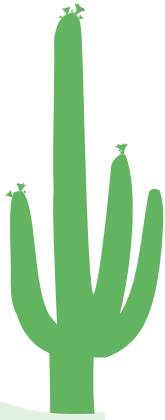
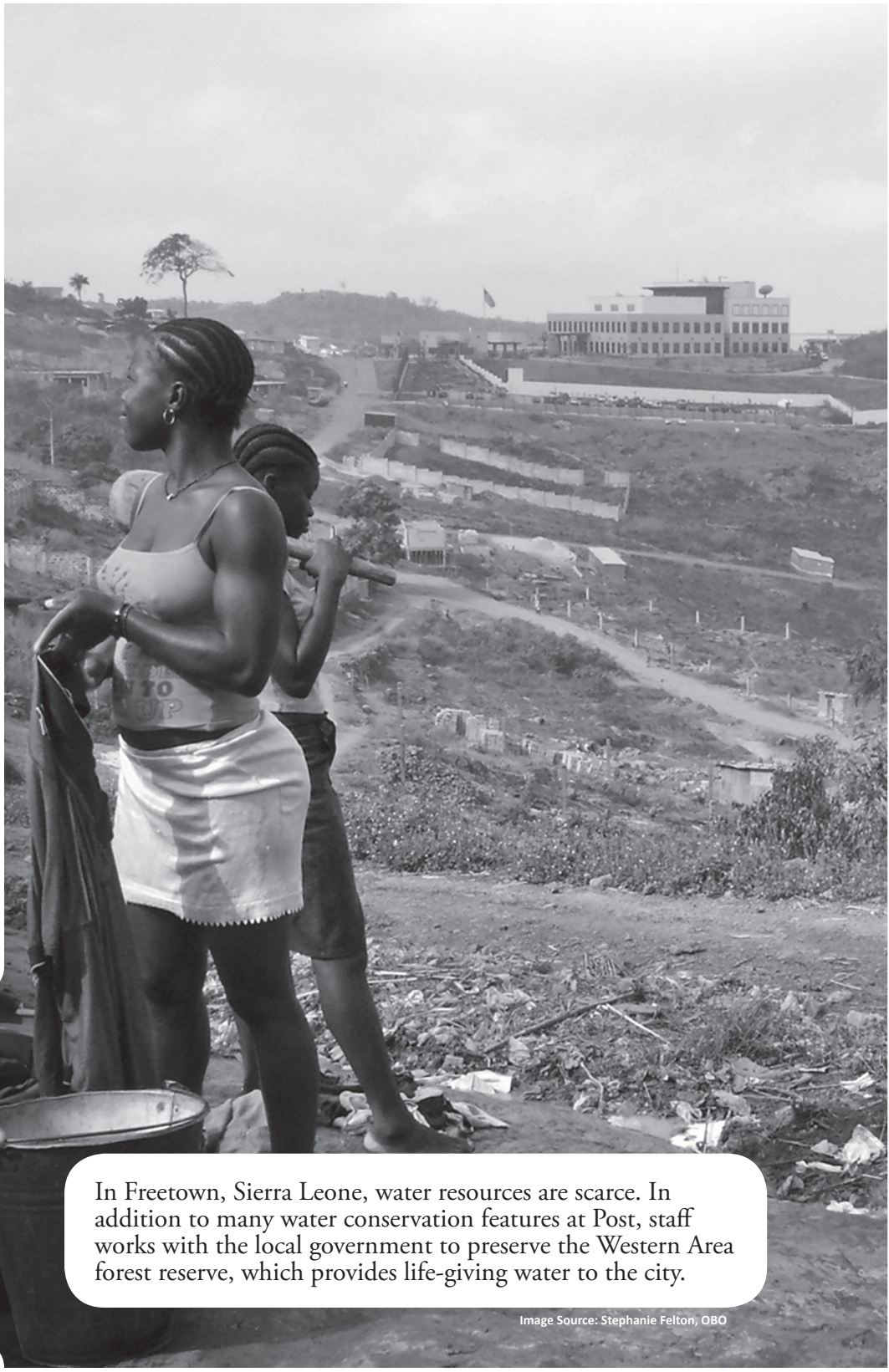
13 *Heat Island Effect: Cool Roofs.* EPA. *http://www.epa.gov/hiri/mitigation/coolroofs.htm*

14 *The People's Garden Initiative.* U.S. Department of Agriculture. *http://www.usda.gov/wps/portal/usda/usdahome?navid=GARDEN_RT1&parentnav=PEOPLES_GARDEN&navtype=RT*

WATER



The saguaro **cactus** is the ultimate water harvester, absorbing a significant percentage of rainwater. The trunk and arms are pleated like an accordion and expand to accommodate absorbed water. Roots of a 15 meter (m) (50 foot (ft)) high saguaro extend to a diameter of 30 m (100 ft), at a depth of only centimeters (cm). This root pattern proves plenty of surface area, enabling the plant to absorb water from even light rainfall.



In Freetown, Sierra Leone, water resources are scarce. In addition to many water conservation features at Post, staff works with the local government to preserve the Western Area forest reserve, which provides life-giving water to the city.

Image Source: Stephanie Felton, OBO

WATER

WATER

Federal Performance Goals

Domestic Water:

- 26% potable water consumption intensity reduction from 2007 baseline by 2020 (2% per year) per Executive Order (EO) 13514

Irrigation:

- Reduce irrigation water intensity for existing buildings by 20% and for new buildings by 50% from 2010 baseline by 2020 per EO 13514

Chapter Overview

There is no other resource on the planet that is more widely used and valued than water. The availability of this resource affects humans on a local, national, and regional level, as fresh water is critical for drinking, agriculture, cooking, sanitation, and industry. More than half of the global population may be living with water shortages within 50 years, and severe water shortages may affect four billion people by 2050.[1]

Only 2.5% of all the water on earth is freshwater, and less than 1% of that freshwater is accessible for ecosystems and human use.

The United States, Greece, Malaysia, Italy, and Thailand have the largest per capita water consumption rates in the world, while the United States, China, and India have the largest absolute consumption (see Figure 1). Figure 2 presents the five countries with the highest dependency on water imports.[2] Water conservation is particularly important for posts located in countries where water is scarce or where the national water footprint is high; however, due to the global imbalance of available water resources, responsible water management in all areas of the world is critical for global stability of water supply and access, and can serve as a model for future development.

The U.S. Department of State (the Department) is committed to achieving the federal performance goals for water consumption reduction by addressing

both indoor and outdoor water conservation measures. Post implementation of strategies in this chapter can decrease demand on host countries' municipal infrastructure of water supply and wastewater treatment (WWT) facilities, where they exist, and demonstrate best management practices for developing countries, thus helping post engage in eco-diplomacy.

Figure 1: Total water use by country

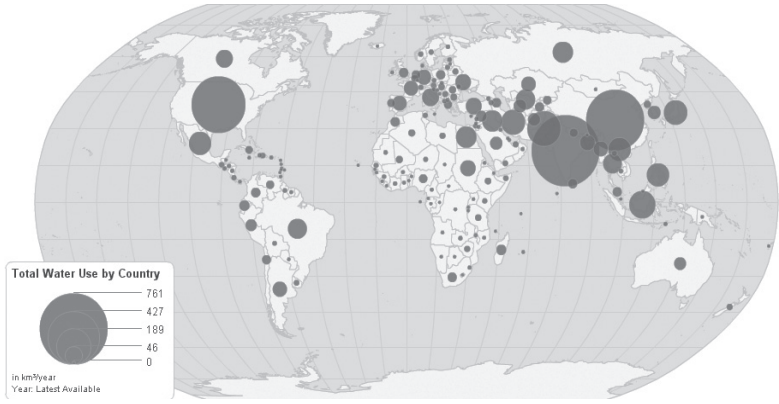


Image Source: ChartsBin

Figure 2: Countries with the highest dependencies on water imports

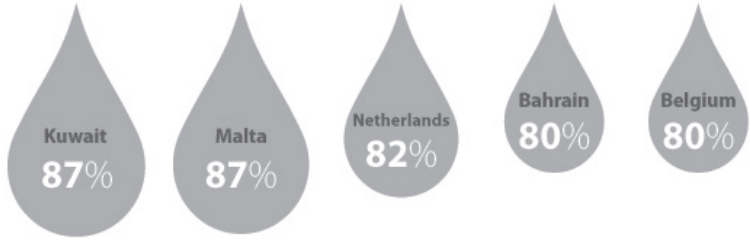


Image Source: The Water Footprint Network

Water security is the foundation for food and energy security and for overall long-term social and economic development. As described by former Secretary of State Hillary Clinton,

> Water represents one of the great diplomatic and development opportunities of our time. It's not every day you find an issue where effective diplomacy and development will allow you to save millions of lives, feed the hungry, empower women, advance our national security interests, protect the environment, and demonstrate to billions of people that the United States cares, care about you and your welfare. Water is that issue.[3]

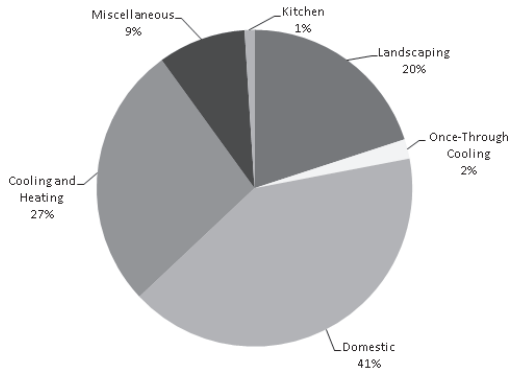
Water Profile

Approximately 41% of potable water use in a typical office building in the U.S. can be attributed to plumbing fixtures (Figure 3).[4] Additionally, 20–30% of potable water consumption is used for irrigation and landscape maintenance.[5] The Department's facilities overseas, built to American standards, typically have a similar load profile; however, some posts use as much as 60% of their potable water for irrigation. Management of water used for operation of plumbing fixtures and irrigation can typically address the majority of overall water consumption.

Considerations

Understanding both indoor and outdoor water usage is essential to water conservation. Posts should begin the water use examination process by determining how water is being used. Water audits provide intelligence on how to prioritize water strategies. In addition to monitoring overall water use, posts should install submeters on irrigation, wells, WWT systems, and cooling tower make-up water.

Figure 3: Typical U.S. office building potable water use



Data Source: U.S. Department of Energy

The most effective sequence for pursuing water efficiency is:

1. **Load reduction:** Making operational improvements on existing water systems can provide instant benefits. The systems' base load can be significantly impacted by occupant behavior, leaks, fixture efficiencies, and irrigation schedules that do not account for outdoor weather conditions.
2. **System efficiency:** Retrofitting plumbing fixtures and irrigation systems, such as with high-efficiency or dual-flush toilets, aerators, low-flow showerheads, and drip irrigation, can lead to significant water savings.
3. **Renewable resources:** Many water end uses can be served by non-potable or renewable water sources, including rainwater or reclaimed wastewater. These systems can make a significant impact on posts that are not connected to fully developed municipal supply or treatment systems.

Strategy Selection Factors

After water end uses have been identified, the facility team should evaluate the unique characteristics of the local climate to determine which strategies in this chapter make the most sense to implement.

Upgrades and retrofits can be prioritized based on the following criteria:

- **Extreme or exceptional drought:** Many parts of the world are in a state of drought (Figure 4). In the 36 months from January 2010 to 2013, drought affected 172 million people.[6] Posts located in one of the areas highlighted as experiencing extreme or exceptional drought should explore all conservation options.

Figure 4: Global drought monitor, based on rainfall data during an assessment period from January 2010 to January 2013

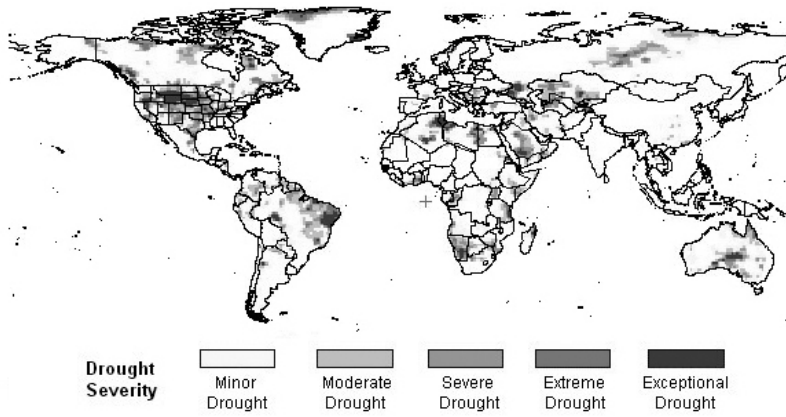


Image Source: University College London Global Drought Monitor

- **Moderate or heavy annual rainfall:** Posts with consistent rainfall throughout the year can typically utilize rain catchment systems to supply irrigation and building uses, and offset municipally-provided water or water from other sources.
- **On-site water treatment**: Many posts do not have adequately reliable, municipally-sourced and -treated water supply or sanitary sewer systems. These posts may rely on trucks to transport potable water to the site; on wells with limited supplies; or on in-house treatment systems that have substantial operations, maintenance, and energy impacts. Intensive operations can make water reduction financially attractive. Where on-site WWT facilities exist, it is advisable to upgrade systems so that treated effluent can be reused for irrigation. At posts where WWT facilities don't

exist or future WWT could be installed, consider constructed wetlands for tertiary treatment and infiltration.

- **Plumbing more than ten years old**: If a building's plumbing fixtures have not been upgraded or replaced within the last ten years, they are less efficient than newer fixtures commercially available today. Upgrades to fixtures and irrigation systems can result in 20–30% water savings.
- **High percentage of landscaped area:** When irrigated landscape and turf areas cover the majority of site areas, there are likely opportunities to replace turf and water-intensive plantings with non-irrigated, native, drought-tolerant species or low-maintenance gravel.

Priority Selection Criteria	Extreme or exceptional drought	Moderate or heavy annual rainfall	On-site water treatment	Plumbing > 10 years old	High percentage of landscaped area
Audit	All posts				
Metering	All posts				
Efficient Fixtures	●		●	●	
Irrigation	●	●	●		●
Rainwater Harvesting		●	●		●
On-site Wastewater Treatment	●		●	●	●
Staff Engagement	All posts				

Case Study: Water Management

Amman, Jordan

According to the World Health Organization (WHO), Jordan "has one of the lowest levels of water resource availability, per capita, in the world,"[7] and water may become an even greater issue as the impacts from population growth and climate change become apparent. U.S. Embassy Amman has addressed this critical issue through a variety of efficiency initiatives:

U.S. Embassy Amman uses landscaping to reduce its irrigation water requirements

Image Source: U.S. Department of State

- Landscaping has been designed to include native, adapted, and drought-tolerant plants, and the overall vegetated area has been decreased to reduce irrigation water requirements.
- High-efficiency plumbing fixtures have been installed throughout the complex, including dual-flush toilets as well as faucet and showerhead aerators, to decrease potable water consumption.
- Embassy personnel have been engaged in water conservation efforts through use of educational signage.

As a result of these strategies, total water consumption has decreased since 2007, despite a 30% staffing increase and 10% facility space increase over that same time period. The success of these initiatives contributes toward Post's goal for water use reductions.

U.S. Embassy Amman's Green Team strives for further success at Post by increasing awareness and promoting environmentally-sensitive behavioral changes among Embassy personnel, and working with landlords of Post's leased facilities to implement sustainability best practices. To encourage participation in sustainability initiatives, the Post Green Team members ask personnel to sign a Green Pledge indicating their commitment to becoming more environmentally aware. The Green Team also conducts contests, includes weekly green tips in the Embassy newsletter, and schedules environmentally-focused educational field trips, all of which contribute to a successful water management program.

Strategies

Strategy	Benefit	Time	Investment
Audit	★★★☆	🕐	$
Metering	★★★☆	🕐🕐	$$
Efficient Fixtures	★★☆☆	🕐🕐	$$
Irrigation	★★★☆	🕐🕐🕐🕐	$$
Rainwater Harvesting	★★★★	🕐🕐🕐	$$$
On-site Wastewater Treatment	★★★☆	🕐🕐🕐🕐	$$$$
Staff Engagement	★★★★	🕐	$

Children collect drinking water in Sierra Leone

Image Source: Bureau of Overseas Buildings Operations

Audit

Benefit ★★★☆	Determines where, when, why, and how water is used in a facility and on-site, and identifies opportunities to improve efficiency
Time 🕐🕐🕐🕐	One week to one month, depending on the size of the compound and the number of fixtures
Investment $ $ $ $	None, or engagement of a professional auditor (optional)
Team Members	**FM** | GSO, OBO, Post Green Team

A water audit is a valuable tool that allows FMs to manage resources by understanding how their facilities use water. Benefits of a water audit include improved knowledge and documentation of the distribution system, including problem and risk areas.

By documenting post's water use over time, the audit provides a baseline for comparison of progress on current and future conservation efforts in response to federal performance goals. A Certified Landscape Irrigation Auditor (CLIA) can provide detailed guidance for posts with intensive irrigation requirements.

No- or low-cost water savings improvements can include faucet aerator and low-flow showerhead installation, washer replacement, leak repair, or use of rainwater catchment barrels for landscape irrigation.

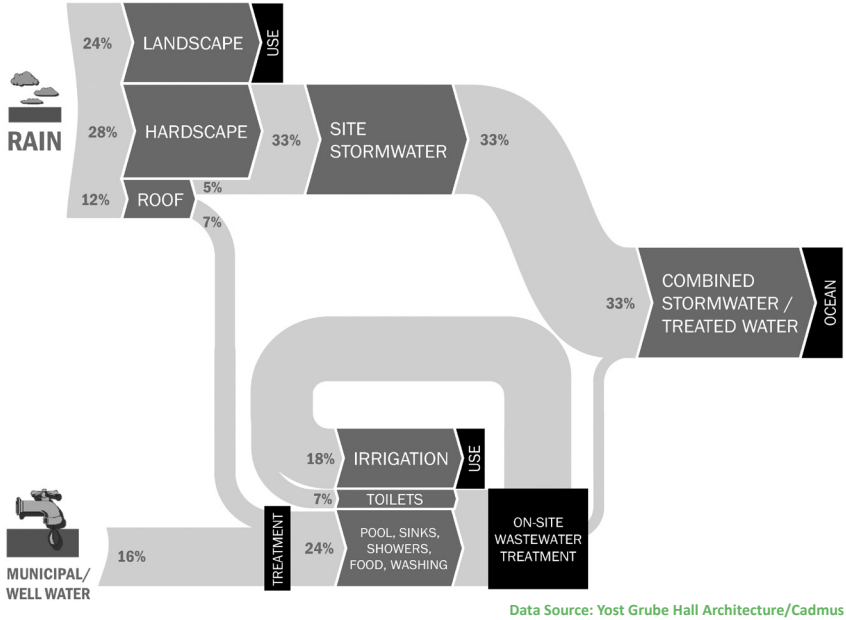
Practical Application

1. **Identify** the most appropriate person to undertake the water audit. Consider whether it is appropriate to engage a professional auditor certified by the Irrigation Association™ (see 🕮 Resources: Irrigation Association).
2. **Create** log sheets to record total water used by each facility and grounds. Review utility usage documented in TREES. Use monthly utility bills, ideally comparing two to three years of data, to establish typical water use patterns.
3. **Identify** all water sources and major end uses, and complete diagrams of post water systems and quantities (Figure 5).
4. **Determine** which end uses are metered or submetered and record which end uses should be targeted for meter installations. This determination

should be based on highest consumption, such as irrigation or cooling tower water use.

5. **Record** subtotal water use at each meter on a monthly basis. Record use in TREES.
6. **Identify** unmetered uses and estimate water consumption.
7. **Determine** whether there are leaks or losses based on unexpected spikes in utility or metered end uses.
8. **Calculate** water consumption per full-time equivalent (FTE) occupants and compare regionally between similar building types to identify anomalies and prioritize conservation efforts. Divide measured water consumption by the number of FTE. This should be identified for each building if individual building metering has been implemented.
9. **Document** findings in an audit report that captures existing water uses, metered sources, data sources, assumptions, and recommendations. Categorize opportunities for water reduction as no-, low-, or high-cost initiatives, as well as short-, mid-, or long-term initiatives.

Figure 5: U.S. Embassy Maputo water balance diagram identifies water sources and end uses



Data Source: Yost Grube Hall Architecture/Cadmus

Metering

Benefit ★★★☆	Allows facilities team to understand and manage water use and cost, and track water savings over time
Time 🕐🕐🕑🕑	Three to six months for meter purchase and installation
Investment $$$$	Cost for purchase and installation of water meters and submeters
Team Members	**FM** | FMO, OBO

Tracking consumption through meter readings is critical for understanding water use. Proper metering allows posts to monitor the impact of improvement measures over time and to prioritize funding for proposed water conservation initiatives. Submetering offers a means of further identifying how water is used.

Where practical, metering should be implemented in the following areas:

- Site or property boundary
- Each individual building
- Irrigation system
- Well water pump
- Process water for heating, ventilating, and air conditioning (HVAC) and other cooling systems
- Specialty systems, such as cafeterias
- Fire suppression pump
- Water treatment and WWT water

Meters can be installed for a relatively low cost, and their installation requires minor design effort. Post properties should have meters at main water supply points, whether they are municipal lines, well pumps, or other sources.

Metering allows posts to monitor their monthly usage and identify spikes in consumption, making it easy to spot and fix leaky irrigation systems, constantly running indoor fixtures, or malfunctioning cooling towers. Data can also be used to determine baseline performance before conservation measures are implemented, calculate return on investment (ROI) for

potential water conservation measures being considered, and evaluate the result of efficiency measures.

Practical Application

1. **Inventory** water meters currently installed. Determine the systems or buildings served by each meter or submeter.
2. **Ensure** that a primary water meter is installed on the main water supply source, regardless of the water source.
3. **Install** submeters, where practical, to track water consumption of separate buildings and major end uses, such as cooling towers or irrigation.
   - When installing a new meter, select a model that can communicate with the existing or future building automation system (BAS). Consult OBO for metering guidance.
4. **Review** measured water data on a monthly or quarterly basis to identify operational issues, optimize building performance, and compare to utility billing for accuracy.
5. **Report** data readings and corresponding changes on a regular basis through TREES.

Typical water meter

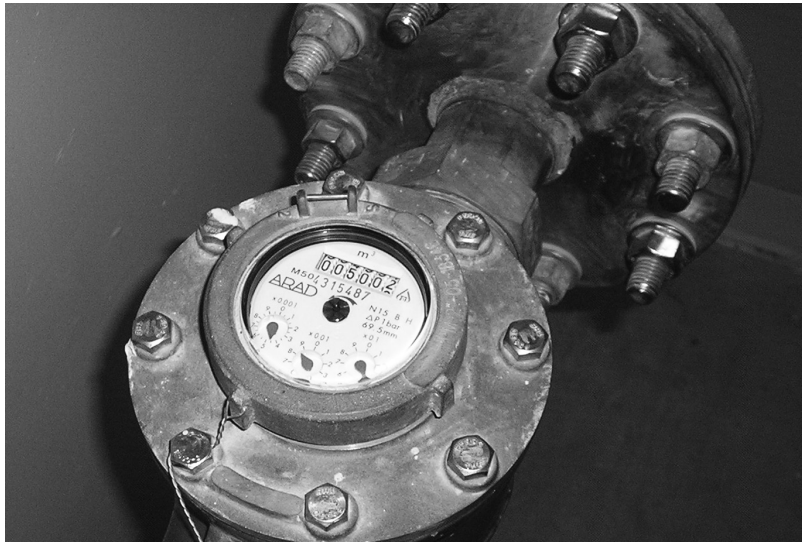


Image Source: Bureau of Overseas Buildings Operations

Efficient Fixtures

Benefit ★★☆☆	Reduces potable water consumption, water heating energy, and utility expenses
Time 🕐🕐🕐🕐	One to two months for fixing leaks and replacing aerators on faucets and six months to select and install fixtures; consider implementing during interior renovation cycles
Investment $$$$	Aerator installation and new fixtures (if needed) for toilets, urinals, or lavatories
Team Members	**FM** | GSO, CLO

Installing water-efficient fixtures such as toilets, urinals, and faucets can provide significant water savings over standard fixtures. Look for WaterSense® labeled products when replacing fixtures. OBO recommends low-flow and automatic faucets and has incorporated efficiency standards into specifications and design guidance (Table 1).

One important consideration for retrofitting with low-flow toilets, low-flow or waterless urinals, is the location of the fixtures along the drainpipe. For a successful retrofit, a plumber should be consulted to ensure that sufficient water can continue to run through the existing sanitary line. Insufficient flow rates due to lower flows along shallow pipe slopes could lead to problems downstream, such as odors, blockages, and pipe corrosion. These problems can be prevented by keeping a conventional urinal or toilet as the farthest (most remote) fixture in the plumbing group, and replacing the others with low-flow or waterless fixtures.

At U.S. Consulate General Shenyang, installation of low-flow aerators, dual-flush toilets, hands-free faucets, low-flow showerheads, and underground piping repairs resulted in a savings of $6,600 from the previous year's water bill.

Toilets: Toilets account for 27% of a typical building's water consumption.[8] Most conventional toilets require 6 liters (L) per flush (Lpf) (1.6 gallons (gal) per flush (gpf)), whereas high-efficiency toilets (HETs) require less than 4.8 Lpf (1.28 gpf) and dual-flush toilets require 3–4.1 Lpf (0.8–1.1 gpf). OBO recommends HETs or dual-flush toilets to reduce domestic water consumption when replacing outdated toilets (Figure 6). Dual-flush adaptor kits are inexpensive, simple retrofits for tank-type toilets.

Table 1: Fixture water consumption: conventional vs. water efficient

Plumbing Fixture	Water Consumption
Urinal	
Conventional	3.8 Lpf (1.0 gpf)
Low flow	0.5–1.9 Lpf (0.125–0.5 gpf)
Waterless	0 Lpf (0 gpf)
Toilet	
Conventional	6.1 Lpf (1.6 gpf)
Tank-type, single-flush	4.8 Lpf (1.28 gpf)
Dual-flush (full flush)	4.1–4.8 Lpf (1.1–1.28 gpf)
Dual-flush (part-flush)	3.0–3.4 Lpf (0.8–0.9 gpf)
Pressure-assisted	3.8 Lpf (1.0 gpf)
Flush valve type	4.1 Lpf (1.1 gpf)
Faucet	
Conventional	8.3 liters per minute (Lpm) (2.2 gallons per minute (gpm))
Low flow (private)	3.0–5.7 Lpm (0.8–1.5 gpm)
Low flow (public)	1.9 Lpm (0.5 gpm)
Showerhead	
Conventional	9.5 Lpm (2.5 gpm)
Low flow	3.8–7.6 Lpm (1.0–2.0 gpm)

Data Source: U.S. Department of Energy

Urinals: Retrofitting with low-flow or waterless urinals instead of conventional urinals can reduce domestic water costs related to urinals by 50–100%. The installed cost of waterless urinals is less than that of conventional urinals; the only maintenance required is cartridge replacement four or five times a year. Waterless urinals use a cartridge 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. There is significantly less cleaning required with these fixtures, due to the lack of flushing water. Specific manufacturer cleaning instructions and maintenance protocol should be followed.

Faucets and showerheads: Both aerating and non-aerating low-flow faucets and showerheads can provide a smooth, laminar stream of water at half the flow rate of a conventional fixture. Manufacturers typically etch flow rates

onto the fixture; these rates can be read directly from the aerator. If the rate is illegible, users can choose to calculate by measuring directly using a measurement cup and a stopwatch.

- **Lavatory faucets:** OBO recommends no-delay, automatic shut-off timing for lavatory faucets.
- **Low-flow showerheads:** Narrow spray jets and an increased mixture of air in the water (providing aeration) reduce water flow while simulating the feel of a conventional showerhead.
- **Touchless controls:** Infrared sensors detect motion, and activate and deactivate lavatory faucets. Water use is minimized, while hygiene is improved. Retrofitted controls require battery replacement every one to two years.

Practical Application

1. **Review** the no- and low-cost water conservation measures identified during the water audit to identify and implement any 'low-hanging fruit,' such as fixing leaks or installing faucet aerators.
2. **Install** low-flow showerheads.
3. **Retrofit** tank-type toilets with dual-flush valve adaptors.
4. **Select** HET or dual-flush toilets, low-flush or waterless urinals, and automatic/low-flow faucets when replacing fixtures.
   - Ensure that products selected are consistent with cultural practices.
5. **Consider** installing touchless controls on faucets.

Figure 6: Dual flush valve—up for half flush and down for full flush

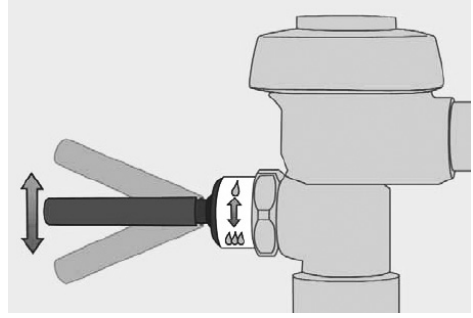


Image Source: U.S. Environmental Protection Agency

6. **Train** facilities staff to maintain new fixtures, and provide occupant education for specialty fixtures, such as dual-flush toilets, waterless urinals, or hands-free faucets using TREES.
7. **Track** utility bills to assess water savings.

Irrigation

Benefit ★★★☆	Reduces potable water consumption and utility expenses
Time 🕒🕒🕒🕒	One to two months for irrigation improvements, six months for landscape and irrigation system re-design, and one to two years for establishment of native or drought-tolerant plantings
Investment $ $ $ $	Existing irrigation system malfunctions repair, irrigation system infrastructure purchase and installation, designer with local knowledge of climate and native species, landscape and irrigation system re-design and installation, and possible upgrade of WWT system
Team Members	**FM** | FMO, CLO, OBO

Several strategies can be implemented to reduce the quantity of potable water used for irrigation: xeriscaping, native or drought-tolerant planting, water-efficient irrigation systems, and use of rainwater and reclaimed water, such as wastewater effluent.

11 billion L (seven billion gal) of water are used every day in the United States for irrigation.[9] That's enough to fill 112 billion drinking glasses.

Xeriscaping refers to landscape design that conserves water through careful plant selection of native or adapted plants. Local landscape designers can provide insight into the most appropriate plants for post's climate and soils, and can recommend plant groupings based on irrigation requirements. Landform alterations, such as berms and grading, can increase visual interest (see Site: Landscaping).

Landscaping best practices include:

- Use of sustainable landscaping materials, such as gravels, native grasses, and groundcovers that require minimal or no irrigation, instead of manicured turf.
- Engagement of a professional landscape architect, designer, or maintenance company familiar with local vegetation, climate, and soils,

to prepare a design for native and adapted drought-tolerant planting (see Site: Landscaping).

Irrigation system best practices include:

- Zone the irrigation system according to plant type groupings into no-, low-, and high-irrigation zones (see Figure 7 and Site: Landscaping).
- Install water-efficient irrigation fixture heads such as pressure-regulated rotary spray heads rather than mist spray heads, where drip irrigation systems are impractical, for lawn areas.
- Use drip irrigation technology for non-lawn areas when irrigation is necessary to establish new plantings, per OBO's current design standards, which specify underground systems. Lawns and other turf areas should be limited and irrigated by rotary spray systems.
- Implement irrigation schedules in conjunction with weather-responsive controllers to ensure that water is delivered at appropriate times of day and frequency, and deactivated during periods of rainfall. Review current irrigation schedules and programming to identify water-saving opportunities. Avoid daytime irrigation and consider reducing watering frequency.
- Use controls such as weather monitors and soil moisture sensors for quantity control. Look for WaterSense® labeled controllers, which can reduce water use by 20% or more. Educate maintenance staff about scheduling for water efficiency.

Drip irrigation uses a network of pipes, tubes, and emitters or micro-sprinklers to minimize the use of water and fertilizer. The system allows water to slowly infiltrate the root zone directly below the ground surface.

Water reuse best practices include:

- Installation of rain barrels or other low-cost stormwater catchment strategies, particularly in residential settings where small amounts of rainwater can provide a significant portion of the irrigation demand.
- Confirmation that minimum quality standards are met to ensure safe and continued use of non-potable sources (see Water: Rainwater Harvesting).
- Consideration of other non-potable irrigation water sources from building systems, such as mechanical condensate or treated wastewater.

Practical Application

1. **Review** the no- and low-cost water conservation measures identified during the water audit, and implement any no- or low-cost items.
2. **Implement** irrigation system strategies to reduce irrigation waste, such as repairs, controls, scheduling, zoning, or system replacements.

3. **Ensure** that landscape professionals working on-site are knowledgeable about local plants and soil conditions.
4. **Consider** non-potable water reuse strategies for irrigation water, such as rain barrels, where appropriate.
5. **Install** an irrigation meter or meters to track water consumption in order to determine the success of implemented strategies. Add submeters to systems where appropriate.
6. **Track** irrigation water use through TREES.

Figure 7: Irrigation zoning can be used to drive plant selection to save water

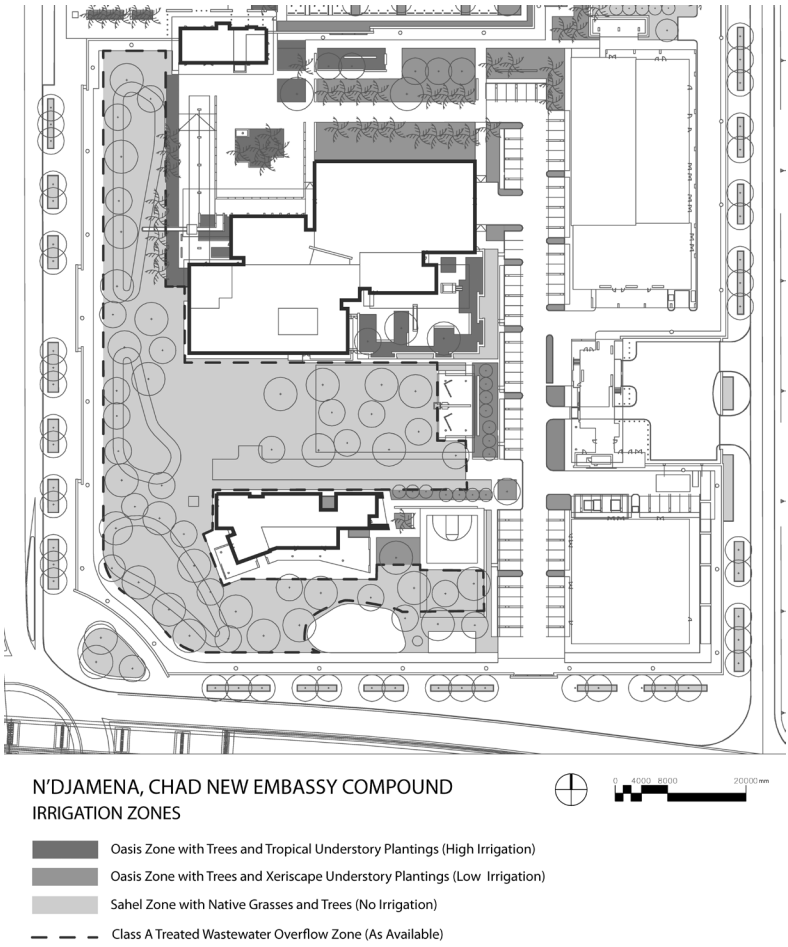


Image Source: Moore Ruble Yudell Architects

Rainwater Harvesting

Benefit ★ ★ ★ ★	Reduces potable water consumption required for irrigation and indoor fixtures, where rainwater is plentiful and regularly occurring
Time	One to five years for large-scale systems involving OBO
Investment $ $ $ $	Engineering services for large-scale systems and cisterns or tanks, and treatment systems for large scale systems
Team Members	**FM** | FMO, OBO

Rainwater may be captured and collected in underground, surface, or elevated tanks for immediate irrigation use or treated for potable uses. In locations with extreme water shortages, rainwater may be treated to a potable level and used to supply building systems.

The feasibility of large-scale rainwater harvesting in a particular location is highly dependent upon the amount, intensity, and yearly distribution of rainfall, as well as the cost and availability of purchased water. As rainfall is rarely distributed evenly throughout the year, rainwater is most often used as a supplementary water source. When rainfall is distributed evenly throughout the year, storage tanks can be smaller, thus reducing the capital cost.

U.S. Embassy New Delhi captures, filters, and uses nearly nine million L (2.4 million gal) of rainwater every year, which is the equivalent of 50,000 bathtubs full of water.

Rainwater collection systems require filters or first-flush diversion treatment to eliminate solids often found in the initial runoff from a rainfall event. Because water from roof surfaces usually contains fewer impurities (oils, heavy metals, and fertilizers) than surface-level water, roofs are typically the first source for rainwater harvesting. Stormwater collection from site surface runoff can be collected in an underground cistern or pond and reused for irrigation or treated appropriately for reuse for non-potable uses, such as sewage conveyance.

Rainwater system maintenance is generally limited to annual cleaning of the storage tank and regular inspection of filters, gutters, and downspouts. 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.

Elevated storage has the advantage of gravity feed. Surface-level tanks require additional care to avoid damage and contamination by people and animals, and may require fencing.

Practical Application

1. **Implement** conservation measures that reduce water demand as identified in the water audit prior to investigating a rainwater harvesting system.
2. **Consult** OBO to evaluate whether rainwater collection is viable for post's climate region and circumstances.
   - Determine annual average on-site rainfall and monthly distribution.
   - Reference online resources to estimate post's potential collection volume.
3. **Engage** OBO to determine the budgeting and approval process for a rainwater collection and treatment system.
4. **Submit** funding request through OBO to install underground cisterns and treatment facilities requiring significant renovations to the site or building.

This image shows typical components of a rainwater harvest system: storage, piping, and photovoltaic (PV)-driven pumps, as well as solar thermal heating

Image Source: Donna McIntire, OBO

Case Study: Water Autonomy

Monrovia, Liberia

Benefit	Annual savings of $180,000, payback within the first year of operation and a net present value (NPV) greater than $3.3 million over the system life
Time	Implemented during the design and construction of the New Embassy Compound
Investment	Estimated at $100,000
Team Members	OBO, new embassy compound planning architect RTKL, and sustainability consultant Paladino and Company

Monrovia's climate offers abundant rainfall, with nearly 500 cm (200 inches (in)) of rain per year. This, coupled with estimated long-term costs of water delivery, led the design team to investigate the feasibility of rainwater harvesting. The project site had 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 approximately $0.06/L ($0.02/gal), with some security risk.

By optimizing roof collection area and tank size, and by installing low-flow fixtures (37% savings from Energy Policy Act (EPAct) requirements), rainwater collected from building roof was designed to supply nearly 100% of all plumbing fixtures, allowing Post to virtually eliminate the need for purchased water delivery. The system collects and treats almost three million L (792,000 gal) of collected rainwater per year.

Collected rainwater is piped to storage tanks, with overflow routed to the stormwater pond located nearby during periods of excessive rainfall. The system includes in-line vortex filters to keep sedimentation generated during the dry season from entering the treatment system.

Figure 8: U.S. Embassy Monrovia uses rainwater collection to achieve greater water autonomy

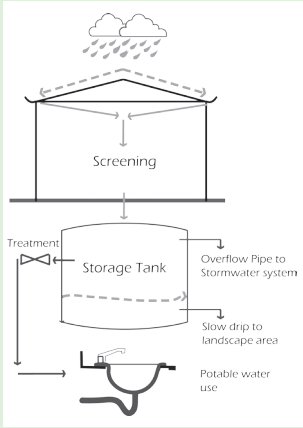


Image Source: Paladino and Company

On-site Wastewater Treatment

Benefit ★★★☆	Reduces the amount and cost of potable water and sanitary sewer discharge, reduces energy cost and related greenhouse gas (GHG) emissions for water treatment, and protects the water quality of host countries
Time 🕐🕐🕐🕐	18 months for design and construction and six months for system testing and commissioning (Cx)
Investment $ $ $ $	Design and installation of a WWT system; regular maintenance and ongoing testing
Team Members	**FM** | OBO

Many missions are located in nations that lack sewage treatment infrastructure or regulations. Posts in these locations are required to treat wastewater on-site and can reuse treated effluent for irrigation or non-potable use. In addition to providing environmental benefit to the host country, reuse of treated wastewater for irrigation or toilet flushing can reduce the utility costs incurred, reduce maintenance required for off-site discharge, and reduce demand on municipal and well water systems.

Pumps and blowers in traditional WWT facilities consume energy, and fugitive emissions are released during the processing of waste. Natural treatment systems, such as constructed wetlands, are preferable to traditional facilities when sufficient site area is available and the system will be serving a small population.

Constructed wetlands can be less expensive than traditional WWT facilities, support biodiversity, and provide site aesthetics. Successfully constructed wetland design includes consideration of site geology and location within the watershed; review of native plant and animal species; and development of a long-term inspection, monitoring, and maintenance plan.

Due to the complexity of design, installation, and operational impact, WWT systems are best utilized when:

- Posts are not connected to municipal WWT systems.
- Host countries do not treat wastewater to WHO standards.
- Demand for irrigation or potable water exceeds municipal supply.

Consider opportunities for reducing discharge, or for upgrading WWT plants to provide effluent that meets reuse standards:

- Undertake water conservation measures to reduce discharge (see Water: Efficient Fixtures, Irrigation, and Rainwater Harvesting).
- Identify minor WWT plant upgrades to provide a net positive environmental benefit, such as eliminating potable water for irrigation.
- Consider treatment and reclamation options for graywater or blackwater, such as biofiltration, filters, disinfection, or other technologies. Consider both site and economic constraints.

U.S. Embassy Ouagadougou treats wastewater using constructed wetlands

Image Source: Robert Jeter, OBO

Practical Application

1. **Review** the results of water audits to determine the need for supplemental water, and identify potential end uses.
2. **Review** OBO's design requirements and EPA's Guidelines for Water Reuse and other resources. Contact SHEM for quality control monitoring guidance.
3. **Identify** minor WWT plant upgrades that could reduce or eliminate the amount of potable water required for irrigation.
4. **Engage** OBO or a local WWT expert to assist with analyzing the options for on-site WWT and reclamation.
5. **Identify** the most viable alternatives, and submit a funding request through OBO to provide assistance with financing, system design, and permitting.

Staff Engagement

Benefit ★★★★	Instills water conservation as a fundamental value and motivates building occupants to adopt water conserving behaviors and habits
Time	One to two months to develop education materials and install signage; regularly scheduled short training sessions
Investment $	Preparation and printing of training materials and signage
Team Members	**Post Green Team** | PAO

The following key behaviors can drive the transformation of water use. They are all simple and easily adopted actions that can be implemented by staff at all levels and throughout all departments.

Encourage post personnel to:

- Scrape (don't rinse) dishes thoroughly and fill the dishwasher to capacity before using.
- Turn off water fixtures such as faucets and showers when they're not being actively used.
- Use water fixtures such as dual-flush toilets and hands-free or metered faucets.
- Take shorter showers.
- Wash cars using a bucket rather than a hose.
- Reduce irrigation and refrain from flood-irrigating with hoses.
- Sweep exterior surfaces rather than hosing them down.
- Report leaks or other potential water-related problems, both outside and indoors, as soon as you notice them.

Practical Application

1. **Review** the general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Offer short training sessions or workshops either hosted by the Post Green Team members or through partnerships with local organizations. Class topics could include: gardening with

native plants; how to use new technologies such as dual-flush toilets and hands-free faucets; or how to identify and report potential water problems such as a broken irrigation line that is saturating a sidewalk, a downspout that isn't discharging water during a heavy rainstorm, sprinklers that are out of adjustment, or a faulty toilet that won't stop running.

U.S. Ambassador Roemer delivers opening remarks at the U.S. Embassy's Water Workshop in New Delhi on March 1, 2011

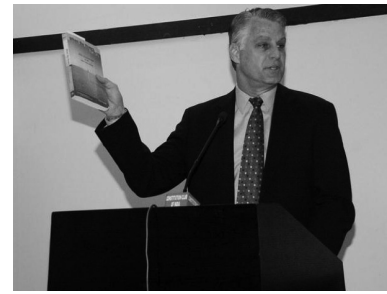


Image Source: U.S. Embassy New Delhi

- Create an incentive program, such as a signed certificate of achievement or public recognition, for staff that demonstrate commitment to water conservation.
- Consider creating a 'water tip of the month' for distribution in post newsletters or broadcasts to staff.

3. **Create** social involvement opportunities.
   - Celebrate World Water Day, March 22 of each year, with a rain garden installation or trip to a water-efficient building or local botanical garden. Work with PAO to coordinate this effort.
   - Encourage staff personnel to achieve water conservation by communicating successes of individual initiatives and prominently displaying post-wide water consumption goals and regularly-updated metrics.
4. **Implement** structural components.
   - When appropriate, install signage to inform occupants about efficient new fixtures or systems.
   - Adopt processes for metering and reporting water use. Provide clear instructions and channels (e.g., a telephone number, form, or email address) for reporting potential problems to maintenance staff.

Resources

📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.htm#water*

Endnotes

1 United Nations Environment Programme. *http://www.unep.org*

2 *United States Water Footprint*. The Water Footprint Network. *http://www.waterfootprint.org*

3 *Global Water Issues.* Bureau of International Information Programs, The Department. *http://photos.state.gov/libraries/amgov/30145/publications-english/Global_Water_Issues.pdf*

4 *Increasing Federal Office Building Water Efficiency*. Energy Efficiency and Renewable Energy, DOE. *http://www1.eere.energy.gov/femp/pdfs/waterefficiency_fedoffices.pdf*

5 *Smart Outdoor Practices*. WaterSense, EPA. *http://www.epa.gov/watersense/outdoor*

6 *Global Drought Monitor*. AON Benfield UCL Hazard Centre, UCL Department of Space and Climate Physics. *http://drought.mssl.ucl.ac.uk*

7 *Jordan: Water is life*. The Health and Environment Linkages Initiative (HELI), WHO. *http://www.who.int/heli/pilots/jordan/en/*

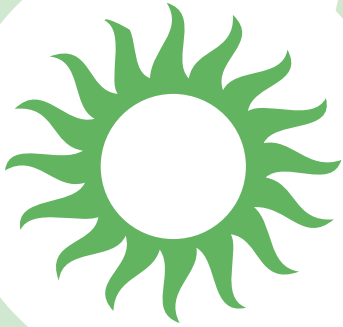
8 *Indoor Water Use in the United States*. EPA. *http://www.epa.gov/WaterSense/pubs/indoor.html*

9 *Smart Outdoor Practices*. EPA. *http://www.epa.gov/watersense/outdoor*

Brigadier General Holman and U.S. Ambassador Retzer at the inauguration of the Longido Water Project

Image Source: U.S. Embassy Dar es Salaam

ENERGY



Harnessing the free solar power of the **sun** is one of the greatest and most critical engineering opportunities of this century. The U.S. Southwest desert could provide the electricity needs of the entire United States through a 260 square kilometers (km^2) (100 square miles (mi^2)) photovoltaic (PV) array, roughly equivalent to the land area occupied by Salt Lake City.

U.S. Embassy Managua will reduce energy purchased from the grid by 54% through an Energy Saving Performance Contract (ESPC) with Lockheed Martin to install a 1 megawatt (MW) PV array; replace interior and exterior lighting with light emitting diodes (LEDs); and improve the chiller equipment.

Image Source: U.S. Embassy Managua

ENERGY

ENERGY

Federal Performance Goals

Energy Consumption:

- 30% reduction in energy intensity from 2006 baseline by 2015 per Executive Order (EO) 13514
- All federally owned buildings to have electricity meters by 2012 per Energy Policy Act (EPAct)

Renewable Energy:

- 7.5% of energy use must be renewable by 2013 where feasible per EPAct

Greenhouse Gas Emissions:

- Report and set 2020 targets using 2008 baseline per EO 13514

Chapter Overview

Energy use and its associated carbon impact is a global issue that must be addressed by all countries. Depletion of fossil fuel resources accelerates as developing nations gain economic stability, and this additional demand is expected to continue to raise global energy prices. The Energy Information Administration estimates that peak oil production may occur in the next few decades, and then decline, intensifying international competition for remaining energy supplies.[1]

As the earth's population grows, energy consumption and associated emissions may continue to rise. Higher concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHGs) in the earth's atmosphere, such as methane and nitrous oxide, intensify the greenhouse effect, which causes global temperatures to warm and contributes to climate change. The effects of climate change include altered precipitation patterns and increased frequency of extreme weather events; increases in ocean temperatures, sea level, and acidity; and melting glaciers and sea ice. Climate change may influence agricultural growing seasons and crop yields; affect human health; cause changes to forests, ecosystems, and species; intensify and increase the frequency of storm events; and impact global water and energy supplies.

Some countries and regions account for a larger portion of total carbon emissions than others. Carbon emissions are more directly tied to a country's population, patterns of development, environmental regulations, and fuel production sources than to its total land area.

Data collected by the Intergovernmental Panel on Climate Change (IPPC) indicates that the United States, Asia, and Europe are the largest contributors to global carbon emissions. A mission located in one of these regions is likely to face questions from its host country about plans, targets, and steps taken to reduce environmental impacts to that country. Conversely, posts located in low-carbon emission regions, such as developing countries, can serve as models for future sustainable development. Therefore, implementation strategies included in the Energy chapter offer opportunities for posts to demonstrate eco-diplomacy, as well as increase the security and energy efficiency of their buildings, while reducing operating costs.

Figure 1: Global carbon emissions by region and year[2]

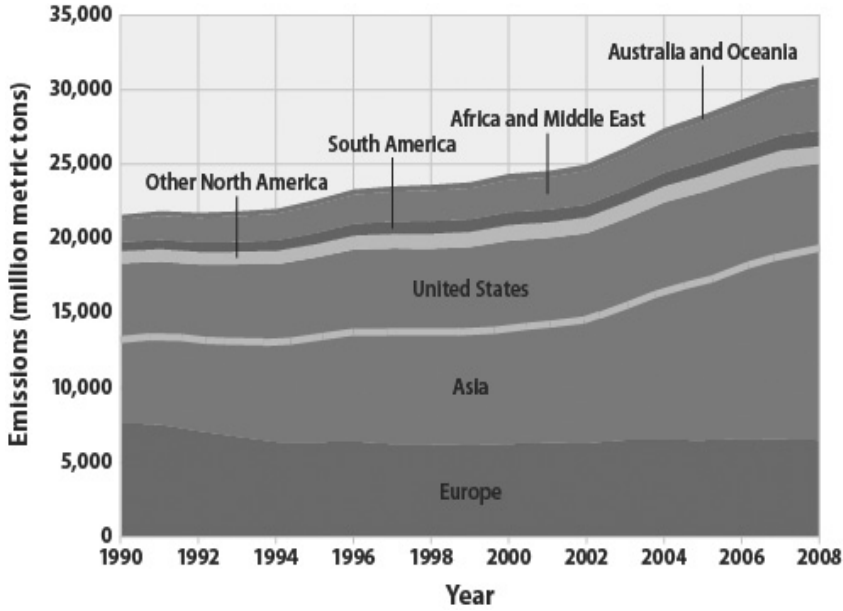


Image Source: Intergovernmental Panel on Climate Change

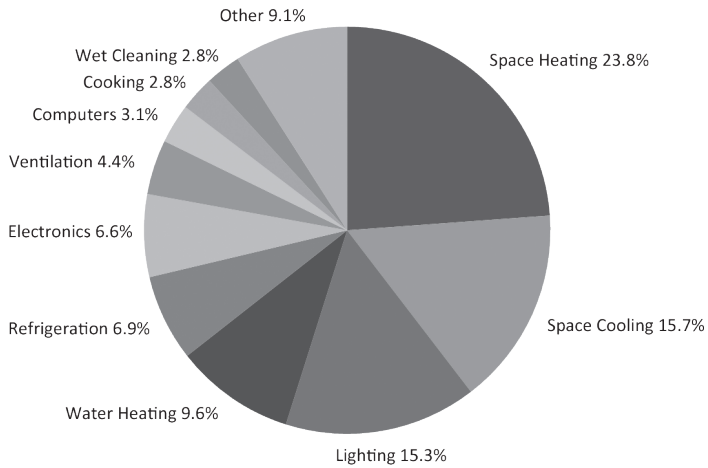
Energy Profile

Buildings produce 40% of U.S. CO_2 emissions and consume over 74% of the retail electricity used in the United States. Carbon emissions from energy use in U.S. buildings average 78 kilograms per square meter (kg/m^2) (16 pounds

per square foot (lbs/ft^2)) per year.[3] U.S. diplomatic facilities overseas, typically built to American standards, perform similarly. By seeking opportunities to reduce loads, improve efficiency, and use renewable forms of energy, every person and all posts can minimize negative impacts of energy consumption and contribute to more sustainable resource use.

In 2011, OBO conducted a net-zero-energy (NZE) study of the first Leadership in Energy and Environmental Design (LEED®) certified embassy, Sofia, Bulgaria. The study showed the Embassy to be operating at 290 kilowatt hours per square meter per year (290 kWh/m^2/yr) (92,000 Btu per square foot per year (92 kBtu/ft^2/yr)).[4] This translates to an energy use index (EUI) of 80–90 kBtu/ft^2/yr, which is standard for an office building built in 2008. However, this EUI is impressive, given the Embassy operates under continuous pressurization and four air changes per hour, a situation uncommon for a typical office building. To meet federal performance goals, all posts must contribute to improving energy efficiency and to implementing load reduction measures.

Figure 2: Typical U.S. commercial building energy consumption by end use[5]



Data Source: U.S. Department of Energy

As seen in Figure 2, a building's primary energy end uses—heating, ventilating, and air conditioning (HVAC) and lighting—can be managed by building setpoints and control sequences, providing the greatest opportunities for savings. Secondary end uses—computers and electronics, cooking and refrigeration, and water heating—are controlled by users and procurement managers. As energy-efficient equipment becomes more readily

available, equipment upgrades can become a significant contributor to improving overall building performance.

Considerations

The Department's Foreign Affairs Manual (15 FAM) Section 169 Energy Cost Controls outlines post responsibilities for effective energy management. (see 🕮 Resources: 15 FAM 169) Posts should begin by optimizing building systems to meet operational needs, and then using on-site renewable power to supply all or part of the remaining load, where feasible.

15 FAM 169.1 requires post to track energy use and cost through the TREES database, to better understand building performance and to benchmark use against industry standards as well as against similar buildings in similar climate conditions. This analysis, in conjunction with a review of the economics of various solutions, is needed to prioritize strategies that can provide the greatest benefit to each facility. For example, bundling inexpensive energy conservation measures (ECMs) with larger, longer-term capital projects, such as installation of PV panels, may result in acceptable overall payback periods. This can be an effective strategy to advance PVs or other expensive yet highly effective technologies to achieve eco-diplomacy goals. To reduce the capital cost impact of major upgrades or new technologies, consider engaging an energy service company (ESCO) to work on an ESPC. DOE's Federal Energy Management Program (FEMP), and OBO are available to provide support throughout this process.

The most effective sequence for managing and reducing energy consumption is as follows:

1. **Load reduction:** Identify every possible means to reduce energy use, including staff engagement, system management awareness and control, implementation of proper schedules of systems, and energy tracking and reporting. Re-commission (re-Cx) systems regularly to verify equipment is operating as intended.
2. **System efficiency:** Once loads have been reduced, ensure that current systems are the most efficient in serving operational requirements, and implement upgrades where feasible. Quick paybacks can be identified during audits, through analysis of energy bills, and by focusing on systems that are significant contributors to total energy load.
3. **Renewable resources:** Seek to serve the remaining energy load with renewable energy produced on-site where cost effective. Sites that have high energy rates and significant solar or wind resources offer the best opportunities to implement this technology.

Strategy Selection Factors

There are a number of no- and low-cost ECMs that can greatly reduce energy usage, energy costs, and carbon emissions.

Photovoltaic panels at U.S. Embassy Monrovia

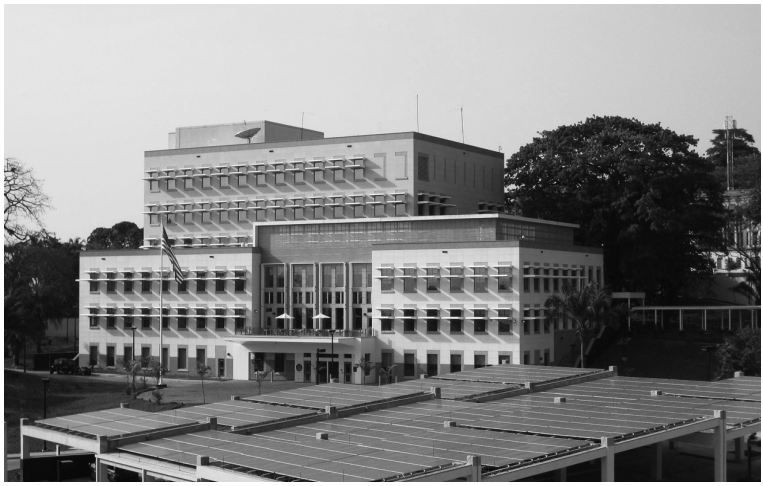


Image Source: U.S. Department of State

Strategies identified in this chapter are especially important for posts with the following characteristics:

- **Posts using prime power generation:** Posts that generate their own electricity on-site can increase security while reducing risk, fuel costs, GHG emissions, and maintenance needs most effectively through implementing load reduction strategies and incorporating renewables.
- **Posts renovated >15 years ago:** Posts with aging HVAC systems or poorly insulated structures likely have opportunities for easy and no-cost ECMs, which can be identified during an energy audit.
- **Posts located in harsh climate zones:** Missions that are located in hot and humid, hot and dry, cold and humid, or very cold climates likely have significant energy expenses (see 🕮 Resources: American National Standards Institute (ANSI)/American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) 169-2006*)*.
- **Lighting systems > eight years old:** Lighting systems have significantly progressed in recent years. An update to lighting controls or fixtures often provides payback within five to ten years.
- **Office and information technology (IT) equipment > five years old:** Older office equipment likely does not contain ENERGY STAR® labels or have

stand-by or auto-off features, or uses outdated technology that is less efficient than new models.

The following table indicates which energy strategies can be most applicable for a mission, based upon the above criteria. Refer to each strategy section for implementation details.

Priority Selection Criteria	Posts using prime power generation	Posts renovated >15 years ago	Posts located in harsh climate zones	Lighting systems > eight years old	Office and IT equipment > five years old
Audit	All posts				
Metering	All posts				
Re-/Retro-Commissioning	●	●	●	●	
Electrical Demand Management	●		●		●
Temperature Controls	●	●	●		
Automatic Lighting Controls	●	●		●	
Site Lighting	●			●	
Lighting Equipment and Lamps	●			●	
Daylighting	●		●	●	
Computers and Office Equipment	●				●
Thermal Solar Water Heating	●				
Photovoltaics	●				
Wind Power	●				
Staff Engagement	All posts				

Case Study: Energy Management

New Delhi, India

Most buildings supporting the U.S. Embassy in New Delhi are over 40 years old; however, through green initiatives, the Embassy has reduced its energy consumption and CO_2 emissions by 2,490 metric tons annually—the equivalent of over 500 cars.

Post's Green Team—the Resource Conservation Unit (RCU)—is a group of committed local staff dedicated to accomplishing green goals. The RCU consolidates their efforts for easier measurement and best practice sharing, and providing a one-stop-shop for expert advice and analysis. In its first year, the RCU saved Post over $175,000.

The Embassy has taken a step-by-step approach to achieving green goals:

1. **Auditing:** National Renewable Energy Lab (NREL) and OBO conducted a thorough audit of the primary buildings supporting the Mission, and Post has used the report as a roadmap for future upgrades.
2. **Metering:** Post implemented extensive metering to improve energy use tracking. Custom metering enables Post's staff to quickly identify energy 'flashpoints,' or spikes, that need correction.
3. **Short-term actions:** Post immediately implemented low-cost actions with quick paybacks, such as replacing site lighting with LEDs, which reduced energy use by 40%, and produced a two year return on investment (ROI).
4. **Long-term actions:** Post is working with OBO to identify and implement capital-intensive recommendations identified in the audit, such as replacing standard electric motors with variable frequency drive (VFD) motors.
5. **Education:** Post uses the *Community Liaison Office* newsletter, the local information magazine from the Public Diplomacy section, and *State Magazine* to educate and engage staff. Post residents receive a monthly energy-use report with a ranking to encourage conservation.

VFDs at Mission New Delhi

Image Source: U.S. Embassy New Delhi

Strategies

Strategy	Benefit	Time	Investment
Audit	★★☆☆	🕐🕑🕑🕑	$$$$
Metering	★★★☆	🕐🕑🕑🕑	$$$$
Re-/Retro-Commissioning	★★★★	🕐🕑🕑🕑	$$$$
Electrical Demand Management	★★☆☆	🕐🕐🕑🕑	$$$$
Temperature Controls	★★☆☆	🕐🕐🕑🕑	$$$$
Automatic Lighting Controls	★★☆☆	🕐🕑🕑🕑	$$$$
Site Lighting	★★☆☆	🕐🕐🕐🕑	$$$$
Lighting Equipment and Lamps	★★★☆	🕐🕐🕐🕑	$$$$
Daylighting	★★☆☆	🕐🕐🕐🕑	$$$$
Computers and Office Equipment	★★★☆	🕐🕐🕐🕑	$$$$
Thermal Solar Water Heating	★★☆☆	🕐🕐🕐🕑	$$$$
Photovoltaics	★★★★	🕐🕐🕐🕑	$$$$
Wind Power	★★★★	🕐🕐🕐🕐	$$$$
Staff Engagement	★★★★	🕐🕑🕑🕑	$$$$

Audit

Benefit ★★☆☆	Identifies both 'low-hanging fruit' and more complex opportunities to implement changes to operations, maintenance, and systems that can improve energy performance in the workplace
Time	One to two weeks to establish access and audit protocol, one week to perform the audit, and two to four weeks to write a report including recommendations
Investment $ $ $ $	External auditor, if qualified auditors are not present at post
Team Members	**FM** | GSO

Energy audits identify operational adjustments and retrofit actions that enable posts to improve energy efficiency and comfort, as well as reduce building operating costs. The Energy Independence and Security Act (EISA) of 2007, Section 432, requires comprehensive energy and water evaluations to be completed for all covered federal facilities once every four years. To meet EISA requirements, an audit must be performed by someone with training in energy auditing and life-cycle cost analysis (LCCA).

The total electricity consumed by idle electronics in the United States equals the annual output of 12 power plants. Identification of phantom loads is the first step to turning them off.[6]

Audits vary in scope, time, and cost. The Practical Application section describes an American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Level I audit, also known as a walk-through analysis, which has minimal cost and is typically completed in less than one week. Level I audits identify 'low-hanging fruit' as well as major problem areas. Large or complex facilities may realize greater benefit from a more intensive Level II (in-depth) or Level III (investment grade) audit, each of which is described in detail in the Audit strategy resources. Table 1 lists items that are typically included in each type of audit and can be used to assist in determining which audit level is most suitable for a particular building.

Table 1: Energy audit level comparison at a glance

	Level I	Level II	Level III
Cost and Resources	Least	Moderate	Most
Identifies No Cost/Low Cost Opportunities	x	x	x
Degree of Accuracy of ECM Energy Savings	+/- 30%	+/- 15%	+/- 8%
Degree of Accuracy of ECM Cost Estimates	+/- 30%	+/- 15%	+/- 8%
Identifies Simple Payback Period	x	x	x
Identifies ROI / Net Present Value (NPV) / Internal Rate of Return (IRR) (Financial Matrix)	x	x	x
Addresses Lighting	x	x	x
Conducts Lighting Photometrics		x	x
Addresses Compressed Air	x	x	x
Addresses Steam System	x	x	x
Addresses Building Envelope	x	x	x
Conducts Thermal Imaging		x	x
Conducts Vibration Analysis			x
Conducts Ultrasonic Analysis			x
Addresses Water Heating and Distribution	x	x	x
Addresses HVAC Equipment	x	x	x
Addresses HVAC Controls—Equipment	x	x	x
Addresses HVAC Controls—Sequence of Operations		x	x
Addresses HVAC Controls—Advanced Control Strategies			x
Conducts On-site Interviews—O&M		x	x
Conducts On-site Interviews—Occupants and Tenants		x	x
Number of Months of Data for Utility Bill Analysis	12	12–36	36–60
Correlates Weather and Other Impacts with Utility Analysis		x	x
Building Plans, As-Built Drawings, and Other Documents are Reviewed		x	x
Uses Data Logging		x	x
Incorporates Data from Built-In and Temporary Systems (Building Management Systems (BMS), Energy Management and Control System (EMCS), Data Loggers, Recorders, etc.)			x
Includes Mission Analysis			x
Includes an Energy Balance			x
Considers Impacts of ECMs on Each Other			x
Uses Computer Modeling to Incorporate Impacts of Outside Factors on Recommended ECMs			x

Data Source: U.S. Department of Energy

An energy audit should be performed by a qualified auditor:

- The auditor may be a qualified member of a Post Green Team (Level I audit) or facilities staff with energy auditing experience, engineering consultants, or dedicated energy auditing contractors (Level II or III audit) (see 🕮 Resources: A Guide to Energy Audits).
- Ensure that the auditor has the required permission and security access to photograph facility equipment, access machine rooms, and collect data from controls systems.

A typical energy audit includes the following major components:

- Analysis of utility bills and submetering data to identify consumption trends: Compare to energy usage of similar facilities using TREES, or the U.S. Environmental Protection Agency (EPA) Portfolio Manager, to understand the scale of potential savings.
- Site assessment of major building systems: Inspect systems (see 🕮 Resources: Energy Savings Assessment Training) and interview operations staff to determine schedules and procedures.
- Inspection of exterior site lighting (see Energy: Site Lighting): Determine the number of each fixture type, lamp type, and wattage; whether lights are required for security or are decorative; whether lights are controlled manually, by photocells, or by time clocks; and whether each light fixture provides uplight or downlight.
- Identification and recommendations of applicable ECMs.

Practical Application

1. **Identify** an energy auditor based on the desired audit level.
2. **Collect and analyze** monthly utility bills or submetering data from the most recent one to three years of operation.
3. **Conduct** an assessment including building controls, systems, and exterior lighting.
4. **Recommend** ECMs and evaluate estimated costs, savings, and payback periods for each ECM using LCCA (see 🕮 Resources: Life-Cycle Cost Analysis).
5. **Prepare** a final audit report with a prioritized list of recommended ECMs.

Metering

Benefit ★★★☆	Allows the facilities team to understand and manage energy use and cost, track performance, and report improvements
Time	One to two months to identify appropriate meter locations, select and procure equipment, and install meters; install meters several months in advance of an energy audit or ESPC to add value to those strategies
Investment $$	Budget for purchase and installation of electricity, fuel, or natural gas meters
Team Members	**FM** | GSO, RSO

Since 2012, metering has been mandatory for all Department buildings over 464 m^2 (5,000 ft^2) per EPAct 2005. Metering helps facilities staff properly manage energy use and cost, verify equipment operations, support decisions, benchmark facilities, and verify utility bills. Metering efforts and ongoing documentation of meter readings inform and help prioritize funding for ECMs and ESPCs.

Advanced meters record data at daily, hourly, or minute-by-minute intervals and can transmit measured data to a remote location; standard meters measure and store cumulative usage data locally. Stand-alone meters can be installed at relatively low cost and their installation requires minor design effort. However, coordination of meters with a building automation system (BAS) is more expensive and requires greater skill for proper implementation.

In 2010, the U.S. Consulate General in Hong Kong implemented a monthly residential utility feedback program that included one year of previous electricity billing data. In 2011, there was a five percent drop in annual electricity consumption among participating residences.

Building metering installations must meet EPAct 2005 requirements, including the provision of individual meters for each building and for specialty system or major equipment. Advanced electric meters are required for each building service entrance and each large mechanical equipment item, such as chillers and boilers. EPAct also requires advanced fuel or gas meters for each building service entrance, generator, boiler, or water heater.

Figure 3: OBO's Utility Dashboard offers insights into utility consumption, costs, comparisons, and trends against targets

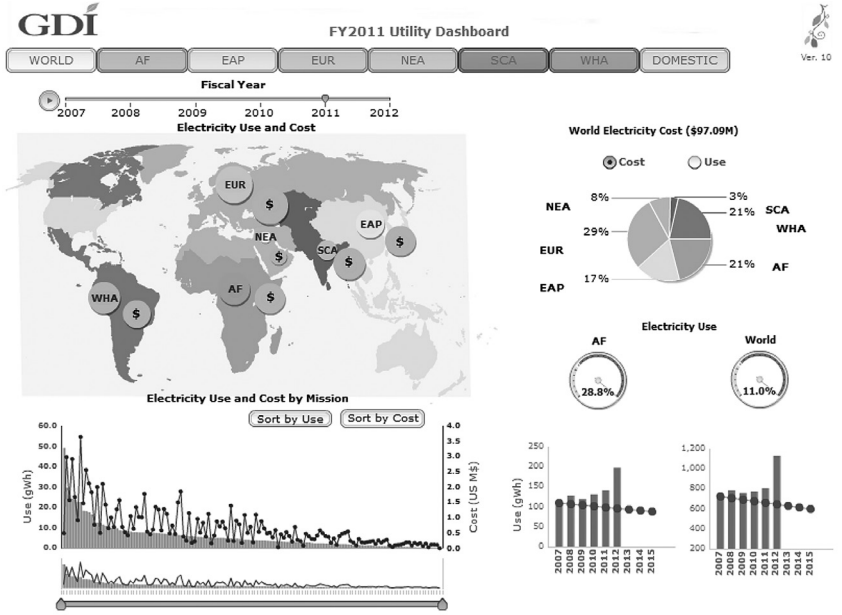


Image Source: Bureau of Overseas Buildings Operations

Practical Application

1. **Inventory** all energy meters currently installed. Be sure to track whether each meter is an advanced meter or a standard meter.
2. **Identify** locations where advanced electric, fuel, or gas meters are required by EPAct 2005, but not currently provided.
3. **Install** additional meters as required by EPAct to track energy consumption of major building systems, such as lighting and plug loads.
4. **Coordinate** with facilities staff to select and install advanced meters where required and beneficial to energy management.
5. **Report** measured energy data on a monthly basis in TREES to identify operational issues and optimize building energy performance.

Re-/Retro-Commissioning

Benefit ★ ★ ★ ★	Identifies operational improvements, capital projects, utility savings, and ROI to improve occupant comfort and optimize energy use
Time	Two to four weeks to plan and two to four weeks to complete
Investment $ $	Commissioning Agent or engineer support services
Team Members	**FM** | GSO, RSO, Cx Agent

Commissioning (Cx) is a process used to verify that facilities and systems are operating properly. Retro-commissioning (retro-Cx) applies to existing buildings that have never been commissioned before. Re-Commissioning (Rx-Cx) occurs when a building that has already been commissioned is commissioned either as part of a regular, periodic building performance review, or when triggered by a building use or system change.

Both re- and retro-Cx consist of testing and adjusting building systems to optimize safety and security, occupant comfort, and energy use and savings.

Cx offers facilities staff a direct, tangible means of supporting business objectives and provides a benchmark by which to measure a building's operational performance improvement.

Economic benefit of Cx includes:

- System optimization and enhanced performance
- Increased energy efficiency
- Identification of operations, controls, and maintenance problems, including reduced premature equipment failure
- Productivity and health benefits from improved indoor environmental quality (IEQ)

Cx also aids in long-term planning and budgeting by identifying targets for future capital improvement projects. Re- or retro-Cx typically occurs after systems have been in operation for at least one year. Best practice recommends re-Cx every five years at a minimum.

Cx is a team effort that frequently involves both internal staff and external contractors. Post facilities staff can often establish the process and perform many of the required tests. Team leads are typically third-party Cx agents, but may also be qualified members of post's facilities staff, mechanical contractors, or design engineers (see 🕮 Resources: Commissioning for Federal Facilities).

According to U.S. DOE, existing buildings have a median Cx cost of $3.23/m² ($0.30/ft²), a median whole-building energy saving of 16%, and a median payback time of 1.1 years.

The Cx team's scope of work should include development of a plan that:

- Identifies Cx goals and objectives, such as reducing energy cost, reducing maintenance time and cost, improving indoor air quality (IAQ), and improving thermal comfort
- Defines which building systems are to be commissioned—the Cx plan should focus on systems that represent a large proportion of a facility's energy use: systems with consistent operational problems; systems where failure presents a high risk to productivity, safety or security; and systems that are responsible for the most occupant complaints
- Determines how selected equipment and systems are intended to operate or how they could operate more efficiently given current building conditions
- Defines performance criteria, functional performance test procedures, or verification checklists for each system or piece of equipment (see 🕮 Resources: Model Commissioning Plan and Guide Specifications and Commissioning Process Templates)

A Cx agent inspecting a rooftop mechanical unit

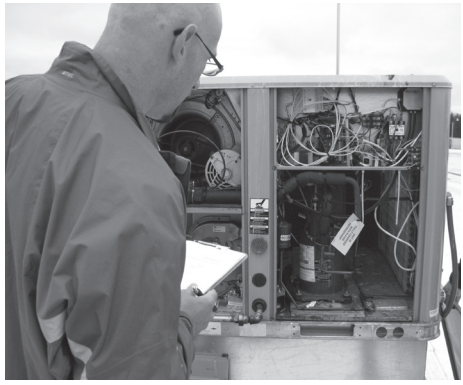


Image Source: Paladino and Company

Table 2: Should this building be commissioned?

Criteria	Yes	No
There is an energy management system	√	
Mechanical equipment is more than 12 years old or is not in particularly good condition	√	
Major renovations are scheduled that could be combined with Cx		√
Energy usage is higher than expected	√	
There are complex HVAC systems		√
There are building operational problems	√	
There are excessive occupant complaints about temperature, airflow, and comfort	√	
There are facilities that use high amounts of outside air to mitigate chemical and biological threats	√	
An ESPC or utility energy service contract (UESC) is being considered		√

Data Source: Adapted from U.S. Department of Energy

Practical Application

1. **Determine** whether the building is a good candidate for Cx using the checklist in Table 2. The more "yes" responses checked, the more ideal this facility is for Cx.
2. **Identify** tools, resources, and lessons learned from previous Cx activities at other posts.
3. **Determine** resource availability at post to conduct Cx, and determine if contracted sources are required.
4. **Assemble** Cx team and select Cx team lead.
5. **Develop** Cx plan and review with relevant post personnel.
6. **Implement** Cx activities per Cx plan.
7. **Review** report findings to prioritize implementation.
8. **Select and implement** repairs and improvements, and retest to verify proper or improved operation.
9. **Train** post staff on any new O&M procedures.

Electrical Demand Management

Benefit ★★☆☆	Reduces utility costs and increases reliability of the electricity supply
Time 🕐🕐🕐🕐	One to two months for utility bill analysis and one to six months for utility negotiations
Investment $ $ $ $	No financial investment required
Team Members	**FM** | FMO

Posts may be able to reduce their reliance on the electricity grid and negotiate better utility rates by managing demand, implementing efficiency measures, and reducing peak loads. By modifying energy usage patterns, posts may lower consumption during more expensive peak periods of use, or qualify for an alternative time-based rate schedule.

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

- **Fixed charge:** Administrative charges such as meter reading costs and other recurring charges unrelated to the quantity of energy consumed
- **Energy charge:** Utility costs directly related to post's energy consumption
- **Peak demand charge**: Cost based on the capacity of the service provided, which depends upon power demanded by post at peak times; the total peak demand on power providers determines the size of the plants and the provider's investment costs
- **Power factor penalty:** Charge assessed for excessive reactive power consumption by loads with low power factor, often due to oversized motors and transformers; the best way to counteract these fees is with a comprehensive energy audit and properly engineered systems

Peak load shaving is the practice of reducing the amount of energy purchased from the utility company during the highest demand hours. This can result in significant savings when the utility rate schedule includes a high monthly peak demand charge, which is sometimes 'ratcheted,' and can persist for several months to a year past the occurrence of a new demand peak.

Consider the following opportunities for peak load shaving:

- Posts may be able to use new or existing generators to offset the load that exceeds the daily average for short periods of time. Evaluate and coordinate with OBO before implementation due to the hidden costs of generator operation.
- Schedule energy-intensive activities to occur during off-peak hours. Pre-heat and pre-cool the building, or schedule cleaning and maintenance to avoid peak hours (see 🕮 Resources: Introduction to Commercial Building Control Strategies and Techniques for Demand Response).
- Implement on-site energy storage and renewable energy production to reduce demand on the utility provider during peak or off-peak periods (see Energy: Photovoltaics and Energy: Wind Power).

Forming collaborative partnerships with local utility providers can help identify opportunities both to reduce energy production demands on the utility providers and to optimize energy savings for post. Some utilities offer demand response programs, which provide financial incentives for participating customers who quickly reduce loads during periods of high demand.

When contacting the local utility provider:

- Negotiate the best possible rates, fees, and surcharges, based on successful implementation of applicable demand reduction strategies.
- Determine whether demand response programs exist, and whether alternative rate or demand schedules are available for time-based billing.
- Participate in available demand response programs, if offered. This requires posts to develop and implement demand response event plans.

New facilities are often set up with a higher-than-needed utility demand schedule to limit overcharges. Reviewing actual demand usage after a year of operation can allow posts to hone the size of the service required, in kilowatts (kW).

Practical Application

1. **Review** at least one year of recent utility bills to understand current rate structures and post's consumption patterns. Identify peak demand charges and correlate with actual peak demand of the facility.
2. **Review** findings of the energy audit for low- and no-cost peak load reduction strategies, and implement these.
3. **Contact** the local power provider to negotiate rates and determine whether demand response programs exist.
4. **Consider** opportunities for peak load shaving through scheduling, generator use, or on-site energy storage or production.

Temperature Controls

Benefit ★★☆☆	Increases effectiveness of mechanical systems and user comfort
Time 🕐🕐🕐🕐	One month to review and modify a BAS, three to six weeks to replace thermostats, and one to four weeks to survey occupants and make changes
Investment $ $ $ $	Thermostats, programming expertise, occupant education training and materials
Team Members	**FM** | FMO, GSO, CLO

Monitoring and adjusting building HVAC systems in response to internal conditions can improve occupant comfort and achieve significant energy savings. Newer BAS are computerized networks of electronic devices that are designed to monitor and control mechanical, lighting, and other systems in the building. Older systems may have stand-alone controls that must be manually adjusted to modify the indoor environment.

A BAS maintains building climate within a specified range, typically controlling cooling, heating, humidification, and CO_2 levels. BAS setpoints are based on an occupancy schedule, allowing the BAS to monitor system performance criteria and device failures, as well as notifications to building engineering staff. The BAS is usually managed by facilities staff.

To ensure that thermal comfort controls are effective and efficient:

- **If the building has a**

Programmable thermostats enable implementation of energy-saving setbacks during periods of non-occupancy

Image Source: U.S. Environmental Protection Agency

BAS: Adjust BAS setpoints to match actual operating hours and desired comfort conditions (see 🕮 Resources: O&M First: Five O&M Ideas on How to Save Money in Your Buildings NOW!).

- **If the building does not have a BAS:** Replace stand-alone manual thermostats with programmable digital models. Select thermostats that have simple controls and can be programmed with hourly, daily, and weekly settings, to provide for the implementation of energy saving setbacks during periods of non-occupancy, such as nights and weekends. If occupant control is not desired, choose a thermostat model that can be enclosed in a secure housing or that defaults to programmed settings after a specified time period, such as one hour.

The Department's recommended range for operational setpoints is: 20-23.5 degrees Celcius (°C) (68-75 degrees Fahrenheit (° F)) during cold weather and 22.5-26 °C (73-79° F) during warm weather, assuming 30-60% relative humidity.

Practical Application

1. **Talk** with facilities staff to determine what type of HVAC system controls are currently present. Identify zones served by each HVAC unit or system.
2. **Observe** or interview occupants of each HVAC zone to determine the appropriate system schedule, if the building does not have a BAS.
3. **Review** and adjust BAS schedules and setpoints, if applicable.
4. **Replace** stand-alone manual thermostats with programmable digital models, if they are not connected to a BAS. Coordinate with facilities staff to install and program thermostats.
5. **Schedule** a training session to demonstrate the features and use of thermostats, if thermostats are adjustable by occupants.
6. **Survey** staff about comfort levels after six months of occupancy to verify that setpoints and schedules are appropriate. Conduct future surveys as discussed in Indoor Environment: Thermal Comfort.
7. **Provide** feedback to facilities staff and ask them to adjust settings as necessary, within acceptable setpoint ranges as established by the Department.

Automatic Lighting Controls

Benefit ★★☆☆	Reduces energy use by ensuring that the indoor lighting system operates only when necessary
Time 🕐🕐🕐🕐	One to three months for simple wall switch upgrades or control system programming, and one year or more for full system retrofits that require engineering services and permits; best completed with re-ballasting or major tenant improvements
Investment $ $ $ $	Purchase and installation of control switches or sensors; engineering services; and new lamps, ballasts, and controls for major improvements
Team Members	**FM** | FMO, RSO, CLO, OBO

Automatic lighting controls can yield considerable energy savings. Occupancy and vacancy sensors ensure that lighting systems operate only when someone is using an area, and can reduce lighting demand by more than half. These sensors are most effective in enclosed spaces that are intermittently occupied.

Daylight harvesting controls, applicable to interior as well as exterior areas, save energy by reducing electric lighting when daylight is available. These systems include photocells to measure light levels, relays to dim or switch electric lights, and controllers that determine when to adjust the lighting state. In existing buildings, daylight harvesting capability may be improved by modifications to lighting control zones by grouping areas with similar daylight conditions and space function.

Different types of controls are required for different space types (see 🕮 Resources: How to Select Lighting Controls for Offices and Public Buildings and Lighting Controls).

The primary types of lighting controls are as follows:

- **Occupancy sensors** automatically turn lights on when someone enters an area and automatically turn lights off when no occupants have been detected for a short, set period of time. Occupancy sensors are most appropriate for spaces with safety or security concerns, spaces where occupants often carry items and can't easily access the lightswitch,

spaces with no daylight, and spaces where switches are in difficult-to-access locations.

- **Vacancy sensors** detect when an area is vacant and turn lights off, but require an occupant to manually turn lights on. Vacancy sensors provide the highest awareness of energy use decisions and achieve the highest level of energy savings. They are recommended for most spaces, including open and enclosed offices, conference spaces, and restrooms.
- **Photo sensors** control lighting in an area based on the amount of natural light available. They can reduce lighting costs by 20% or more and can easily be combined with occupancy or timer controls (or both). Daylighting controls are best suited to exterior spaces as well as perimeter rooms and spaces with moderate to large windows or skylights that provide ample daylight.
- **Timers** are devices ranging from simple time clocks to advanced controls used to regulate lighting in large areas. If the building is shut down completely at night, a timer can ensure the lighting is turned off, leaving minimal lighting for security and emergency navigation, as required by life safety building codes and security protocol.
- **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 use of natural light), occupancy sensors, and timers to ensure that lights are off when not needed. As sensor technologies have evolved, combinations of different sensor technologies in single devices have increased reliability and reduced instances of false shut-downs.

Occupancy and vacancy sensors can reduce lighting energy use by 20% (in open plan offices) to over 60% (in conference rooms, storage spaces and restrooms).[7]

Note that not all sensors are security-approved for all building locations. OBO has prepared guidance for developing and implementing an interior lighting control strategy (see 🕮 Resources: Sustainable Lighting Study).

Practical Application

1. **Talk** with facilities staff to determine what types of lighting controls are already present in the building. Ensure that existing sensors are programmed and functional.
2. **Update** timer control schedules to match the official hours of building operation. To save more energy, set timers to turn lights off, and allow occupants to turn lights on manually.

3. **Walk** through the building(s) and site to determine which areas are best suited for automatic lighting controls.
4. **Determine** which type of control is most appropriate for each identified space.
5. **Ensure** that the RSO has approved proposed lighting modifications and is satisfied with the desired control for security.
6. **Consult** facilities staff to determine whether the new controls can be selected and installed by post staff, or whether an engineer is needed to integrate new controls into the existing lighting control systems.
7. **Determine** if an OBO permit is required for design, design review, funding, permitting, management, installation, or Cx.
8. **Educate** occupants about automated lighting controls operation to discourage manual override or disabling of controls that are unpredictable or unsatisfactory.

Figure 4: Sample lighting control components

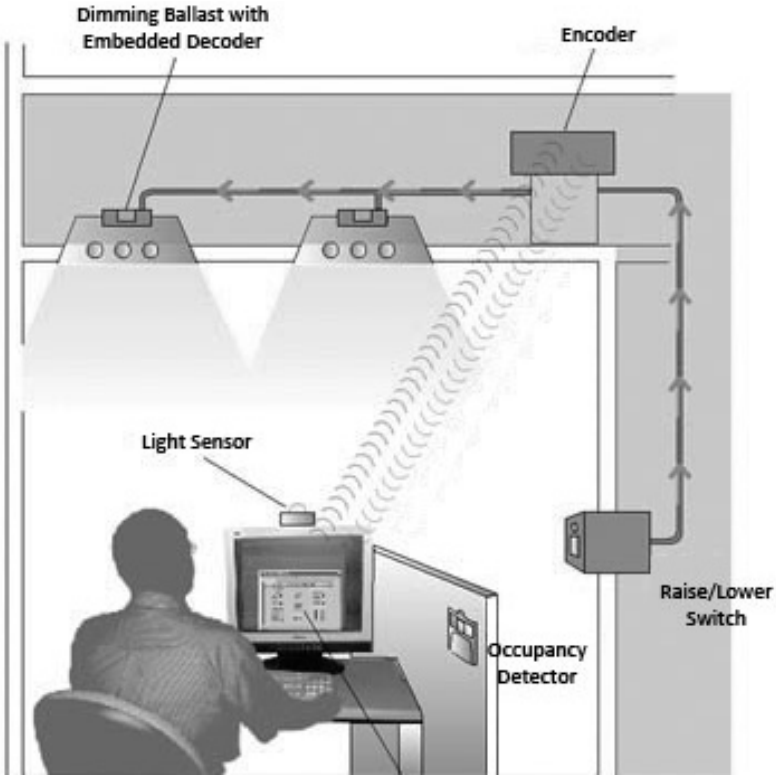


Image Source: Lawrence Berkeley National Laboratory

Site Lighting

Benefit ★★☆☆	Helps preserve dark skies and reduces excess energy used for lighting
Time 🕐🕐🕐🕐	One month to review lighting security issues and assess current site lighting, one month to revise controls of current fixtures not related to security, and six months to select and install new fixtures, where feasible
Investment $ $ $ $	Purchase and installation of new fixture, lamps, shields, and photocell sensors, if required
Team Members	**FM** | RSO, OBO

Energy required to power site lighting contributes to GHG emissions (see Energy: Introduction). Additional potential problems associated with outdoor lighting include sky glow that interferes with astronomy, disrupts natural sleep patterns that affect human health, and disrupts the nocturnal patterns of many species.

Light pollution is defined as light that escapes from a property upwards into the night sky or onto adjacent properties. Light spill, or trespass, may occur due to the type and location of site lighting fixtures, or may result from interior lighting that remains on during nighttime hours.

LED site lighting is approved for post use by Diplomatic Security. LED lamps can reduce energy use for exterior lighting by more than 50% from conventional high-pressure sodium lights,[8] and lengthen the replacement period for fixtures and lamps, thereby reducing maintenance costs.

Site lighting improvements include efficient fixtures and lamps, controls, downlighting, and cut-off shields. OBO has site-specific security requirements for site lighting, which may impact the applicability of certain lighting strategies. Consult OBO for site lighting guidelines and requirements.

Practical Application

1. **Discuss** site-specific security lighting issues and concerns with the RSO. Identify any lighting zones with fixtures that must be unshielded for security purposes or have defined lumen (lm) requirements (i.e. require light measurement).

2. **Review** the audit results to identify any fixtures that have unnecessarily high wattage, are manually controlled, are decorative lighting fixtures that remain on throughout the night, or currently emit light upwards at any angle (more than 90 degrees from straight down).
3. **Retrofit** site lighting with LED fixtures where possible, after consultation with OBO.
4. **Install** photo sensors or time-clock controls on non-security site lighting.
5. **Determine** whether any fixtures emit light past the property boundary during a night assessment, if not already determined during the audit. Retrofit lamps to meet OBO design criteria for downlighting and light trespass.
6. **Talk** with the FM to determine how interior lighting is controlled and how to ensure that non-security lights are turned off when the building is unoccupied to avoid unnecessary light spillage (see Energy: Automatic Lighting Controls).

Figure 5: U.S. Embassy N'Djamena site lighting plan

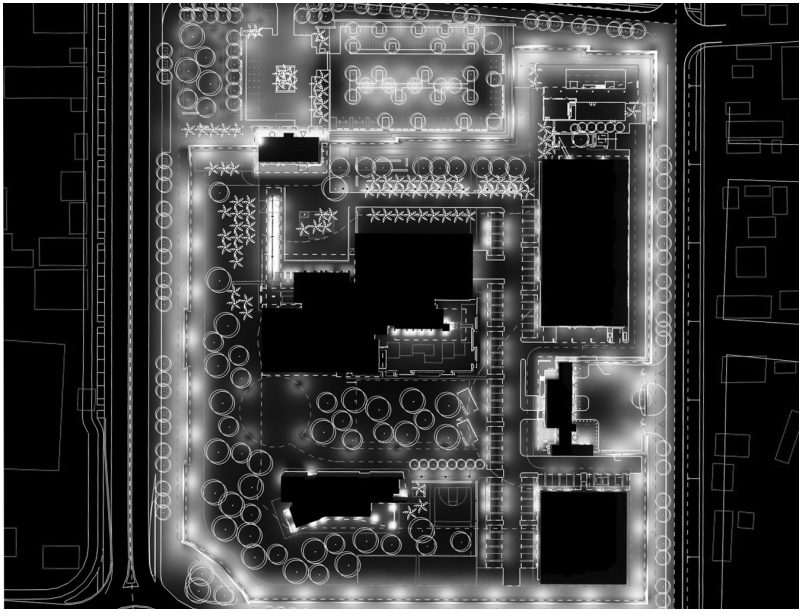


Image Source: Moore Ruble Yudell

Lighting Equipment and Lamps

Benefit ★★★☆	Reduces lighting energy use while maintaining appropriate light levels and improving visual acuity
Time 🕐🕐🕐🕐	One to six months for lamp and ballast replacement and six to 18 months for fixture replacement (may be completed in a series of stages); best implemented during regular re-ballasting or re-lamping, or concurrently with controls improvements
Investment $ $ $ $	Replacement lamps or ballasts and high-efficiency light fixtures
Team Members	**FM** | GSO, FMO, OBO

The first step to an efficient lighting system is to ensure light levels are appropriate for the tasks performed in the space. According to the Illuminating Engineering Society (IES) recommendations, general lighting levels in an office should be 25 to 35 footcandles (fc) (269-377 lux), with task lighting delivering upward of 50-60 fc (538-646 lux). Hand-held light meters are useful for evaluating existing lighting levels.

The second step is to deliver the necessary light using efficient equipment. Daylight is the highest quality and most energy efficient light source. Electric lighting should be used as a supplement to natural daylight where necessary to achieve the recommended light levels (see Energy: Daylighting).

As of 2014, per EISA, incandescent light bulbs may no longer be sold in the U.S.. Replacing one 100 watt (W) incandescent lamp with a 23 W compact fluorescent lamp (CFL) has little effect on human vision, but saves nearly $27 of electricity per year in a typical office with an electric rate of $0.08 per kilowatt-hour (kWh).

Replacement of inefficient lamps and ballasts can have a significant effect on energy consumption. Incandescent and halogen lamps are easy to replace with CFLs and LEDs, both of which are available in standard bulb base sizes and often do not require any change to the light fixture. Wherever possible and cost-effective, give preference to LED lamps, as they save more energy, do not contain mercury, last longer, and can provide more pleasing color resolution.

Table 3: Benefits of using LED lighting

	LED	Fluorescent	Incandescent
Life span (how long can the bulb last?)	60,000 hours	10,000 hours	1,200 hours
W per bulb (wattage equivalent at 60 W)	6	14	60
Cost per bulb	$15.98	$2.98	$1.25
kWh of electricity used over 60,000 hours	360	850	3,600
Electricity cost (@ $0.20 per kWh)	$72.00	$168.00	$720.00
Bulbs needed for 60,000 hours of usage	1	6	50
Equivalent 60,000 hour bulb expense	$15.98	$17.88	$62.50
Total for 60,000 hours	$87.98	$185.88	$782.50
Energy savings per 60,000 hours, assuming 30 bulbs at $0.20 per kWh:			
Total cost for 30 bulbs	$2,639	$5,576	$23,475
Savings by switching from incandescent	$20,836	$17,899	0

Data Source: U.S. Department of Energy

Beyond phasing out all incandescent bulbs, aging linear fluorescent lighting systems are also prime candidates for upgrades. Low-wattage 28W T-8 lamps fit into the same fixtures as standard 32W T-8 and 40W T-12 lamps, but reduce energy consumption by 12-30%. Electronic ballasts are interchangeable with inefficient magnetic ballasts, eliminate flicker, and reduce energy use by 10% or more.[10]

For all lamp and ballast replacements, implement the following best practices:

- Select dimmable lamps for fixtures that are located near windows or that have multi-purpose tasks requiring different amounts of light.
- Do not install instant-start lamps in fixtures that are controlled by occupancy sensors, as rapid on-off cycling reduces lamp life.
- Energize linear fluorescent lamps for 100 hours at full intensity before dimming.

- Match color temperature and color rendering index of new lamps to existing lamps, to avoid noticeable mismatch between fixtures.
- Group re-lamp rather than spot re-lamp, for color consistency and ease of maintenance, whenever possible.

Consumers can choose from a variety of energy-efficient lamps

Image Source: Dennis Schroeder, NREL 19469

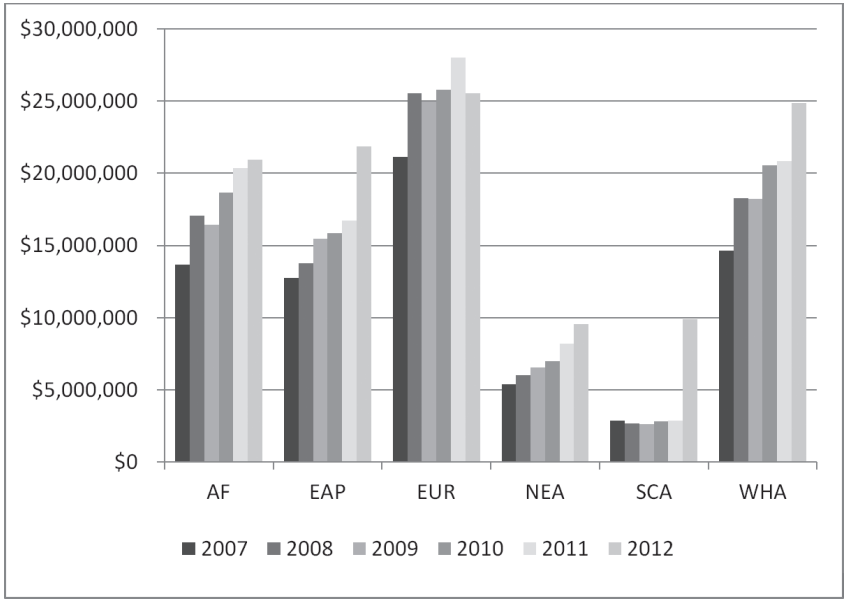
Lighting equipment changes are likely to affect lighting quality, so it is important to consider impacts on light levels, contrast ratio, color index, and glare. Consult a lighting engineer to evaluate light level and quality before embarking on any significant retrofit projects.

Practical Application

1. **Review** the energy audit report to identify recommendations for no- and low-cost lighting improvements.
2. **Walk** through building(s) to identify inefficient equipment, such as incandescent lamps and exit signs, as well as halogen accent lighting. Also look for spaces with lighting quality issues, such as inappropriate light levels, glare, flicker, and high contrast.
3. **Replace** incandescent lamps with screw-in LED lamps or CFLs.
4. **Replace** T-12 lamps and aging T-8 lamps with reduced-wattage T-8 and T-5 lamps, after verifying socket compatibility.
5. **Replace** magnetic ballasts with electronic ballasts. Select program-start or rapid-start electronic ballasts rather than instant-start ballasts, which limit control opportunities.
6. **Replace** or retrofit incandescent and fluorescent exit signs with LED.
7. **Use** a handheld light meter to identify spaces with illumination significantly above or below recommended levels. If a light meter is not available, talk with building occupants to identify spaces with light levels that are uncomfortably dim or overlit.

8. **Provide** an adjustable LED task light in underlit areas that require supplemental or specific task lighting, such as at desks, under cabinets, over equipment, or over kitchen countertops.
9. **Consider** removing one or more lamps per fixture, where the ballasts allow, to reduce energy use in overlit spaces where lighting equipment is in good condition and reasonably efficient, such as T-8 or T-5 lamps (see 🕮 Resources: Delamping for Energy Savings).
10. **Engage** OBO for design, financing, and permitting assistance with a full lighting system retrofit for spaces with lighting quality issues, and for lighting systems older than eight years.

Figure 6: Global Financial Management System Electricity Costs by Region



Data Source: Bureau of Overseas Buildings Operations

Case Study: Lighting Retrofitting

Helsinki, Finland

Benefit ★★★☆	$60,000 projected net savings over ten years
Time 🕐🕐🕐🕐	Three to six months
Investment $$$$	$46,348 for LED lamps, fixtures, and labor

U.S. Embassy Helsinki's Malmi warehouse was retrofitted with LED light fixtures in 2011. Serving as post's primary warehouse, Malmi is a 4,000 m^2 (43,000 ft^2) facility that houses storage and mail processing, and serves as a staging area for construction projects.

U.S. Ambassador Oreck demonstrates the lack of a lamp shatter field on old fixtures

Image Source: League of Green Embassies

Prior to retrofit, the facility used high-pressure mercury vapor lamps. Mercury vapor lamps have low efficacy (55 lumens per watt (lm/W)), short lives (three years), and long warm-up periods that prevent them from being turned off throughout the day when warehouses are unoccupied. These lamps also pose a safety risk, as they occasionally shatter due to operation under high pressure or at high temperatures.

The new LED fixtures have improved efficiency (92 lm/W), a longer life (10 years or more), and can be equipped with motion sensor controls to dim or turn off lights during periods of low or no occupancy. The cost of the LED fixtures was comparable to replacing mercury vapor fixtures with shatter shields, but both operating cost and maintenance cost are significantly reduced. Annual savings are expected to range from $9,700 to $11,300.

Although Finland has a very low electricity rate, payback is anticipated to occur in fewer than five years. For locations with higher energy rates, the payback for this type of lighting retrofit may be as low as two years.

Daylighting

Benefit ★★☆☆	Increases workplace satisfaction and reduces lighting energy consumption by taking advantage of natural daylight
Time 🕐🕐🕐🕐	One week to evaluate daylight availability on an overcast day, six to 12 months to plan and implement space reorganization, and three to 12 months to evaluate, design, and install daylighting devices
Investment $$$$	Workspace reconfiguration (moving or replacing furniture, telephone, and data system modifications); engineering support for daylight simulation analysis; and daylighting devices, such as window blinds, light shelves, or site shading devices
Team Members	**FM** | FMO, GSO, CLO, OBO

The human eye's preferred source of illumination is natural daylight. Maximizing interior use of natural daylight reduces demand for artificial lighting, which benefits occupants' experience within a building, and reduces electricity costs for lighting power and any cooling required to offset the heat gain from the lighting fixtures. Work spaces and community spaces can be organized to take advantage of or reduce daylight as appropriate.

According to research compiled by Carnegie Mellon University, effective daylighting yields an average productivity improvement of over 5% in addition to providing energy savings.[9]

New facilities use exterior building shading devices to maximize the penetration of daylight in office buildings. Light shelves—light-reflecting overhangs with high-reflectance upper surfaces that are placed above eye level to enable daylight to penetrate into buildings—can also be used (see Figure 7). With thoughtful consideration and daylight design simulation, these techniques can be implemented in existing facilities as well.

Daylight harvesting controls can enable posts to take maximum advantage of available natural light and reduce electric lighting use (see Energy: Automatic Lighting Controls).

Practical Application

1. **Survey** post building(s) to identify spaces where daylighting makes sense. On an overcast day, turn off the ambient (ceiling) lights in each space and with meters, and objectively, determine whether there is enough light from windows and skylights to perform the types of tasks that typically occur in the space (see Energy: Lighting Equipment and Lamps).
2. **Consider** moving enclosed offices to the building's interior and open office areas to the perimeter, to maximize daylight penetration. Contact OBO for design input, review, and permitting, as required.
3. **Reconfigure** open office workstations to support effective daylighting. Lower tall and opaque workstation components, such as overhead cabinets, or orient perpendicular to the window wall(s) to maximize daylight penetration into the space.
4. **Contact** OBO to engage an engineer to perform a daylight simulation to determine whether the space would benefit from the installation of light shelves, external building shades, or daylight harvesting controls.
5. **Analyze** the cost and benefit of installing manual or automatic window blinds or shades to reduce solar gain and provide glare control.
6. **Educate** occupants about how daylighting systems work. Consider a user's manual that can be shared with staff and used to orient posts' new employees.

Figure 7: Building section, showing components of a well daylit space

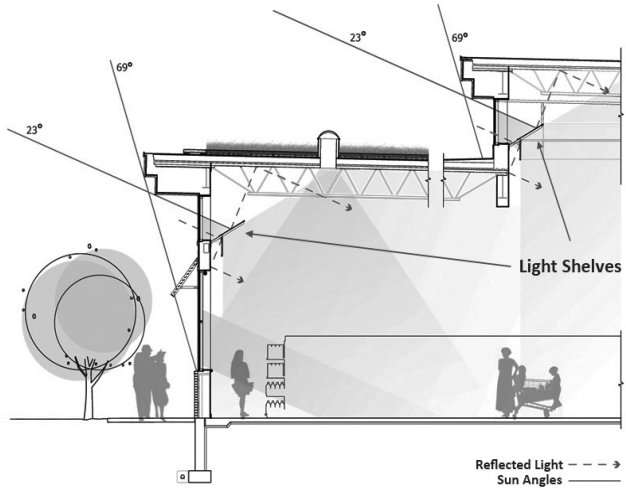


Image Source: U.S. Department of Energy

Computers and Office Equipment

Benefit ★★★☆	Reduces energy consumption of office equipment, thereby reducing cooling energy from HVAC systems, both of which contribute to lower utility consumption and associated costs
Time 🕒🕒🕒🕒	One to four weeks for power management adjustments and technology survey, six to 12 months for acquisition and implementation of equipment, and one to four weeks for occupant education
Investment $$$$	Power management software, advanced power supplies, laptops or thin-client computer hardware, and occupant education training and materials
Team Members	**IMO** | GSO, FM, CLO

In this era of IT, the global economy shift from paper to digital information requires greater computer capacity and server storage. Highly conditioned server rooms primarily contain electronic equipment used for data processing and communications networking, essential to the functioning of business, communications, academic, and governmental systems. Individual computers also consume significant energy and are often left on unnecessarily. The Department deployed a 'Night Watchman' program at all posts to automatically turn off computers at night. Since March 2012, this program has realized $2.5 million in power savings, earning the Department recognition as "one of 15 Superstars of Sustainable IT," and the only federal agency named, in *InfoWorld*.[11]

Activating stand-by or hibernate features can save $50 or more per computer per year.[12]

A thin-client solution can further reduce energy consumption from 60W to 6W per desk by supporting only a monitor, keyboard, and mouse at the individual workstation, with no central processing unit (CPU). Thin-clients convey input and output between user and remote server, where all processing activities occur. In contrast, a fat-client or traditional desktop PC does local processing and passes only data for communications and storage

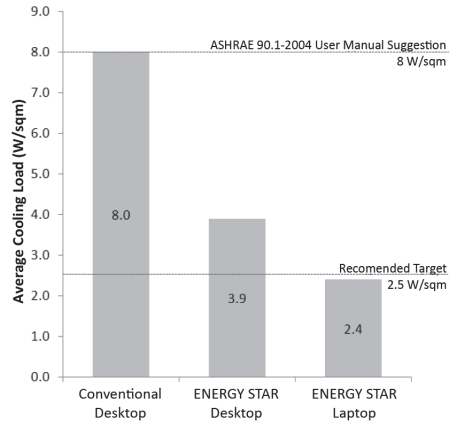
to the server. Many thin-client devices run only web browsers or remote desktop software, but recent models give users the same look and feel as a PC. Thin-client solutions also minimize IT maintenance for hardware and software upgrades, application deployment, security, and data backup.

Inkjet printers, copiers, and multi-function devices use substantially less energy than laser technologies and have a lower overall life-cycle environmental impact.[13] Additionally, ink-jet printing devices also have a lower impact on IAQ. Inkjet devices are most appropriate for low-to-moderate printing volumes and where print quality is more important than print speed (see Indoor Environment: Pollution Prevention).

Practical Application

1. **Activate** power management settings on computers, printers, and photocopiers to place equipment into 'sleep' mode after a period of inactivity.
   - Contact IMO to determine whether power management settings can be set remotely across the entire network, and to confirm that the Department's 'Night Watchman' program has been implemented.
   - Notify and educate occupants about power management settings.
2. **Install** smart power supplies equipped with occupancy sensors at each workstation.
3. **Identify** high-power devices, such as individual printers and aging equipment, and replace as budget allows.
4. **Eliminate** individual printers and consolidate printing to central office printers or multifunction devices.
5. **Replace** energy-intensive equipment with low-power alternatives and select new equipment that meets the most recent Energy Star® specifications.
6. **Explore** thin-client alternatives for computing.
   - Ensure that IMO has received authorization and leads this process.
   - Educate staff about energy savings achievable by thin-client technology.

Figure 8: Reducing office cooling load



Data Source: U.S. Environmental Protection Agency

Thermal Solar Water Heating

Benefit ★★☆☆	Reduces use of fossil fuels, thereby reducing utility expenses and increasing post energy independence and security
Time 🕐🕐🕐🕐	Six to 12 months for design and procurement and one to two months for installation and testing
Investment $ $ $ $	Engineering services, solar thermal modules, substructure and mounting system for modules (roof-mount or ground-mount), and balance of systems (e.g., pumps, valves, piping, tanks)
Team Members	**FM** | FMO, GSO, OBO

Thermal solar water heating systems collect radiation from the sun to heat water with no fuel cost or GHG emissions, and with low operation and maintenance cost. A solar water heating system includes solar thermal collector panels and storage tanks.

Two types of thermal solar water heating systems are available:

- **Active systems** constantly recirculate water or heat-transfer fluid (used in colder climates) in an indirect circulation system.
- **Passive systems** do not circulate fluid and offer three different technology options: flat-plate (such as those used for swimming pools), integral collectors (such as those used for any pre-heat tank system), and evacuated tubes. Evacuated tube collectors can produce near-boiling temperatures and are particularly effective for kitchen applications, which require higher-temperature water for sanitization.

Figure 9: The components of a solar thermal system

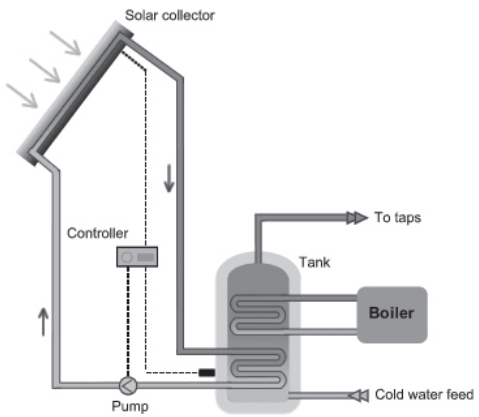


Image Source: www.uksolarenergy.org.uk

These technologies are quickly and easily implemented and are most suitable for residential and commercial laundry and kitchen applications, where hot water demand is high.

Thermal solar hot water technology works in most climates—not just in hot, sunny locations—to achieve cost-effective results.

To determine the potential for using thermal solar water heating at posts:

- Look online for solar insolation maps (see 🕮 Resources: Climate Consultant), which show the average daily solar radiation a location is likely to receive, depending on the time of year. Note that solar thermal water heating is most cost-effective on sites with an average daily solar insolation of 4.5 kWh/m^2.
- Consider that sites with lower solar insolation but high costs for conventional water heating (more than $0.02 per thousand British thermal units (BTUs) are good candidates). Sites with lower solar insolation but high avoided energy costs are also good candidates: this includes sites with electricity rates over $0.034/kWh, with poor access to natural gas, or with aging boilers.

Consider the following when identifying locations for solar thermal modules:

- **Space:** Ensure there is adequate ground or roof space for solar thermal modules.
- **Solar access:** Look for flat or tilted areas that receive little or no shading from adjacent structures and landscaping. Select south-facing surfaces in the northern hemisphere and north-facing surfaces in the southern hemisphere. Near the equator, horizontal surfaces work best.
- **Security:** Consult security personnel to confirm that location of and access to solar systems are not in conflict with security criteria.
- **Use adjacency:** Look for available surfaces nearest the most significant or concentrated uses of hot water as identified above.
- **Installation:** Identify areas that are already tilted toward the sun or that are off the ground, such as rooftops.
- **Maintenance:** Consider areas with easy access for maintenance personnel for cleaning and repair. In addition to optimizing solar harvest, tilting panels also reduces required cleaning frequency.

Payback for thermal solar water systems can be as short as one year, depending on local energy costs. Implementing simple and inexpensive strategies to reduce heat loss and wasted hot water prior to sizing a solar water heating system can help minimize the payback period.

Practical Application

1. **Review** audit reports for water and energy systems performance, backcheck against TREES reported data, and implement conservation measures that reduce hot water demand, such as insulating hot water pipes and tanks, adding aerators to faucets, and upgrading to low-flow showerheads.
2. **Identify** primary uses of hot water at post, and engage facilities management staff to obtain quantities of hot water used.
3. **Explore** availability of solar resources at post.
4. **Determine** potential locations for solar thermal modules in conjunction with RSO.
5. **Work** with OBO to determine life-cycle cost, design, installation, and Cx of the solar thermal system.
6. **Develop** a written system maintenance plan for facility operators to use. Identify cleaning and testing procedures and frequency, as well as resources for future repair and replacement.

At U.S. Embassy Antananarivo, roof-mounted solar thermal panels are used to heat post's swimming pool

Image Source: U.S. Embassy Antananarivo

Photovoltaics

Benefit ★ ★ ★ ★	Reduces dependency on off-site energy for electricity and annual utility expenses
Time 🕒 🕒 🕒 🕒	Six to 12 months for design and three to six months for installation and testing
Investment $ $ $ $	Engineering services, photovoltaic (PV) modules, substructure and mounting system for modules, and balance of system (e.g. wires, controllers, disconnects, and inverters)
Team Members	**OBO** | FM, GSO, FMO

On-site power generation increases security through energy independence and control of the power source. A PV system generates on-site power from solar energy with no fuel cost or GHG emissions. If a PV system produces more electricity than the facility needs, surplus power can be sent or sold back to the grid provider through 'net metering,' and some utilities may provide green power incentives for PV installations, or reduce electricity rates for facilities with PV systems. PV systems are typically modular, and installation can be phased.

There are three common types of PV installations:

- **Battery systems** charge direct current (DC) batteries, which are available for use during day or night, but have high maintenance needs.
- **Grid-connected systems** connect directly to the facility power system and supplement the base power source (utility or generator).
- **Simple feed systems** connect directly to the facility power system and are designed to operate independently of the electric utility. Only grid-connected or simple-feed systems have been installed or planned for Department facilities overseas to date.

OBO completed a preliminary PV feasibility analysis to develop an evaluation list, which ranked posts on the basis of payback period according to OBO's understanding of post electricity costs and solar opportunities. Note, however, that short payback ECMs combined with longer payback projects such as PVs may result in acceptable payback periods.

To determine the potential for installing PV systems at posts:

- Look online for solar insolation maps (see 🕮 Resources: Climate Consultant). Note that PV systems are most cost-effective on sites with an average daily solar insolation of at least 4.5 kWh/m^2.
- Also consider that sites with lower solar insolation but electricity rates higher than $0.24/kWh are also good candidates.
- Contact OBO to determine whether posts are in high priority locations according to OBO's PV Evaluation list.

Consider the following when identifying locations for PV modules (see Energy: Thermal Solar Water Heating):

- PV panels can be located on building roofs or walls or as free-standing, ground-mounted arrays that may also serve to provide solar shading for windows, walkways, and parking areas.
- Non-chancery rooftops are preferred, due to restrictions for maintenance access.
- Installing panels with at least 10% tilt can reduce maintenance and cleaning costs.
- Installing thin-film cells on curved or irregularly shaped surfaces greatly increases installed cost, thus reducing payback potential.

PV installation of 251 kW array at U.S. Embassy Kigali

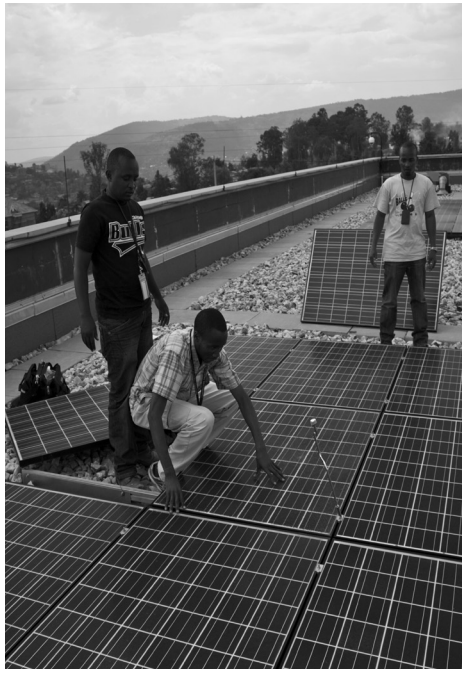


Image Source: David Shaffer, OBO

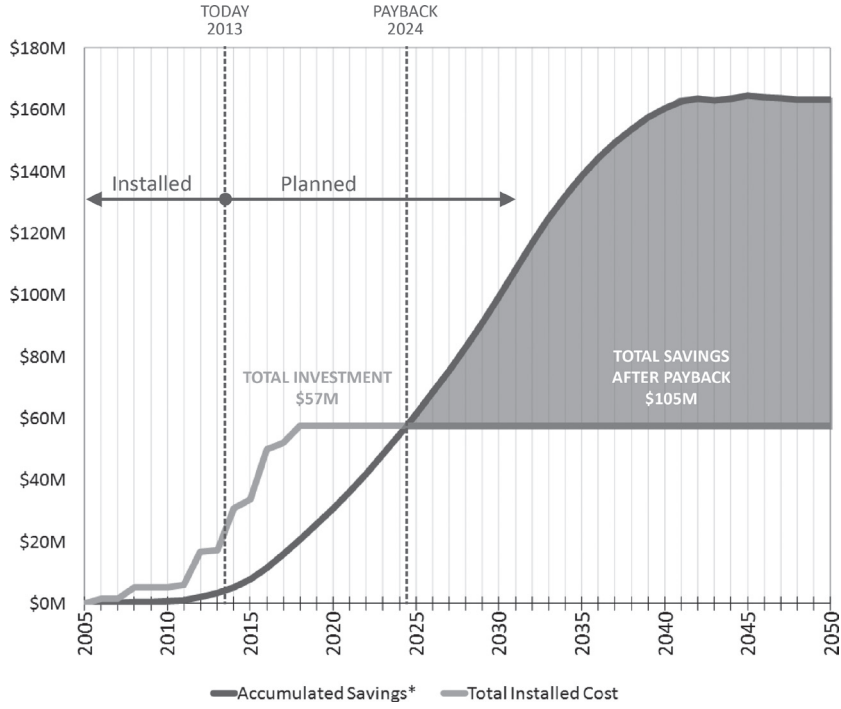
Practical Application

1. **Implement** ECMs to reduce electricity demand before selecting or sizing a PV system.
   - Review the energy audit report, backcheck against TREES data, and implement recommended no- and low-cost savings measures.

- Consider implementing other strategies in this chapter before PV (see Energy: Re-/Retro-Commissioning, Electrical Demand Management, Automatic Lighting Controls, Lighting Equipment and Lamps, and Computers and Office Equipment).

2. **Consult** OBO for feasibility of solar power.
3. **Explore** availability of solar resources at post.
4. **Determine** appropriate locations for PV modules.
5. **Work** with OBO to determine life-cycle cost, design, installation, and Cx of the PV system.
6. **Develop** a written system maintenance plan for facility operators to use. Identify cleaning and testing procedures and frequency, as well as resources for future repair and replacement.

Figure 10: Projected lifetime savings of Department PV installations overseas



Data Source: Bureau of Overseas Buildings Operations

Table 4: Completed and in-progress post PV installations

PV projects	kW
Completed	**Total = 1,635**
Abuja	100
Athens	100
Bujumbura	300
Dakar	307
Geneva	119
Kigali	251
Lisbon	36
Monrovia	183
Monterrey	237
In Construction	**Total = 2,621**
Abuja	290
Cotonou	200
Managua	958
Mbabane	220
Nouakchott	129
Port Moresby	100
Santo Domingo	456
Valletta	250
Vientiane	18
In Design	**Total = 2,030**
Istanbul	350
Bangkok	100
Djibouti	360
Juba	500
N'Djamena	445
New Delhi	175
Taipei	100

U.S. Embassy Abuja

U.S. Embassy Bujumbura

U.S. Consulate Monterrey

Data and Images Source: U.S. Department of State

Wind Power

Benefit ★ ★ ★ ★	Reduces GHG emissions associated with fossil fuel consumption and increases energy independence and security
Time 🕒 🕒 🕒 🕒	One year to record wind data for a specific location, six to 12 months for design, and six months for installation
Investment $ $ $ $	Engineering services, wind turbine and tower, and balance of system (switches, relays, meters, wiring, controllers)
Team Members	**FM** | FMO, GSO, OBO

As with other renewable energy generation sources, wind can contribute to power independence for post, increasing energy security and reducing costs and GHG emissions. Use of on-site wind to generate power has proven to have beneficial financial payback, depending on utility and fuel costs and wind speeds. Wind energy has been used as a supplement to prime power sources (on-site power generation) and as a strategy to reduce electrical use during peak load conditions. Low maintenance requirements make wind turbines attractive and minimally impactful to operations budgets.

OBO has deployed its two Sonic Detection and Ranging (SODAR) systems at posts in Managua, Istanbul, Nouakchott, and Curacao. The devices log wind data to assess viability of wind power in a specific location.

There are two primary types of wind turbines:

- **Horizontal axis turbines** are most common and most efficient. These have two or three blades that must point perpendicular to the wind, and rotate around a horizontal rotor shaft at the top of a tower. The electrical generator is located at the top of the tower.
- **Vertical axis turbines** have a vertical rotor shaft. These turbines need not face into the wind, which is advantageous on sites with variable wind direction. The generator can be located at ground level for ease of maintenance. However, vertical axis turbines are 15-25% less efficient than horizontal-axis turbines.

OBO produced a comprehensive study to evaluate wind-generated electrical power as a renewable resource for posts around the world (see 🕮 Resources: Wind Generated Electrical Power*)*. This study evaluated available wind generation technologies; provided an analysis with multiple screening criteria; and contained additional information such as wind maps, product evaluations, LCCA, and turbine manufacturer product data. OBO uses the wind-ranking criteria score to review the wind resource potential of specific locations.

The OBO study evaluated three turbine sizes: small (<10 kW), medium (15-60 kW), and large (100-250 kW) for general feasibility and life-cycle cost. While large turbines were the most cost effective, the small and medium turbines proved to be a more reasonable scale solution for mission facilities. Final turbine selection depends on utility rates, land availability, height, permitting restrictions, and available wind speeds.

Figure 11: Wind turbine sound comparison

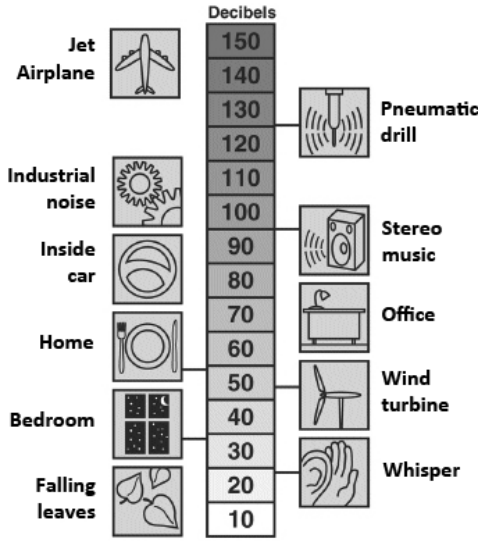


Image Source: Ontario Ministry of Agriculture and Food

Although wind systems have relatively low environmental impact compared to fossil fuel power plants, there is some concern about turbine noise and effects on bird populations. See Figure 11 for comparison of wind turbines to noise level. To minimize noise pollution and ensure safety, provide a 'topple zone' equal to the height of the turbine. Wind energy projects should not be located in areas with a high incidence of fog and mist, frequent severe weather events, or where birds and bats are known or suspected to reside during breeding, nesting, maternity, hibernating, or overwintering periods.[15]

Practical Application

1. **Review** OBO's wind turbine feasibility checklist to determine whether wind is an appropriate energy source for post (see Table 5).
   - Consult locally available wind data from airports, meteorological associations, or websites.

- Higher unobstructed elevations are better candidates for wind power.

2. **Contact** local authorities to confirm whether wind turbines are allowed, and if so, identify the permitting process for erecting a turbine.
3. **Contact** OBO to start the process to measure wind speed and direction with a SODAR system. Collect data for one year.
4. **Review** at least one year of electricity bills to determine post's typical consumption patterns to inform the wind system design.
5. **Work** with OBO and local contractors to determine the best location, type, and size for the turbine, given specific site conditions, to estimate the investment cost for the proposed wind power system, and to determine requirements for its design, installation, and Cx.
6. **Develop** a written system maintenance plan for facility operators to use. Identify cleaning and testing procedures and frequency, as well as resources for future repair and replacement.

Table 5: Wind turbine feasibility checklist

Wind Turbine Criteria	Feasibility
Wind Resource	The annual wind speed should be above 5.5 m/s annually.
Electrical Rate	The electric rate should be above $0.15/kWh.
Area	Turbine requires a clear circular zone with a radius equal to the tower height.
Obstacles	The turbine hub should be located 10 m above any obstacle within 90 m. The turbine should be located in a high location, not in a depression. Ideally, the turbine should be located on the windward side of a hill or gradient.

Data Source: Bureau of Overseas Buildings Operations

Staff Engagement

Benefit ★ ★ ★ ★	Instills energy efficiency as a fundamental value and motivates building occupants to adopt energy-conserving behaviors and habits
Time	One to two months to customize education materials, install signage, and implement regularly scheduled short training sessions
Investment $ $ $ $	Preparation and printing of training materials and signage
Team Members	**Post Green Team**

Buildings with the same function and located in the same climate can demonstrate very different energy performance. A significant factor contributing to the discrepancy is occupant behavior. Office occupants who intentionally adopt conservation-oriented behaviors can save up to half a typical building's energy consumption, while wasteful occupants can almost double energy consumption.[16]

According to the U.S. Green Building Council, inefficient occupant behavior may account for more than half of a building's total energy consumption.

The following key occupant behaviors can drive the transformation of post's energy use. They are all simple and easily adopted actions that can be implemented by staff at all levels.

- Avoid unnecessary plug loads, such as space heaters, personal coffee makers or appliances, radios, battery chargers, or individual printers. Establish and enforce policies regarding these types of auxiliary equipment.
- Place computer monitors, printers, and other office equipment in sleep mode, or turn off at night.
- Turn out lights when leaving a room, even if vacancy sensors are present.
- Keep blinds or curtains drawn during hot, sunny days, and open them during sunny parts of cold days.
- Make sure floor or wall vents are not blocked by furniture or other obstructions.

- Encourage staff to dress in layers to allow individual control and flexibility in personal thermal comfort.

Practical Application

1. **Review** general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Building occupants are often unaware of their individual impact on a facility's energy use. The Post Green Team can raise awareness by providing education sessions that make connections between building energy use and specific occupant behaviors. Occupant education should include information about specific energy-related goals, as well as tips on how occupants can gain by contributing to energy conservation efforts (e.g., through improved comfort and well-being).
   - Occupants may lack some skills necessary to reduce energy use. The Post Green Team can respond by offering training sessions that teach occupants such skills as how to use computer energy management settings; how to maintain comfort without using personal heaters; how to use building controls, such as thermostats, lighting controls, and window shades; and how to communicate problems, such as cracked or poorly insulated walls, ceilings, doors or windows. Professional development training with a focus on energy conservation is also useful for operations staff, provided that it is commensurate with their advanced technical knowledge and skill.
3. **Implement** structural components.
   - Perform day and night walk-throughs to identify users who demonstrate energy-saving behaviors. Consider public recognition for specific achievements, or placing placards or other rewards in appreciation for valuable efforts.
   - Send prompts and reminders electronically or install in strategic locations, such as on light switch covers.
   - Display awards, such as the Energy Star® plaque, prominently in the building.
   - Collect energy consumption information and create monthly report cards that help occupants to understand progress toward annual reduction targets and the results of their actions, and to encourage friendly competition between groups (e.g., buildings, floors, or departments) to further reduce energy use.

Resources

📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.htm#energy*

Endnotes

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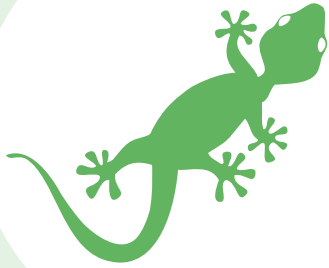
MATERIALS



With the bond on a single toe, the **gecko** can support its entire body. Biomimicry scientists continue to study the microscopic hairs (setae) of the **gecko's** toes to improve their developing model for the first dry, self-cleaning adhesive.

During construction of the U.S. Consulate Dubai, 75% of waste generated was diverted from landfills and incinerators. This savings was achieved by separating cardboard, plastic, wood, and metal scraps for the recycling hauler to remove prior to having the other materials taken away.

Image Source: U.S. Department of State

MATERIALS

MATERIALS

Federal Performance Goals

Solid Waste:

- Diversion of 50% of non-hazardous solid waste generated by the construction, demolition, and operation of federal facilities from landfills by 2015 per Executive Order (EO) 13514

Procurement:

- 95% of new contract actions, task orders, and delivery orders for products and services meeting the Environmentally Preferable Purchasing (EPP) standards per EO 13514

Chapter Overview

Earth's three billion urban residents generate 1.2 kilograms (kg) (2.6 pounds (lb)) of municipal solid waste per person per day, 3.5 trillion kg (7.8 trillion lb) in total, or the equivalent weight of more than 10 Empire State Buildings. It is estimated that, by 2025, the urban population may likely increase to 4.3 billion urban residents, each generating approximately 1.4 kg (3.1 lb) per person per day.[1] Solid waste is generally considered an urban issue, and is expected to become more problematic as the number of urban residents rises, particularly in developing countries. Thus, as global urbanization expands and economies strengthen, solid waste management may become increasingly important.

Table 1 illustrates the percentage of solid waste generated by each region of the world, with countries in the Organization for Economic Cooperation and Development (OECD), East Asia and Pacific, Europe and Central Asia, and Latin America and the Caribbean projected to have the greatest per capita generation rates of solid waste by 2025.[2] Posts located in regions with high per capita solid waste production should consider all materials strategies as a top priority. Posts that work with a host country to support or develop recycling programs demonstrate eco-diplomacy and can make a quantifiable positive environmental impact.

Table 1: Worldwide solid waste generation

Region	Current Available Data			Projections for 2025			
	Total Urban Population (millions)	Urban Waste Generation		Projected Population		Projected Urban Waste	
		Per Capita (kg/capita/day)	Total (tons/day)	Total Population (millions)	Urban Population (millions)	Per Capita (kg/capita/day)	Total (tons/day)
Sub-Saharan Africa	260	0.70	169,119	1,152	518	0.85	441,840
East Asia and Pacific	777	1.00	738,958	2,124	1,229	1.50	1,865,379
Europe and Central Asia	227	1.10	254,389	339	239	1.50	354,810
Latin America and Caribbean	399	1.10	437,545	681	466	1.60	728,392
Middle East and North Africa	162	1.10	173,545	379	257	1.43	369,320
OECD	729	2.20	1,566,286	1,031	842	2.10	1,742,417
South Asia	426	0.50	192,410	1,938	734	0.77	567,545
Total	2,980	1.20	3,532,252	7,644	4,285	1.40	6,069,703

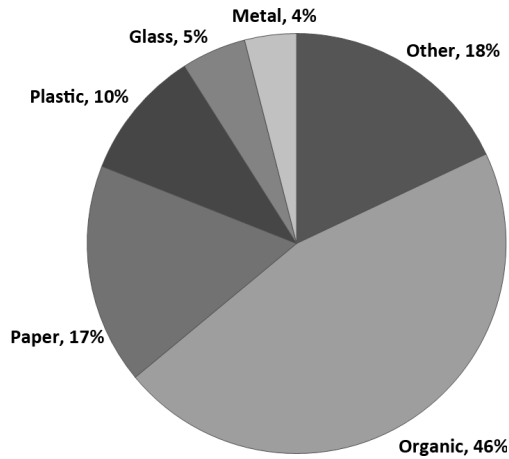
Data Source: The World Bank

Materials Profile

Globally, the largest contributor to solid waste is organic waste (Figure 1). Recyclable paper and plastic represent more than a quarter of all waste;[3] however, a disproportionate quantity of plastic contributes to ocean pollution. Between 60–80% of oceanic pollution is composed of plastic waste,[4] which is the primary contributor to the Great Pacific Garbage Patch.[5] This garbage patch is a massive ocean area approximately the size of Texas, polluted with partially decomposed plastic from around the world, with devastating effects on marine animals. Posts can have a positive global environmental impact through reducing purchases of Styrofoam™, bottled water, and other disposable plastic products.

According to the U.S. Environmental Protection Agency (EPA), in typical office buildings, paper and recyclable paper products account for almost 90% of all waste. Posts can make a

Figure 1: Estimated global waste stream composition



Data Source: The World Bank

substantial net positive impact by providing composting for organic materials, and recycling for paper and plastic, after first implementing resource consumption reduction strategies. For large posts or for posts located in well-developed regions, nearly 100% of the waste stream can be diverted from landfills through careful planning, management, and tracking provided under a comprehensive waste and diversion program.

Considerations

A successful sustainable materials plan encompasses all life-cycle stages of resource consumption, including environmentally-conscious purchasing, resource reuse and reduction, and responsible waste disposal or diversion.

Figure 2: The major stages in a material's life-cycle

Image Source: U.S. Environmental Protection Agency

All strategies should be incorporated into policy documents for facility operations and renovations, and the policies should be communicated to post personnel. Each post should perform an audit to determine particular waste stream composition at its facilities and review current purchasing standards to identify EPP opportunities. Results of these assessments can allow post to

establish a materials-focused plan that include the elements outlined in each of the individual strategies.

The most effective sequence for managing waste and reducing resource consumption is as follows:

1. **Green purchasing**: Implement and follow an EPP policy for new purchases. Consider product characteristics such as recycled content, compostability, reusability, and non-toxic material content, as well as locally-sourced products. The procurement of low-impact products and materials is especially critical for posts where municipal or third-party waste diversion is lacking.
2. **Source reduction and reuse:** Implement operational strategies to decrease consumption and reduce waste and product purchasing quantities. Source reduction includes reusing products and materials, extending the lifespan of products, and avoiding the downstream impacts of new purchases. Source reduction strategies are most important at posts that lack municipal or third-party waste disposal infrastructure; sending even low-level hazardous materials, such as AAA batteries, to a landfill can affect the local population, animals, and plants.
3. **Disposal management:** Once the quantity of generated waste has been reduced, ensure responsible disposal of the remaining waste stream, particularly construction demolition waste and hazardous waste, such as mercury-containing lamps or electronics. Where municipal or third-party recycling systems are available, posts may further increase their waste diversion. Investigate opportunities for on-site and off-site composting.

Strategy Selection Factors

Consider the following characteristics in order to prioritize materials-focused strategies:

- **Waste recycling availability:** If municipal or third-party waste recycling is available, ensure that as much recyclable material as possible is diverted from the landfill.
- **Presence of a cafeteria or more than 100 full-time equivalent (FTE) staff:** These posts likely have a large amount of organic and office product waste, which can be attractive sources for local vendors. Through a site separation strategy, posts can provide clean volumes of waste that make recycling easier and less costly to implement, facilitating the development of a recycling market in host countries.

- **Plans for construction or upgrades within three years:** Renovations or facility system or electronic upgrades create a significant volume of construction waste quickly, often dwarfing annual waste from non-demolition sources. Special consideration should be given to sustainable purchasing of new materials and their packaging, as well as responsible diversion of demolition materials.

Priority Selection Criteria	Waste recycling availability	Presence of a cafeteria or more than 100 FTE staff	Plans for construction or upgrades within three years
Audit	All posts		
Resource Reduction and Reuse	●	●	
Green Purchasing	●	●	
Recycling and Composting	●	●	
Hazardous Waste Disposal	●	●	●
Staff Engagement	All posts		

Case Study: Plastic Recycling

Yerevan, Armenia

In Yerevan, the municipal solid waste collection and disposal service does not yet sort or treat waste. Wastewater and pollutants are discharged directly into rivers, and polyethylene terephthalate (PET) plastic is one of the main pollutants in the country's rivers. It is estimated that 4.5 million kg (5,000 tons) of PET bottle waste are generated each year in Armenia.[6]

To address this problem at a local level, the Green Embassy Committee (GEC) of U.S. Embassy Yerevan initiated plastic recycling on campus. GEC negotiated with a local plastic recycler in Armenia, Eco-Engineering, to set up a plastic recycling program at the Embassy.

4.5 million kg (5,000 tons) of used PET plastic bottles are generated annually in Armenia

Image Source: United Nations Development Programme

Success of the U.S. Embassy Yerevan recycling program led the GEC to encourage Eco-Engineering, United Nations Development Programme, and the U.S. Agency for International Development to work together on a national pilot recycling collection program in local communities. The national program works with small-to-medium enterprises to organize, advertise, and implement a plastic collection system. The private plastic recycling company advises and assists them with purchasing equipment necessary to process the plastic for reuse in Armenia. These efforts have resulted in approximately 2.7 million kg (3,000 tons) of PET waste now recycled annually.

Strategies

Strategy	Benefit	Time	Investment
Audit	★★☆☆	🕐🕐🕐🕐	$ $ $ $
Resource Reduction and Reuse	★★★☆	🕐🕐🕐🕐	$ $ $ $
Green Purchasing	★★★☆	🕐🕐🕐🕐	$ $ $ $
Recycling and Composting	★★★☆	🕐🕐🕐🕐	$ $ $ $
Hazardous Waste Disposal	★★★☆	🕐🕐🕐🕐	$ $ $ $
Staff Engagement	★★★★	🕐🕐🕐🕐	$ $ $ $

Recycling crushed rubble from the Haiti earthquake

Image Source: U.S. Embassy Port-au-Prince

Audit

Benefit ★★☆☆	Provides baseline information about post's materials purchasing, consumption, and waste to inform conservation efforts
Time 🕐🕐🕐🕐	Two weeks to plan audit, one month to perform audit, and two weeks to write report
Investment $ $ $ $	Gloves, bags, and tarps for waste auditing
Team Members	**FM** | Post Green Team, CLO

The Department encourages posts to focus on both the inflow and outflow of resources, by implementing environmentally-friendly procurement policies and reducing landfill-bound waste. Conducting audits of current purchasing activities and waste stream contents is critical for identifying opportunities to reduce post's materials-related environmental footprints and achieve operational savings.

Consider items in categories that align with major activities, such as:

- **Kitchen and food services:** disposable cups, plates and utensils, food waste and compost, plastic wrap, bottles, and cans
- **Paper products:** newspaper, printer paper, folders, and cardboard
- **Office supplies:** printer cartridges, packaging, binders, pens, and markers
- **Electronics:** computers, batteries, keyboards, light bulbs, printers, and cameras
- **Facilities maintenance and cleaning:** paper towels, toilet paper, cleaning supplies, and plastic bags
- **Renovations:** carpeting, lights, furniture, drywall, and paint

U.S. Embassy Beijing's Post Green Team has implemented resource and materials programs that have reduced chemicals in cleaning supplies by 60%, reduced waste by 15% through an expanded recycling program, and eliminated 14,000 plastic bags per year by switching to reusable bags.[7]

During waste audits, materials are separated into groups by material type rather than by use; these might include paper, glass, plastic, cardboard, metals, food waste, electronics, hazardous waste, and demolition waste (see 🕮 Resources: How to Perform a Waste Audit).

Posts should determine whether conservation strategies for procurement, resource use, and disposal are already in place, and which would be appropriate to implement, as discussed later in this chapter.

Practical Application

1. **Work** with the chief procurement officer to evaluate purchasing policies and practices.
2. **Familiarize** staff with the Department's EPP policy, participate in the annual Federal Green Challenge for Waste or Purchasing, and join programs such as EPA's WasteWise (see 🕮 Resources: Federal Green Challenge).
3. **Review** the most commonly purchased categories of materials to assess the status of the EPP program. Review and document existing resource conservation strategies and compliance with federal performance goals.
4. **Assign** teams to conduct a one-day or week-long audits of post's waste streams to establish building waste baselines. Sort and measure total waste by volume or weight within each category. Follow EPA or Natural Resources Defense Council (NRDC) guidelines for the audit, and use logging spreadsheets.
5. **Research** local recycling or composting programs, and determine the availability of local, environmentally-preferable products and services.
6. **Identify** opportunities for reduction in each procurement and waste category.
7. **Prepare** a summary report outlining the findings of the reviews and audits, and listing no- and low-cost measures.

OBO conducts a recycling audit with U.S. Embassy Kathmandu

Image Source: Bureau of Overseas Buildings Operations

Resource Reduction and Reuse

Benefit ★★★☆	Decreases consumption and reduces waste and product purchasing quantities through implementation of operational strategies
Time	One to two months for development and implementation of a basic policy for resource consumption
Investment $ $ $ $	Reusable materials such as shopping bags, mugs, and utensils
Team Members	**FM** | Post Green Team

Source reduction is at the top of the EPA's hierarchy of waste reduction techniques, because it lessens all impacts of the material life-cycle, including production, sourcing, use, recycling, and waste disposal. Reuse ranks second on EPA's hierarchy, because reused materials do not become waste or produce environmental impacts associated with recycling processes. Posts should prioritize reduction and reuse strategies above recycling, which diverts waste from landfills and incinerators and reduces the need for virgin materials, but requires energy, money, and other resources.[8]

Save a paper cup a day for 40 years and you can save 40 trees, 18 days of energy to power your house, and 816 kg (1,800 lbs) of wood.[9]

No- and low-cost strategies may include setting printers to default to double-sided printing; using rechargeable batteries; refilling used whiteboard markers and printer cartridges; or providing or requiring reusable rather than disposable bags, coffee mugs, and utensils.

Procurement policies can reduce source consumption and increase reuse, by encouraging the purchase of recycled and reusable products (see Materials: Green Purchasing). Integrated sustainable building operations plans can help posts meet resource conservation goals, improve occupant health, and reduce operational costs.

Practical Application

1. **Appoint** a 'resource reduction champion' to manage the program and coordinate with GSO and other post procurement staff.
2. **Review** the recommendations outlined in the materials audit to identify and implement any no- or low-cost strategies for reducing resource consumption.
3. **Evaluate** additional opportunities for reducing consumption in categories such as kitchen and food services, paper products, other office supplies, electronics, facilities maintenance, renovation and construction, or other areas relevant to post. Prepare a list of proposed reduction and reuse best practices in each category.

U.S. Ambassador Wharton and U.S. Embassy Harare staff separate waste into groups by material type

Image Source: U.S. Embassy Harare

4. **Create** a brief policy and procedure document that includes proposed best practices and implementation plans for resource reduction and reuse. Include this in the overall resource management plan.
5. **Develop** a plan for engaging and educating post staff to implement best practices (see Materials: Staff Engagement).

Green Purchasing

Benefit ★★★☆	Reduces costs, consumption, and disposal quantities and improves environmental and occupant health
Time 🕐🕐🕑🕑	Two to three months to develop and implement an EPP program
Investment $ $ $ $	May be some cost rebalancing i.e., more expensive materials purchased less frequently, or eliminating bottled water
Team Members	**GSO** | Post Green Team

Materials selection plays a significant role in sustainable building operations because of the environmental and health consequences associated with a material's life-cycle, including extraction, processing, transportation, use, and disposal (See Figure 2). These activities can pollute water, land, and air; destroy native habitats; and deplete natural resources.

The environmental burden of the harvesting, manufacturing, consuming, and disposing of materials varies by material type. To reduce environmental impacts related to operations, maintenance, upgrades, and renovations of buildings, consider alternative materials, and develop an EPP.

EPP policies reduce material impacts by ensuring that materials and supplies have sustainable attributes. An effective EPP policy prioritizes materials that are locally sourced, reusable, compostable, recycled, recyclable, salvageable or refurbishable, rapidly renewable, non-toxic, have minimal packaging, have a manufacturer take-back program, or have low embodied energy (total amount of energy consumed from extraction through final use).

Procurement personnel should aim to identify EPP alternatives for post's most commonly purchased items, such as the following examples:

- **General office operations:** recycled paper (at least 30% post-consumer content per EO 13514) and refillable printer cartridges.
- **Hazardous or electronic products:** non-incandescent, low-mercury content, or light-emitting diode (LED) lamps; rechargeable batteries; Energy Star®-rated electronic products; and electronics from manufacturers with take-back programs.
- **Food services:** reusable mugs and serviceware, tap water to replace bottled water, compostable paper plates, and bulk coffee purchasing.

- **Cleaning and maintenance:** phosphate-free dish detergents, recycled paper towels, non-toxic pest management (see Site: Integrated Pest Management), and green cleaning supplies (see Indoor Environment: Green Cleaning).

Environmentally-friendly products are readily available worldwide, particularly from larger mass market retailers. The single largest-volume office supply used in most offices is paper; look for high post-consumer recycled content but not less than 30%. Food and drink present an opportunity to have a positive environmental impact through reducing disposable packaging and containers for products that abound in lunchrooms, cafeterias, meeting rooms, offices, and workstations. Posts should ensure that recycling facilities exist before purchasing aluminum cans and plastic bottles that can otherwise end up in a landfill.

Table 2: EPA's Guiding Principles for EPP

Guiding Principle	Key Concept
Price Environment Performance	Environmental considerations should be part of normal purchasing practice, consistent with such traditional factors as product safety, price, performance, and availability.
Pollution Prevention	Consideration of environmental preferability should begin early in the acquisition process and be rooted in the ethic of pollution prevention, which strives to eliminate or reduce, up-front, potential risks to human health and the environment.
Life-Cycle Perspective/ Multiple Attributes	A product or service's environmental preferability is a function of multiple attributes from a life-cycle perspective.
Comparison of Environmental Impacts	Determining environmental preferability might involve comparing environmental impacts. Federal agencies should compare reversibility and geographic scale of environmental impacts, degrees of difference among competing products or services, and overriding importance of protecting human health.
Environmental Performance Information	Comprehensive, accurate, and meaningful information about the environmental performance of products or services, such as embodied energy or water, is necessary in order to determine environmental preferability.

Data Source: U.S. Environmental Protection Agency

Table 3: Ecological Priority Impacts Matrix

Scale	Irreversibility		
	Years	**Decades**	**Centuries/ Indefinite**
Local/ Regional	Erosion Conventional Pollutants	Habitat Loss	Toxins from Solid Waste
National	Hazardous Air Pollutants Chemical Releases	Bioaccumulative Pollutants	Species Loss
Global		Desertification Oceanic Pollution	Loss of Biodiversity Ozone-Depleting Chemicals Global Warming

Data Sources: Adapted from U.S. Environmental Protection Agency

Practical Application

1. **Review** the recommendations outlined in post's materials audits.
2. **Implement** resource reuse and reduction strategies to reduce purchasing quantities prior to initiating procurement policy changes (see Materials: Resource Reduction and Reuse).
3. **Review** EPA's *Green Purchasing Guides for Federal Purchasers,* EPP information and tools, and OBO's standard purchasing specifications.
4. **Work** with the chief procurement officer or requisitioning personnel from the Department to determine EPP alternatives for the most commonly purchased items.
5. **Create** spreadsheets to evaluate options by cost, practicality, alignment with EO 13514 and other standards, and environmental benefit, based on post's location and program availability. For example, compostable plates made of starch or sugar cane are best practice when composting is available.
6. **Prepare** lists of recommended changes to post's current practices.

Recycling and Composting

Benefit ★★★☆	Eliminates hazardous materials from landfills
Time 🕐🕐🕑🕑	Three to six months to coordinate waste management programs
Investment $ $ $ $	Engagement of private recycling companies and dedicated storage bins/areas
Team Members	**GSO** | FM, Post Green Team

Recycling and composting are becoming mainstream practices; however, not all posts take full advantage of municipal or third-party recycling systems, and others do not have these services available. Posts that actively engage with their host country can support or help establish a market for materials and demonstrate the viability of a recycling industry, which reduces waste and creates jobs.

Waste management programs for ongoing consumables should consider disposal of paper, glass, plastic, cardboard, metals, and food waste (for additional considerations for electronics, batteries, mercury-containing lamps, and demolition debris, see Materials: Hazardous Waste Disposal). For facilities renovations or retrofits, follow OBO's construction demolition waste management program, implement environmentally responsible demolition waste disposal, identify potential recycling opportunities, and perform on-site waste stream separation of materials to allow for recycling or reuse.

90% of all office waste consists of recyclable paper or paperboard products.[10]

To implement a recycling program for common materials, posts should:

- Identify whether municipal or private recycling infrastructure is available nearby, and for what materials. Consider opportunities for donating certain types of materials to community organizations or local residents.
- Establish dedicated, clearly marked areas within post where recyclables can be separated and held until they are picked up. Work with contractors to investigate off-site storage, if on-site space is unavailable.

- Work with the custodial staff to implement no- and low-cost recycling initiatives, such as providing staff with individual recycling bins and increasing the number or size of recycling bins in common areas.
- Determine opportunities for on-site or off-site composting by reviewing local regulations, and identifying any site considerations for restrictions. If composting is viable, install kitchen food waste bins for compostable materials, with instructions for acceptable food waste materials.
- Provide centralized collection bins for yard waste, located away from buildings to prevent pest problems.
- Create an education and communication plan to ensure that post staff is aware of recycling and composting options.

Practical Application

1. **Undertake** no- and low-cost resource use reduction strategies prior to implementing major waste diversion programs.
2. **Read** the recommendations listed in the waste audit report for each major type of waste.
3. **Meet** with custodial staff to discuss current waste collection and disposal methods.
4. **Determine** whether recycling and compost facilities exist locally or can be developed on-site, and implement recycling and compost programs.
5. **Create** a waste disposal policy for each applicable type of waste, and include these in post's overall resource management plans. Set a recycling goal for each of the major waste streams, based on practicality of implementing the program, and track recycled materials to measure progress against these goals.
6. **Develop** a plan for engaging and educating post staff to implement responsible disposal practices (see Materials: Staff Engagement).

The People's Garden at U.S. Embassy Prague provides fresh produce and educational opportunities for composting techniques and rainwater capture

Image Source: U.S. Embassy Prague

Case Study: Upcycling

Banjul, The Gambia

Benefit	Demonstrates eco-diplomacy and reduces municipal waste
Time	Ongoing program management
Investment	Source separation storage areas
Team Members	**Post Green Team**

To reduce landfill and incineration waste, U.S. Embassy Banjul's Green Committee began a recycling and reuse program for newspapers, shredded paper, magazines, plastic bags, glass bottles and jars, and aluminum cans. They found an opportunity to fulfill their mission of eco-diplomacy by creating partnerships with local community members to upcycle, including:

- The Paper Recycling Project, a local non-governmental organization, which mixes paper with sawdust and compresses it into bricks that are sold as fuel to local businesses. Magazines are converted into products of higher value, or upcycled, to make beads for necklaces and bracelets, and plastic bags are woven into various types of reusable bags.
- The Association of Small Scale Enterprises in Tourism (ASSET), which advocates for Gambian businesses, such as craft market vendors, tourist taxi drivers, official tourist guides, juice pressers, and fruit sellers, as well as a number of small hotels and ground tour operators. Bottles, jars, and cans are delivered monthly to ASSET, which uses them as containers to sell local honey, jam, oil, and wine. The cans are also upcycled into jewelry and bicycle safety reflector strips.

Between these two partnerships, U.S. Embassy Banjul recycles, upcycles, or reuses 3,200 newspapers, 2,600 plastic bags, 100 bags of shredded paper, and 360 magazines every year.

Fuel brick made from recycled magazines

Image Source: Paper Recycling Skills Project

Hazardous Waste Disposal

Benefit ★★★☆	Lowers disposal fees, eliminates hazardous materials from landfills, and reduces impact of landfill wastes
Time 🕐🕐🕑🕑	Three to six months to coordinate hazardous waste management programs
Investment $ $ $ $	Engagement of private hazardous recycling companies and dedicated storage bins and areas, if available on property
Team Members	**GSO** | FM, Post Green Team

EPA has designated some widely-generated hazardous wastes—including certain batteries, pesticides, mercury-containing equipment, and lamps—as 'universal wastes'. 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.

When considering disposal alternatives for electronics and other hazardous waste, security of data is of utmost importance for all posts and compliance with disposal regulations is required. Discuss security requirements for recycling with your RSO and IMO prior to undertaking any disposal activities.

Standard fluorescent lamps are used for 90% of lighted commercial floor space in the United States.[11] These and other mercury-containing lamps used in buildings include compact fluorescent lamps (CFLs) and high-intensity discharge (HID) sources. The small yet significant amount of mercury in these lamps allows for high energy efficiency and long life, compared to other lighting options. As there is

Figure 3: Percentage of Americans adults who own a cell phone

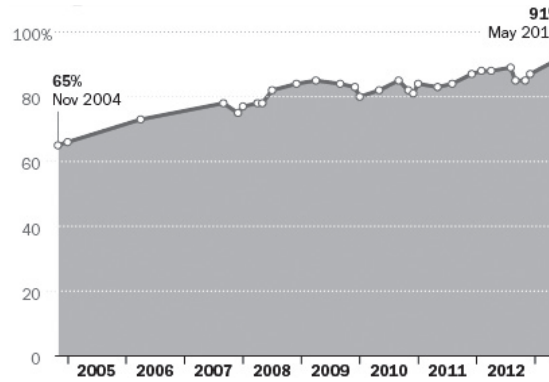


Image Source: Pew Research Center

no known method for completely eliminating mercury in fluorescent lights while maintaining energy efficiency, posts should aim to purchase lower mercury content lamps, as defined by the EPA and the National Electrical Manufacturers Association (NEMA), or inverter LED light sources where viable.

Another source of toxins commonly found in buildings comes from batteries, which contain heavy metals, such as mercury, lead, cadmium, and nickel. If disposed of improperly, these metals can lead to pollution of land and waterways. Battery recycling programs are gaining understanding and participation across the globe. Posts can support this important best practice.

Typical types of batteries include:

- **Alkaline and carbon zinc (9-volt (V), D, C, AA, and AAA).** Alkaline batteries are everyday household batteries used in flashlights, remote controls, and other appliances.
- **Silver-oxide and zinc-air (button).** These are often used in small electrical devices such as calculators or watches.
- **Lithium (9-V, C, AA, coin, button, and rechargeable).** These are appropriate for small electronics, such as smoke detectors or clocks.

Recycling one million laptops can save enough energy to power 3,657 U.S. homes for one year.[12]

Computers are made up of more than 1,000 different materials, many of which are highly harmful, such as toxic metals, biologically active materials, acids, plastic, plastic additives, and, in some cases, lead. However, many parts of computers, cell phones, and other electronic equipment are recyclable, and consist of rare, valuable, and expensive materials.

There are several activities that can be undertaken as part of establishing a hazardous waste collection and recycling program:

- Confirm data security requirements with your IMO and RSO.
- Determine whether battery or lamp recycling programs are available through a local utility or qualified private provider.
- Provide clearly marked battery collection bins and lamp storage areas.
- Investigate and implement opportunities for recycling or local reuse programs for computers, printers, cell phones, and other electronic equipment.

Practical Application

1. **Review** the recommendations listed in the waste audit report to determine priorities for hazardous waste collection and safe disposal.
2. **Meet** with custodial staff to discuss current waste collection and disposal methods.
3. **Establish** battery, mercury, and e-waste collection and recycling programs, as appropriate.
4. **Create** a waste disposal policy for each applicable type of hazardous waste, and include in post's overall resource management plan.
   - Set a reduction goal for landfill diversion for each major hazardous waste stream, based on practicality of implementing the program, and measure progress against goal.
5. **Develop** a plan for engaging and educating post staff to participate in responsible disposal practices (see Materials: Staff Engagement).

U.S. Embassy Canberra ensures all fluorescent tubes are properly recycled

Image Source: U.S. Embassy Canberra

Staff Engagement

Benefit ★ ★ ★ ★	Instills resource stewardship as a fundamental value, and motivates building occupants to adopt resource conservation behaviors and habits
Time	One to two months to develop education materials and install signage; regularly scheduled short training sessions
Investment $ $ $ $	Preparation and printing of training materials and signage
Team Members	**Post Green Team** | PAO

The following key occupant behaviors can change the way that post staff interacts with materials, both at work and at home. The behaviors are all simple and easily adoptable actions that can be implemented by post staff at all levels and throughout all departments.

Principal Officer Sundwall, Consulate employees, and third graders celebrate Earth Day 2010 in the Azores

Image Source: U.S. Consulate Ponta Delgada

Encourage post personnel to:

- Consider biodegradable products as an alternative to washable products where water is scarce.
- Use reusable fabric shopping tote bags.
- Separate recyclable items, such as paper, glass, metals, and cardboard, as well as hazardous items such as batteries, electronics, and light bulbs, in appropriate collection bins.

- Purchase EPP products such as local, lightly packaged, or recycled content products.
- Print less and, when printing is necessary, use double-sided mode and the smallest acceptable font, to reduce document length.

Practical Application

1. **Review** general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Provide regular education sessions to raise awareness of international, national, and local challenges related to materials use and disposal. Include topics such as hazardous waste, plastic recycling, and buying local and organic.
   - Provide skills training to procurement staff so that they may more easily identify environmentally- and socially-preferable products.
3. **Create** social involvement opportunities.
   - Organize a local collection event or a special activity to celebrate America Recycles Day each November 15.
   - Plan a field trip to the local recycling facility.
   - Encourage friendly waste reduction competition between small groups. Publish results internally and reward the winners with prizes that reinforce responsible materials use, such as shopping bags.
   - Work with PAO, perhaps in partnership with local organizations, to organize periodic events such as e-waste or paper shredding parties, where post personnel can bring personal electronics or documents that they cannot properly dispose of at home.
4. **Implement** structural components.
   - Include sustainable criteria in procurement policies.
   - Install clear signage on recycling containers.
   - Locate printers away from occupants to reduce ease of access, which leads to unnecessary ‘convenience’ printing.
   - Establish relationships with location organizations to pick up used items donated by post staff, or set up a ‘freecycling’ room at post, where staff members can trade items that they no longer want or use for items that they need.
   - Create a community outreach plan that informs local citizens of post’s sustainable procurement and waste management processes.

Resources

📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.htm#materials*

Endnotes

1 *What a Waste: A Global Review of Solid Waste Management.* The World Bank. *http://go.worldbank.org/BCQEP0TMO0*

2 *Ibid.*

3 *Ibid.*

4 *Marine Debris in the North Pacific.* EPA. *http://www.epa.gov/region9/marine-debris/pdf/MarineDebris-NPacFinalAprvd.pdf*

5 *De-mystifying the Great Pacific Garbage Patch.* National Oceanic and Atmospheric Administration. *http://marinedebris.noaa.gov/info/patch.html*

6 Eco-Engineering. *http://www.ecoengineering.am*

7 The League. *http://www.leagueofgreenembassies.org/?p=700*

8 *Leadership in Energy and Environmental Design (LEED®) for Existing Buildings Reference Guide.* U.S. Green Building Council. *http://www.usgbc.org*

9 *Why Reuse a Cup?* EcoLife Brands. *http://www.factorydirectpromos.com/why-reuse-a-cup*

10 *Paper Recycling: Schools and Offices.* EPA. *http://www.epa.gov/wastes/conserve/materials/paper/setting/schoolwork.htm*

11 *Fluorescent Lamps and the Environment.* NEMA. *http://www.nema.org/Standards/Pages/Fluorescent-Lamps-and-the-Environment.aspx*

12 *General Information on E-Waste.* EPA. *http://www.epa.gov/epawaste/conserve/materials/ecycling/faq.htm#impact*

INDOOR ENVIRONMENT

On hot days, **honeybees** collect water to cool their hives. Foraging **honeybees** distribute water throughout the hive and in egg-containing cells, and fan the water through rapid wing-beating to accelerate the evaporative cooling effect.

The interior design for the new U.S. Embassy in Berlin 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.

Image Source: Werner Huth

INDOOR ENVIRONMENT

INDOOR ENVIRONMENT

Federal Performance Goals

- Prohibit smoking within all federal facilities and in outdoor areas adjacent to air intakes per Executive Order (EO) 13058
- For renovation and new construction projects, meet the current version of American National Standards Institute (ANSI)/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62.1; Ventilation for Acceptable Indoor Air Quality per 15 FAM 954; and the current version of ANSI/ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy

Chapter Overview

According to the U.S. Environmental Protection Agency (EPA), Americans spend an average of 90% of their time indoors.[1] Therefore, indoor environmental quality (IEQ) has a significant impact on occupant health, productivity, and well-being. The indoor environment is the result of dynamic interactions between climate, site conditions, building systems, and activities conducted in the building, and encompasses indoor air quality (IAQ), thermal comfort, acoustic well-being, ergonomics, visual quality, and connection to nature through principles of biophilia.

Currently, 80% of the world's population lives in locations that exceed the World Health Organization (WHO) recommended level of ten micrograms per cubic meter ($\mu g/m^3$) of air for this type of pollution.[2]

Poor IAQ poses a health risk for up to half the world's population.[3] Indoor air pollution originates from both outdoor and indoor sources. Outdoor air pollutants enter buildings through doors and windows, ventilation systems, cracks in structures, and foundation penetrations. Exposure to outdoor air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments.[4] Figure 1 illustrates annual fine particulate air pollution around the world. Posts

located in regions with high pollution levels should take extra precautions to prevent migration of outdoor air pollution to indoor environments.

Figure 1: Annual means for fine particulate matter ($PM_{2.5}$) in selected cities (2009)*

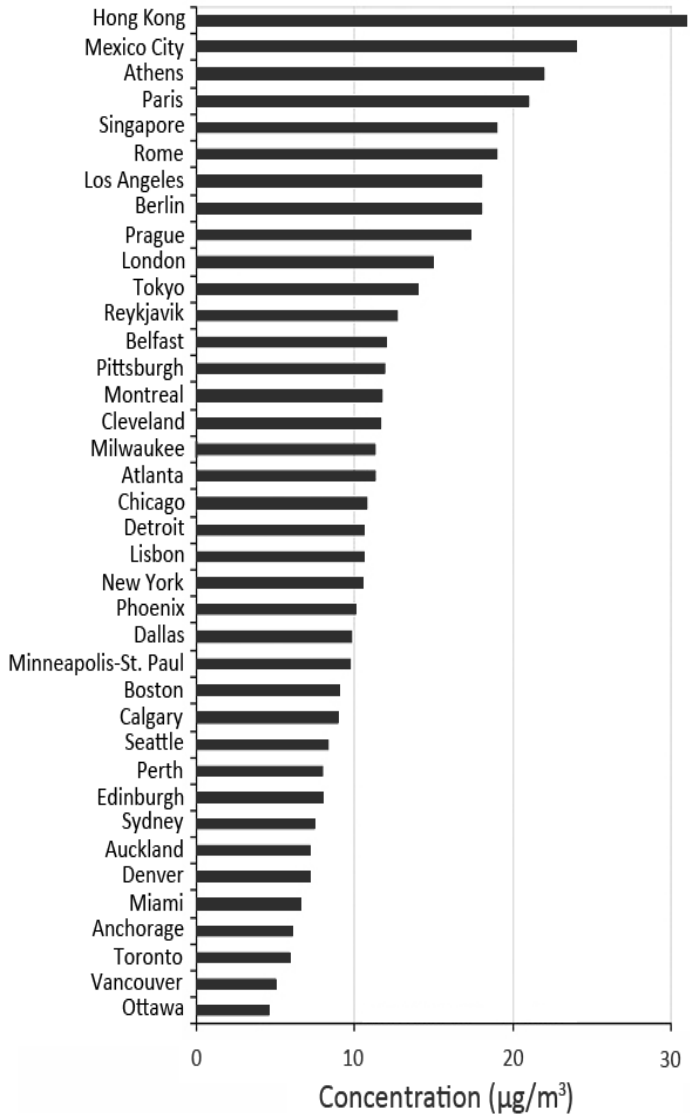
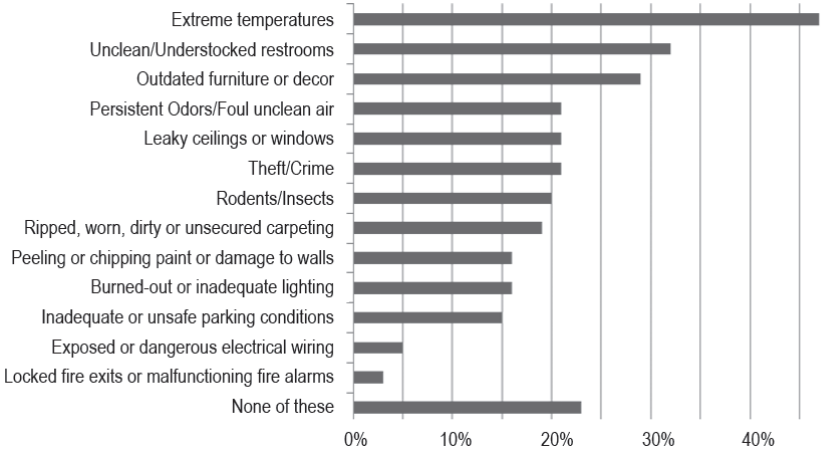


Image Source: Environment Protection Authority South Australia
*see Indoor Environment: Air Quality for information on air quality in Beijing

Indoor sources of pollution include combustion sources; cleaning chemicals; biological contaminants, such as mold; and chemical emissions (off-gassing) from building materials, finishes, and furnishings. In many developing countries where coal and biomass are the principal fuel sources, open fires and poorly-functioning stoves are the primary sources of indoor air pollution, particularly in residences.[5]

Providing and maintaining high IEQ is an important component of eco-diplomacy. In developing countries, U.S. standards for IAQ can be demonstrated to host countries grappling with the balance between development and impact on population health and safety. For example, providing designated smoking areas away from buildings and selecting the appropriate heating, ventilating, and air conditioning (HVAC) system filters based on local air quality are two best practices that could be shared.

Figure 2: Common IEQ problems observed at U.S. office buildings



Data Source: Blumberg Office Properties, 2008

Indoor Environment Profile

The indoor environment impacts the health and productivity of individuals working within a facility. Sick building syndrome and Legionnaire's disease first generated headlines in the 1970s and 1980s, but outbreaks and problems continue in buildings around the world. The advent of building-related illnesses was due to a convergence of changes in the building industry: increased off-gassing 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. OBO's construction standards have incorporated strategies and requirements to prevent these problems.

When one considers salaries, benefits, and general health of personnel, the cost of operating a facility is a mere fraction of the cost of the overall mission. Therefore, health and productivity become major factors in decisions that affect the indoor environment. Even a very small improvement in productivity can result in significant cost savings to a mission's operations.

Surveys indicate that the top office complaints from U.S. workers all relate to IEQ: temperature, cleanliness, air quality, leaks, moisture, and lighting.[6,7] Because these complaints factor into the overall productivity and satisfaction of staff, IEQ improvements to address these issues are a worthwhile investment.

Buildings that are designed to accommodate changing future uses and are operated and maintained well are likely to avoid IEQ problems. In contrast, suboptimal IEQ can result in buildings where closets become offices or where water damage to building materials is chronic.

U.S. Embassy Sofia includes biophilic art in its public spaces to promote occupant well-being

Image Source: U.S. Department of State

Considerations

Posts should first assess the overall IEQ of their facilities with an audit. An audit assists in evaluating whether facilities are designed, maintained, and operated in a manner that supports the health and comfort of occupants.

Following the audit, the most effective sequence for pursuing high IEQ is as follows:

1. **Contaminant reduction:** Identify significant contributors to indoor contamination. No- to low-cost options include fixing leaky pipes, replacing moldy ceiling tiles, locating outdoor smoking areas to best prevent smoke migration, adding walk-off mats at building entries, replacing old HVAC filters, and relocating high-volume copiers and janitorial supplies away from occupants.
2. **Comfort improvements:** Improving HVAC system operational efficiencies and ensuring the proper amount of outside air is being used contributes to more satisfactory space conditions. Additionally, providing staff with adjustable thermal controls and ergonomic workstation furniture can increase physical and acoustic comfort.
3. **Low-emission materials:** Develop a policy to ensure that future purchasing includes non-toxic, environmentally-friendly building materials, finishes, cleaning supplies, and equipment.

Strategy Selection Factors

After the Post Green Team has compiled occupant feedback and evaluated system and space conditions, the team can assess post's unique characteristics.

Consider the following factors to determine which strategies are most applicable for your post:

- **High volume of occupant complaints:** For posts with a high number of occupant complaints, there is likely an opportunity to increase productivity by examining space conditions, percentage of fresh air, and workspace characteristics.
- **Age of building > 15 years:** Aging buildings can contain outdated system controls and sequences and inefficient or ineffective HVAC systems, and have a higher probability for the development of mold and mildew.
- **Last commissioned > five years ago:** Regular commissioning (Cx) aids in identifying and rectifying IEQ concerns. Buildings that have not been commissioned recently are likely to require HVAC system adjustments to restore operation to design conditions or to accommodate changes in occupancy and space usage.

- **Poor outdoor air quality:** Countries that are experiencing rapid urbanization may have high particulate levels due to inadequate regulations for vehicle or industrial air emissions, while less-developed and rural locations may experience elevated pollution due to dust from unpaved roads and uncontrolled coal and wood combustion. In these areas, it is necessary to prevent migration of outdoor contaminants to interior spaces and to minimize sources of indoor pollution, such as volatile organic compounds (VOCs) from building products, finishes, and cleaning supplies; migrating secondhand smoke; construction activities; mold; mildew; and radon.
- **Renovation plans within one year:** Posts that intend to renovate within one year should choose environmentally-safe building materials and develop an IEQ management plan prior to construction.

Priority Selection Criteria	High volume of occupant complaints	Age of building > 15 years	Last commissioned > five years ago	Poor outdoor air quality	Renovation plans within one year
Audit	All posts				
Contaminant Reduction	All posts				
Pollution Prevention	●	●		●	●
Ventilation	●	●	●	●	
Green Cleaning		●		●	
Acoustics		●	●		
Thermal Comfort	●		●		●
Ergonomics	●				
Biophilia	●			●	●
Staff Engagement	All posts				

Case Study: Air Quality

Beijing, China

U.S. Embassy Beijing has taken numerous steps to improve IAQ. This issue is particularly important at Post, since the Beijing region faces severe air quality challenges due to pollution from increasing industrial activity.

The Embassy monitors the outside air quality[8] and warns mission personnel and the American community at the Embassy when pollution reaches dangerous levels. The air quality monitor detects fine particulates, which are believed to pose the greatest health risk, especially to sensitive populations such as those with heart or lung disease, children, and older adults. Post converts the particulate measurements into an air quality index (AQI) and uses social media to broadcast whether conditions are good (little potential to affect public health), hazardous, or in between. The building can be used as a 'clean air shelter' in extreme events. In residences, room air cleaners are provided.

The Beijing region faces severe air quality challenges

Image Source: National Institute of Health

To minimize contaminants created within buildings, U.S. Embassy Beijing implemented a green cleaning program, reducing hazardous chemicals in cleaning supplies by 60%. Green cleaning supplies are non-toxic and biodegradable, and are ideally procured locally. The embassy building's design includes extensive natural light and state-of-the-art mechanical systems to ensure occupant comfort and efficiency. Together, these measures help Post contribute to positive IAQ, despite the challenges posed by the particularly poor outdoor air conditions.

Strategies

Strategy	Benefit	Time	Investment
Audit	★★☆☆	1	$
Contaminant Reduction	★★★★	1	$
Pollution Prevention	★★★☆	2	$
Ventilation	★★★★	3	$$
Green Cleaning	★☆☆☆	1	$
Acoustics	★★★☆	2	$$
Thermal Comfort	★★☆☆	1	$
Ergonomics	★★★★	2	$$
Biophilia	★☆☆☆	3	$$
Staff Engagement	★★★★	1	$

Audit

Benefit ★★☆☆	Provides a profile of the building's indoor environment and identifies existing and potential IEQ problems
Time 🕐🕐🕐🕐	One week to one month, depending on the expertise and availability of engineering staff
Investment $ $ $ $	HVAC contractor, as needed
Team Members	**FM** | Post Green Team

An indoor environment audit is the first step to ensuring that post facilities are designed, maintained, and operated in ways that support occupant activities, health, and comfort. An indoor environment audit evaluates system and space conditions; identify critical design, operational, and maintenance deficiencies; and identify no- and low-cost measures and procedures to support improved IEQ, occupant comfort, and equipment operation. Audits do not require special expertise, but they can benefit from inclusion of a team member with knowledge of mechanical systems and equipment, since IEQ improvements often relate to a building's HVAC system.

Preventive maintenance sustains IEQ and saves money in the long run. Maintenance tasks as simple as changing filters and checking belts and cleaning pans regularly can ensure a clean and functional system.[9]

Plan to undertake the following typical indoor environment audit activities:

- Review record drawings, control system setpoints and sequences of operation, operations and maintenance (O&M) manual, maintenance and complaint logs, and material safety data sheets (MSDS) for cleaning products to identify potential problem areas prior to walk-through.
- Survey occupants about acoustics; lighting; thermal comfort conditions during heating, cooling, and swing seasons; ergonomics; and perceived IEQ of open office, conference, and gathering spaces. Identify opportunities to include biophilic design (see Indoor Environment: Biophilia).
- Record observations and measurements during the walk-through (see 🕮 Resources: I-BEAM Forms and Building Air Quality: A Guide for Building Owners and Facility Managers).

- Look for problem indicators, such as glare, noise, odors, excessive dust, mold or mildew, moisture, or discoloration of building materials.
- Note signs of occupant discomfort, such as covered air vents, individual desk fans or heaters, and makeshift monitor glare screens.
- Use handheld meters to spot-measure temperature, humidity, air speed, daylight levels, noise levels, and carbon dioxide (CO_2) .
- Inspect HVAC equipment and identify components that need to be cleaned, repaired, or replaced.
- Use building automated system (BAS) records to determine the volume of outside air supplied. If the BAS does not monitor outside airflow, use CO_2 measurements to calculate the proportion of outside air in the supply air. EPA's Baseline IAQ Audit Form for Indoor Spaces includes guidance on how to perform this calculation.
- Compare total supply air volume to exhaust air volume to determine whether the building is positively or negatively pressurized.
- Identify the location of contaminant sources, such as building entries, janitor closets, and copy rooms, and note whether exhaust fans are present and operational in these spaces and vented directly to the exterior.

Practical Application

1. **Assemble** an auditing team.
   - Consider including facilities staff, building engineer, and operations staff familiar with post's building systems, or a mechanical contractor.
   - Ensure that the auditing team has the required permission and security clearance to photograph facility equipment, access machine rooms, and collect data from controls systems, as necessary.
2. **Review** building documentation to identify potential problem areas.
3. **Survey** occupants about satisfaction with lighting, views, ergonomics, acoustics, and thermal comfort.
4. **Conduct** a building walk-through to document problem areas.
5. **Use** the information from the occupant survey and building walk-through to identify existing conditions as well as maintenance and operations practices that could, or already do, adversely affect IEQ.
6. **Prepare** an audit report with a ranked list of recommended improvements. Prioritize solutions for major problems, malfunctioning parts, schedule changes, and lamp replacement.

Contaminant Reduction

Benefit ★ ★ ★ ★	Maintains high IAQ and supports occupant health
Time	One to three months for moisture and mold remediation and one year for radon testing
Investment $	Testing and mitigation for mold, asbestos, lead, and radon
Team Members	**FM** | GSO, POSHO, SHEM

Indoor contaminants can present serious health risks to occupants and can compromise the integrity of buildings. Excessive indoor mold growth can cause discoloration and odor problems, damage building materials, and trigger allergic reactions in susceptible individuals. Moisture is the most important factor influencing mold growth.

To prevent or remove mold, consider the following best practices:

- Dry damp surfaces immediately.
- Remove water-damaged materials and items within 24 to 48 hours.
- Wash mold off hard surfaces with detergent and water, and dry completely.
- Replace absorbent materials such as ceiling tiles, drywall, and carpet that have become moldy.
- Fix leaky plumbing and other water sources.

Radon is a naturally occurring radioactive gas and known human carcinogen that can migrate from the soil and accumulate in buildings, particularly in basements or where ventilation is deficient. Radon is colorless, odorless, and tasteless, so testing and monitoring radon levels is essential to maintaining healthy IAQ.

Radon is estimated to cause approximately 21,000 lung cancer deaths per year in the U.S., according to EPA's 2003 Assessment of Risks from Radon in Homes.[10]

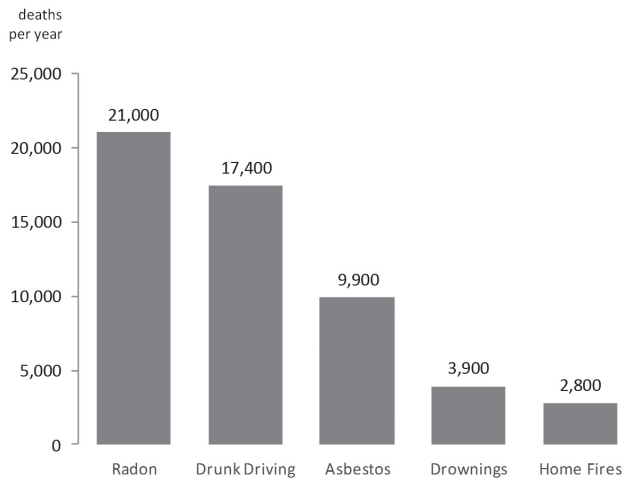
Asbestos is a known carcinogen that was widely used in a number of building components prior to being banned in many countries in 1980. Asbestos is

commonly present in older buildings in previously-installed insulation, fire protection board, roofing, and siding, and is not harmful in an undisturbed state. OBO has developed an asbestos management plan for each overseas post that lists locations of asbestos-containing materials in post facilities, and procedures for how to manage asbestos in place.

Practical Application

1. **Review** the indoor environment audit report, identify primary focus areas, and implement any no- and low-cost measures.
2. **Contact** SHEM for assessment assistance upon identification of a potential concern.
3. **Identify** and engage FM staff to remediate moisture intrusion, leaks, and mold.
4. **Incorporate** moisture management best practices into post O&M procedures (see 🕮 Resources: Mold Remediation in Schools and Commercial Buildings: Prevention).
5. **Review** post's asbestos management plan and ensure that the appropriate staff is aware of the location and proper management of asbestos-containing materials, particularly prior to any renovation activity.
6. **Contact** SHEM for assistance with radon testing, interpreting results, and determining whether mitigation is needed.

Figure 3: Radon and asbestos are estimated to cause tens of thousands of deaths in the U.S. each year



Data Sources: U.S. Environmental Protection Agency

Case Study: Mold Remediation

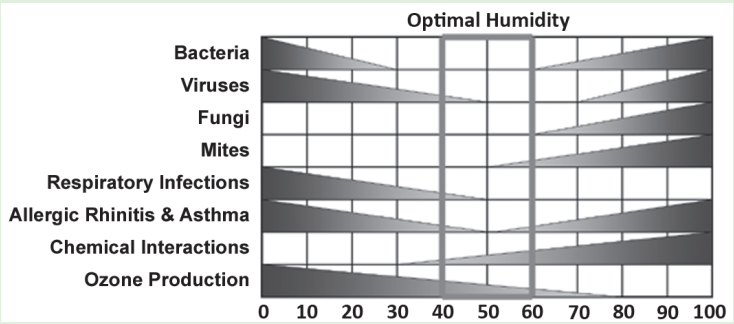
Belize City, Belize

Benefit	Identifies, remediates, and resolves a significant IAQ problem before it impacts occupant health
Time	Less than two weeks
Investment	Caulking, cleaning, and replacing drywall
Team Members	**FM**

Mold, a type of fungus, is a problem that is especially prevalent in humid climates such as Belize. It can have a significant effect on IAQ and occupant health. At the former Embassy location in Belize City, mold was discovered on the exterior metal surfaces of a fan-coil air conditioning unit in an office in the chancery. High humidity caused condensation, resulting in mold growth on various surfaces in the room. Maintenance protocol did not include cleaning those surfaces, and the equipment manufacturer insisted that mold growth should not have occurred.

After researching the cause, it was determined that openings in the building envelope continually allowed humid air to enter the space, so the room remained humid despite air conditioning. Accessible affected surfaces were thoroughly cleaned. Materials that could not be cleaned of mold were replaced. To prevent recurrence of mold growth, walls were carefully sealed to ensure that the desired interior humidity levels would be maintained.

Figure 4: Optimum relative humidity levels (%) to minimize contaminants



Data Source: American Society of Heating, Refrigerating and Air-Conditioning Engineers

Pollution Prevention

Benefit ★★★☆	Improves IAQ, protects occupant health, and reduces maintenance costs
Time 🕐🕐🕑🕑	One to three months to develop plans; three to 12 months to make minor facility upgrades, such as relocating printers, sealing partitions, and adding entryway systems
Investment $ $ $ $	Entryway mats or grates and ongoing maintenance; construction or modification of copy and print room partitions and exhaust systems; construction activity segregation
Team Members	**FM** | GSO, OBO

Indoor pollution is generated by a variety of indoor and outdoor sources.

To be comprehensive, an approach to pollution prevention must include, at a minimum:

- Prohibition of smoking indoors
- Isolation of contaminant-generating tasks
- Use of no- or low-VOC containing materials
- Careful management of renovation activities

Smoking in federal buildings is prohibited by EO 13058, but secondhand smoke can still be drawn into buildings through doors, windows, and mechanical system intakes. Locate outdoor smoking areas more than 7.5 meters (m) (25 feet (ft)) away from any building entrance or HVAC system outdoor air intake to prevent indoor environmental tobacco smoke pollution.

Contaminants brought indoors on shoes can soil or damage flooring and can become airborne and enter the building ventilation system. Capturing contaminants at building entrances with walk-off mats can reduce the cost and need for cleaning and maintenance throughout the building. Similarly, fresh HVAC filters can minimize pollution entering the ventilation system through outside air.

During operation, office printer and copier toners emit ozone, VOCs and particulates, which accumulate indoors and are human health hazards. Isolation of high-volume office printers and copiers supports IAQ and has become a standard best practice in buildings.

Many building products contain compounds that have a negative impact on IAQ and the earth's atmosphere, such as VOCs and formaldehyde. OBO design criteria require low- or no-VOC wet-applied finishes.

Levels of several VOCs—such as formaldehyde and benzene—average two to five times higher indoors than outdoors.[11] VOCs can cause nausea, headaches, and other adverse human health effects.

No- and low-emission building products include:

- Wet-applied finishes (adhesives, sealants, paints, and coatings) that meet Leadership in Energy and Environmental Design (LEED®) for New Construction (LEED®-NC) and LEED for Existing Buildings: Operations and Maintenance (LEED® EB:OM) VOC limits
- Flooring and carpet that complies with FloorScore®, or the Carpet and Rug Institute (CRI)'s Green Label Plus requirements
- Finishes and furnishings with GREENGUARD® or Scientific Certification Systems (SCS) Indoor Advantage certification
- Plywood and particleboard that does not contain added urea-formaldehyde

U.S. Embassy Surabaya designated smoking area prevents tobacco smoke pollution from entering the building

Image Source: U.S. Embassy Surabaya

Construction activities within the building can generate dust and chemical off-gassing, so it is important that post has an IAQ management plan in place before undertaking any renovation projects.

The Sheet Metal and Air Conditioning National Contractors Association (SMACNA) provides guidelines for IAQ protection during construction:

- Isolate and install construction dust barriers around work areas.
- Either seal affected registers, or protect the HVAC system by installing temporary filters with a minimum efficiency reporting value (MERV) 8 or higher on return registers during the construction process.
- Exhaust 100% of construction area 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.
- Schedule activities with high pollutant emission potential during off-peak, unoccupied hours.
- Schedule installation of absorbent materials, such as carpet and ceiling tile, after any off-gassing from other materials has occurred.
- Conduct a flush-out after construction is complete and all furnishings and finishes have been installed, but prior to occupancy.

Practical Application

1. **Provide** or relocate designated outdoor smoking areas at least the minimum required 7.5 m (25 ft) distance from any building entrance or air intake. Include benches and proper receptacles in designated smoking areas.
2. **Install** walk-off mats, floor grilles, or floor grates at all primary entries to reduce pollutants entering the building.
3. **Develop** and implement a maintenance plan for entryway systems, including weekly cleaning.
4. **Coordinate** with facilities staff to replace air handling unit (AHU) filters with new MERV 11 activated carbon filters to reduce outside air pollutants. Schedule replacement regularly.
5. **Identify** all high-volume copying and printing equipment that produce more than 20,000 pages per month. Relocate these items to enclosed spaces, isolated from occupants, with direct outdoor exhaust.
6. **Minimize** the use of individual distributed copiers and printers. Educate staff on reasons for redistribution.
7. **Develop** and implement a plan to use no- or low-emission products for maintenance and renovation activities.
8. **Require** a construction IAQ management plan for renovation projects, based on SMACNA guidelines.

Ventilation

Benefit ★ ★ ★ ★	Improves IAQ, protects occupant health, and can reduce HVAC energy consumption
Time	One to three months for ventilation system maintenance and adjustments, three to six months to select, install and configure CO_2 sensors, and six to 12 months for implementation of demand-controlled ventilation
Investment $ $ $ $	Budget for testing and balancing, replacement filters, and CO_2 sensors for high-occupancy spaces
Team Members	**FM** | TAB Contractor, OBO

Ventilation supplies outdoor air to dilute pollutants of indoor origin, increase oxygen levels, and remove stale air. Ventilation may be accomplished by a mechanical AHU, operable windows, or both. Either too little or too much ventilation can be a problem. A building with insufficient outside air may smell, feel stuffy, and affect staff productivity. Over-ventilation results in high energy costs and may make humidity control difficult. ASHRAE maintains standards for minimum outside air ventilation rates in buildings. The current ASHRAE requirement for office space is 8.5 liters per second (L/s) (17 cubic feet per minute (CFM)) per person, given typical occupant density of five people per 100 square meters (m^2) (1,000 square feet (ft^2)).

Research by the Department of Energy's Lawrence Berkeley National Laboratory suggests that decision-making performance declines with indoor CO_2 levels as low as 1000 parts per million (ppm), far below OSHA's current exposure limit of 5000 ppm.[12]

IAQ problems often result from improper pressurization, which causes unwanted airflow from outdoors to indoors or between areas within the building. To reduce introduction of unconditioned outdoor air and pollutants, the building should operate with slight positive pressure to the outdoors. If the building is designed with a tiered pressurization scheme, the delta between each tier should be a minimum of 2.5 Pascals (Pa) and the lowest tier should be a minimum of 2.5 Pa above the outdoors (see 🕮 Resources: Building Air Quality: A Guide for Owners and Managers).

Even though CO_2 occurs naturally in the atmosphere at low concentrations, elevated levels correlate to human activity (breathing) and can indicate inadequate dilution of indoor contaminants. As a result, CO_2 sensors can be used as a means of monitoring IAQ. ASHRAE recommends that indoor CO_2 levels be maintained at a maximum of 700 ppm above outdoor levels;[13] OBO criteria state 900 ppm, not relative to outdoor conditions.

Figure 5: Balancing pollutant concentration and energy use

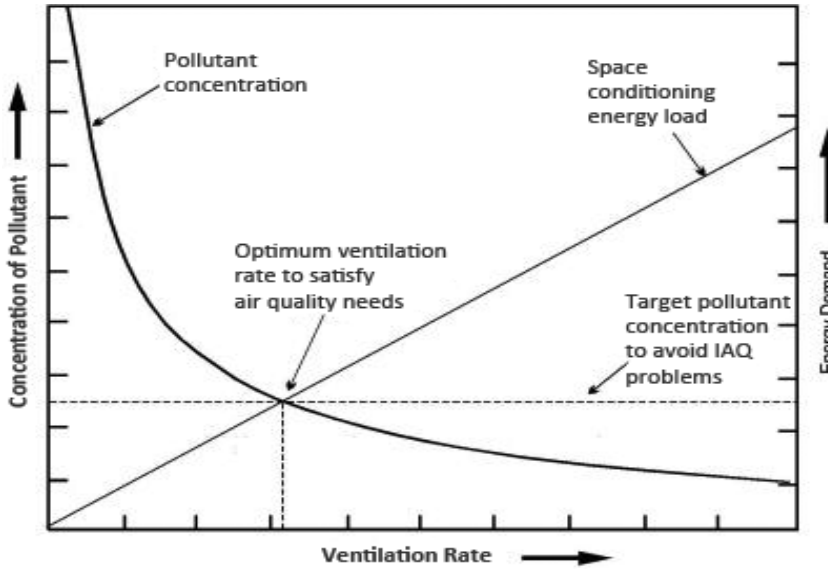


Image Source: Air Infiltration and Ventilation Centre

Best practices for monitoring and reducing CO_2 levels include:

- Installation of CO_2 sensors in occupied areas, especially in spaces where a high number of occupants may congregate.
- Selection of sensors with an alarm function and programming the alarm to notify occupants or the building engineer when CO_2 levels rise above 900 ppm.
- Development of a plan to recalibrate CO_2 sensors every five years, or at the manufacturer's recommended interval.
- Research of sensor options for automated demand control ventilation (DCV). DCV regulates the amount of outside air based on number of occupants in the building and is particularly appropriate for spaces where occupancy levels vary, such as multi-purpose rooms. DCV control systems vary based on the existing equipment and control system, and are

likely to require OBO engineering services (see 🕮 Resources: Demand Controlled Ventilation Using CO_2 Sensors for guidance).

Practical Application

1. **Review** the audit report to identify ventilation deficiencies, such as blocked vents, high CO_2 levels, and inadequate exhaust.
2. **Uncover** blocked supply and return air vents.
3. **Ensure** that spaces are used for their designed purpose to prevent inadequate ventilation, comfort conditioning, or isolation. For example, avoid using storage areas as office space.
4. **Divide** the total volume of outside air identified in the audit report by the total number of building occupants to determine L/s (CFM) per person. If the outside air per person is less than 5 L/s (10 CFM) or more than 10 L/s (20 CFM), talk with facilities staff about adjusting the outside air damper to lie within this ventilation range.
5. **Verify** that exhaust fans for kitchen, bathrooms, janitor closets, high-volume print and copy areas, and disintegrator rooms are vented to the outside and are operating properly. Also ensure that clothes dryers are vented to the outside.
6. **Adjust** fans to ensure that the building is appropriately pressured per the Department's criteria.
7. **Engage** a mechanical or TAB contractor to test and balance the ventilation system every five years to maintain prescribed ventilation and exhaust rates and pressure differentials.
8. **Coordinate** with facilities staff to seal all ducts to prevent air leakage and contaminants from entering and circulating throughout the building.
9. **Select** and install CO_2 sensors.
10. **Talk** with FM staff about installing CO_2 sensors for automated DCV, if applicable.

Green Cleaning

Benefit ★ ☆ ☆ ☆	Reduces occupant and custodial exposure to toxic chemicals and improves IAQ
Time	One to two months for development and implementation of a green cleaning policy
Investment $ $ $ $	Green products can be slowly introduced whenever supplies are purchased
Team Members	**GSO** | FM, Post Green Team

Green products used for both interior and exterior building cleaning protect IAQ and ecosystem health. Conventional cleaning products are more likely to contain increased concentrations of VOCs and carcinogens that may cause human reproductive health problems, irritate the eyes or skin, and bioaccumulate in local flora and fauna. Whether used indoors or outdoors, green cleaning and maintenance products minimize the introduction of pollutants into buildings without compromising product performance or maintenance budgets.[14]

OBO recommends the use of Green Seal®-certified (or equivalent) cleaning products. These products have been tested for toxicity, biodegradability, and air quality degradation, as well as for their potential to impact human health and the environment negatively. Green Seal-certified products are priced similarly to their conventional counterparts, and are available from most janitorial supply vendors.

U.S. Embassy Beijing's custodial teams procure local non-toxic and biodegradable cleaning supplies, and have reduced hazardous chemicals in cleaning supplies by 60%, resulting in fewer toxins entering the buildings at Post.

Recommended cleaning and custodial products include:

- Cleaning products that meet Green Seal GS-37, Green Seal GS-40, EPA Design for Environment, or Environmental Choice EcoLogo™ standards.
- Disposable custodial paper products and trash bags that meet the minimum requirement of the EPA's Comprehensive Procurement Guidelines.

With appropriate isolation of chemical storage and mixing facilities, building occupants are better protected from inadvertent exposure to hazardous materials.

Recommended custodial equipment purchasing guidelines include:

- Selection of vacuum cleaners that meet CRI Seal of Approval requirements, which can capture 96% of particulates 0.3 microns (µ) in size and have a sound level less than 70 decibels
- Use of hot water extraction equipment for deep cleaning carpets, which can remove sufficient moisture to allow carpets to dry in under 24 hours
- Selection of powered maintenance equipment—including floor buffers, burnishers, and automatic scrubbers—that are equipped with vacuums, guards, or other devices for capturing fine particulates; operate with a sound level less than 70 decibels; are ergonomically-designed to minimize vibration, noise, and user fatigue; and have rubber bumpers to reduce damage to building surfaces
- Selection of automated scrubbing machines equipped with variable-speed feed pumps to optimize use of cleaning fluids
- Use of active microfiber technology to reduce cleaning chemicals used

Figure 6: Green Seal is often used as the standard for green cleaning

Image Source: Green Seal

Practical Application

1. **Prepare** purchasing guidelines for cleaners and disposable products.
2. **Create** a spreadsheet to assist in evaluating alternative products by comparing product attributes, applicable standards, and relative cost-to-value metrics, using life-cycle cost analysis (LCCA) as well as first costs.
3. **Review** results of the audit to identify conventional cleaning chemicals used at post, and alternative products that meet green guidelines.
4. **Develop** purchasing guidelines for cleaning equipment.
5. **Construct** or retrofit janitor closet walls with deck-to-deck partitions and seal penetrations. Ensure that direct exterior exhaust is provided and is operating correctly to negatively pressurize the closet.
6. **Develop** a plan for educating post custodial staff about how to use green cleaning products and equipment.
7. **Create** a policy document that includes proposed best practices and implementation plans for green cleaning.

Acoustics

Benefit ★★★☆	Improves occupant productivity and comfort
Time 🕐🕐🕐🕐	One month for acoustics assessment and three to 12 months to select, procure, and install acoustical improvements
Investment $ $ $ $	Acoustic ceiling tiles and wall material; construction or modification of partitions
Team Members	**FM** | GSO, Post Green Team, OBO

High acoustic quality is a key contributor to occupant productivity and well-being in the workplace. Sources of noise can include vehicular and airplane traffic, weather, conversations, occupant activities, and HVAC equipment.

The ability to find quiet times and places is essential for supporting complex knowledge work, while the ability to have planned or spontaneous interactions without disturbing others is necessary for team work, collaboration, and relationship development. Additionally, speech privacy is necessary for confidential interactions and work processes. Acoustical comfort is achieved when the workplace provides appropriate acoustical support for interaction, confidentiality, and concentrative work.

Acoustic problems are a leading source of employee dissatisfaction in offices.[15]

Typical strategies for achieving acoustic quality in workplaces include:

- **Sound-absorbing materials:** High-sound transmission loss walls, floors, and ceilings reduce ambient noise.
- **Sound masking systems:** These systems introduce an unobtrusive background sound that reduces interference from distracting noise.
- **Acoustically treated HVAC systems:** While some level of HVAC noise can act as background white noise, equipment and ductwork can often create disruptive noise. HVAC noise can be reduced through larger diameter ducts with lower velocity airflows; sound-absorbing duct, pipe, and equipment insulation; and equipment that is vibration-isolated.

Consider the following no- and low-cost improvements:

- Caulking cracks or seals between spaces
- Wrapping exposed pipes and ductwork in acoustic insulation
- Using design elements that are lightweight and acoustically absorbent, such as clouds, banners, or artwork, to add visual interest while improving acoustic comfort and privacy
- Purchasing of inexpensive 'personal privacy' masking products, available from mass-market retailers

Improvements made during renovations could include the following:

- Installing sound-absorbing ceilings and walls; specifying ceilings with a minimum noise reduction coefficient (NRC) of 0.9 in open office areas and 0.8 in meeting rooms; in meeting rooms, providing absorptive panels on 25% of walls with a minimum NRC of 0.8
- Specifying sound-masking systems
- Procuring desk systems with acoustic partitions between occupants
- Locating mechanical equipment rooms, printers, and copy machines away from occupants
- Extending walls from the floor to the structural deck
- Insulating partition cavities and increasing partition sound transmission class (STC)
- Using ducted return air systems rather than plenums

Practical Application

1. **Review** the results of the audit to identify acoustic concerns.
2. **Walk** through the facility and identify the balance of concentration and interaction needed for employees on each floor.
3. **Identify** and implement no- and low-cost measures to improve acoustics.
4. **Evaluate** and develop plans to implement short-, mid-, and longer-term acoustical improvements.
5. **Develop** a plan to survey occupants about acoustical quality every few years, and to track and respond to occupant concerns. Consider incorporating this into other indoor environment occupant assessments, such as a thermal comfort survey (see Indoor Environment: Thermal Comfort).

Thermal Comfort

Benefit ★★☆☆	Improves occupant satisfaction and can improve energy performance
Time	One to three months for repairs and controls adjustments
Investment $ $ $ $	Minor upgrades and repairs, such as air sealing and diffuser adjustment or replacement
Team Members	**FM** | GSO, HR

The most prevalent complaint concerning IEQ is thermal comfort, which is a product of environmental conditions (temperature, humidity, air flow, and radiant temperature), personal preferences, metabolism, activity, age, attire, and cultural expectations.

In a 2009 survey of FM staff, 94% reported that occupants complain about being too cold and 91% reported that occupants complain about being too hot.[16]

ANSI/ASHRAE Standard 55 identifies indoor thermal environmental ranges that are acceptable to approximately 80% of occupants when attired appropriately for the climate and season, based on global laboratory and field research. ASHRAE's acceptable ranges of temperature and relative humidity for mechanically heated and cooled spaces are shown in Table 1. A wider range of conditions is comfortable in naturally conditioned spaces (see 🕮 Resources: ANSI/ASHRAE Standard 55-2010).

Providing individual control over environmental factors is the most effective way to ensure that all occupants remain comfortable. However, individual control is frequently not possible in buildings with central conditioning systems. In such cases, careful management of temperature and humidity levels is the key to achieving high levels of occupant satisfaction.

Strategies for improving thermal comfort include:

- Adjusting humidity and temperature setpoints to fall within ANSI/ASHRAE-recommended ranges (see Table 1)
- Changing temperature setpoints to meet guidance put forth by the Secretary of State, which recommends cold weather settings of 20–23.5

degrees Celsius (° C) (68–75 degrees Fahrenheit (° F)) and during warm weather settings of 22.5–26° C (73–79° F), assuming 30-60% relative humidity

- Adjusting HVAC schedules to ensure that heating and cooling systems scheduled for night setbacks turn on early enough to heat or cool the space before occupants arrive
- Allowing a seasc nally-appropriate dress code
- For buildings with BAS systems, incorporating alarm functions to notify FM staff when a zone drifts outside of the recommended ranges

Table 1: Acceptable temperature and humidity ranges for thermal comfort according to ANSI/ASHRAE Standard 55-2010[17]

Conditions	Relative Humidity	Acceptable Operating Temperatures	
		°C	°F
Summer (light clothing)	If 30%, then If 60%, then	24.5 - 28 23 - 25.5	76 - 82 74 - 78
Winter (warm clothing)	If 30%, then If 60%, then	20.5 - 25.5 20 - 24	69 - 78 68 - 75

Data Source: Adapted from ASHRAE 55-2010

Practical Application

1. **Review** the results of the audit to identify thermal comfort concerns.
2. **Develop** a plan to survey occupants about thermal comfort every few years, in different seasons.
3. **Engage** facilities staff to seal leaky or drafty windows, adjust diffusers, and make other low-cost repairs that could improve thermal comfort.
4. **Enforce** the Department's temperature and humidity setpoints and schedules, and work with FM staff to modify existing settings, if necessary.
5. **Review** post's dress code to determine if staff can wear seasonally-appropriate clothing, rather than business attire.
6. **Evaluate** opportunities for mid- to longer-term improvements, such as insulation improvements, window upgrades, or re-zoning HVAC systems.

Ergonomics

Benefit ★ ★ ★ ★	Minimizes risk of developing musculo-skeletal disorders and increases comfort and productivity
Time 🕐 🕐 🕐 🕐	One to three months for ergonomic assessment and training; three to 12 months to select, procure and install ergonomic improvements; consider implementing during interior renovation projects
Investment $ $ $ $	Education and training materials; purchase and installation of workstation improvements (e.g., keyboard trays) or workstation replacement
Team Members	**FM** | FMO, Post Green Team, POSHO, Health Unit Nurse, SHEM

Occupational ergonomics is the science of improving employee performance and well-being in relation to job tasks, equipment, and environment. Researchers apply continual effort to design the workplace for what people do well and design against what people do not do well, thereby fitting the job to the person to enhance human performance.[18]

A successful ergonomics program not only reduces the number and severity of work-related injuries and illnesses, lost workdays, and workers' compensation costs, it improves worker morale and productivity.[19]

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, keyboards, mouse trays, and monitor arms, to allow tailoring to an individual's size and range of motion (Figure 7), resulting in enhanced employee health and productivity.

SHEM provides on-site and online ergonomic assessments. All employees experiencing any workplace-related physical discomfort should complete SHEM's online discomfort survey in advance of the assessment. The POSHO can take photos of the employee working and submit those photos to SHEM for evaluation.

Practical Application

1. **Walk** through the facility and record the type of furniture and equipment at each workstation. Note whether desks and chairs are adjustable. Also note ergonomic risk factors such as glare on monitors, ill-fitting chairs, desk heights, and keyboard and computer mouse positions on the workstation surface.
2. **Identify** and implement no- and low-cost measures to improve position workstation comfort, such as workstation height adjustments, glare screens, headsets, keyboard and mouse trays, palm supports, and footrests.
3. **Develop** plans to provide ergonomic training to post occupants. The training sessions should cover topics including, but not limited to, how to adjust furniture; ways to minimize eyestrain from prolonged computer work; and workplace stretches to prevent pain, stiffness, and fatigue (see 🕮 Resources: Mayo Clinic Guide for additional guidance).
4. **Refer** occupants with complaints about back, neck, or other musculo-skeletal discomfort to their supervisor to request an ergonomic assessment.
5. **Work** with post's GSO and OBO to plan and implement mid- to long-term improvements, such as replacing fixed furniture with adjustable furniture.

Figure 7: Features of an ergonomic workstation

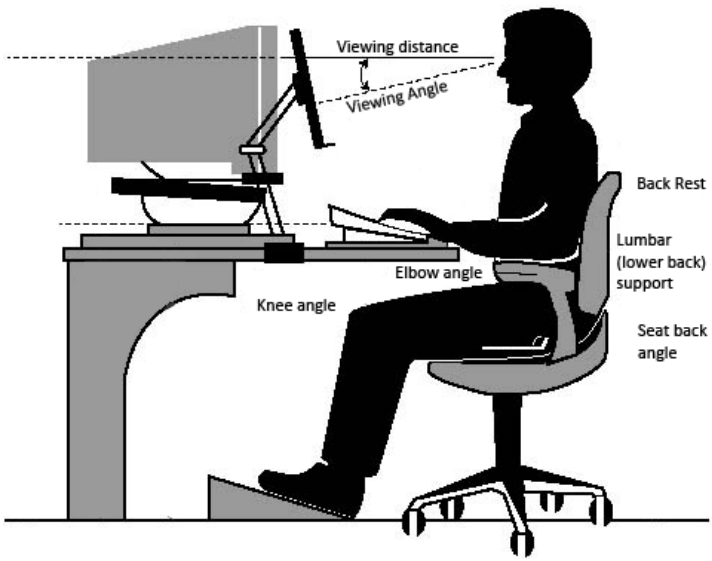


Image Source: Occupational Safety and Health Administration

Biophilia

Benefit ★★★☆	Improves occupant productivity and well-being
Time 🕐🕐🕐🕐	One to three months for assessment and minor improvements; six months to a year for long-term improvements
Investment $ $ $ $	Plants, water features, pictures, aquariums, courtyard gardens
Team Members	**FM** | GSO, Post Green Team, OBO

The concept of biophilia (Greek for 'love of nature') proposes that humans hold a biological need for connection with nature on physical, mental, and social levels, and that this connection affects our personal well-being, productivity, and societal relationships. Whether one is engaging with nature by walking through a park, by interacting with animals, or simply by having a view of greenery from one's home or place of work, biophilia has many applications that help transform mundane settings into stimulating environments.

Humans have continually improved the places in which they live and work to increase their comfort and productivity. These improvements have been based upon technological advancements that increase the health and welfare of building occupants, but little attention has been paid to more subtle physiological needs. Recent advancement in our understanding of natural systems, coupled with growing research regarding the subtle neurological and physiological functions associated with contact with nature, have allowed us to identify strategies to increase economic gains, improve health and productivity, and strengthen the social fabric of our communities, while embracing the natural environment.

The term Nature-Deficit-Disorder[20] suggests that the increase in occurrence of conditions such as obesity, attention disorders, and depression are partly due to a decrease in exposure to nature at a young age.

Although the cognitive benefits of biophilia are well-studied by the scientific community, the economic benefits of biophilic design remain an understudied design element of our built environment. Recently studies

explored examples of how access to nature in buildings, at a low up-front cost, could produce very healthy returns.[21]

The following three key concepts serve as the tenets of biophilic design:

- **Nature in the space:** The incorporation of plants, water, and animals into the built environment. These direct connections to nature, and in particular, dynamic nature that incorporates movement, produce the strongest biophilic reactions. Measures can include potted plants, water features, aquariums, and courtyard gardens, as well as views to nature from the inside of a building. The prevalence of the courtyard in traditional architecture is a good example of our early attraction to incorporating nature directly into our built environment.
- **Natural analogs:** One degree of separation away from true nature, natural analogs are materials, finishes, and patterns that evoke nature and are characterized by four broad types: representational artwork, ornamentation, biomorphic forms, and the use of natural materials. The benefits of nature represented in artwork are measurable but less effective than benefits derived from actual trees or plants in the outdoors. Measures can include pictures or sculpture of trees, animals, and water; building elements that mimic shells and leaves; and furniture with organic rather than geometric shapes and visible wood grain.
- **Nature of the space:** The way humans respond psychologically and physiologically to different spatial configurations.[22] Our innate preference for open spaces does not extend to just any open space; physiological research indicates that our bodies react most positively to savanna-like settings with moderate to high depth and openness. Some of these preferred spatial conditions are called prospect, refuge, mystery, and risk. Measures can include spaces with elevated unimpeded views (prospect) and secluded protected spaces (refuge).

Practical Application

1. **Review** the results of the audit to identify opportunities for the use of biophilia to improve the indoor environment.
2. **Identify** and implement no- and low-cost nature in the space and natural analog measures.
3. **Explore** opportunities to implement nature of the space measures.

Staff Engagement

Benefit ★ ★ ★ ★	Contributes to improved occupant health and productivity
Time	One to two months to customize education materials and install signage; regularly scheduled short training sessions
Investment $ $ $ $	Preparation and printing of training materials and signage
Team Members	**Post Green Team**

The following occupant behaviors can significantly improve IEQ. Staff at all levels can adopt these simple and easy actions.

Encourage post personnel to:

- Only smoke away from the building entrance and ventilation intakes.
- Minimize odors in the building through avoidance of such products as scented candles, perfume, room deodorants, and strong-smelling cleaning products.
- Use walk-off mats to prevent introduction of outdoor contaminants.
- Avoid tampering with HVAC systems and refrain from using personal heating or cooling devices such as space heaters, even when not prohibited by post policies.
- Dress appropriately for the weather, when permitted by post management.
- Adjust window coverings to control room temperature and avoid glare.
- Report persistent heating, cooling, lighting, or odor problems.
- Increase biophilic measures by adding natural elements, artwork, and indoor plants for those without exterior views.

Practical Application

1. **Review** general tips on how to implement an occupant engagement program (see Using This Guide: Influencing Occupant Behavior).
2. **Educate** occupants on personal contributions.
   - Raise awareness about the importance of good IEQ through 'brown bag' education sessions.

- Distribute information in broadcasts, newsletters, pamphlets, or through social media.
- Train employees to modify their working habits to improve ergonomics, reduce repetitive strain injuries, and enhance their productivity.

3. **Create** social involvement opportunities.
   - Hold plant-potting parties to decorate staff workspaces with houseplants that help clean indoor air.
   - Celebrate local ecosystems by populating post with relevant biophilic imagery and artwork.
4. **Implement** structural components.
   - Remove personal printers from desktops and locate within dedicated, separately exhausted work rooms.
   - Install automatic closers on photocopy room doors, add walk-off mats at main entrances to buildings, and provide comfortable smoking areas away from building intakes and entrances.
   - Ensure that a process is in place for occupants to report problems or concerns related to IEQ.
   - Distribute occupant comfort surveys every few years to assess IEQ satisfaction and effectiveness.

Air quality awareness is important at every age; celebrate Air Quality Awareness Week to educate occupants and visitors

Image Source: U.S. Environmental Protection Agency

Resources

📖 Visit http://www.state.gov/obo/green/greenguiderefs/index.htm#indoorenvironment

Endnotes

1 *Healthy Buildings, Healthy People: A Vision for the 21st Century.* EPA. http://www.epa.gov/iaq/pubs/hbhp.html

2 *Global Estimates of Ambient Fine Particulate Matter Concentrations from Satellite-Based Aerosol Optical Depth: Development and Application.* Environmental Health Perspectives, National Center for Biotechnology Information, National Institute of Health, 2010. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2898863/pdf/ehp-118-847.pdf

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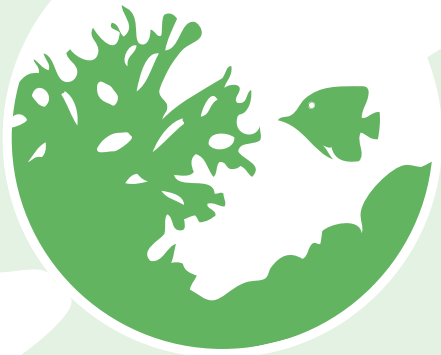
Figure 8: U.S. Consulate General Guangzhou uses educational signage to inform visitors about sustainability

Image Source: Bureau of Overseas Buildings Operations

RESIDENTIAL



Using sunlight and the nutrients absorbed from its surroundings, **coral** secretes calcium carbonate to create reefs. These **coral** reefs are home to a tremendous diversity of sea life that create some of the most productive ecosystems on earth.

RESIDENTIAL

After energy assessment of several residences, U.S. Embassy Kathmandu added requirements to their 'Housing Pre-Leasing Checklist,' including programmable thermostats, faucet aerators, water-efficient toilets, and site-lighting photocells.

Image Source: Donna McIntire, OBO

RESIDENTIAL

RESIDENTIAL

Federal Performance Goals[i]

Energy:

- 30% energy reduction from 2007 baseline by 2020 (3% per year) per Executive Order (EO) 13514

Water:

- Reduce irrigation water intensity for existing buildings by 20% and for new buildings by 50% from 2010 baseline by 2020 per EO 13514
- 26% potable water consumption intensity reduction from 2007 baseline by 2020 (2% per year) per EO 13514

Integrated Pest Management:

- Practice Integrated Pest Management (IPM), as described in the OBO's IPM Program Document, and as required by 15 FAM 957.2

Greenhouse Gas Emissions:

- Report and set 2020 targets using 2008 baseline per EO 13514

Utility Costs:

- Meet the requirements of 15 FAM 169.2 Residential Cost Controls for Utilities

[i]These goals are most appropriate for buildings >464 square meters (m^2)

Chapter Overview

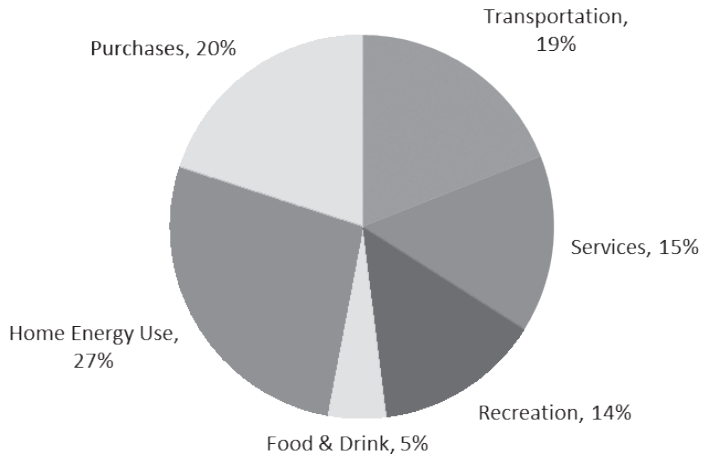
Post-managed residences, both owned and leased, can play a significant role in reaching environmental goals. In the United States, residential buildings account for 20.8% of the nation's total carbon dioxide (CO_2) emissions and 9.7% of the nation's total water consumption.[1] Residential building operations also contribute to air quality issues; in rapidly developing nations, nearly one million children die every year from pneumonia related to indoor air pollution, largely caused by cooking with solid fuels.[2] Environmental tobacco smoke is another indoor environmental contaminant in the home that poses significant respiratory health risks, including bronchitis, pneumonia, and asthma, particularly to young children. Finally, housing raises challenges related to material selection. For example, many older homes may contain

lead-based paint or asbestos-containing materials, which can expose people to toxins through paint chips, dust, and contaminated soil.

Resident comfort and health can be improved by implementing strategies that address energy, water, materials, waste, and indoor air quality (IAQ). As seen in Figure 1, home energy use, food and drink, and purchases account for roughly half of an individual's carbon footprint. Post's responsibilities for residential utility management are outlined in the U.S. Department of State (the Department) Foreign Affairs Manual (15 FAM) section 169.2 Residential Cost Controls for Utilities (see 🕮 Resources: 15 FAM 169). Post Green Teams should prioritize and reinforce the appropriate residential strategies that have the greatest net positive environmental impact.

Addressing residential resource use allows missions to establish a firm and credible foundation for eco-diplomacy, save utility costs, and help accelerate the adoption of sustainable practices in their host country.

Figure 1: Residential carbon footprint in the U.S.



Data Source: U.S. Environmental Protection Agency

Residential Profile

Over 16,500 of the Department's owned or leased buildings are residential. This represents approximately 87% of all the Department's buildings, as shown in Table 1. The large proportion of residential buildings within the overall portfolio presents a significant opportunity for posts to leverage environmental improvements, either as landlord or tenant.

It is important to remember that the people who live in these residences also work at post. Therefore, implementing residential initiatives on top of post

sustainability activities can reinforce best practices at home and at work. This increases the likelihood that positive operational and behavior changes can be successfully adopted.

Regional conditions may limit some posts' ability to undertake energy, water, or other sustainability upgrades. Restrictions might include security issues, local code requirements, lack of waste management infrastructure, or geographical constraints. Alternately, other posts may be located in areas with multiple environmental initiative opportunities, such as reliable public transit or municipal recycling programs. Identify any context-specific restrictions that may affect environmental impact areas as well as opportunities for improvement in other aspects of sustainability.

Table 1: Number of residential vs. non-residential Department buildings by Bureau (2009)

Bureau	AF	EAP	EUR	NEA	SCA	WHA	Total
Residences	2,577	2,866	4,127	2,158	1,331	3,688	16,747
Non-residential buildings	535	447	544	285	211	452	2,474
Total number of buildings	3,112	3,313	4,671	2,443	1,542	4,140	19,221
% of residential buildings	15.4%	17.1%	24.6%	12.9%	7.9%	22.0%	100%

Data Source: Bureau of Overseas Buildings Operations

Considerations

Impact areas included in the residential chapter parallel those incorporated into the remainder of the *Guide to Green Embassies* (the *Guide*): energy, water, materials, and indoor environment. Site factors cross many of these impact areas and are not covered separately within this chapter.

Recommended initiatives presented in each impact area are designed to facilitate positive occupant behavior toward the Department's goal of reducing resource consumption and greenhouse gas (GHG) emissions in order to meet federal performance goals. For each impact area, posts should encourage residents to make effective changes using engagement strategies and minor structural improvements prior to implementing major initiatives or upgrades.

The extent of posts' control over the sustainability of residences largely depends on whether the buildings or units are owned or leased. For leased buildings, posts should consider tenant-focused strategies, encourage landlords to undertake larger retrofits as part of lease negotiations,

and implement green leasing strategies. Especially for those leased buildings where the Department pays utilities, posts should also add lease requirements that enable resource efficiency, such as energy-efficient lighting, programmable thermostats, and water-efficient fixtures. For Department-owned residences, posts should strive to meet performance goals related to transportation, water, energy, GHG emissions, and waste, referencing the relevant strategies for upgrades and improvements. At posts where major residential renovations or construction projects are planned, follow the guidance contained in other chapters of the *Guide* for additional strategies, such as renewable energy.

The most effective sequence for pursuing residential sustainability strategies is as follows:

1. **Resident engagement:** The success of tenant-focused residential strategies largely depends on the ability to influence resident behavior. Occupants have significant impact on the adoption of conservation technologies and strategies, and their engagement can accelerate posts toward meeting or exceeding sustainability goals.[3] Post Green Teams should pay particular attention to ensuring that appropriate tools are provided and residents are aware of programs and goals.
2. **Auditing and improvements:** A residential audit can be performed on all housing facilities or on a representative sample, depending on the quantity and type of housing included in the portfolio. The audit is easier to perform if residences are separately metered or monitored for water, energy, purchases, and waste management. No- and low-cost measures identified in the audit can have immediate and significant benefits in each impact area, for both leased and owned facilities.
3. **Upgrades:** In locations where posts own residential buildings, there are both short- and long-term benefits in pursuing efficiency upgrades. Life-cycle cost analysis (LCCA) allows posts to prioritize proposed efficiency upgrades. For leased buildings, posts should approach landlords to pursue efficiency upgrades as part of lease negotiations.

Strategy Selection Factors

Review the relative number and size of residences in post's portfolio as well as the condition and cost of each residence, to balance needs with availability of funds and resources.

To identify and prioritize residential strategies, consider environmental issues that are of greatest concern in the region and host country. Note that contaminant reduction and IEQ issues should be addressed at all posts to improve occupant health.

Evaluate the following issues:

- **Energy cost and security:** Although all posts benefit from the implementation of residential energy conservation measures (ECMs), it is particularly critical where host countries have few indigenous energy resources, are reliant on fossil fuels, or do not have reliable power supplies. Identify applicable tenant behaviors and work with landlords to implement conservation strategies. At owned properties, identify opportunities for envelope improvements and appliance and equipment upgrades or replacements.
- **Water cost and scarcity:** In countries with limited access to water, or immature water delivery or wastewater treatment (WWT) infrastructure, posts should prioritize water conservation. Examine results of the audits and engage post personnel to assist with implementing conservation strategies.
- **Minimal waste infrastructure:** If waste management infrastructure is not well developed, reduce post's impact on the host country by reducing the quantity of waste produced by residents, and explore procurement policies that support further waste reduction.

Priority Selection Criteria	Energy cost and security	Water cost and scarcity	Minimal waste infrastructure
Audit	All posts		
Green Leasing	All posts		
Water Efficiency	All posts		
Energy Efficiency	All posts		
Materials and Waste Management			●
Contaminant Reduction	All posts		
Moisture Management	All posts		
Staff Engagement	All posts		

Case Study: Green Technology

Rome, Italy

U.S. Embassy Rome implemented significant green technology improvements at the U.S. Ambassador's residence, Villa Taverna, a historically significant building. The upgrade was executed in conjunction with the League of Green Embassies' (the League) Energy Efficiency Sweep initiative for COM residences, a collaborative effort involving the Department, the U.S. Department of Commerce, the Alliance to Save Energy, and corporate vendors of efficiency products and equipment.

U.S. Ambassador Thorne explains the technology upgrades to M'illumino di meno event attendees

Image Source: The League of Green Embassies

At Villa Taverna, Post installed light-emitting diode (LED) interior and exterior lighting fixtures; thermal window film; heating, ventilating, and air conditioning (HVAC) and building controls upgrades; 'smart' power strips that combat phantom loads; water faucet aerators; and high efficiency washers, dryers, refrigerators, wine coolers, and microwaves. Combined, the improvements are expected to reduce electricity costs by 48% ($30,000 per year).

One of the primary challenges was determining how to maintain the cherished historical character of Villa Taverna, a 16th century Italian villa. The project team carefully considered the preservation of historical design elements when implementing environmental strategies. For example, inefficient lamps in chandeliers were replaced with similar-looking LEDs, demonstrating just one of the ways in which the project team was able to retain the building's character while implementing new technology. Previous upgrades at the residence included site improvements, such as rainwater collection for irrigation and the establishment of vegetable gardens.

To coincide with a national 'M'illumino di meno' ('I use less light') energy efficiency consciousness-raising campaign, Post held an event on February 15th, 2012, to highlight the building improvements, increase awareness and education, and support the mission of eco-diplomacy.

Strategies

Strategy	Benefit	Time	Investment
Audit	★★☆☆	🕐	$
Green Leasing	★★★★	🕐🕐	$$$
Water Efficiency	★★☆☆	🕐🕐	$$
Energy Efficiency	★★★☆	🕐🕐🕐	$$
Materials and Waste Management	★★★☆	🕐🕐🕐	$$
Contaminant Reduction	★★☆☆	🕐	$
Moisture Management	★★★★	🕐	$$
Staff Engagement	★★★★	🕐	$

U.S. Chief of Mission Residence, Bern—site of Energy Efficient Makeover, 2011

Image Source: The League of Green Embassies

Audit

Benefit ★★☆☆	Identifies opportunities for residential water and energy efficiency, and examines building condition for occupant health impacts
Time	Two to four hours per audit, depending on residence size
Investment $ $ $ $	Auditing spot meters (power, light, moisture, and temperature), radon testing (if needed)
Team Members	**FM** | PRE, Post Green Team, Residents

A residential sustainability audit provides critical baseline information about the building's existing condition and performance. The audit also can identify immediate remediation needs and inform a prioritization list for upgrades and retrofits. Issues to investigate include water, energy, household purchases, waste, contaminants, moisture, and mold.

Home energy audits identify easy upgrades that can reduce energy bills by 5–30%.[4]

A detailed audit should be performed by post FM staff or a contractor; however, residents can undertake some elements of an audit autonomously. Posts may decide to audit a single, prototypical residence or multiple residences.

Sample checklist items include the following:

Water

- Collect, review, and report water use and cost through the TREES database tool.
- Locate the water meter or note that the residence is not individually metered.
- Examine indoor and outdoor piping and fixtures to identify the location of any leaks.
- Record the age and model number of all water-consuming appliances, including dishwashers and washing machines.
- Note whether toilets are dual-flush toilets.
- Identify viable locations to collect and store rainwater for irrigation reuse.

Energy

- Collect, review, and report energy use and cost through TREES.
- Locate the electric and gas meters or note that the residence is not individually metered.
- Identify any other fuel type, such as propane or diesel.
- Interview residents to determine whether seasonal issues exist regarding thermal comfort, such as drafts in winter or the need for space heaters.
- Note issues of intense solar heat gain.
- Inspect doors and windows to ensure that caulking and weatherstripping are present, and investigate attic areas for insulation levels.
- Note whether there are programmable or 'learning' thermostats, which gather information about occupant schedules and preferences and adjust accordingly over time.
- List all lighting sources, including quantities and wattage of indoor and outdoor fixtures.
- Record the type, age, and model number of all appliances, to assist with further research on energy use.
- Check whether hot water piping is insulated and if older hot water tank models have jacket insulation. Record temperature setpoints of the water heater and note if a timer is being used.

Materials

- Review procurement policies and practices for residential purchases (see Materials: Green Purchasing).
- Determine whether there are recycling bins and yard waste or compost bins, as appropriate.
- Consider a waste stream audit (see Materials: Recycling and Composting).
- Refer to OBO Waste Management Policy for guidance typically required for dryers and toilet rooms.

Indoor environment

- Inventory the household cleaning and maintenance products, noting harmful chemicals (see Indoor Environment: Green Cleaning).
- Confirm that exhaust fans are operational.
- Note signs of moisture buildup and mold, such as discoloration, musty smells, damp basements, or patches of mold or mildew.
- Record incidents of condensation on windows and air conditioning systems.
- Note any peeling paint.

- In cold climates, note icicles and ice dams.
- Confirm that functioning carbon monoxide (CO) detectors are properly located in bedrooms and living areas.
- Perform a radon test, or engage a professional to perform one, where regional data indicates presence of radon, particularly in residences with basements or slab on grade.
- Prior to any renovation project, confirm whether asbestos or lead paint is present. Contact SHEM for information and guidance.
- Document cleaning and maintenance products being used, noting harmful ingredients. Consult OBO's Green Cleaning policy for guidance.

Practical Application

1. **Determine** whether an audit should be performed for water, energy, materials, or IAQ, or whether multiple impact areas can be audited.
2. **Outline** the scope of each audit, the number of buildings under review, and who can perform the audit. Review appropriate Residential strategies.
3. **Determine** whether residential policy documents exist that include, or could be modified to include, maintenance, repairs, renovations, energy and water efficiency, waste disposal, and procurement. Confirm whether post has resident self-help guidelines.
4. **Prepare** a checklist or matrix for the items to be audited. Detailed audit checklists are available from websites listed in the Resources section.
5. **Send** the checklist to residents; include education about how the audit relates to post goals, and schedule times to visit residences.
6. **Undertake** the audit.
7. **Prepare** a prioritized list indicating recommendations for replacement or repair. Indicate immediate needs, e.g. potential health concerns, such as mold, and low- and no-cost measures.

Table 2: Residential energy consumption at U.S. Embassy Kathmandu is approximately 42% of the Embassy's spending on building-related energy

Description	Budget
ECM budget	$3,009
Aerators and showerheads	$120
Water pipe installation	$100
Site lighting photocell	$140
Programmable thermostat	$240
LED lamps replacing compact fluorescent lamps (CFLs)	$240
Refrigerators	$400
WC upgrades	$1,200

Data Source: Bureau of Overseas Buildings Operations

Green Leasing

Benefit ★ ★ ★ ★	Ensures that leased facilities support federal performance goals, encourage sustainable transportation, and protect resident health
Time 🕐 🕐 🕐 🕐	One to three months to prepare and approve new lease language
Investment $ $ $ $	Variable; may include trade-offs between leasing rate and tenant improvements
Team Members	**GSO** | FM

Green leases include clauses to ensure that a tenant's sustainability goals are addressed through operational factors and facility improvements. Posts can help the Department achieve performance targets by negotiating with landlords to include applicable clauses in residential lease contract documents.

To support the intent of federal performance goals, U.S. General Services Administration (GSA) and the U.S. Department of Energy (DOE) include recommended sustainability elements in leasing policies, procedures, and document templates (see 🕮 Resources: Green Lease Policies and Procedures for Lease Acquisition and Request for Proposal (RFP)). Typical green leasing clauses can include physical building requirements, such as environmentally-preferable requirements for construction and demolition waste, construction and interior finishing materials, or IAQ; operational requirements including recycling programs or submetering; or compliance with programs promoting high energy and water efficiency such as Energy Star®.

Posts that encourage local landlords to perform green tenant improvements are promoting eco-diplomacy by generating market demand for sustainability, while also increasing skills of local property owners and tradespeople. When negotiating new leases, prioritize improvements and upgrades that are most important to post, based on issues relevant to post residents, the local community, and host country. Also consider the size of the leased property; post is likely to have greater influence when leasing entire apartment complexes or several residences rather than individual units or single-family dwellings.

When examining potential residential properties, evaluate the following location factors:

- **Proximity to post compounds:** Select residential property locations that allow staff to walk, bike, or take public transit to post. Where alternative commuting options are not available, and require use of personal vehicles, aim to minimize residents' travel distance.
- **Walkability:** Identify neighborhoods that allow residents to walk or bike to basic amenities, such as shops, schools, services, and medical facilities.
- **Accessibility to public transit:** If safe and reliable public transit is available, ensure that residents are able to use the service. Select properties within walking distance of transit lines or stations, or those with park-and-ride facilities.

Evaluate the benefits and drawbacks of different types of leases, such as the following:

- **Gross lease:** Landlords pay all utilities and expenses and benefit from any savings, therefore are encouraged to make capital investments. However, there is limited incentive for tenant efficiency.
- **Net lease:** Tenants pay all utilities, thus are encouraged to implement conservation measures. However, landlords are not incentivized to make capital improvements based on resource efficiency, and residents are subject to volatile energy price fluctuations and escalations over the lease term.

Consider incorporating the following ongoing operational requirements into the lease:

- **Green power:** Green power purchasing, where available and when utilities are provided by the landlord
- **Low-impact site maintenance:** Non-toxic landscaping and site maintenance products
- **Green cleaning:** Environmentally-preferable cleaning products
- **HVAC system maintenance:** Scheduled and implemented regular furnace and equipment maintenance, as well as duct cleaning and filter replacement
- **Recycling:** Recycling service and collection bin or separation area
- **IAQ:** Immediate remediation of mold or indoor air pollution issues, or temporary housing provided for residents during pest control treatment application
- **IAQ:** No- or low-volatile organic compound (VOC) paints, carpeting, and furnishings

Practical Application

1. **Determine** the environmental factors that are most critical to post's locations. Note applicable federal performance goals.
2. **Identify** potential facilities that satisfy the highest priorities for leased residences. If appropriate, issue an RFP and prepare a shortlist of preferred properties.
3. **Consider** the types of leases being offered and prioritize them in order of maximizing landlord and tenant motivation toward sustainability.
4. **Work** with FM to generate preferred list of tenant improvements and operational elements to be included in the lease. Consider surveying potential residents to prioritize the list.
5. **Obtain** pricing estimates from preferred landlords for sustainable tenant improvements (e.g., insulation, programmable or 'learning' thermostats, and water-efficient plumbing fixtures).
6. **Perform** a present-value cost analysis over the length of the lease for each alternative. Use a spreadsheet, such as the ones available from GSA or DOE (see 🕮 Resources: Present Value Analysis Model and Building Upgrade Value Calculator). At a minimum, consider utility costs, upgrades, and lease rates.
7. **Negotiate** to include preferred alternatives in the lease agreement, for both physical improvements and process changes. Include language from GSA or DOE templates, as appropriate.
8. **Confirm** that the final lease represents all verbal agreements made prior to signing.
9. **Provide** clear guidance in the lease for responsibilities of the landlord and contractors performing tenant improvements, to ensure that they understand the requirements. Where necessary, work with the landlord to provide training.
10. **Ensure** that specified pre-occupancy upgrades and any required air quality flush-outs are completed prior to residents moving in.
11. **Audit** the property six months after signing, to confirm that tenant improvements are operating properly, and that any operational changes required in the lease have been implemented.

Water Efficiency

Benefit ★★☆☆	Lowers utility costs and consumption, reducing reliance on resources
Time 🕐🕐🕐🕐	One to three months to undertake minor improvements, and three to six months to replace inefficient fixtures and appliances
Investment $ $ $ $	Maintenance for minor improvements and replacements; new toilets, faucets, dishwashers, clothes washers, water heaters
Team Members	**FM** | Residents, Post Green Team, CLO

According to EPA, a typical American household of four uses more than 984 liters (L) (260 gallons (gal))—approximately five full bathtubs—of water every day. Toilet flushing accounts for almost a quarter of that total; showers, faucets and clothes washing each represent another 10–15% (Figure 2). The cost of outdoor water consumption, typically used for irrigation and car washing, can comprise 30% of a residential water bill. It is estimated that 10% of all residential water consumption is lost to leaks, indicating an obvious opportunity to save water.[5]

U.S. DOE estimates that pool covers can reduce evaporation by 50-70%. Evaporation of one pound (lb) of 26.7 degrees Celcius (^{0} C) (80 degrees Fahrenheit (^{0} F)) water takes 1,048 British thermal units (Btu) of heat with it.[6]

Tenant Measures

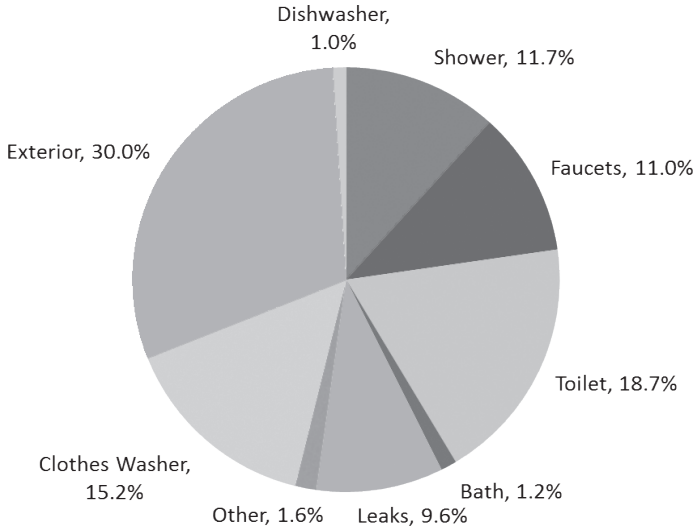
Residents can easily undertake a variety of water efficiency strategies with the assistance or encouragement of post FM staff.

Implement the following tenant measures:

- Ensure that plumbing fixtures do not leak.
- Install faucet aerators (1.9 liters per minute (Lpm) (0.5 gallons per minute (gpm)) and efficient, low-flow showerheads (5.7 Lpm (1.5 gpm)) that maintain the same level of performance while consuming less water.
- Retrofit toilets with dual-flush valve adaptors.
- Use rain barrels to collect rain for irrigation at posts where there is adequate precipitation (see Water: Rainwater Harvesting).

Post can also implement education and engagement programs to encourage residents to conserve water (see Residential: Staff Engagement).

Figure 2: Residential water end uses in the U.S. (2010)



Data Source: American Water Works Association

Owner Measures

Many older plumbing fixtures and appliances, such as dishwashers, do not meet current efficiency standards for water consumption. EPA estimates that replacing an old toilet with a WaterSense®-labeled toilet can save over 15,000 L (4,000 gal) per year. Toilet alternatives include high-efficiency, pressure-assist, and dual-flush toilets.

In their 2013 Greening Diplomacy Initiative (GDI) Greening Success Award submission, U.S. Embassy Canberra reports that 96% of all U.S. government-owned residences in Canberra are equipped with solar hot water systems and 33% are harvesting rainwater.

Old and inefficient water-consuming clothes washers and dishwashers should be replaced with Energy Star®-qualified or A+ Energy Plus-class or higher models for water and energy efficiency. Horizontal axis (front-loading) washing machines typically use much less water than the top-loading variety. Older water heaters should be replaced with Energy Star® tank or tankless water heaters, or solar water heating (see Residential: Energy Efficiency). Additionally, insulating the hot water tank and piping near the tank and placing the tank near hot water-consuming fixtures can save water, as less is

wasted while waiting for water to get to the desired temperature at the point of use.

Where appropriate, apply to residential properties the same irrigation and landscaping practices used at post, such as rainwater harvesting, drip irrigation systems with weather-responsive controls, native or drought-tolerant plantings, and the grouping of species with similar irrigation needs together (see Water: Irrigation and Site: Landscaping). Additionally, residences with swimming pools can achieve considerable water savings by installing pool covers, greatly reducing evaporation losses.

Practical Application for Tenants

1. **Review** results of the residential audit to identify and implement any no- or low-cost recommendations.
2. **Identify** the individual responsible for each recommended improvement.
3. **Request** that landlords fix leaking pipes, dripping faucets, and running toilets.
4. **Install** minor plumbing fixture upgrades as noted above.
5. **Encourage** residents to undertake conservation practices (see Residential: Staff Engagement).
6. **Incorporate** these best practices into post's residential operations and maintenance (O&M) policy document and include guidance in new employee welcome packets and resident self-help guidelines.

Practical Application for Owners

7. **Review** water bills to identify residences that consume the most water and that may warrant upgrades.
8. **Track** monthly water bills to identify spikes in water usage that may indicate leaks or malfunctioning systems or fixtures.
9. **Review** the costs and benefits associated with new Energy Star® products to replace existing water-inefficient appliances.
10. **Identify** a preferred water fixture package for all future upgrades and implement as appropriate.
11. **Make** upgrades to the oldest residences, which may be prone to leaks, before implementing upgrades on other properties.
12. **Use** TREES to track residential water use and cost over time.

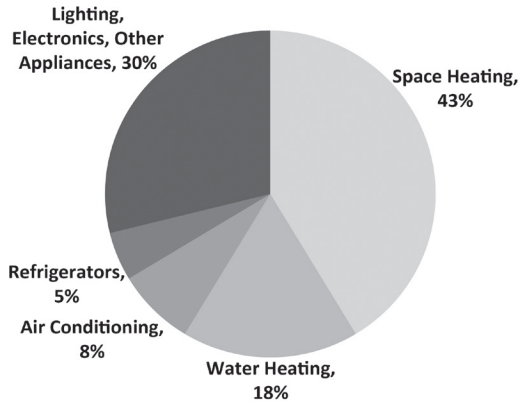
Energy Efficiency

Benefit ★★★☆	Lowers utility costs and consumption, reducing reliance on non-renewable resources
Time 🕐🕐🕐🕐	One to three months to undertake minor improvements and six to 12 months to prioritize, purchase, and install upgrades
Investment $ $ $ $	Programmable or 'learning' thermostats, efficient lamps, insulation, caulk, weather-stripping, duct sealing tape, appliances, lighting fixtures, HVAC equipment, and contractors to perform the work
Team Members	**FM** | Residents, Post Green Team, FMO, GSO

People spend approximately half of their time at home, consuming energy through a combination of lighting, heating and cooling, water heating, kitchen appliances, personal electronics, and small appliances, such as fans.

In the United States, heating and cooling accounts for approximately 50% of home energy consumption (Figure 3).[7] Appliances and electronics also represent a similar percentage of total energy consumption, and other small electronics and electric devices typically consume more than a quarter of the overall usage.

Figure 3: Typical residential energy end uses



Data Source: U.S. Energy Information Administration

Tenant Measures

There are various simple, low-cost actions that can increase residential energy efficiency through minor upgrades and improvements.

Consider the following energy efficiency conservation measures:

Lighting

- Replace incandescent light bulbs with CFLs or LEDs.
- Add controls for indoor and exterior lights to coincide with daylight, motion, or occupancy.

Heating and cooling

- Caulk and weatherstrip air leaks around windows and doors.
- Seal ductwork with metal tape or mastic.
- Install programmable thermostats. Set temperatures to coincide with occupancy, including night setbacks, and recommend thermostat settings of 20° C (68° F) or lower in heating season and 25° C (78° F) or higher in cooling season.
- Install timer controls for bathroom exhaust fans.
- Replace or clean furnace filters regularly.
- Install and utilize shade control devices where solar heat gain is high.

Figure 4: The interactive Energy Star® Home Efficiency Tool offers dozens of tips for every room in a house*

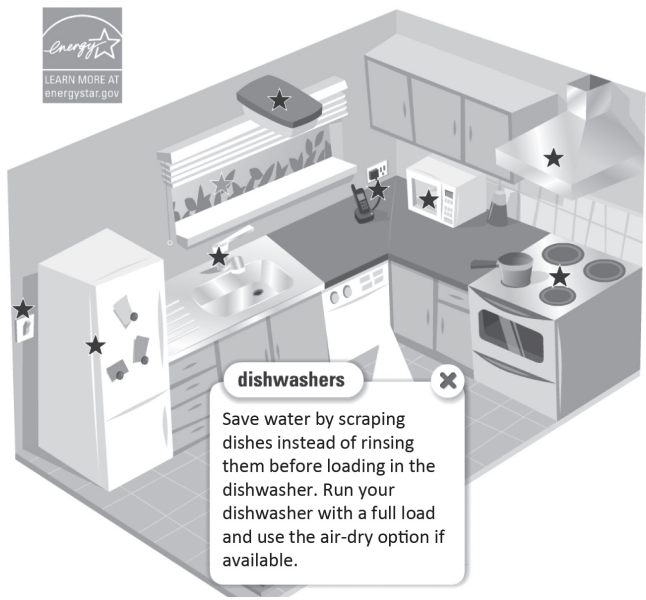


Image Source: U.S. Environmental Protection Agency

* see 🕮 Resources: Home Efficiency Tool

Appliances

- Set water heater thermostats to 49° C (120° F) or lower.
- Insulate storage water heaters and hot water pipes.
- Choose Energy Star® appliances, such as refrigerators, freezers, water heaters, washers, dryers, oven/ranges/microwaves, toaster ovens, and dishwashers (see 🕮 Resources: Home Improvement).

A typical single-family home is responsible for approximately twice as many annual GHG emissions as an average car.[8]

Phantom loads

- Use smart power supplies with occupancy sensors for larger loads.
- Unplug equipment when not in use.
- Purchase televisions and computer monitors that are Energy Star®-rated or A+, A++, or A+++ Energy Class-rated under the European Union (EU) Energy Labeling Directive.

Figure 5: EnergyGuide and Lighting Facts labels allow consumers to compare estimated annual energy consumption and utility costs of appliances and equipment

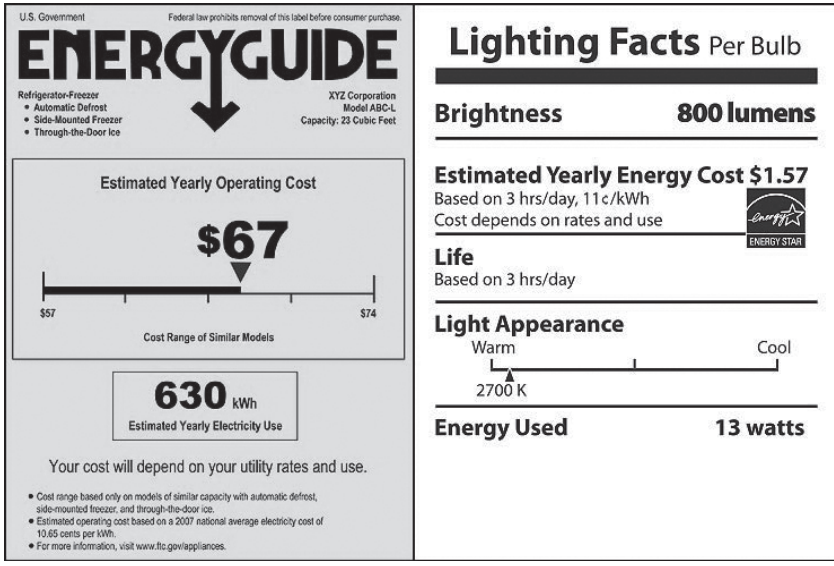


Image Source: U.S. Environmental Protection Agency

Owner Measures

Heated and cooled air can escape through roofs, attics, walls, basements, and ductwork. Install the maximum feasible amount of recycled content-containing and formaldehyde-free insulation. Evaluate other envelope upgrades, such as replacement of doors and windows.

Heating and cooling system improvements can also reduce energy use. Consider controls upgrades, such as programmable thermostats and timers, or humidistats for bathroom fans. Where ceiling heights permit, consider installing ceiling fans to reduce reliance on air conditioning systems.

If undertaking a larger HVAC system upgrade, consider installing a zoned system that can heat and cool spaces independently, such as a ductless split system, to avoid conditioning unoccupied rooms. In colder climates, air-to-air heat exchangers are an efficient way to heat ventilation air. Select Energy Star®-qualified heating and cooling equipment, and on-demand (tankless) water heaters.

Take into account energy implications when making upgrades for aesthetic or maintenance reasons. When replacing light fixtures, select CFL- or LED-compatible models to reduce lighting energy consumption. For roof replacements, select light-colored materials to reduce solar heat gain, and select light-colored blinds and shades to reflect heat to the outside, unless in cold climates, where solar gain is desirable.

Finally, consider opportunities for renewable energy, such as solar water heating, an effective residential technology for both domestic hot water and swimming pool heating (see 🕮 Resources: Solar Water Heating). Photovoltaics (PV) are another source of renewable energy; consult OBO for feasibility (see Energy: Photovoltaics).

Ten to 15% of the electricity used to power home electronics and appliances is due to phantom loads, consumed while the products are turned off.[9]

Practical Application for Tenants

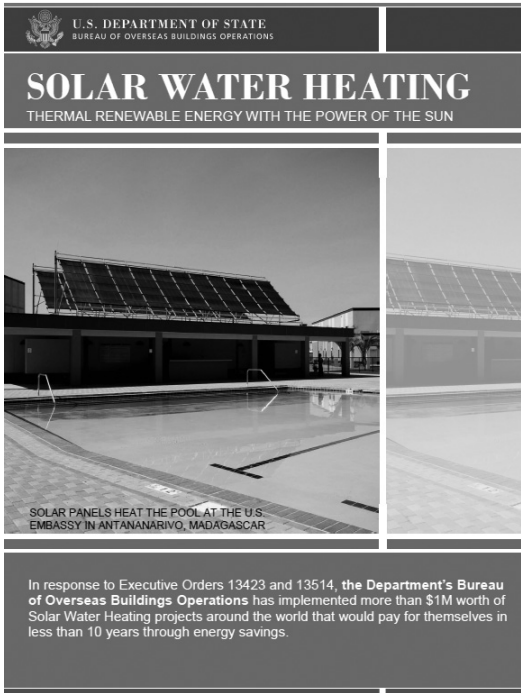
1. **Review** results of the residential audit to identify and implement any no- or low-cost recommendations.
2. **Explore** the Energy Star® interactive tool to identify room-specific strategies (see 🕮 Resources: Home Efficiency Tool).
3. **Identify** the individual responsible for each recommended improvement.

4. **Establish** an HVAC maintenance schedule to replace or clean furnace and air conditioning filters regularly.
5. **Implement** strategies to combat phantom loads.
6. **Encourage** residents to undertake conservation practices (see Residential: Staff Engagement).
7. **Incorporate** these best practices into post's residential O&M policy document and, where appropriate, into resident self-help guidelines.

Practical Application for Owners

8. **Identify** any equipment or appliances recommended for replacement. Consider upgrading any items that are more than 10 to 15 years old.
9. **Engage** a qualified contractor to undertake retrofits or renovations.
10. **Assess** the viability of renewable energy with assistance from OBO.
11. **Establish** a maintenance schedule for all equipment and systems.
12. **Use** TREES to track residential energy use and cost over time.

Figure 6: OBO's Solar Water Heating brief discusses strategies and successes



Source: Bureau of Overseas Buildings Operations

Case Study: Solar Water Heating

U.S. Mission South Africa

Benefit	The Mission expects to save 40% on residential utility bills
Time	Three months
Team Members	**Post Green Team**

At U.S. Mission South Africa, the Green Team has installed solar water heaters on residences and other post buildings, a particularly effective strategy for the sunny South African climate.

The solar hot water and recirculation systems pump water to panels on the building roofs, where it is heated by the sun and then pumped down to living areas. This process efficiently heats the water without use of a conventional electric water heater. One hundred residences at Mission South Africa, including the U.S. Ambassador's and U.S. Deputy Chief of Mission residences, have been converted from conventional electric water heaters to solar water heaters.

Solar water heating has a particularly high environmental and economic impact in South Africa, where 90% of electricity is generated from coal, the burning of which releases GHGs such as CO_2, sulfur dioxide, and nitrogen oxide, as well as mercury and particulates. South Africa's national power company, Eskom, offered purchase and installation rebates as part of a nationwide initiative to reduce fossil fuel-based energy consumption.

Electricity rates in South Africa are projected to rise 25% per year for the near future, and the use of a solar water heating system reduces energy-related risk by promoting energy independence.

Installed solar water heaters at U.S. Mission South Africa residences

Image Source: U.S. Mission of South Africa

Materials and Waste Management

Benefit ★★★☆	Reduces consumption of natural resources, supports the local economy, and reduces landfill waste
Time 🕒🕒🕒🕒	One to three months to procure and distribute gardening products, recycling bins, and other supplies; three to six months to establish recycling or reuse programs; and three to six months to find alternative construction demolition disposal, and to source, procure, and install materials
Investment $ $ $ $	Recycling bins, compost bins, natural pest management products; standard construction values for renovation materials
Team Members	**GSO** | Residents, Post Green Team, FM

In general, the procurement, resource use, and disposal policies that apply at post-level can be applied to residences. Where post undertakes large-scale purchasing for tenants, the procurement officer should aim to make bulk purchases to reduce packaging, specify recycled material content, and buy items that can be recycled after use. For example, engage a local company to provide refillable water coolers for residences, rather than supplying single-serving bottled water, particularly if there are no plastic recycling services available (see Materials: Green Purchasing).

More than 25% of all municipal waste consists of food scraps and yard trimmings that could be composted.[10]

Tenant Measures

Where appropriate, residential gardens can be used to provide rainwater retention, improve resident health and well-being, reduce heat island effect, control pests, offer a location and a reason for composting, and even provide food for residents. Distribute compost bins to collect yard and food waste.

In addition to composting food scraps and yard waste, consider opportunities for recycling and reuse based on program availability at post:

- Establish partnerships with the local community to identify groups that would benefit from donated clothing, books, or small electronics.
- Contact food banks or neighborhood groups that could pick or consume the fruit, if fruit trees are abundant.
- Identify recycling companies for metals, paper, cardboard, glass, plastic bags, and plastics.
- Work with the local government to identify programs for hazardous waste, such as oils, paints, chemicals, batteries, CFLs, and electronics.

Provide residents with containers for separating recyclables, both curbside and indoors, and distribute information to indicate acceptable materials (see Residential: Staff Engagement). Ensure that outdoor disposal receptacles are located away from homes, and are securely fastened against pests and insects that are common to the region.

Owner Measures

For government-owned properties, renovations present an opportunity to demonstrate environmental leadership through the use of healthy, environmentally-friendly, and local materials, as well as the responsible disposal of demolition waste.

Renovation projects contribute over 40% of all annually generated construction and waste debris.[11]

When undergoing demolition, consider the following best practices:

- Use appropriate precautions when working with asbestos, lead, or other hazardous materials.
- Carefully separate waste to allow reuse or recycling.
- Contact community organizations or local businesses to ask if they want reusable or salvaged items such as doors, millwork, furniture, flooring, or working appliances.
- Seal ductwork and minimize dust generation.
- Keep all exposed wall cavities dry to avoid moisture and mold damage.

When undertaking renovations, consider purchasing products from the host country or local region, using salvaged or recycled materials, selecting low-emission and low-toxicity products, and creating less packaging waste through bulk purchasing (see Materials: Green Purchasing).

Recommended residential renovation product and material attributes include:

- Low-VOC, low toxicity products, such as paints, coatings, adhesives, and caulks
- Local products (sourced within a 500-mile radius)
- Certified products and materials (e.g., Forest Stewardship Council (FSC), Global Ecolabelling Network or similar Type 1 International Organization for Standardization (ISO) 14024, Carpet and Rug Institute (CRI) Green Label, FloorScore®, Energy Star®, Energy Labeling Directive, WaterSense, Cradle-to-Cradle, Greenguard®, Scientific Certification Systems (SCS) Indoor Advantage)
- Post-consumer recycled content in insulation, concrete, gypsum board, flooring, and carpeting
- Reclaimed or rapidly renewable materials, such as recycled paper-based countertops, or bamboo or cork flooring
- Energy and water-efficient fixtures and appliances
- Durable, low-maintenance finishes and products, such as LED light fixtures that require infrequent lamp replacement, or hardwood floors instead of carpet
- Products from manufacturers with take-back programs (those that accept used products or packaging for disposal or remanufacture at the end of their useful lives)
- Products with limited waste potential, through buying only as much as needed, or requesting minimal packaging

Practical Application for Tenants

1. **Review** results of the residential audit to determine whether there are any specific needs related to purchasing and waste disposal, such as recycling bins.
2. **Work** with the chief procurement officer to identify opportunities for bulk purchasing of environmentally preferable products.
3. **Collaborate** with Post Green Team members to establish recycling and reuse programs and develop educational materials.
4. **Ensure** that each residence has compost bins and recycling bins for each applicable waste stream, and that residents know what goes in each bin.
5. **Coordinate** resident education programs for gardening, Integrated Pest Management (IPM), composting, and recycling (see Residential: Staff Engagement).

Practical Application for Owners

6. **Assess** the size of proposed renovation projects, and determine the appropriate personnel for undertaking the work.
7. **Review** OBO's Construction Demolition Waste guidelines for renovation projects prior to beginning any work.
8. **Implement** environmentally-responsible demolition waste disposal. If the renovation involves disturbance of any areas that may contain asbestos, be sure to consult OBO's asbestos protocol, or test prior to disturbance.
9. **Select** local and environmentally-preferable building products, finishes, and furnishings.
10. **Prepare** documentation outlining specific cleaning requirements and a maintenance schedule for the upgraded space.

U.S. Embassy Nairobi educates employees with a hands-on composting workshop

Image Source: U.S. Embassy Nairobi

Contaminant Reduction

Benefit ★★☆☆	Improves air quality to protect the long-term health of occupants
Time 🕐🕐🕐🕐	One to three months to select, purchase, and install materials
Investment $ $ $ $	CO detectors, finish materials and furniture, and cleaning products
Team Members	**FM** | GMO, Residents, SHEM

Poor air quality within homes can lead to respiratory illnesses, such as asthma or severe allergies. Dust, VOCs, CO, and radon are examples of common harmful contaminants. Contaminant sources include exterior pollution; smoking; pets; combustion fuels used for indoor cooking; chemicals in cleaning products and household pesticides; off-gassing of materials such as paints, finishes, fabrics, or carpets; and issues related to the physical condition of the building and HVAC systems.

Pet allergens remain suspended in the air much longer than allergens from cockroaches or dust mites; because of their microscopic size and jagged shape, pet allergens easily stick to furniture, bedding, and fabrics.

Outdoor pollutants can enter a residence on occupants' shoes or through open windows or ventilation systems. To minimize these pollutants, provide entry mats, check that exhaust fans are working properly, clean ducts regularly, and replace or clean air conditioning filters. Locate emergency generators away from building openings.

Environmental tobacco smoke contains CO, hydrogen cyanide, and numerous other known carcinogens. Eliminating smoking in indoor spaces is the only way to fully protect nonsmokers from secondhand smoke exposure, and smoking cessation programs are encouraged.[12]

Cleaning and pest control chemicals can cause adverse health reactions, particularly in people with sensitivities. Look for natural cleaning products, such as Global Ecolabelling Network-certified products or other Type 1 eco-labeling programs, as defined by International Standards Organization (ISO) 14024. Use citrus-based or benign cleaners rather than solvent-based. Select liquid or powder products rather than aerosols. Implement post's IPM

programs at all residences and inform residents of any self-help measures (see Indoor Environment: Green Cleaning).

Off-gassing—the 'new car smell' from items such as glues and adhesives used in composite wood for furniture and cabinets, in carpets, paints, and sealants, and in flame retardants used on fabrics and carpets—contributes to poor IAQ. Select zero- or very low-VOC paints, sealants, adhesives, and composites for all interior applications. Consult OBO for design criteria. Ensure that there is no added urea formaldehyde in wood products. Minimize use of carpeting to avoid dust or mold growth. Where carpeting is desired, look for products that carry the CRI Green Label Plus certification. If using hard-surface flooring, choose FloorScore certified products. Ventilate all spaces to allow furniture and finish materials to off-gas fully before occupancy (see Indoor Environment: Pollution Prevention).

Finally, the condition of a building and its systems can create air contaminants from growth of mold (see Residential: Moisture Management).

Practical Application

1. **Review** results of the residential audit and implement any no- or low-cost improvements that may be immediately undertaken.
2. **Identify** the individual responsible for implementing each recommended improvement.
3. **Ensure** that each residence has a functioning CO alarm.
4. **Provide** entry mats at all exterior entryways.
5. **Use** natural or green cleaning products and implement IPM techniques (see Site: Integrated Pest Management).
6. **Select** no- or low-VOC and sustainably certified finishes and furniture, and use hard flooring when possible for renovations.
7. **Address** moisture issues identified in Residential: Moisture Management
8. **Inspect** and replace furnace and air conditioning filters at least every three months, and clean ducts as needed. Inspect fuel-burning heating appliances annually to protect against CO poisoning.
9. **Engage** a contractor to remediate any space where testing of air quality or materials indicates unacceptable levels of radon, asbestos, or lead (see Indoor Environment: Contaminant Reduction).
10. **Incorporate** the above strategies into the residential maintenance policy document. Include guidance in resident welcome packets and in any resident self-help guidelines.

Moisture Management

Benefit ★ ★ ★ ★	Improves air quality to protect the health of occupants
Time 🕐 🕐 🕐 🕐	One to three months to identify and remediate moisture and mold issues
Investment $ $ $ $	Cleaning products and replacement materials, such as drywall
Team Members	**FM**

Building occupants can experience various adverse health effects from mold and mildew, including allergies and asthma. Excessive moisture is the primary cause of mold growth and can be the result of plumbing leaks; condensation buildup; splashing around sinks and baths; unventilated restrooms; or the infiltration of water or humid air through walls, windows, roofs, or basements. When moisture does not dry quickly, mold can form, and rot or other damage can occur.

Signs of potential moisture problems in a home can include:

- Condensation on windows
- Dampness on walls and mirrors in shower rooms
- Discoloration of ceilings or walls, and patches of mildew or mold
- Odor problems or a musty smell
- Peeling paint
- Dampness around building foundations, basements, or crawl spaces
- Standing water in drip pans below air conditioning units or refrigerators

Once identified, mold should be cleaned immediately to eliminate growth and avoid adverse health effects.

To remediate moisture and mold:

- Dry damp basements or other areas immediately.
- If mold is suspected within the HVAC system, turn off the fans, and have the ducts professionally cleaned.
- Fix plumbing leaks and dry all areas.
- Scrub mold off hard surfaces with detergent and water. Bleach is not necessary if the space is kept dry.

- Remove and replace moldy drywall, carpet, or other damaged finishes.
- Do not paint directly over mold. Clean and dry surfaces first.

To prevent moisture and mold issues in buildings:

- Install exhaust fan timers in showers, and encourage residents to use them.
- Ensure that rainwater does not drain to, or collect around, the building foundation. Install sump pumps or additional gutters as necessary, and direct downspouts away from the building.
- Drain air conditioning system condensate to avoid standing water.
- Insulate cold pipes where condensation occurs.
- Replace single-paned windows with double-glazed, insulated windows.
- Measure relative humidity inside the building, and set the HVAC systems to maintain 30–60% relative humidity, if possible. This may require adjusting the temperature or adding humidifiers or dehumidifiers.
- Replace moldy finishes with less absorbent materials.
- Identify and report locations of obvious mold if additional FM attention is warranted.

Mold can be found anywhere moisture is present, and can grow on almost any type of surface.[13]

Practical Application

1. **Review** results of the residential audit to determine where mold or moisture issues were observed.
2. **Provide** a way for residents to immediately report mold and moisture issues, and educate them about identifying mold unique to your region (see Residential: Staff Engagement).
3. **Identify** the individual responsible for each recommended improvement. Identify and engage FM staff to assist with moisture control.
4. **Engage** an expert to identify and fix moisture leaks in the building envelope and to remediate any mold that may be growing inside the walls or ceiling.
5. **Undertake** measures to prevent future moisture and mold issues.
6. **Incorporate** the above strategies into the residential maintenance policy document, and in any resident self-help guidelines.

Staff Engagement

Benefit ★ ★ ★ ★	Motivates building residents to adopt resource-conserving behaviors and habits, contributing to better resident health
Time	Updates and minor renovations scheduled during vacancies between occupants when possible; one to two months to develop materials; regularly scheduled short training sessions
Investment $ $ $ $	Preparation and implementation of education programs
Team Members	**Post Green Team** | PAO, Residents

The vast majority of the Department's owned or leased buildings are residential; resident behavior can result in significant impacts, both in meeting federal performance goals and in improving personal health. The following key behaviors can significantly reduce resource use while helping to create healthier living spaces and minimize landfill waste. They can be implemented by post staff and their families.

In each of the following impact areas, encourage post personnel to undertake best practices:

Energy

- Program thermostats to align with occupied hours and appropriate setpoints for the season.
- Turn off lights when not needed.
- Turn off or unplug electronics when not in use.
- Consider drying clothes on a clothesline, if culturally appropriate and sanctioned by post.

Water

- Fully load appliances, such as dishwashers and clothes washing machines, before use.
- Take shorter showers. Aim for five minutes.
- Turn off faucets while brushing teeth or shaving, and fill the sink to wash dishes, to avoid continuously running water.

- Take advantage of the opportunity to save water by using the lighter flush to dispose of liquid waste in residences with dual-flush toilets.

Materials reuse and disposal

- Compost kitchen scraps, recycle whatever local infrastructure allows, and dispose of hazardous waste responsibly.
- Sell or donate unnecessary household furnishings and effects.
- Move as few items as possible when transferring to a new post.
- Recycle as much household waste as possible.

Indoor environment

- Use water-based, environmentally-friendly cleaning products.
- Use operable windows and window coverings to manage indoor temperature and to bring in fresh air, where outdoor air quality is acceptable.
- Leave bathroom exhaust fans running during baths and showers and for sufficient time afterward to clear humidity, and to minimize moisture and condensation in the fan body and ducting.

In general, ask post personnel to report malfunctioning equipment, leaks, and other potential problems as soon as they notice them.

U.S. Embassy Hong Kong is saving $4,200 of housing energy costs per year through the use of a tool called eGauge, which makes post residents aware in real-time of their electrical consumption, allowing them to adjust their behavior to become more efficient.

Practical Application

1. **Review** the Using This Guide: Influencing Occupant Behavior for general tips on how to implement an occupant engagement program.
2. **Educate** occupants on personal contributions.
   - Raise awareness. Where possible, provide information to residents that can allow them to compare their energy consumption with that of their neighbors.
   - Develop residents' understanding and skills. Distribute educational materials including information on acceptable recycling materials. Offer classes on home maintenance, green cleaning, gardening and composting, and efficient landscaping and irrigation practices. Offer an education session on IPM protocol, with specific emphasis on local pests, including applicable self-help techniques. Distribute

stickers for light switches reminding residents to turn off lights when they leave a room.

3. **Educate** residents on which electronics and appliances are dual voltage (i.e., 110/220 volt (V)) and need only a simple plug adapter rather than a voltage converter. Encourage residents to turn off or unplug voltage converters when not in use and inform residents of the 'stand-by' power consumed even when off.
4. **Create** social involvement opportunities.
   - Coordinate with PAO to host an electronics recycling event at post, or tour a local recycling plant.
   - Organize tours at a local botanical garden that grows native and edible plants that thrive in the region.
   - After move-in, provide the opportunity to meet with experienced or local staff members to review the thermostat function, lighting controls, energy options on appliances, and recycling and trash sorting protocol.
5. **Implement** structural components.
   - Offer 'green home starter kits' that include reusable and non-toxic products such as linen dish cloths, reusable shopping bags, environmentally-friendly cleaning products, LED or CFL lamps, reusable coffee mugs and water bottles (for the office), and a home compost bin.
   - Ensure that post reporting mechanisms and information for manufacturers, resource providers, and water and recycling center services are functional, with up-to-date phone numbers, web pages, and email addresses.

The U.S. Embassy Montevideo Green Team at a recycling event

Image Source: U.S. Embassy Montevideo

Case Study: Resident Engagement

Vilnius, Lithuania

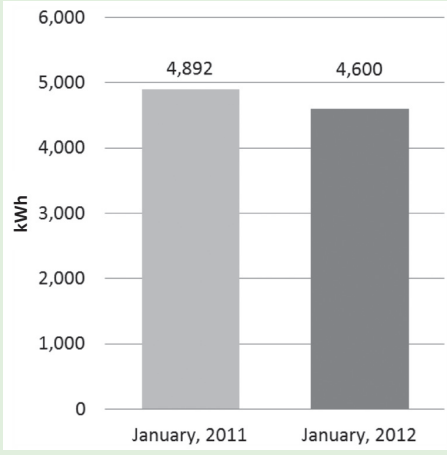
Benefit	Reduces operating expenses for residential utilities
Time	One year to fully establish
Investment	Signage and educational materials
Team Members	**Post Green Team**

U.S. Embassy Vilnius instituted a program to cut energy use at its residences, called 'TAIP! We Can Do It' ('taip' is Lithuanian for 'yes'). The program educates Post residents about their energy use by distributing a chart detailing each unit's consumption of electricity, gas, and water for the month. Usage is compared to the previous year and to average embassy residential use, which together provide benchmarks and assist with goal-setting.

Residents can choose to participate in a friendly competition, in which awards are presented to the residence with the greatest energy consumption reduction. As motivation, tips on energy conservation are distributed every month and building statistics are posted in the Embassy newsletter, increasing awareness of energy use in the Post community.

Although residents of Embassy housing do not pay for utilities directly, this program encourages conservation and environmental stewardship among residents, reduces Post utility costs, and contributes to achieving the federal performance goals for energy reduction.

Figure 7: U.S. Embassy Vilnius Marine Security Guard Residence dropped its utility usage by 6% for the month of January between two consecutive years



Data Source: U.S. Embassy Vilnius

Resources

📖 Visit *http://www.state.gov/obo/green/greenguiderefs/index.htm#residential*

Endnotes

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GLOSSARY

The new U.S. Consulate General in Guangzhou, China earned an innovation point under the Leadership in Energy and Environmental Design (LEED®) green building rating system by using signage throughout the building and site to inform occupants and visitors of the benefits of sustainable design strategies.

Glossary

Albedo
See Solar Reflectance.

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
International technical society organized to advance the arts and sciences of heating, ventilation, and air conditioning (HVAC), and refrigeration.

Asbestos
A naturally occurring mineral fiber used for thermal and acoustic insulation. Disturbed, damaged, or deteriorating asbestos releases fibers into building air, which, when inhaled into the lungs, can cause lung cancer, mesothelioma, and asbestosis. Since the mid-1980s, use of asbestos has been banned in many countries.

Audit
An in-depth analysis of a building's capacity to support current and future program needs. Typical systems examined include structure and envelope, mechanical, electrical, lighting, plumbing, site, hazardous materials, and life safety. Sustainability audits focus on the categories included in this Guide to Green Embassies (the *Guide*).

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.

Biophilia
The concept (Greek for 'love of nature') that humans hold a biological need for connection with nature on physical, mental, and social levels, and that this connection affects our personal well-being, productivity, and societal relationships.

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 (GHG) emissions produced as a result of human activity, measured in carbon dioxide equivalent (CO_2e) output. The main human activity that emits carbon dioxide (CO_2) is the combustion of fossil fuels for energy and transportation; certain industrial processes and land use changes also emit CO_2.

Climate Change
Any significant change in the measures of climate lasting for an extended period of time, including major changes in temperature, precipitation, sea level rise, or wind patterns, among others, that occur over several decades or longer.

Carbon Dioxide (CO_2)
The primary GHG emitted through human activities. CO_2 sensors are used in HVAC applications to respond to varying occupancy loads by controlling the amount of outdoor ventilation air introduced into a building to dilute indoor air contaminants, such as CO_2 exhaled by occupants.

Commissioning (Cx), Re-Commissioning (Re-Cx), and Retro-Commissioning (Retro-Cx)
A process of testing and balancing a building's systems to ensure compliance with design intent, increase system efficiency and performance, and test the interdependency of the systems. Cx applies to new buildings; existing buildings undergo Re-Cx to fine-tune performance or Retro-Cx if they have never been previously commissioned.

Constructed Wetlands
A biological wastewater treatment technology designed to mimic processes found in natural wetland ecosystems. Constructed wetlands are typically shallow basins filled with filter material (usually sand or gravel) and planted with vegetation tolerant of saturated conditions. Wastewater is introduced into the basin and through the filter medium, and is discharged out of the basin as treated effluent.

Daylighting
Illumination that is provided by light from the sun—as opposed to that from an artificial light source—and that typically includes controls to dim or turn off artificial lighting when the required light levels are met by daylight.

Effluent
Treated or untreated wastewater that flows out of a treatment plant, sewer, or industrial outfall and that is generally discharged into surface water.

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

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. Ergonomics encompasses safety, comfort, ease of use, productivity, performance, and aesthetics.

Executive Order (EO)
A rule or order issued by the president to the executive branch of the government and having the force of law.

Full-Time Equivalent (FTE)
The calculation used to define occupancy load for systems and infrastructure purposes. FTE represents the number of employees assigned to work an eight-hour shift, or combination of part-time employees that would equal an eight-hour shift. Visitors are also included in FTE, according to their duration of stay (e.g., four visitors staying an average of two hours each would equal one FTE).

Graywater
Synonymous with greywater. A non-industrial wastewater generated from domestic processes such as dish washing, laundry, and bathing. Graywater comprises 50-80% of residential wastewater. Graywater is distinct from blackwater, in that it does not contain contaminants such as feces or toxic chemicals.

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

Green Power
See Renewable Energy.

Green Roof
See Vegetated Roof.

Greenhouse Gas (GHG)
A gas that contributes to the greenhouse effect by absorbing infrared radiation. The primary GHGs are water vapor, CO_2, methane, nitrous oxide, and ozone. Other GHGs include chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Greening Diplomacy Initiative (GDI)
A U.S. Department of State (the Department) overarching program to lead by example and reduce the Department's environmental footprint, comprehensively looking at both policy and implementation impacts on sustainability (see Using This Guide: Resources).

Heat Island Effect
Also known as urban heat island effect. The condition experienced in urban areas with higher temperatures than surrounding areas, due to absorbed solar radiance of dark surfaces such as roads, roofs, and other paving. Heat island effect can raise temperatures by as much as 10 degrees Celsius (^{o} C) (15 degrees Fahrenheit (^{o} F)).

Impervious Surfaces
Surfaces characterized by a reduction or elimination of precipitation infiltration on the ground plane, resulting in increased runoff. The imperviousness of a site can be calculated by the types of surfacing (e.g., asphalt, pavers, grass, shrubs, or slope) and their corresponding coefficients of runoff.

Indoor Air Quality (IAQ)
The result of the interaction between site, climate, building system, construction techniques, contaminant sources, and building air quality as influenced by occupants. IAQ is often quantified by measuring the concentration of airborne pollutants in parts per million (ppm).

Indoor Environmental Quality (IEQ)
The overall quality of the indoor environment, encompassing IAQ, thermal comfort, daylighting, views, acoustics, and ergonomics.

Integrated Pest Management (IPM)
A management policy and program that uses a combination of tactics—including authorized use of pesticides—to control what attracts or facilitates pest access in order to reduce pest populations.

International Organization for Standardization (ISO)
International standard-setting body that promotes worldwide, proprietary, industrial and commercial standards.

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

Light Emitting Diode (LED)
A semiconductor diode that emits electroluminescent light when power is applied. 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 use 10% of the power and last up to five times longer than incandescent lighting.

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 U.S. Environmental Protection Agency (EPA).

Minimum Efficiency Rating Value (MERV)
A 16-point scale developed by ASHRAE measuring the effectiveness of air filters at capturing particulate matter ranging from 0.3 to 10 microns (μ). 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. In some instances municipal water may not be potable as provided, but must be treated on-site for use as domestic building or site water supply.

Photocell
A device that measures light intensity, usually to activate a switch that engages artificial lighting when the light level falls to a preset limit. Photocells are 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 renewable technology that uses specially constructed panel arrays to absorb the sun's energy and convert it into electrical current. Appropriate use of PVs can help offset reliance on grid-produced, fossil fuel-based power.

Pollinator-Friendly Habitat
An outdoor ecosystem that specifically attracts nectar-feeding organisms such as butterflies, hummingbird moths, honey bees, and hummingbirds. The human food chain relies on the productivity of pollinators, and it is therefore beneficial to provide these organisms with appropriate habitat.

Potable Water
Water meeting EPA's quality standards to serve as drinking water, whether or not it is used as such. Sources of potable water can include rainwater, wells, or municipal water systems, though some may require treatment.

Radon
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 and slabs. The amount of radon present in indoor air depends on the weather, soil porosity, soil moisture, and the relative pressurization of the building.

Rainwater Harvesting
The collection of rainwater to supply building water, typically requiring treatment prior to use, or to offset potable water for irrigation purposes. Rainwater harvesting minimizes municipal water use and depletion of groundwater aquifer.

Renewable Energy
Synonymous with 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 biofuels.

Solar Insolation
A measure of solar radiation energy received on a given surface area and recorded during a given time. Measured in megajoules per square meter (MJ/m^2).

Solar Reflectance
Synonymous with Albedo. The ratio of the reflected solar energy to the incoming solar energy over wavelengths of approximately 0.3 to 2.5 micrometers (µm). A reflectance of 100% means that all of the energy striking a reflecting surface is reflected, and

none of the energy is absorbed by the surface. White surfaces have the highest albedo.

Sustainability
In its environmental usage, the potential longevity of vital human ecological support systems, such as the planet's climatic system; systems of agriculture, industry, forestry, and fisheries; and the systems on which they depend. Typically includes environmental, social, and economic considerations. In recent years, public discourse has led to a use of 'sustainability' in reference to the period of time over which human ecological systems can be expected to be usefully productive.

Tririga Real Estate and Environmental Sustainability (TREES)
OBO's Utility Management, Analysis, and Reporting tool (see Using This Guide: Resources).

Upcycle
Reuse so as to create a product of a higher quality or value than the original.

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.

Vegetated Roof
Synonymous with Green Roof. A building roof that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane. Vegetated roofs control stormwater run off, reduce the heat island effect, provide insulation to reduce energy consumption, attract biodiversity, and filter pollutants out of the atmosphere.

Volatile Organic Compound (VOC)
A carbon compound that vaporizes (evaporates) at room temperatures. Examples of such compounds include gasoline, paint, paint thinners, adhesives, and cleaning solvents. VOCs can cause eye, nose, and throat irritations; headaches; dizziness; visual disorders; and memory impairment. Some VOCs are known or suspected carcinogens.

Wastewater
Any water that has been adversely affected in quality by human contamination, whether industrial or residential. Called 'blackwater' when containing fecal matter.

Xeriscaping
Landscaping that results in water savings. In common usage, xeriscaping (from the Greek 'xeri,' or 'dry') refers to the practice of using native or adapted plants that require no supplemental irrigation.

Credits

Managers

OBO/PDCS/DE: William Miner, Office Director
OBO/PDCS/DE/ESD: Donna McIntire, Chief
Melanie Berkemeyer, Managing Editor
Danielle Sines, Graphic Design Manager

Authors and Producers

Paladino and Company: Tom Paladino, Brad Pease, Wanda Lowrey, Lexy Relph, Megan Snyder, Grey Fowles, Andrew Lee, Maggie Santolla, Hanna VanOverschelde, and Kelley Manuel

Contributors

OBO/PDCS/DE/ESD: Robert Jeter, Water and Site Chapter Lead
Beth Kempton, Residential Chapter Lead
Dena Richardson, Indoor Environment and Materials Chapter Lead
David Shaffer, Energy Chapter Lead
A/OPR/GSM: Chappell Garner, Transportation Chapter Lead
OBO/EA: Christine Foushee, Amanda Hauck, and Angelina Rotella
OBO/PDCS/DE/AD: Tetsuya Yamamoto
OBO/PDCS/DE/EE: Richard Moss
OBO/PDCS/DE/ME: Joseph Cafferata
OBO/PDCS/PDC: Lisa Bolten
OBO/OPS/SHEM: Claire Huson, Ronald Martin, and Regina McClelland
OBO/CFSM/FAC: Fernando Ospina
OBO/CFSM/CM/CS: Stanley Scofield
M/PRI: Landon Van Dyke
A/OPR/FMS: Janice Smith and Mico Miller
IRM/BMP/SPO/SPD: Robert Glunt and Cecelia Henderson
League of Green Embassies: John Molesky
Franklin Fellow: Todd Fein

Peer Reviewers

Department of State Foreign Service: Jennifer Johnson, Santiago
Laura Garcia Olson, Lagos

General Services Administration: David Bosley, Amanda Dean, Andrea Azarcon Heller, and Melissa Walker

OBO Industry Advisory Group: Michael Beirut, Penny Bonda, and William Browning

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