1. Introduction

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1.1 Overview

ENERGY STAR® is a voluntary government and industry partnership that makes it easy for businesses and consumers to save money and protect the environment. The current program began in 1991 as the U.S. Environmental Protection Agency (EPA) Green Lights program, followed shortly by the introduction of the ENERGY STAR label. In 1996, the EPA partnered with the U.S. Department of Energy to increase the range of ENERGY STAR product offerings. The label now covers new homes, commercial and institutional buildings, residential heating and cooling equipment, major appliances, office equipment, lighting, and consumer electronics. The ENERGY STAR logo is the most recognizable symbol of exemplary energy performance in the U.S., with labeled buildings, homes, and products providing cost-effective solutions to the challenges of energy management and pollution prevention.

Because commercial buildings are major energy consumers, representing 18 percent of the total energy used in the U.S., the EPA developed the Guidelines for Energy Management to help building owners and operators identify and implement cost-effective strategies and technologies to reduce energy use (see www.energystar.gov/guidelines). The guidelines are based on the successful practices of ENERGY STAR partners and offer a proven strategy for superior energy management. With tools and resources available for each step of the way, the guidelines can help an organization improve its energy and financial performance and distinguish itself as an environmental leader.

Energy management begins with a senior-level commitment to continuous improvement in energy efficiency. Executive leadership demonstrates this commitment by issuing a formal energy policy for the organization and by supporting the energy objectives with adequate financial and staffing resources. Every organization should form an energy team that is responsible for overseeing the stated energy objectives and for performing periodic evaluations of energy use for all of the organization's major facilities and functions. The first time this evaluation is performed, the information can be used to establish a baseline against which progress can be measured. Energy goals should be established relative to that baseline to guide decision-making and to form the basis for tracking and measuring progress. Communicating the goals engages the entire organization in the process and can motivate staff to support energy-management efforts.

Clear performance goals also inform the development of an energy action plan. Effective plans should include company policies, financial strategies, and technical building upgrades aimed at achieving continuous improvement in energy efficiency. A detailed action plan identifies specific activities, responsible parties, and measures of success. The plan should be reviewed regularly and updated to reflect recent achievements, changes in performance, and shifting priorities.

As an organization proceeds with its energy action plan, it is important to evaluate progress through a formal comparison of actual energy consumption data and stated performance goals. This comparison will determine whether goals have been achieved, will identify the organization's best practices, and will inform decisions about how to achieve future goals. Those individuals and groups that helped achieve significant results should be recognized for their accomplishments based on this review, and the organization should seek opportunities for external recognition of those achievements. Formal recognition encourages further efforts and builds support for the plan.

Given the cost-savings potential of improving energy efficiency in existing buildings, the EPA has developed this Building Upgrade Manual to assist organizations in planning and implementing profitable upgrades. This manual outlines a process for developing a comprehensive energy-management strategy and an integrated approach to upgrading existing buildings. It also provides information on proven energy-efficient technologies that can produce energy savings of 35 percent or more. The EPA estimates that if the energy efficiency of commercial and industrial buildings improved by just 10 percent, Americans would save about $20 billion annually and reduce greenhouse gas emissions equal to the emissions from almost 30 million vehicles. As part of its efforts to encourage energy efficiency in buildings, the EPA has awarded the ENERGY STAR to thousands of facilities for their superior performance. (For more on the ENERGY STAR Buildings Program, visit www.energystar.gov/buildings.)

1.2 Technical Advice

The building upgrade effort, like most business projects, will be most successful if it involves a commitment from senior-level management to energy performance and pollution prevention. The recommended upgrade process follows a five-stage approach and emphasizes continuous improvement. The five stages are appropriate for any type of facility, but different types of facilities have different needs and characteristics that will influence just how the stages are implemented.

Managing an Upgrade Project

The process recommended in this manual begins with management and planning advice. Strategies that contribute to the success of any major business undertaking should be applied to building upgrades:

- *Benchmarking (Chapter 2).* Comparing the energy use of facilities with others nationwide helps to identify opportunities for savings. The EPA's Portfolio Manager is an interactive energy management tool available in a secure online environment. It allows organizations to effectively benchmark by tracking and assessing energy and water consumption across an entire portfolio of buildings. Certain types of buildings can use the tool to go a step further and compare building energy performance relative to the national population of buildings with similar characteristics and receive a score on a scale of 1 to 100. A score of 75, for example, indicates that the building performs better than 75 percent of all similar buildings nationwide and may qualify that facility for an ENERGY STAR label (www.energystar.gov/benchmark).

- *Investment Analysis (Chapter 3).* As with any other investment, potential building upgrade projects should be analyzed based on their expected cash flows. Organizations typically employ one or more financial-analysis tools rooted in cash flow to study, rank, and choose among investment opportunities. To compete successfully for capital against other investments, building upgrades should be evaluated using the same tools.

- *Financing (Chapter 4).* Many opportunities exist for financing efficiency projects, and new opportunities are being created all the time. In addition to traditional sources of funding such as financial institutions and capital markets, many utilities, governments, and nonprofit organizations offer financial support through grants, rebates, and loans. Well-designed efficiency projects are almost always fundable.

Staged Approach to Building Upgrades

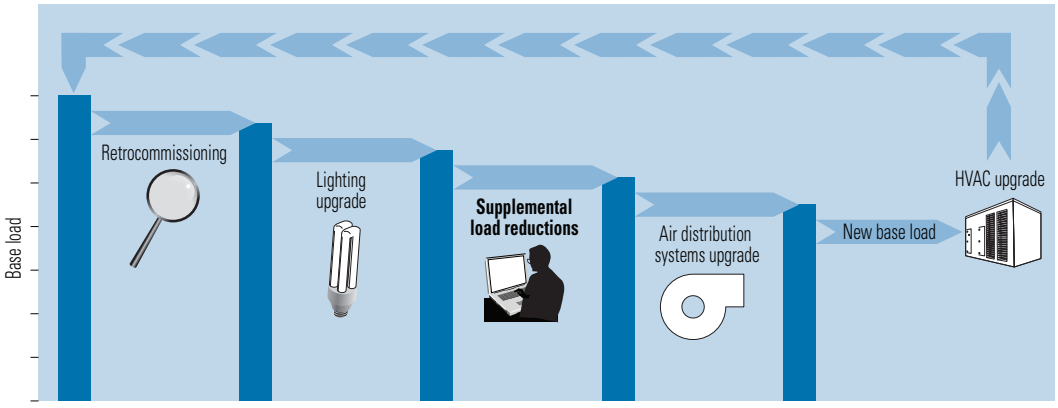
A staged approach to building upgrades will help to increase the financial and environmental benefits realized. The stages recommended by the EPA account for the interactions among all the energy flows in a building (**Figure 1.1**) and produce a systematic method for planning upgrades. Each stage includes changes that will affect the upgrades performed in subsequent stages, so when they are performed sequentially they set up the overall process for the greatest energy and cost savings.

The five stages recommended by the EPA are:

- *Retrocommissioning (Chapter 5).* Retrocommissioning is the first stage because it provides an understanding of how a facility is operating and how closely it comes to operating as intended. Specifically, it helps to identify improper equipment performance, equipment or systems that need to be replaced, and operational strategies for improving the performance of the various building systems.
- *Lighting (Chapter 6).* Lighting upgrades, which may include new light sources, fixtures, and controls, come early in the process because the lighting system has a significant impact on other building systems. Lighting affects heating and cooling loads and power quality.
- *Supplemental Load Reductions (Chapter 7).* Supplemental load sources, such as building occupants and electronic equipment, are secondary contributors to energy consumption in buildings. They can affect heating, cooling, and electric loads. With careful analysis of these sources and their interactions with HVAC systems, equipment size and upgrade costs can be reduced.
- *Air Distribution Systems (Chapter 8).* Air distribution systems bring conditioned air for heating or cooling to building occupants, and therefore directly affect both energy consumption and occupant comfort. Fan systems can be upgraded and adjusted to optimize the delivery of air in the most energy-efficient way.

Figure 1.1: The staged approach to building upgrades

The staged approach recommended by ENERGY STAR accounts for the interactions among all the energy flows in a building. Each stage includes changes that will affect the upgrades performed in subsequent stages, thus setting the overall process up for the greatest energy and cost savings possible.



Stages of an integrated upgrade approach

Courtesy: E SOURCE

- *Heating and Cooling Systems (Chapter 9).* If the steps outlined in the first four stages have been followed, cooling and heating loads are likely to have been reduced. That reduction, coupled with the fact that many existing HVAC systems are oversized to begin with, means that it may be possible to justify replacing an existing system with one that is properly sized or retrofitting a system so that it operates more efficiently. In addition to saving energy, proper sizing will likely reduce noise, lower the first costs for equipment, and optimize equipment operation, often leading to less required maintenance and longer equipment lifetimes.

Energy management should also be viewed as a path of continuous improvement. As illustrated in Figure 1.1, after completion of the fifth stage, the process can begin again with a recommissioning effort to determine where further savings can be found.

Unique Building Challenges

The overall strategy described in this manual is appropriate for all types of facilities, and many of the specific measures described can be used no matter what type of building is under consideration. However there are also many strategies, priorities, and opportunities that are unique to, or most effective in, specific facility types. To address these unique challenges and opportunities, the manual includes chapters on the following types of facilities:

- *K–12 Schools (Chapter 10).* Because of the need to ensure a good educational environment, important considerations when upgrading schools include security and safety, indoor air quality, thermal comfort, visual comfort, and acoustic comfort.
- *Supermarkets (Chapter 11).* A major opportunity for energy savings unique to supermarkets lies with the refrigeration equipment that keeps food from spoiling. Careful attention should be paid to the interactions among refrigeration and other building systems, such as lighting and space conditioning.
- *Hotels and Motels (Chapter 12).* The major challenge in upgrading hotels and motels is to maintain guest comfort in a wide variety of spaces, including guest rooms, public lobbies, banquet facilities and restaurants, lounges, offices, retail outlets, and swimming pools. The opportunities for improved guest comfort, longer equipment life, lower operating costs, and an improved corporate image make the challenge worthwhile.
- *Retail Establishments (Chapter 13).* Energy is one of the few expenses that can be reduced without negatively affecting a retailer's operation. In fact, a building upgrade can provide a number of benefits, including increased profitability, reduced vulnerability to energy price fluctuations, increased sales, and improved public image.

1.3 Getting Started Now

Energy consumption represents a significant portion of any building's operating cost, whether that building is used to educate students, host weary travelers, or provide any other function. For many facilities, energy costs are the single largest controllable cost of operations, so improved energy efficiency has a direct and substantial payback for investors. Each day of delay in boosting efficiency means lost potential savings. The first step in starting the upgrade process and beginning to reap the benefits is to become an ENERGY STAR partner. When a senior executive signs a Partnership Letter, it means that the organization is committed to improving energy performance by:

- Measuring and tracking the energy performance of the organization's facilities where possible by using tools such as those offered through ENERGY STAR
- Developing and implementing a plan consistent with the ENERGY STAR Guidelines for Energy Management to achieve energy savings
- Helping to spread the word about the importance of energy efficiency to its staff and the surrounding communities
- Supporting the ENERGY STAR Challenge, a national call to action intended to help improve the energy efficiency of America's commercial and industrial buildings by 10 percent or more
- Highlighting their achievements with recognition offered through ENERGY STAR

The EPA provides resources and assistance that can help an organization achieve exemplary energy-performance goals. That assistance takes the form of analytical software tools, publications, technical guidance, and visible recognition of achievements. To learn more, visit the ENERGY STAR web site (www.energystar.gov) or call the ENERGY STAR Hotline at 1-888-STAR-YES (1-888-782-7937).

Bibliography

U.S. Department of Energy, Energy Efficiency and Renewable Energy, "2006 Buildings Energy Data Book" (September 2006), http://buildingsdatabook.eere.energy.gov.

U.S. Environmental Protection Agency, "The ENERGY STAR for Buildings," www.energystar.gov/index.cfm?c=business.bus_bldgs.