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From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency

by

William R. Prindle
ICF International

PEW CENTER ON Global CLIMATE CHANGE

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Prepared for the Pew Center on Global Climate Change

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Foreword *Eileen Claussen, President, Pew Center on Global Climate Change*

Driven by rising energy prices and growing concerns about greenhouse gas emissions, companies are implementing aggressive, corporate-wide energy efficiency strategies. Leading companies are not only setting ambitious energy savings targets, they are reaching out to suppliers and customers, and engaging employees at all levels of the organization to advance an ethic of energy efficiency.

The results are impressive. Some companies reported billions of dollars of cost savings and millions of tons of avoided greenhouse gas emissions from their efficiency efforts. These businesses are leading the way in demonstrating that the climate challenge can be met in a way that allows for continued, robust economic growth. The companies that have achieved these successes share several key attributes. In this Pew Center report, author William R. Prindle of ICF International, catalogues and describes these attributes, which include:

- **A commitment to energy efficiency must start at the top.** Strong leadership from senior managers, including the CEO, is essential to getting an energy efficiency strategy started and sustaining it over time.
- **Data management matters a great deal.** Today's best efficiency programs strike a delicate balance: they collect voluminous data, without inundating decision makers with an overwhelming volume of information.
- **Results can be maximized by expanding efficiency efforts to suppliers and customers.** Many companies have found that much of their energy use and greenhouse gas emissions occur outside of their own direct operations. As a result, companies are reaching out across their value chain to tap into even larger energy savings opportunities.
- **An emphasis on energy efficiency can lead to broader innovation and process improvements within a company.** As companies in this study have found, the benefits of energy efficiency go beyond dollars saved and carbon emissions reduced; it can also lead to product quality and productivity improvements.

The Pew Center would like to thank Dr. Marilyn Brown, Matthew Cox, Adam Hinge, and Christopher Russell for their comments on an earlier draft of the report, and the many member companies of our Business Environmental Leadership Council that provided comments and guidance throughout the research process.

Acknowledgements

Many individuals, companies, and organizations contributed to the development of this report. The Pew Center wishes to acknowledge all those who volunteered their time and expertise, and in particular, to thank the members of our project advisory committee, the six case study companies, and the many members of our BELC that provided comments and guidance throughout the research process. The Pew Center would also like to thank Toyota for its generous support of the project. The flow chart below illustrates and describes the different components that went into the report.

Advisory Committee

Marilyn Brown
Georgia Institute of Technology

R. Neal Elliott, III
ACEEE

Peter Garforth
Garforth International, LLC

Jay Golden
Arizona State University

Ashok Gupta
Natural Resources Defense Council

Adam Hinge
Sustainable Energy Partnerships

Kathleen Hogan
U.S. Department of Energy

Glen A. Lewis
University of California, Davis

Christopher Lynch
The Wharton School, University of Pennsylvania

Gene Rodrigues
Southern California Edison

Kyle Tanger
Clear Carbon Consulting

BELC Workshops

Energy Efficiency Workshop I: Operational & Facilities Strategies

Energy Efficiency Workshop II: Supply Chain Strategies

Energy Efficiency Workshop III: Products and Services

Energy Efficiency Workshop IV: Sharing Best Practices

Survey

The Pew Center developed a 65-question survey and distributed it to 95 companies in January 2009. The purpose of the survey was to gather quantitative data and identify broad trends in corporate energy efficiency strategies among major companies with a demonstrated commitment to climate and energy issues. A total of 48 companies completed the survey, for a response rate of approximately 53 percent.

Case Studies

1. **Dow Chemical** (Integrated Approaches)
2. **United Technologies** (Integrated Approaches)
3. **IBM** (Integrated Approaches)
4. **Toyota** (Internal Operations)
5. **PepsiCo** (Supply Chain)
6. **Best Buy** (Products & Services)

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Business Input
Including the members of the Pew Center's Business Environmental Leadership Council

Underwritten by the generous support of TOYOTA

Project website: **www.pewclimate.org/energy-efficiency**

Executive Summary

This report stems from a historic shift in business leaders' perceptions of energy and climate change issues. In the last decade, rising and volatile energy prices have converged with increasing concern about climate change and growing consumer support for action on energy and environmental issues to drive a surge of corporate environmental commitments. As companies have begun to act on these commitments, energy efficiency has emerged as a first-priority strategy. Accordingly, many companies have launched aggressive efficiency strategies, in many cases well beyond the scope and reach of earlier efforts.

This report documents these leading-edge energy efficiency strategies, distilling the best practices and providing guidance and resources for other businesses choosing this path. It was developed over nearly two years of effort from Pew Center on Global Climate Change staff, a project advisory committee, members of the Pew Center's Business Environmental Leadership Council (BELC),[1] project consultants, and report authors. The project encompassed a detailed survey of BELC members and other leading companies, in-depth case studies of six companies, a series of workshops on key energy efficiency topics, broader research in the corporate energy field, and development of a full-featured web portal to provide a platform for highlighting and updating key findings from the project as well as providing tools, resources, and other important information. The report covers efficiency strategies encompassing internal operations, supply chains, products and services, and cross-cutting issues.

A key finding from this report is that climate change has reframed corporate energy strategies. Companies that take on carbon footprinting and reduction strategies quickly come to see their energy use in a whole new light. On average, companies surveyed for this study reported spending less than five percent of total revenues on energy—even in today's relatively high cost energy environment. But when these companies calculate their carbon footprint, they typically find that their energy consumption accounts for the great majority of their directly measurable emissions impact. Suddenly, energy shifts from a small cost item to the biggest piece of their carbon footprint. Viewed from this perspective, energy efficiency becomes a sustainability[2] imperative.

This report summarizes the core elements of the best corporate energy efficiency strategies into "Seven Habits" of core practices and principles, cutting across internal operations, supply chains, and products and services. These habits are summarized in **Table ES-1**, and include: efficiency is a core strategy; leadership and

Table ES-1

The Seven Habits of Highly Efficient Companies

1. Efficiency is a Core Strategy	
• Efficiency is an integral part of corporate strategic planning and risk assessment and not just another cost management issue or sustainability "hoop" to jump through.	• Efficiency is an ongoing part of the organization's aspirations and metrics for itself.
2. Leadership & Organizational Support is Real & Sustained	
• At least one full-time staff person is accountable for energy performance. • Corporate energy management leadership interacts with teams in all business units. • Energy performance results affect individuals' performance reviews and career advancement paths.	• Energy efficiency is part of the company's culture and core operations. • Employees are empowered and rewarded for energy innovation.
3. The Company Has SMART Energy Efficiency Goals	
• Goals are organization-wide. • Goals are translated into operating/business unit goals. • Goals are specific enough to be measured.	• Goals have specific target dates. • Goals are linked to action plans in all business units. • Goals are updated and strengthened over time.
4. The Strategy Relies on a Robust Tracking & Measurement System	
• The system collects data regularly from all business units. • The data is normalized and baselined. • Data collection and reporting is as granular as possible. • The system tracks performance against goals in a regular reporting cycle.	• Performance data is visible to senior management in a form they can understand and act upon. • Energy performance data is shared internally and externally. • The system is linked to a commitment to continuous improvement.
5. The Organization Puts Substantial Resources into Efficiency	
• The energy manager/team has adequate operating resources. • Business leaders find capital to fund projects.	• Companies invest in human capital.
6. The Energy Efficiency Strategy Shows Demonstrated Results	
• The company has met or beat its energy performance goal. • Successful energy innovators are rewarded and recognized.	• Resources are sustained over a multi-year period.
7. The Company Effectively Communicates Efficiency Results	
• An internal communications plan raises awareness and engages employees.	• Successes are communicated externally.

organizational support are real and sustained; the company has SMART (specific, measurable, accountable, realistic, and time-bound) energy efficiency goals; the strategy relies on a robust tracking and measurement system; the organization puts substantial resources into efficiency; the energy efficiency strategy shows results; and the company effectively communicates efficiency results internally and externally.

The report also describes common barriers companies face in developing and implementing energy efficiency strategies, and provides examples of successful approaches to overcoming these barriers. The most common barriers identified by the companies studied in this report include: lack of project funding; lack of personnel with the appropriate skill sets; inadequate management tools; and insufficient technical information.

Augmenting the report are case studies of six unique and highly effective corporate energy efficiency programs. These case studies, built through a combination of site visits, phone interviews, and email data requests, add depth and detail to the major trends and conclusions identified in the body of the report. Three of the case studies examine integrated approaches to achieving superior corporation-wide energy performance and another three look at specific initiatives targeting products and services, the supply chain, and internal operations. The case study subjects are: The Dow Chemical Company, United Technologies Corporation (UTC), and IBM (integrated approaches); Toyota (internal operations); PepsiCo (supply chain); and Best Buy (products and services).

These and other leading companies are showing what organizations can do to reduce energy use and carbon emissions. Businesses have the power, through their people and their collective resources, to drive not only technology changes, but behavioral and cultural changes. And since businesses account for the majority of energy use, at least in the U.S. and other industrialized economies, this study suggests that they may possess some of the most powerful tools needed to meet today's climate challenges. The Seven Habits principles and practices identified in this report could become the basis for new standards of practice that companies drive not just through their operations, but also across their value chains, creating a powerful force for meeting the climate challenge.

I. Introduction

A. Background

This report stems from a historic shift in corporate leaders' perceptions of energy and climate change issues. In the last decade, rising and volatile energy prices coupled with increasing concern about climate change and growing support for action on energy and environmental issues has driven a surge of corporate environmental commitments. Energy efficiency has emerged as a key component of these commitments. Over the last several years, many companies, including numerous members of the Pew Center's BELC, have launched aggressive efficiency strategies, in many cases surpassing the ambition of previous efforts.

This report documents these leading-edge energy efficiency strategies, describing best practices and providing guidance and resources for other businesses seeking to reduce energy use in their internal operations, supply chains, and products and services. It was developed over almost two years of effort from Pew Center staff, the project advisory committee, BELC members, project consultants, and report authors. The project encompassed a detailed survey of BELC members and other leading companies, in-depth case studies of six companies, a series of workshops on key energy efficiency topics, broader research in the corporate energy field, and development of a full-featured web portal to provide a platform for highlighting and updating key findings from the project as well as providing tools, resources, and other important information.

Pew Center Corporate Energy Efficiency Web Portal

The Pew Center's corporate energy efficiency web portal (www.pewclimate.org/energy-efficiency) contains additional information and supporting documentation for key themes covered in this report. Resources available on the site include:

- A comprehensive, searchable database of energy efficiency initiatives undertaken by the 46 companies in the Pew Center's BELC.
- Key results from the survey undertaken to gather key quantitative data for this report. A PDF of the original questionnaire sent out to survey participants is also available for download on the site.
- Presentations delivered at a series of workshops held by the Pew Center to support the project.
- Notable external resources on corporate energy efficiency strategies and news articles.
- An inventory of partnerships and programs devoted to improving energy efficiency in the private sector.

The report and case studies are also posted on the portal, and the Pew Center will make presentations and other content from its April 6–7, 2010 conference available for download as well. The site will continue to be updated as new materials and events are generated and announced in conjunction with this project.

B. Purpose of the Report

Meeting the global climate challenge requires a multi-faceted effort, from de-carbonizing energy sources to fostering sustainable agriculture and forestry practices. Many of these solutions will take decades or generations to fully engage, but energy efficiency is a resource that is available today. Efficiency also comes with a strong business case for reducing operating costs and risks, driving operational and technical innovation, and opening opportunities for new products and services. While these business benefits do not come without risks, leading companies have judged efficiency investments to be typically lower-risk than other uses of funds and organizational resources.

Companies have pursued efficiency successfully and have results to show for it. The energy crises of the 1970s jolted many companies into efficiency action, and while some of those actions were delayed or sidetracked during the intervening decades of inexpensive energy, the experience companies gained during this period has helped them respond to the latest set of energy shocks.

The report is designed to achieve two overarching purposes: 1) Articulate the business case for energy efficiency strategies. In many cases, companies' climate change strategies help drive their energy efficiency efforts, but this study has shown that there is a robust business basis for more aggressive efficiency strategies;

and 2) Educate corporations and other organizations on the most effective energy efficiency strategies and overall management approaches in their operations, supply chains, and products and services. These approaches include tactics for reducing the barriers to wider adoption of energy efficiency.

To bring focus to this complex topic, the report breaks efficiency strategies into four categories of best practices: organization-wide, internal operations, supply chains, and products and services. This categorization, while helpful for organizing the report, should not be used to fragment the overarching principles and success factors. Companies with successful energy efficiency strategies maintain company-wide programs engaging people at many levels and across many functions and operating units. Internal operations, supply chains, and company products are interwoven with the company's customers and suppliers; for example, one company's supply chain is another company's products. Some companies use what they learn through internal operations to develop innovative products and services. Others have transferred knowledge gained from administering their own efficiency programs to their suppliers. The companies that fully "get" the scope of winning efficiency strategies drive them as far as they can, cutting across the report's categories. One of the clearest hallmarks of success in today's best energy efficiency strategies is that they break down walls between functional units, business units, and other organizational domains. This kind of strategy goes far beyond cost management, supporting productivity and innovation and creating new streams of customer and shareholder value.

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C. Overview and Organization of the Report

The report consists of the following main sections:

- **Making the case for corporate energy efficiency strategies**—This section summarizes the rationale and specific motives that support new or increased commitments to robust energy efficiency strategies.
- **Pew Center survey findings—**This section presents key findings from a 65-question survey on corporate energy efficiency that the Pew Center distributed to leading corporations (see Appendix A, page 160, for background on the survey and its methodology).
- **Organization-wide principles and practices: the "Seven Habits of Highly Efficient Companies"—**Distilled from the Pew Center survey, case studies, input from the project advisory committee and other sources, this section defines seven organization-wide characteristics of companies that succeed in advancing energy efficiency strategies.

- **Internal operations strategies and practices**—This section focuses on strategies and practices that most effectively reduce energy used in manufacturing processes and facilities.
- **Supply chain strategies and practices**—Looking "upstream" from their own operations, more and more companies are developing strategies and practices to work with their suppliers to reduce the energy needed to make and transport materials and goods.
- **Products and services strategies and practices**—A high percentage of companies engaged in this project have developed strategies to design and market more energy-efficient products and services, in some cases drawing on experience from their internal operations.
- **Case studies**—Six companies provided detailed interviews, data, and shared their energy efficiency stories for this project. Four of the case studies also benefited from site visits by the author. The best practices sections above draw heavily on examples from these case studies, but they make compelling stories in and of themselves. The case study subjects are:
    - **The Dow Chemical Company (integrated approaches):** One of the world's leading chemical manufacturers, Dow uses approximately the same amount of energy on an annual basis as Australia. Having felt deeply the effects of rising energy prices, Dow views energy efficiency as an important risk management strategy.
    - **United Technologies Corporation (integrated approaches):** UTC is a highly decentralized company that uses a sophisticated data management system to keep its disparate business units pulling in the same direction on energy efficiency. UTC's efficiency strategy stems from a corporate commitment to root out waste in all forms throughout the company.
    - **IBM (integrated approaches):** A high technology company, IBM developed a robust energy efficiency strategy that has allowed it to exceed its 3.5 percent annual energy conservation target. IBM has also been able to parlay its internal efficiency expertise into a profitable client offering, including in the area of data center efficiency.

- **Toyota (internal operations):** Toyota's commitment to continuous improvement has allowed it to become one of the most energy efficient car companies in the world. Its "treasure hunt" process, in which teams of employees and sometimes senior executives comb through a plant searching for energy efficiency opportunities has been emulated by dozens of leading manufacturers.
- **PepsiCo (supply chain):** PepsiCo has made great strides in helping its suppliers become more energy efficient. It has conducted comprehensive analyses of its products' life cycle carbon footprint, and shares energy savings resources, tools and goals with its suppliers. PepsiCo is also at the leading edge of a growing number of companies that are beginning to link energy efficiency and water efficiency strategies.
- **Best Buy (products and services):** A consumer-facing company, Best Buy works hard with its sales staff and external partners to promote energy-efficient products. Best Buy estimates that in 2008 its sales of EPA ENERGY STAR labeled products saved its customers over $90 million in electric utility bills.

- **Appendices—**These include details on methodology for the survey and the average energy savings target calculated from the survey results.

II. Making the Case For Corporate Energy Efficiency

A. The Policy Environment

The policy environment inevitably shapes the business environment and vice versa. This section begins with a summary of the policy case for energy efficiency, which has been made many times by elected officials, government agencies, environmental advocates, and research experts. Generally speaking, it focuses on the broader, societal benefits of energy efficiency and can be summarized by the following points:

Efficiency is the largest near-term greenhouse (GHG) reduction opportunity—Studies have shown that the magnitude of the energy efficiency resource, in industrial and commercial facilities as well as residential buildings and vehicles, is larger than any non-emitting energy resource that can be deployed in the near term.[3] Research from McKinsey & Company (illustrated in **Figure 1**) shows not only that energy efficiency technologies and practices taken together comprise the largest potential emission reductions, but also that efficiency measures tend to be among the lowest-cost options, typically producing net economic benefits over their lifetime.

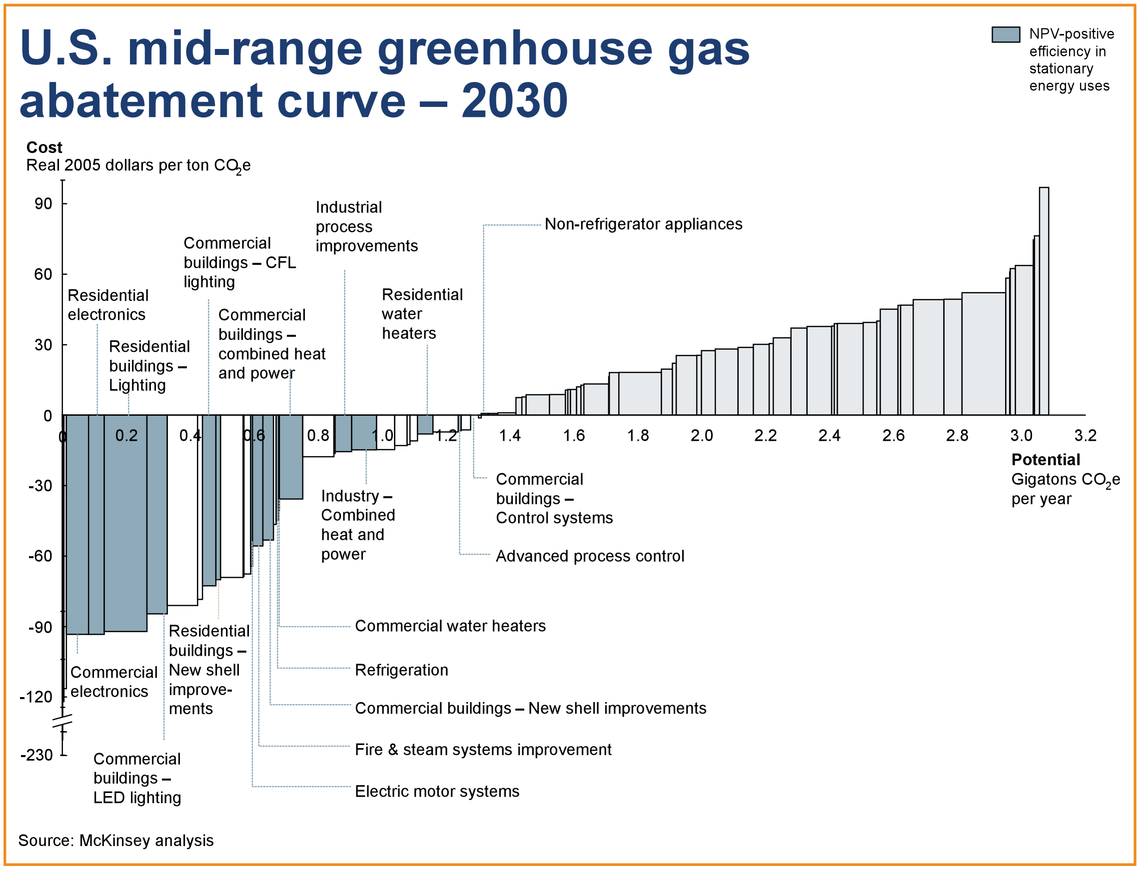
Efficiency "buys time" for the de-carbonization of energy supplies—Long-term solutions to the climate challenge depend largely on converting energy supply systems to non-GHG-emitting technologies. But energy efficiency can produce fast, near-term emissions abatement, allowing time for longer-term technologies to mature and diffuse into the marketplace. Additionally, unless energy demand is substantially reduced from current forecasts, deploying enough non-emitting supply resources will be unattainable or extremely expensive.

Efficiency is the lowest-cost GHG reduction option—On a levelized lifecycle cost basis, efficiency costs less than conventional energy supplies, often creating net economic savings while reducing GHG emissions.[4] Significant investment in energy efficiency will reduce the total economic cost of emissions reduction regulations.

Efficiency is often a no-regrets investment—Because efficiency is often cost-effective with or without GHG reduction benefits, it has long been termed a "no-regrets" policy that would create economic benefits even absent climate change considerations.

Figure 1

Energy Efficiency as a **GHG Reduction** Resource



In the McKinsey cost curve depicted above, the width of the bars represents the potential GHG reductions available from specified abatement options, while the height of the bars illustrates the costs of the abatement options, as measured on a dollar per ton of avoided carbon dioxide equivalents (CO_2e) basis. Efficiency opportunities are highlighted in blue. Many of these reside on the left hand side of the curve, indicating positive economic returns from undertaking the projects. Source: Granade et al (2009). *Unlocking Energy Efficiency in the U.S. Economy.* McKinsey Global Energy & Materials, multi-client study.

Many corporate leaders understand and support these arguments, and some sustainability commitments explicitly include them. But from a purely financial bottom-line, near-term perspective, the final point above is most relevant when considering whether to launch a corporate energy efficiency strategy. In addition to any broader sustainability commitments, a corporation needs a sound business rationale for moving forward with an aggressive energy efficiency strategy.

> *In addition to any broader sustainability commitments, a corporation needs a sound business rationale for moving forward with an aggressive energy efficiency strategy.*

The policy case for energy efficiency as a climate change mitigation strategy was made as long ago as the 1980s, when U.S. and international climate policy first came into focus. However, energy prices were relatively low, and neither climate nor energy issues were on the front burner of public opinion. In the past decade, however, energy prices and concern about climate impacts made news headlines. Corporate leaders, noting these trends, began to take action, with energy efficiency emerging as a leading component of that action.

This new wave of corporate focus on energy efficiency was captured in a 2007 report from the Global Business Network (GBN) called *Energy Strategy for the Road Ahead*.[5] Summing up the shifting attitudes in the business community, the report stated:

> "…[C]orporate America has reached a tipping point, with companies across a host of industries now making the cost, availability, and environmental impact of their end-to-end energy consumption a strategic priority. Increasingly, the wider impact of climate change on their markets and operations is being factored in. They are now frequently viewing energy management as a form of risk management. What had once been managed purely as a cost is increasingly being managed as a strategic risk—and even, intriguingly, as a source of new value and opportunities."

The GBN report explored several potential future energy scenarios and identified five strategic steps companies should consider for their energy strategies:

1. Master the fundamentals of energy efficiency inside the organization.
2. Take a longer and broader view of investments, practices and other strategic decisions across the entire supply chain.
3. Seek business transformation opportunities for operational and technology innovation and productivity improvement, driven by aggressive efficiency commitments.
4. Develop contingency strategies for disruptive energy market events.
5. Take personal action as leaders within organizations and across industries.

These steps expand the vision for energy efficiency beyond its historical role in most corporations. In the past, energy was seen mainly as a cost management issue, and was assigned to mid- and lower-level staff, typically at the facility level. The mission of energy managers in those days was to keep energy flowing and manage its costs without affecting the core business. Energy was a "boiler room" issue in this vision—specialized, limited in scope, and only peripherally related to the company's core business. While there are certainly exceptions to this rule, especially for energy-intensive industries such as primary manufacturers, it holds for the majority of the business sector.

Energy-Intensive Industries

Energy-intensive industries face a unique set of challenges relative to other sectors of the economy. The industrial sector overall accounts for about one-third of total energy use in the United States.[6] A small group of energy intensive industries—chemical, primary metal, pulp and paper, and non-metallic mineral product (including stone, glass, clay and cement)—account for roughly half of industrial energy use.[7] Due to their high levels of energy use, these industries are particularly sensitive to energy price increases. As such, companies within these industries typically have longer experience with energy efficiency programs. A number of public and private initiatives have focused on efficiency measures for energy-intensive industries.[8] While many of these measures can be applied across the industrial sector, many others involve process changes that are unique to the individual industry.

Still, analysts have identified ample opportunities for further energy efficiency improvements in energy-intensive industries. McKinsey & Co. identified 1,550 trillion end use BTUs of energy savings potential by 2020, equivalent to a 15 percent reduction in energy use in these energy intensive industries against business as usual levels.[9] Barriers to greater efficiency within the energy intensive industries are similar to the barriers facing the industrial sector overall, including limited access to capital and short payback requirements. While these companies tend to pay more attention to their energy bills than most companies, insufficient awareness and attention to efficiency opportunities is still an issue.

B. Shifting Out of the Boiler Room Paradigm

The "boiler room" mentality made sense when energy first became a front-page issue in the 1970s due to oil supply shocks. In those days, energy was put under the microscope as companies struggled to understand and control their energy consumption. But this microscope approach also created a "stovepipe" effect; energy was viewed as a single, narrow set of technical issues. Energy managers zoomed in on the fastest and cheapest ways to reduce energy waste in heating and cooling systems, lighting, compressed air, pumps, fans and motor systems. And they succeeded to a large extent—controlling waste in boilers, chillers, lighting systems, and other areas. But much of these gains went unnoticed in the wider organization. In the recent wave of energy efficiency strategies, leading companies are looking "outside the energy box," using energy performance goals to re-assess a wide range of technologies and practices. What they are finding is that energy efficiency can produce benefits other than direct energy savings.

Table 1 illustrates the evolution of energy efficiency strategies from the boiler-room mentality of the 1970s to the global sustainability paradigm emerging in the 21st century.

Table 1

Evolution of Energy Efficiency Strategies

Era	Theme	Key Focus Areas	Limiting Factors
1970s	"Shock and Audits"	• Short-term energy cost savings • Energy audits kept narrow focus on energy systems • Incremental change at organizational level	• Efficiency efforts stovepiped • Few efficiency technologies available
1980s	"Free Markets"	• Market and price expected to yield optimal results	• Falling energy prices took the focus off energy efficiency • Market focus alone unable to address inter-connected issues
1990s	"Global Awakening"	• International climate policies appeared • Voluntary U.S. programs launched • Corporate sustainability programs emerged	• Low energy prices reduced urgency • Policy uncertainty
21st Century	"A Carbon-Constrained World"	• Price spikes add urgency and renew business case for efficiency • Efficiency becomes core element of companywide sustainability strategies • Efficiency targets set, backed by measurement and performance accountability measures • Efficiency drives broader innovation	• Worldwide recession limits investment • Lack of global and domestic climate policies limits certainty • Energy price volatility and geopolitics hobbles planning

C. Forces Driving the Paradigm Shift

The forces that drove this shift "out of the boiler room" can be summarized in two overarching perceptions:

1. **The era of cheap energy is over**—There is a growing concern that conventional world oil production capacity will plateau or peak in the coming decades. Coupled with growing global energy demands, this strengthens the perception that current supply is becoming strained. This perception was borne out by rising prices in oil and other fossil fuel markets in the last decade, notwithstanding lower energy prices in the current worldwide economic slowdown. Respondents to the Pew Center survey saw their energy costs rise an average of 60-70 percent since 2000; for the most energy-intensive companies, energy costs more than tripled. While energy-savvy leaders expect price volatility, they are convinced that energy prices are going to rise much faster in coming decades than in the last 30 years. More than half of survey respondents believe that world oil prices will be back over $100/barrel by 2014.[10]

2. **Climate change reframes energy strategies**—Most of the climate actions taken in the corporate sector to date have been voluntary, with exceptions for companies operating facilities subject to mandatory regulations such as the European Union's carbon cap-and-trade program. There is growing momentum in the United States, however, towards mandatory climate change policies. The Regional Greenhouse Gas Initiative (RGGI), for example, is a mandatory cap-and-trade program that covers the electric sector in 10 Northeast states, and the Midwest Governors Greenhouse Gas Reduction Accord and the Western Climate Initiative are making progress toward implementing economy-wide cap-and-trade programs in their respective regions.[11] Additionally, almost all of the Pew Center survey respondents expect federal mandatory carbon policies to be enacted in the United States by 2012.

Leaving aside compliance-driven carbon reductions, companies that take on carbon footprinting and reduction strategies quickly come to see their energy use in a whole new light. The survey respondents, even in today's higher-priced energy markets, spend less than five percent of total revenues on energy. But when they calculate their carbon footprint, they typically find that their energy consumption accounts for the great majority of their directly measurable emissions impact. Suddenly, energy shifts from a small cost item to the biggest piece of their carbon footprint. Viewed from this perspective, energy efficiency becomes a sustainability imperative.

> ***…companies that take on carbon footprinting and reduction strategies quickly come to see their energy use in a whole new light.***

A common misperception exists that climate policy, especially in the form of cap-and-trade programs, will automatically drive energy efficiency efforts by making efficiency a tradable commodity in carbon markets. But efficiency is difficult to commoditize as a credit in cap-and-trade systems because the cap, at least with respect to electricity, is typically placed at the emissions source with energy producers such as power plants. Reductions in end-use energy consumption are commonly referred to as "indirect" emissions reductions, because the actual reductions are taking place at the power plant. Since the power plant is the capped entity, those reductions count towards the power plant's compliance obligation and/or result in excess allowances that the plant owner can sell or bank for future use. Allowing energy end users to claim carbon credits for those same efficiency improvements would lead to double counting of emissions reductions and damage the integrity of the cap.

Even without the ability to use efficiency as a carbon credit, cap-and-trade systems still provide incentives for energy efficiency because the embedded carbon price will drive energy prices higher, making efficiency projects more attractive financially. The carbon price alone, however, is insufficient to overcome additional market failures, such as imperfect information and organizational disconnects, keeping investments in energy efficiency below optimal levels. For these reasons, many policymakers have begun pursuing energy efficiency through parallel or "complementary" energy policies in conjunction with economy-wide cap-and-trade legislation.

These complementary policies can include auctioning allowances and using the funds for efficiency, as is happening with RGGI, or they can take the form of targeted regulations such as building codes or appliance standards. In the U.S., 19 states now have mandatory energy savings targets for electric and/or gas utilities. Most states have active utility- or state-sponsored energy efficiency programs offering incentives, technical assistance, and other mechanisms to help customers save energy. Building codes, appliance standards, and tax incentives are also providing either requirements or incentives to improve efficiency in buildings, equipment, or technology systems. And continuing research and development (R&D) efforts are bringing new technologies to market. Such energy efficiency policies and programs can help facilitate the corporate energy paradigm shift, by both prodding and supporting corporate efficiency strategies. Many of the survey respondents in this study participate in utility programs to support their energy efficiency strategies. Some companies make products that are directly covered by efficiency standards, like Carrier's air conditioners or Toyota's vehicles, or are affected by building codes, such as Owens-Corning's insulation products or PPG's window glass.

D. Boiling Down the Business Case

Boiled down to a single word, the business case for energy efficiency can be summed up as "competitiveness." By reducing costs, reducing risks, and driving improved productivity and innovation, a sound efficiency strategy makes a company more competitive. But beyond internal operations efficiency, many companies have found that their products need to be more energy efficient to compete in a new era of higher energy prices and consumer environmental concerns, be they Toyota cars and trucks, Carrier air conditioners, or IBM blade servers.[12] Energy efficiency also becomes much more salient in a rising-energy-price environment, because lower energy costs mean lower product costs. Dow's bulk chemicals, for example, compete in markets where profit margins can be very thin, so saving a few cents per pound of product can be vital to protecting or growing the company's market share. Toyota's energy-used-per-vehicle-produced efficiency target was set partly on the basis of benchmarking competitors' performance. Retailers such as Best Buy respond to consumer demand for more green products, but they also know that store energy consumption can affect their operating margins in a competitive retail environment.

From the literature and what companies shared about their experiences testing this rationale, the business case for corporate energy efficiency strategies can be elaborated as the following benefits, or value streams (specific examples are taken from the case studies included in this report, unless otherwise noted):

Bottom line value—Companies have found energy efficiency investments have rapid paybacks and competitive rates of return, often at low cost and usually with low risk.

Examples: Since 1994, Dow estimates its efficiency efforts have saved the company $8.6 billion. DuPont estimates its efficiency initiatives saved the company approximately $3 billion between 1990 and 2005.[13] Since 2002, Alcoa's efficiency efforts have led to $20 million in annual energy savings.[14]

Productivity and other co-benefits—The new wave of efficiency strategies is driving productivity gains beyond direct energy savings. By forcing technology and innovation across multiple processes and operations, efficiency is helping to reduce water use, materials waste, labor costs, production downtime, and injuries. These co-benefits can sometimes substantially exceed the value of direct energy savings.

Example: PepsiCo's Frito-Lay tortilla chip operations initially installed oven draft controls to save natural gas, but they found that better draft controls improved the quality of the chips. Additionally, company officials found that installing oven heat recovery systems also increased product throughput. Thus efficiency drove both quality and productivity improvements.

Innovation value—Robust efficiency programs not only save energy, they can also open doors to innovation across the company. By engaging people across the organization and tapping their creativity to meet energy savings goals, companies are finding other innovations as more and more processes and practices are put under the microscope.

Examples: IBM's continuous R&D effort to improve microchip performance has not only reduced energy use in products that use its chips, it has also helped IBM develop efficient applications of such chips in IT systems through server virtualization.[15] Toyota's work with its paint shop operations saved not only energy, but reduced water use and eliminated an entire production step, improving productivity while maintaining quality standards.

The best efficiency strategies are based on an understanding of the risk management value of effective energy management.

Risk reduction value—The best efficiency strategies are based on an understanding of the risk management value of effective energy management. Energy efficiency lowers near-term exposure to price volatility and lowers the longer-term risk of carbon-price driven cost increases.

Examples: Dow uses energy efficiency as a price hedge. With more than half its operating costs in energy commodities, every British Thermal Unit (BTU)[16] of natural gas it saves reduces its exposure to price volatility. PepsiCo's Indian operations, as part of the company's overall energy efficiency strategy, shifted a third of their boiler fuel from imported fossil fuel to locally produced biomass pellets, reducing both price and supply risk.

Top line benefits—Efficiency-driven innovations not only reduce operating costs, they can also drive business growth opportunities. Some companies apply the technologies and practices they innovate internally to their customer offerings, gaining a double stream of benefits.

Examples: IBM uses the knowledge it gained in driving down energy use in its own data centers to offer a range of customer solutions that improve information technology (IT) services while reducing energy use. UTC relies on efficiency and related innovation to keep its top product lines, including Pratt and Whitney aircraft engines and Carrier air conditioners, competitive.

Human capital value—Efficiency and related sustainability initiatives have been found to resonate with people across the organization. Channeling enthusiasm, creativity and human energy can increase morale, support innovation, and help attract and retain quality employees.

Examples: PepsiCo's 2009 Sustainability Summit, in which peers teach peers about efficiency and other sustainability innovations, drew 400 people and generated tremendous excitement, even in a down economy. T. Rowe Price expanded its sustainability program in the fall of 2008, despite one of the worst business environments it had ever seen, in part because leadership knew how important these issues were to employees.

Reputational value—Companies are finding that efficiency, as an eminently measurable sustainability indicator, can quickly lead to documented accomplishments that increase reputational value among employees, investors, and other stakeholders. As the emphasis on climate change and carbon emissions becomes a larger part of the sustainability equation, the fact that energy consumption accounts for the majority of most companies' carbon footprints means that energy efficiency's importance as a sustainability indicator will likely continue to rise.

Example: PepsiCo knows its snack food brands' success depends largely on customer perceptions, and as such, the company works hard to demonstrate its sustainability commitment as a way to maintain customer loyalty.

There is also evidence suggesting that efficiency strategies can have measurable impacts on shareholder value. Innovest Strategic Value Advisors studied the food and real estate industries based on companies' energy management performance. Their analysis of the retail food sector strongly implies that energy management improves profits and generates value for shareholders.[17] Share prices for the top six companies rated by Innovest for energy management outperformed the below average companies by 17 percentage points, and tended to score higher on a series of other financial metrics, including price-to-earnings ratios, return on assets, and return on equity.

On a more micro level, the box below shows energy efficiency efforts at individual companies that yielded impressive financial returns.

Companies' Bottom-Line Financial Results from Efficiency Strategies

Dow Chemical—Dow's energy efficiency efforts since the 1990s have not only reduced energy used per pound of product by more than 20 percent, they have also saved the company $8.6 billion (see Dow case study, page 72, for more details). The extraordinary cost savings in this case stem partly from the fact that Dow is an exceptionally energy intensive company—these bottom-line benefits are unlikely to occur in companies that use low or moderate amounts of energy.

IBM—In 2008, IBM implemented energy conservation projects that reduced or avoided 6.1 percent of its total 2008 energy use against the company's goal of 3.5 percent. These reductions contributed to a net five percent year-to-year reduction in energy use from 2007 to 2008, leading to direct financial benefits in excess of $30 million. From 2007 to 2008, the company spent an additional $9 million—over and above its considerable routine investments in its operational energy conservation program—for specific energy efficiency investments (see IBM case study, page 99, for more details).

Food Lion, LLC—One of the largest supermarket chains in the United States, Food Lion operates some 1,300 stores. In 2008, the company certified its 805th ENERGY STAR store, and owns more than half the nation's ENERGY STAR-rated grocery stores. In the past five years, Food Lion has reduced energy consumption by more than 2.29 trillion BTU. To generate the same net income, Food Lion would have had to sell an additional $1 billion worth of merchandise.[18]

USAA Real Estate Company—USAA is an active participant in EPA's ENERGY STAR energy performance rating system, within its Portfolio Strategic Energy Management Plan. Specifying portfolio-wide and facility-wide energy management goals generated more than $2.6 million in savings for 2004 alone. At a seven percent capitalization rate, the company estimates these energy savings have increased real estate portfolio asset value by over $37.6 million.[19]

Owens-Corning—The largest U.S. insulation manufacturer, Owens-Corning's corporate energy efficiency strategy includes a 25 percent reduction target for energy used per pound of product from 2002 to 2012. Through 2008, the company had invested some $20 million in energy efficiency improvements, saving a cumulative 600 million kilowatt hours (KWH) of electricity. That averages 3.3 cents per KWH, less than half the average U.S. industrial electricity price—and that average will fall as these efficiency projects continue to deliver savings over their full lifetimes.[20]

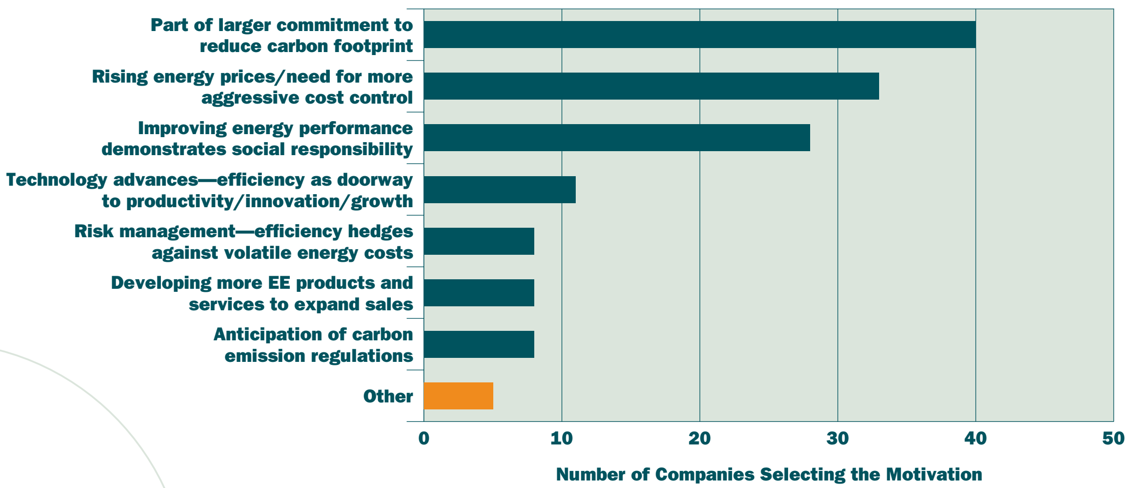
III. Pew Center Energy Efficiency Survey Findings

The Pew Center developed a 65-question survey, which it distributed to nearly 100 companies, to gather quantitative data and identify key trends in corporate energy efficiency. Findings from the Pew Center's survey support the notion that energy is undergoing a paradigm shift in the minds of more and more corporate leaders. Most respondents to the survey conducted for this study expect world oil prices to be back above $100/barrel by 2014 and almost all expect national climate legislation to be enacted by 2012, with a majority expecting it to pass by 2010. The regulatory risk associated with climate change legislation appears to have grown more immediate for corporations. A previous Pew Center survey conducted in 2006 found that 90 percent of companies believed legislation was imminent, but of those only 15 percent believed legislation would pass before 2010 and 67 percent predicted it would happen between 2010 and 2015.

These perceptions appear to shape respondents' leading motivations for their efficiency strategies, which as **Figure 2** indicates, are driven by a larger commitment to reduce carbon emissions and a desire to reduce operating costs. About 40 companies cited carbon reductions as the principal motivation, while 33 pointed to cost control reasons (in this question, companies were allowed to select more than one response). On the other hand,

Figure 2

Pew Center Survey Respondents' **Leading Motivations** for Efficiency Strategies



Source: Pew Center 2009.

"anticipation of carbon emissions regulations" was identified by relatively few survey respondents as a leading motivating factor for undertaking energy efficiency strategies. This may reflect the fact that companies face more immediate pressures to reduce carbon emissions—stemming either from voluntary commitments and customer and stakeholder demands—and/or that many of the companies participating in the survey will likely not be directly regulated by forthcoming climate change regulations.

Several other corporate sustainability studies tend to support these findings from the Pew Center survey:

- In Siemens' 2009 *Greening of Corporate America*[21] survey, energy cost savings are reported as the top driver for corporate sustainability efforts.
- *The Economist's* Intelligence Unit[22] survey found that 54 percent of corporations had established a company-wide climate change strategy, but a greater percentage (62 percent) had taken significant action on energy efficiency, partly in response to energy prices and partly in response to the need to begin curbing carbon emissions.
- A Johnson Controls Inc. (JCI) 2009 survey[23] found cost control and carbon footprint reduction are the two most important drivers for companies implementing energy efficiency strategies.

A. Efficiency Goals, Timelines, and Benchmarks

Until this century, few companies set quantitative, company-wide, long-term energy savings targets and timetables. Now, quantitative targets have become a common feature of corporate energy efficiency strategies. This marks a major shift in the energy and sustainability field, because setting fixed targets requires measuring energy performance for the whole company, driving a cascade of tracking, reporting, and improvement efforts both horizontally across organizational lines and vertically from "shop floor to top floor." Most efficiency goals were set on an intensity basis[24]—that is, they were normalized by units of production, square feet of space, dollars of revenue, or other company-wide metrics. The average energy savings target, for the 21 companies in the Pew Center survey that reported such data, was 3.8 percent per year. The time spans for these targets varied greatly, ranging from one year to 34. (See Appendix B for a more detailed discussion of this issue).

The Netherlands' Long-Term Agreement (LTA) program provides a useful benchmark to evaluate the Pew Center's survey results on efficiency targets. Coordinated by SenterNovem, the LTA engages 895 companies in a "voluntary but not without obligation" effort to improve energy efficiency across a wide range of business sectors. LTA has been tracking energy performance since 1992, using and reporting a series of energy performance indicators.[25]

The LTA data shows an improvement in energy used per unit of product of about 15 percent over six years, or slightly less than two percent per year. Given the size and diversity of the participation group, sustaining that level of improvement over six years is an impressive achievement. As noted above, respondents to the Pew Center survey have set targets averaging close to four percent annually; however, there are no long-term results across a larger sample of companies to report at this time. Anecdotally, several of the case study companies in this project have realized annual energy intensity improvements of two percent per year or greater. As more companies measure and report results, new company-level energy performance benchmarks may emerge to guide future efficiency strategies.

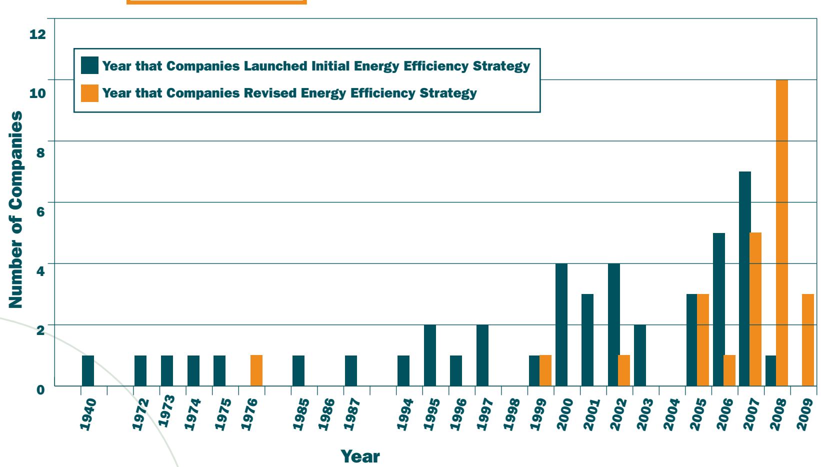
Timeline of efficiency strategies—By asking respondents when they had initiated their efficiency strategies, and then when they had reset their savings targets, the survey revealed the rapid growth and evolution of energy efficiency strategies among the respondents. **Figure 3** provides a visual timeline for Pew Center survey respondents' energy efficiency strategies, showing that the great majority of initiatives have occurred since the late 1990s.

Benchmarking—Most of the companies in the Pew Center survey (80 percent) reported benchmarking their strategies using the performance of other companies in their industries or third-party organizations in the nonprofit or government sectors. The most frequently-reported third party sources were:

- U.S. EPA ENERGY STAR Buildings
- U.S. EPA Climate Leaders
- The Carbon Disclosure Project
- Dow Jones Sustainability Indexes
- The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED)

Figure 3

Historical **Timelines** of Corporate Energy Efficiency Strategies



Source: Pew Center 2009.

- Electronic Products Environmental Assessment Tool (EPEAT)
- U.S. Department of Energy/EIA Manufacturing Energy Consumption Survey (MECS)

B. Leadership, Staffing, and Accountability

One of the most remarkable characteristics of today's energy efficiency strategies is the high percentage of companies in which senior management, including the CEO, is directly involved. In the Pew Center survey, 75 percent of respondents identified senior management, including the CEO, as the key champions of their energy efficiency strategies (see **Figure 4**). Evidence gathered through interviews with the case study companies indicates that this new saliency of senior management engagement stems from the confluence of cost, climate and sustainability issues in the organization, for which energy is a common theme.

A Note on the Recent Recession

The economic downturn beginning in late 2007 has affected most companies' environmental and climate strategies, including their energy efficiency efforts. *The Economist* worldwide survey reports that energy efficiency appears to have benefited slightly, compared to other environmental priorities. In a recession, internal efficiency investments are viewed as relatively safe and inexpensive, and when larger expansion-oriented plans are shelved in a slow economy, the hunt for near-term cost savings and operating margin improvements intensifies. On the downside, there is less capital available for project investments, stymieing some larger projects, while declining energy prices have reduced the attractiveness of some projects.

One result of the economic slowdown is that some companies have seen their energy intensity metrics trending up. Most companies' efficiency targets are set as intensity goals, that is, energy consumed per unit of product, rather than absolute energy usage. When company production slows, energy use typically cannot fall in a 1:1 ratio, as some energy systems such as lights or heating, ventilation and air conditioning (HVAC) must remain on. Companies like Dow, for example, have seen their intensity indicators rise, even though actual energy use fell; on the other hand, IBM sets a project related goal to implement energy conservation projects that reduce or avoid 3.5 percent of the energy use in that calendar year. Achieving this goal requires investment in energy efficiency projects, whether the economy is slow or otherwise.

Companies included in this study report that their energy efficiency strategies have not been stalled by economic conditions. The main effect has been reduced access to capital as corporate capital budgets are trimmed; but operational improvements have continued apace. Several companies also noted that efficiency, as part of their company's sustainability culture, resonates well with employees. Senior management appears to be aware of the morale value of keeping up sustainability commitments; so when the economic news is bad, with layoffs and other negative impacts occurring, sustainability programs are seen as one way to maintain a positive working environment.

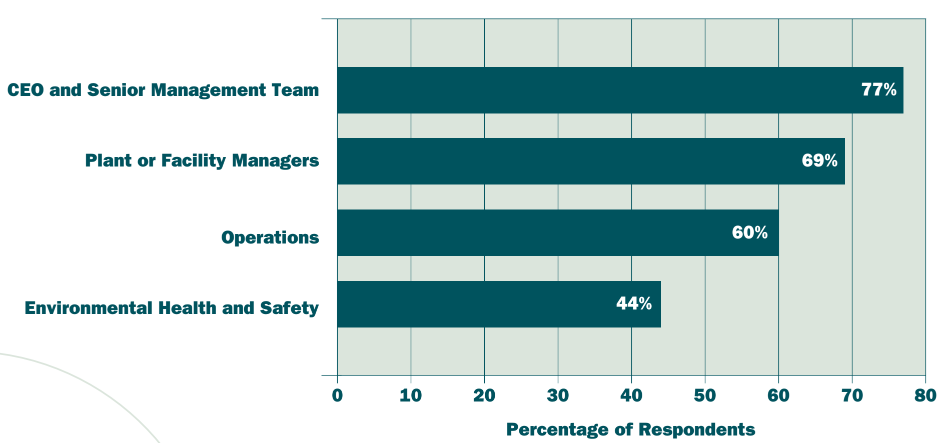
Staffing—In many companies, energy efficiency has traditionally been the province of facility managers or plant engineers, or another function related to energy technology and facility operations. In this study's survey, most companies (60 percent) reported they had an energy manager designated at the corporate level—working out of corporate environment, health and safety; corporate sustainability; or other company-wide organizations. This represents a significant shift from the "old days" of facility-level energy management. Placing this role at the corporate level requires broader and more consistent accountability across facilities and business units. It also allows the energy manager to keep the efficiency program visible and affords better access to corporate resources to support the program.

The energy challenge now involves many more people, with different skill sets, different functions, and different levels of management.

Energy teams today also tend to cut across organization lines, including functional lines and levels of management. One survey participant summarized his company's energy management team's staffing approach as "all and none," indicating that the energy strategy is not "stovepiped" into a single department or management level, but rather part of many people's jobs across the organization. While a corporate energy manager is often on the organization chart, the efficiency team is not a separate, full-time unit. The energy challenge now involves many more people, with different skill sets, different functions, and different levels of management. It is this "all and none" quality that appears to be a key element of success in today's energy efficiency strategies—having a centralized point of energy accountability while engaging people across the whole organization.

Figure 4

Key Champions of Energy Efficiency Strategies

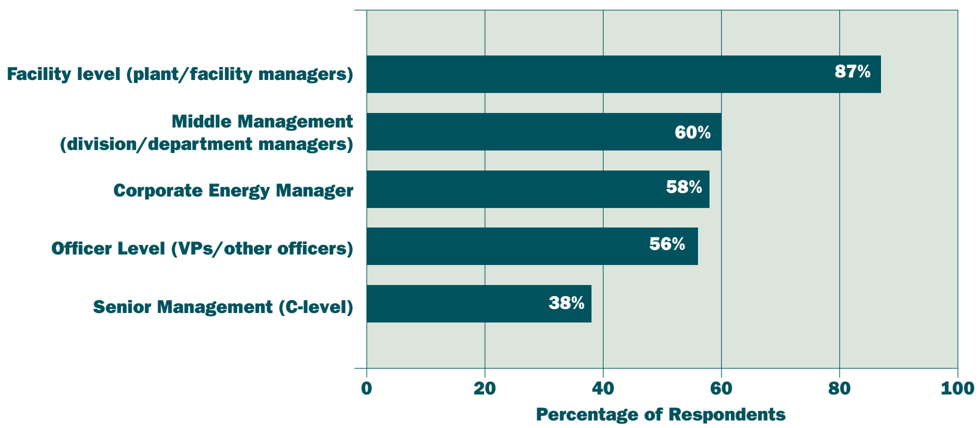


Source: Pew Center 2009.

Accountability—Accountability systems that measure performance against goals are key to successful energy efficiency programs. Today's leading companies build accountability into performance reviews for individuals, from facility managers to CEOs, and from individual facilities to entire business units. Among the Pew Center survey respondents, accountability for energy performance was applied at many levels of the company. While 87 percent of respondents reported performance accountability at the facility or plant level, a majority held officer-level individuals accountable, and 38 percent included energy performance in CEO-level accountability (see **Figure 5**).

Figure 5

Where Energy Performance is **Measured and Accounted** for



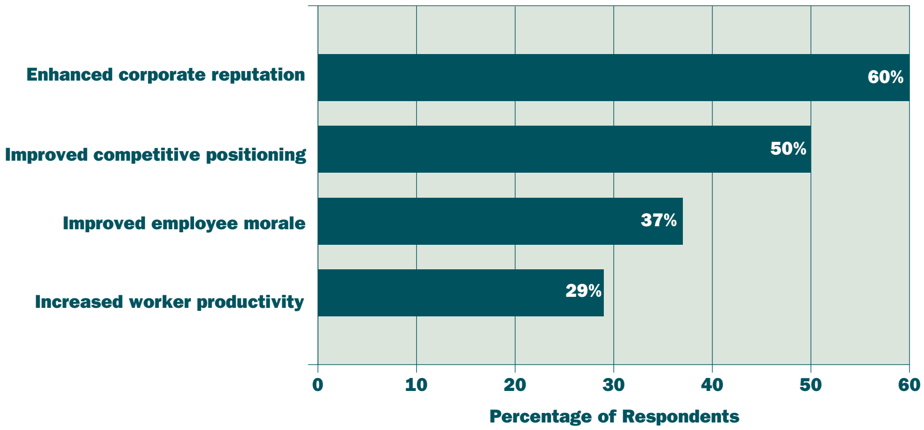
Source: Pew Center 2009.

C. Financing and Risk Management

The largest obstacle to efficiency improvements reported in the Pew Center survey was access to capital. Finding financing methods and expanding how companies assess and justify projects is thus an important element of a successful energy efficiency strategy. Energy efficiency investment decisions in the past were viewed in simple terms through metrics like "simple payback," the ratio of annual energy savings to investment costs. Three-year paybacks were about as far as most companies were willing to go. While companies still use simple payback (survey respondents averaged 2.8 years), and other analyses like Internal Rate of Return (IRR) (survey respondents averaged 18.5 percent IRR[26]), the best efficiency strategies today often take other factors, or co-benefits, into account. These co-benefits are summarized in **Figure 6**.

Figure 6

Co-Benefits of Energy Efficiency Investments



Source: Pew Center 2009.

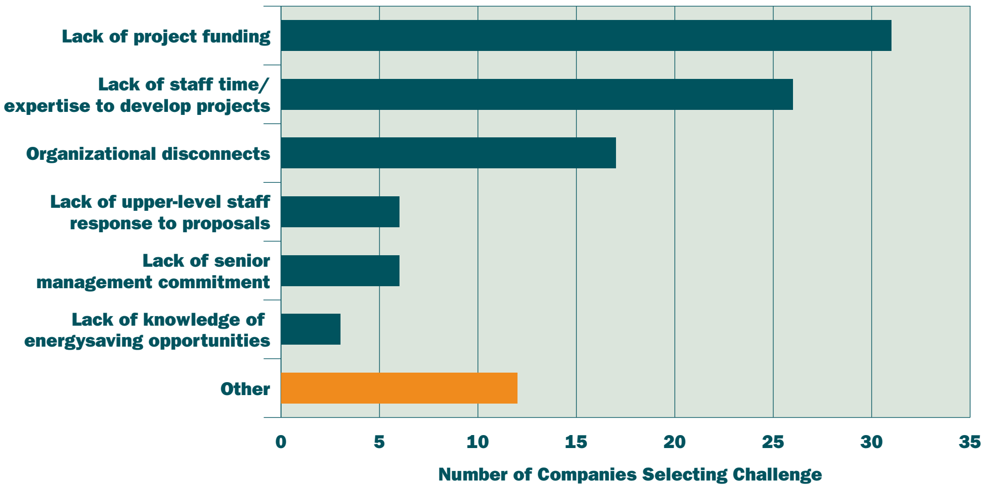
D. Challenges, Surprises, and Future Needs

Survey respondents were asked where they met challenges in making their energy efficiency strategies work within their companies. **Figure 7** summarizes the responses. While the number one challenge—lack of funding for efficiency projects—was somewhat predictable, other challenges were more revealing. For example, many companies found lack of staff time and expertise to develop projects to be a larger challenge than lack of knowledge of energy savings opportunities. Put another way, most companies knew what they could be doing, but many lacked the people with the time and skills to make it happen. Third on the list was "organizational disconnects," short for what economists call the "principal-agent" problem. For example, in many companies, procurement departments specify energy-using equipment, operations units are responsible for how the equipment is used, and accounting pays the bills for the energy the equipment uses. These departments are often disconnected, in terms of the information they see and their main motives. A procurement manager may want to minimize first costs for equipment, accounting may want to minimize annual energy bills, and operating units may be focused on maximizing production or employee comfort. These "split incentives" can create systemic and persistent barriers to energy efficiency improvement.

Surprises—The survey asked respondents what surprised them as they implemented their programs. The top two responses were: (1) how much enthusiasm they found among employees; and (2) the speed with which the program took off and exceeded expectations. Other companies, though, admitted that it was more difficult to get some aspects of their programs running, and that finding funding was a challenge. But they also reported surprise at the sheer volume of good ideas and specific project opportunities. The human capital resonance factor is a core

Figure 7

Greatest Challenges to Implementing Energy Efficiency Strategies



Source: Pew Center 2009.

theme in the survey responses that is borne out by the case studies. It suggests that the new wave of efficiency strategies is tapping a potentially powerful force for companies—the people who work there. In the past, efficiency was viewed as a technical issue and generally limited to small numbers of people in technology-related functions. But today's strategies, driven by wider, longer-term sustainability goals, can tap a broader and perhaps deeper vein of employee motivation to make a difference beyond their immediate job function. A high percentage of Pew Center survey respondents cited employee interest and enthusiasm as the biggest surprise or unexpected result that came out of the implementation of their energy efficiency strategy. Select survey responses are reprinted in the box.

Employee Engagement, Empowerment, and Enthusiasm Matter

Quotes from survey respondents on what surprised them most in implementing their energy efficiency strategies:

"Our biggest surprise was the broad employee interest in energy and environmental action."—*Cummins Inc.*

"The backbone of our strategy is employee engagement. Without that even the best capital projects can fail."—*Citi*

"There is a wealth of creative ideas at every level of the organization. All we need to do is provide opportunities for those ideas to surface and grow."—*PepsiCo*

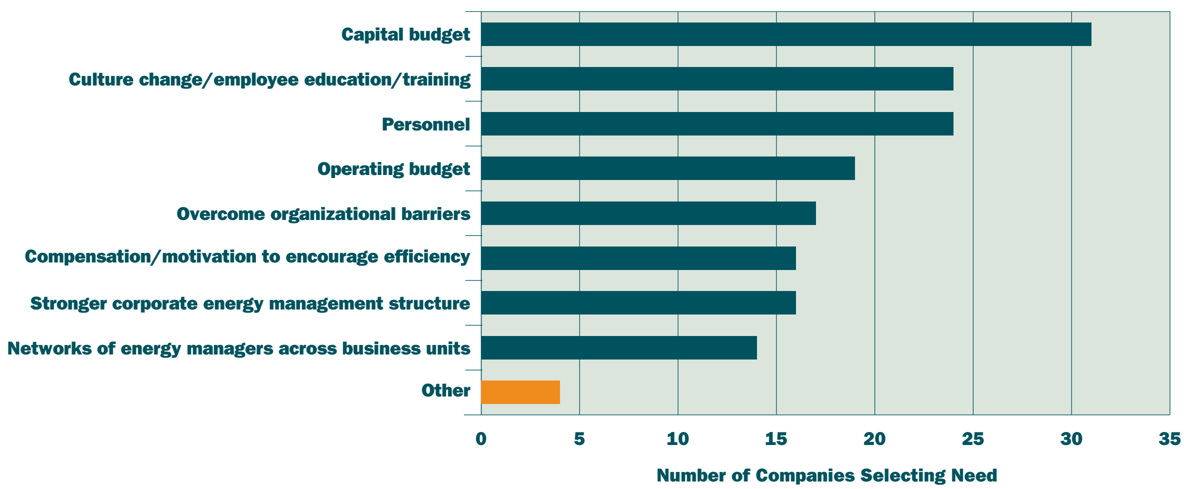
"It is important that teams on the ground feel empowered to implement initiatives, and are given the support and resources to take initiative on their own."—*News Corporation*

"An increasing number of employees are starting to care passionately about the Group's energy and GHG performance."—*Rio Tinto*

Future needs—Survey respondents were asked what they saw as their companies' longer-term needs to reach and sustain their energy efficiency goals. Not surprisingly, larger capital budgets were mentioned most often. In a sense, limited capital is a given for the typical programs. But consistent with the survey's findings about the power of employee motivation and creativity, the second most frequently mentioned need was for "culture change." Further down the list were overcoming organizational barriers, and better compensation and motivation systems to encourage efficiency, both of which could be viewed as means to better engage a wide range of employees to meet efficiency goals. On balance, companies seem to see at least as many needs on the human capital side of their resource ledgers, in addition to the capital and technology resources that efficiency programs have typically sought (see **Figure 8**).

Figure 8

Key Needs to Sustain/Improve Corporate Efficiency Strategies



Source: Pew Center 2009.

IV. The Seven Habits of Highly Efficient Companies

This section distills the core elements of an exemplary corporate energy efficiency strategy into "Seven Habits" of core practices and principles. The Seven Habits (summarized in **Table 2**) are company-wide principles, cutting across internal operations, supply chains, and products and services. Subsequent sections delve deeper into the more specific practices applicable to these three spheres of activity.

The Seven Habits framework is indebted to others who broke ground in this fast-evolving field. While the habits are borne out in the Pew Center's survey results and case studies, they have come to light in earlier work, notably U.S. EPA's ENERGY STAR program, in which a set of energy management guidelines were developed.[27] The Superior Energy Performance program developed at the U.S. Department of Energy and envisioned as a self-governing organization, follows similar conceptual principles and is part of a wider effort to develop an organization-level energy management standard (ISO 50001) over the next few years.[28] The Road Ahead report cited earlier also mirrors many of these key principles.

1. Efficiency is a Core Strategy

For companies with leading strategies, energy efficiency is an integral part of corporate strategic planning and risk assessment. It is not treated like just another cost management issue, or as a sustainability "hoop" to jump through. It has become part of an ethos and a corporate culture in which energy efficiency is essential to a thriving enterprise in the 21st century. It is an ongoing part of the organization's aspirations and metrics for itself, and is understood, talked about, and acted upon at all levels of the organization. The companies profiled as case studies in this report: Dow, IBM, UTC, Toyota, PepsiCo, and Best Buy all show these characteristics.

2. Leadership and Organizational Support is Real and Sustained

When energy efficiency is a core part of the organization, its leaders can talk about it without notes. When a CEO like Louis Chenevert of UTC or Andrew Liveris of Dow talks about energy, they are eloquent, committed, and know key facts. Beyond what CEOs and other leaders say in speeches, leadership commitment to efficiency

Table 2

The **Seven Habits** of Highly Efficient Companies

1. Efficiency is a Core Strategy	
• Efficiency is an integral part of corporate strategic planning and risk assessment and not just another cost management issue or sustainability "hoop" to jump through.	• Efficiency is an ongoing part of the organization's aspirations and metrics for itself.
2. Leadership & Organizational Support is Real & Sustained	
• At least one full-time staff person is accountable for energy performance. • Corporate energy management leadership interacts with teams in all business units. • Energy performance results affect individuals' performance reviews and career advancement paths.	• Energy efficiency is part of the company's culture and core operations. • Employees are empowered and rewarded for energy innovation.
3. The Company Has SMART[29] Energy Efficiency Goals	
• Goals are organization-wide. • Goals are translated into operating/business unit goals. • Goals are specific enough to be measured.	• Goals have specific target dates. • Goals are linked to action plans in all business units. • Goals are updated and strengthened over time.
4. The Strategy Relies on a Robust Tracking & Measurement System	
• The system collects data regularly from all business units. • The data is normalized and baselined. • Data collection and reporting is as granular as possible. • The system tracks performance against goals in a regular reporting cycle.	• Performance data is visible to senior management in a form they can understand and act upon. • Energy performance data is shared internally and externally. • The system is linked to a commitment to continuous improvement.
5. The Organization Puts Substantial Resources into Efficiency	
• The energy manager/team has adequate operating resources. • Business leaders find capital to fund projects.	• Companies invest in human capital.
6. The Energy Efficiency Strategy Shows Demonstrated Results	
• The company has met or beat its energy performance goal. • Successful energy innovators are rewarded and recognized.	• Resources are sustained over a multi-year period.
7. The Company Effectively Communicates Efficiency Results	
• An internal communications plan raises awareness and engages employees.	• Successes are communicated externally.

shows up in many forms, in multiple media, and such communications are frequent and prominent, inside the company and out. More specific aspects of leadership commitment and organizational support include:

> ***When a CEO like Louis Chenevert of UTC or Andrew Liveris of Dow talks about energy, they are eloquent, committed, and know key facts.***

- **At least one full-time staff person is accountable for energy performance.** 60 percent of the Pew Center survey respondents reported having full-time corporate energy managers.
- **Corporate energy management leadership interacts with teams in all business units.** Today's best efficiency strategies build an energy management organization that crosses lines, engaging facility managers, plant managers, engineering departments, procurement and accounting personnel, and others as needed.
- **Energy performance results affect individuals' performance reviews and career advancement paths.** Today, energy performance is a review factor in most leading companies for both facility and plant managers (87 percent of survey respondents) and officer-level management (more than half of survey respondents).
- **Energy efficiency is part of the company's culture and core operations.** In leading companies, the energy issue is owned by whole teams and/or whole departments and does not fade away when champions move on to other causes. It is supported by change-management processes that ensure the new practices become part of the company's culture. It becomes self-sustaining, with lots of people engaged, lots of results showing, and the "buzz" remaining strong.
- **Employees are empowered and rewarded for energy innovation.** Sustaining an energy efficiency strategy requires rewarding people as individuals and as teams on a consistent basis over time. Leading companies are finding that the most effective ways of rewarding people may not involve money. Instead, validating ideas, acting on recommendations, and funding projects motivates people by recognizing their contribution to the company's sustainability goals.

3. The Company Has SMART Energy Efficiency Goals

SMART is a well-known acronym for Specific, Measurable, Accountable, Realistic, and Time-bound, and has been used in mission and goal-setting exercises for years. What makes the SMART concept specific and unique to energy efficiency strategies are the following characteristics:

- **Goals are organization-wide.** Today's best efficiency strategies engage most facilities, plants, and organizational units, instead of focusing on specific plants, facilities, or processes.
- **Goals are also translated into operating/business unit goals.** Effective strategies need to be set, and bought into, at the operating unit level as well as corporation-wide.
- **Goals are specific enough to be measured.** Effective efficiency strategies set goals with numbers and metrics that enable independent parties to verify whether the company met its targets.
- **Goals have specific target dates.** Without a timeframe, there is no way to gauge how much effort or investment is needed, nor much urgency to prioritize energy efficiency compared to other needs. Respondents to the Pew Center survey averaged an eight-year timeframe from the base year to the year in which the target was to be met.
- **Goals are linked to action plans in all business units.** The first, and often biggest, test for an efficiency program is what happens when an operating unit falls short of its goal. Effective strategies back up goals with action plans; they do facility assessments to identify the best efficiency opportunities, develop technical assistance networks, develop best-practice checklists, and make solutions accessible across the organization via web-based information, active peer networks, and other means.
- **Goals are updated and strengthened over time.** The leading companies have been at their efficiency strategies long enough to show that a successful strategy reveals additional efficiency potential, leading to a reassessment point at which goals are renewed and typically increased.

4. The Strategy Relies on a Robust Tracking and Performance Measurement System

The adage that "you can only manage what you measure" applies to energy efficiency strategies as much as any critical cost factor or performance indicator. What makes an energy tracking and performance measurement system challenging in larger organizations is that it tends to be both *pervasive* and *indirect*. Energy is pervasive in that it is consumed in virtually every part of every facility; it is indirect in that except for certain manufacturing processes, energy plays a supporting role—energy provides the lighting, the human comfort conditioning, the shaft power, the electricity supply, or the thermal energy to enable the company to run its business.

The first job of an effective energy tracking and performance system, then, is to collect the energy data, reconnect it in a timely manner to the people that actually use the energy, and give those people metrics they can use to understand their performance.

Creating an effective energy tracking and performance system thus requires collecting a lot of data from a lot of disparate sources. Energy suppliers in different U.S. states and other countries may use metering and billing systems that are different enough to require special effort to normalize the data for tracking and reporting purposes. As an organizational matter, however, the biggest challenge in setting up the energy tracking system is bridging the disconnects between organization units. Typical practice is for energy bills to be paid through procurement or accounting systems as a straight financial transaction with no accounting for the amount of energy purchased, let alone any link between the energy used and the useful work it performed.

As a consequence, the people who pay the energy bills are often not the people who operate the facilities or the production processes that use the energy. The first job of an effective energy tracking and performance system, then, is to collect the energy data, reconnect it in a timely manner to the people that actually use the energy, and give those people metrics they can use to understand their performance.

Below are key characteristics of world class energy tracking and performance measurement systems. Further elaboration of these principles, as well as specific examples of how they are applied in practice, can be found in the best practices in internal operations section, beginning page 34.

The system collects data regularly from all business units. Effective systems connect the dots between accounting, procurement, operations, and engineering functions by collecting energy billing and other data and reporting it in a format accessible to all functions.

The data is normalized and baselined. To turn raw data into performance metrics, energy use is typically normalized by one or more factors the organization considers critical to its overall performance. So instead of total energy use or cost, the data is often normalized by units of production, floor space, or another denominator. Effective systems also develop baseline energy usage using a specific year's data, which becomes the basis of target-setting and measuring progress against the target.

Data collection and reporting is as "granular" as possible. The challenge for energy managers is to develop as much specificity in the reporting system as is feasible. Energy-intensive facilities like manufacturing plants or data centers typically have more monitoring equipment at various levels of detail, and companies with these capabilities can "layer" their programs, by targeting more specific data to facilities managers while sending to senior managers only data that displays bigger picture trends.

The system includes feedback mechanisms that support corrective action. In the companies studied for this project, senior management sees tracking reports monthly or quarterly and communicates with lagging facility or plant staff to seek ways to get them back on track. In these programs leaders not only see performance information, but have practical channels to act on it. In addition, facility-level staff are supported by project data or operating checklist guidance they can tap to improve their unit's performance.

Performance data is effectively visible to senior management. Senior management has to see energy performance data regularly and in a form they can understand and act on. Many companies do not lack data as much as information tools that raise the quality of key data into useful form. The most effective programs use information dashboarding techniques to make performance data readily available.

Energy performance data is broadly shared internally and externally. Today, modern IT combined with public corporate commitments drives a broader and more accessible energy information platform. For proprietary reasons, not all data is fully transparent, but most systems post data for external viewing on an aggregated, company-wide basis.

The system is linked to a commitment to continuous improvement. The best energy management programs go beyond a compliance approach and tap into a broader cultural ethic of continuous improvement, using the energy reporting system as a tool to empower people to find new efficiencies and associated innovations. They foster a "learning organization," in which people use new energy information with their curiosity and resourcefulness to improve their operations.

5. The Organization Puts Substantial and Sustained Resources Into Efficiency

Any effective effort in an organization requires resources—people, capital, systems, etc. Energy efficiency is no different. The leading companies in this field, however, have not necessarily relied primarily on capital investments to drive energy efficiency results, but have obtained substantial savings through operational practice changes and moderate-cost technologies. While most of the companies in this project invested in new technologies, they also focused at least as hard on operating practices.

Companies studied for this project primarily shifted priorities to include energy. The most frequent response to the Pew Center survey question about how companies obtained resources for their programs was "reassignment of existing staff." In many cases, energy was added to the portfolio of issues critical staff were asked to manage. Based on the survey results and case study interviews, three broad observations can be made about the way leading companies funnel resources to efficiency programs.

The energy manager/team has adequate operating resources. Corporate energy managers are not necessarily given blank checks to hire people or draw personnel from other business units, but they are given the resources needed to set up and maintain tracking and performance measurement systems, do facility assessments, hold meetings, and educate staff. In most cases, these resources were provided in-kind within the organization, helped by the fact that senior management had committed to the program, and leaders around the company agreed to shift priorities and retask staff. Much of this boils down to the priorities people were asked to put their time into. In large organizations like these, much of the talent existed—it was a matter of finding the time to focus on this new collective goal.

Business leaders find capital to fund projects. Throughout the survey and case studies, there was a common refrain that "there is never enough money for projects." And yet, the leading companies could all point to a significant list of projects that had been implemented through the efficiency program. This suggests that expectations should be calibrated along the following lines: "there is never enough money for projects, but we are seeing more investment and getting more results than we used to." Particularly in the recent deep recession, capital budgets have been trimmed, yet some energy efficiency projects move forward. This is an area in which relative shifts in priorities matter more than absolute dollars from year to year.

Companies invest in human capital. The ascendancy of human capital—people—over technological capital is a recurrent theme in this study. The best companies do not just invest in hardware—they invest in their people. Some invest in formal education, as UTC does through its Employee Scholar

> ***The best companies do not just invest in hardware—they invest in their people.***

program that pays up to 100 percent of tuition for degree programs and gives paid time off for courses. Others provide training and education internally, like PepsiCo's Sustainability Summit that brought over 400 people together for four days. Other approaches revolve around empowerment and collaboration; rather than keeping employees within narrow boxes dictated by rigid job descriptions, they encourage people to think independently, bring forward ideas, and take the time to collaborate with peers within and outside their immediate units. This latter approach fosters the kind of learning organization that can sustain the types of innovation an effective efficiency strategy requires.

6. The Energy Efficiency Strategy Shows Demonstrated Results

A winning strategy has to show winning results. The companies in this study not only conceived and launched their strategies, they followed through with operational changes and capital projects, and captured the results through their energy performance measurement systems. The key features of leading programs in this respect include:

The company met or beat its energy performance goal. Leading companies in this study set goals of varying aggressiveness and with different time horizons, with many meeting or exceeding these goals, or at least making significant progress if the target year is still in the future. UTC was five years early in meeting its previous goal to reduce energy used by 25 percent per dollar of revenue below 1997 levels by 2006.

Successful energy innovators are rewarded and recognized. The program's success needs to be mirrored in recognized achievements of individuals and teams. For an effective company-wide program, this should be people on the corporate energy team, and in the operating units. This encourages their peers to pick up the ball, and ingrains the program across the corporate culture.

Resources are sustained over a multi-year period. The annals of industrial psychology show that many new work practices or technology innovations can create performance improvements—temporarily. The hard part is sustaining success and institutionalizing change. The best companies in this study had not only set up their programs and met their initial targets, but were expanding their goals as the program's innovation wave produced new savings opportunities. Dow set its first 10-year goal in 1995, surpassed it, and is now in its second ten-year cycle. Toyota has been driving down its energy used per vehicle produced since 2002.

7. The Company Communicates Energy Efficiency Results as Part of the Core "Stories" It Tells

Modesty is an accepted virtue, and the best energy efficiency programs do not brag unrealistically. But the best companies in this field do make energy efficiency a living part of their story and place efficiency successes prominently in both internal and external communications. Energy efficiency becomes a part of the story the company tells about itself, part of its identity and culture. Key features of leading companies' efficiency strategies include:

An internal communications plan raises awareness and engages employees. There is no lack of creativity in companies' internal communications efforts. Internal newsletters are quite common, and energy efficiency success stories get prominent play on a regular basis. Many companies, like UTC, give formal awards from the Environmental Health & Safety department for energy efficiency improvements. At IBM, employees can get $500 awards for a wide range of energy innovation; but leaders have found that what motivates the winners is not so much the money as the recognition and the encouragement. And Toyota Motor Manufacturing Kentucky's (TMMK) NASCAR "Race for the Greenest" combines internal communications with friendly competition, hard-number results, and an element of fun.

Successes are communicated externally. Companies with world-class energy efficiency strategies tell their stories externally in prominent ways. Efficiency goals and successes show up in annual reports as well as public sustainability reports. Companies whose products and services include efficiency-related features make efficiency part of their paid media campaigns. IBM's 2008 TV ads, based on the radical savings it has found in its data centers, combined energy cost reduction with a "green" theme that included Disney-esque animations of birds and flowers. UTC's national newspaper print ads feature a green building theme with UTC products playing prominent roles. Best Buy is a leading ENERGY STAR partner, having won national awards for its energy efficiency product marketing efforts; and it also tells the story of its own green building efforts on its website.

The Seven Habits described in this section form the core of a successful energy efficiency strategy. They are primarily organization-wide principles and practices, though many can also be applied at the individual facility level. An effective strategy, however, does not stop at simply embracing these principles. It must go deeper into the nuts-and-bolts details of the management systems, the technology analyses, and the other resources needed to support an ambitious effort. And it must be sustained over time—not just years but ultimately over decades.

The sections that follow go deeper into best practices for internal operations, supply chains, and products and services. They are designed to provide more information on the tools and resources companies need to put the Seven Habits into practice.

V. Best Practices: Internal Operations, Supply Chains, and Products and Services

This section delves deeper into best practices, focusing more specifically on techniques, tools, and other issues that have proven to be salient among the best energy efficiency strategies. It comprises three subsections: Internal Operations, Supply Chain, and Products and Services. Internal Operations refers to facilities owned or operated directly by the company. The Supply Chain section focuses on efforts aimed at suppliers of products or services to the company. Products and Services refer to what the company sells into its customer markets. While the boundaries between these spheres of action can be somewhat fluid, and their relative size and nature can vary from company to company, this report segments them in this way to tease out and highlight the specific practices most effective in each sphere.

To provide readers expanded and updated information, additional tools, resources and other materials are found on the Pew Center program website at http://www.pewclimate.org/energy-efficiency.

A. Internal Operations

Companies typically focus their energy efficiency efforts first on internal operations. This section describes leading practices companies have put in place to reduce energy use in manufacturing processes, buildings, and other facilities."

(i) Energy Team Organization and Relationships to Other Parts of the Company

There is no single ideal organization chart for the "best" energy efficiency strategies. In fact, the best programs seek to fit the efficiency organization to the company's structure and culture, rather than create a separate energy efficiency organization. The one irreducible common feature of effective efficiency organizations is that they involve all key functions and operating units in the company.

…the best programs seek to fit the efficiency organization to the company's structure and culture, rather than create a separate energy efficiency organization.

The best organizations typically have someone who is identified as the corporate energy manager or energy team leader. They may operate out of Environment, Health, and Safety; Sustainability; Engineering; or Operations units. The locus of the team leader is not as important, however, as the way the team is built across functions and operating units. Effective energy efficiency team structures, based on the best programs studied in this project, typically include the following traits:

Cross-functional—While the functions vary depending on the larger organizational structure, they typically include a technical or engineering function, an operations function with direct management responsibility for key facilities, an environment/health/safety function, an energy procurement/accounting function, and the sustainability function if the company has formalized this in the corporate structure.

Multi-level—The energy team includes both senior staff with corporate level access and facility-level staff with line operational responsibility, and possibly layers in between. It is thus able to maintain senior management engagement and field operations engagement in the same structure on an ongoing basis.

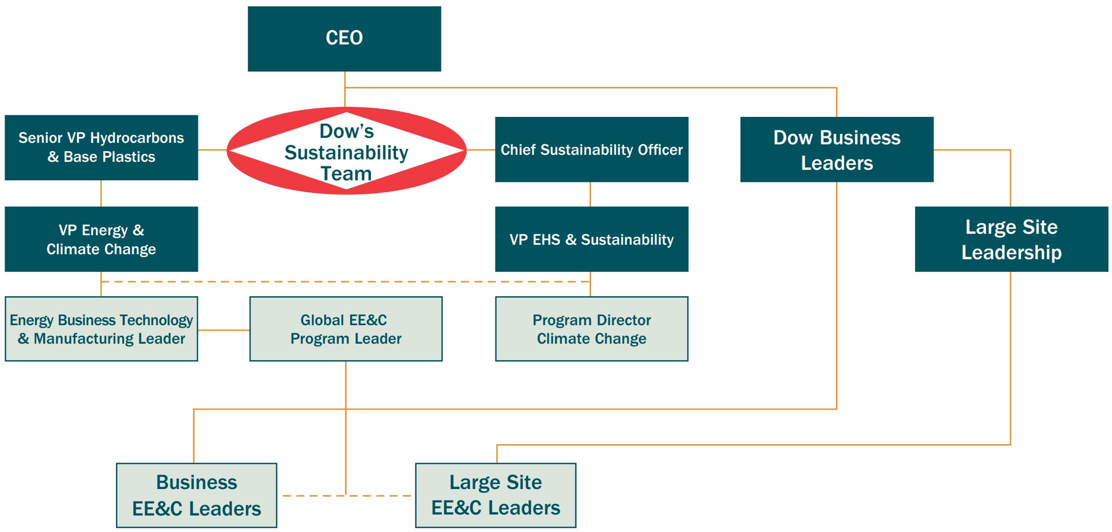
Matrixed—Almost no one, with the exception of the corporate energy manager and possibly a few support staff, spends 100 percent of his or her time on the energy team. Most employees likely have line management responsibility, other sustainability issues, or other functions to manage day to day. This creates an "all and none" staffing pattern, in which the energy team is not set off from the rest of the organization, but rather is fully integrated into ongoing operations and across a variety of functions. It can take effort to keep people engaged, given competing demands on individuals' time. The best team leaders invest time to build relationships, gain trust, listen well, provide helpful information, and keep time commitments manageable. The better-run teams also serve as learning organizations, so that individuals are not just given top-down instructions. Rather, employee participation is genuinely valued, and staff find it worth participating for the educational benefit. See **Figure 9 and Table 3** for examples of how Dow organizes its energy team and its efficiency work. In these images, the acronym EE&C stands for Energy Efficiency and Conservation.

(ii) Overcoming Organizational Barriers

Part of the work in setting up an effective energy efficiency organization is breaking through organizational walls or "stovepipes," which in the past often kept energy efficiency in a narrow functional range focused on a few limited technical areas. To tap the organization's full efficiency potential, the efficiency program must be able to reach into all aspects of operations. Common organizational barriers and examples of solutions that have worked to overcome them are described below.

Figure 9

Dow's Energy Team



Recreated from image provided courtesy of Dow Chemical (2009).

Table 3

Dow Energy Efficiency Organizational Chart

Business EE&C Teams

Site EE&C Teams
- Charter
- Leadership
- Membership
- Plans
- Roles

EE&C Global Leader	Business A EE Leader	Business B EE Leader	Business C EE Leader	Business D EE Leader	Business E EE Leader
Site 1 EE Leader	Plant A 1	Plant B 1	Plant C 1	Plant D 1	Plant E 1
Site 2 EE Leader	Plant A 2	Plant B 2	Plant C 2	Plant D 2	Plant E 2
Site 3 EE Leader	Plant A 3	Plant B 3	Plant C 3	Plant D 3	Plant E 3
Site 4 EE Leader	Plant A 4	Plant B 4	Plant C 4	Plant D 4	Plant E 4
Site 5 EE Leader	Plant A 5	Plant B 5	Plant C 5	Plant D 5	Plant E 5

Recreated from image provided courtesy of Dow Chemical (2009).

Production priorities—Especially in a manufacturing environment, but also in technically complex operations like data centers, operations managers tend to resist changes that could affect quality or production volume. Effective energy efficiency programs reach out to and gain the trust of production staff through two primary means:

1. **Using peers—**Companies like Toyota use production staff from other facilities in the "treasure hunts"[30] the energy team conducts at its plants. Having recommendations come from peers builds credibility and a comfort level with production staff. Toyota also uses peer competition through events like its "Race for the Greenest" to keep production shops focused on energy goals.
2. **Pilot projects—**New technologies or practices can often be tested in pilot projects. Successes documented in these projects can then be used to convince other facility staff to adopt those technologies or practices.

The organizational disconnect or "principal-agent" problem—When the unit that makes equipment purchasing decisions is different from the unit that pays the energy bills, and facility operations are managed by yet a third unit, the barrier known by economists as the "principal-agent" problem stymies energy efficiency performance.[31] Companies determined to break through this barrier succeed by building a program that brings these "agents" together to pursue a common objective. They connect procurement policies with billing systems with facility operations and investment decisions. The motives of all organizational units are aligned under a single goal—meeting and beating the company's energy performance targets. IBM, for example, consolidated its energy management team into a global team within its Real Estate and Site Operations group. This brought together management of energy purchases and energy efficiency initiatives under a single global team improving management of its 1,100 facilities.

Scale—Most energy efficiency investments are small, and considered individually can be hard to notice, compared to the many larger investment opportunities corporate leaders entertain, be it buying companies, opening new plants, or creating new product lines. Winning corporate energy efficiency strategies that assess and assemble the potential for energy savings across hundreds or thousands of facilities and projects can show senior management the total bottom-line value of these investments. This can bring to light ideas that astute individuals may have known about for years, but only when the program made them visible in a meaningful way to senior management do they become actionable. Toyota and UTC addressed this issue by developing online databases of efficiency projects that could be implemented, with key design, costs, and impacts details, and making this system available across the company. This makes efficiency options visible; and when the performance measurement and reporting system shows a need to improve, such a resource can quickly show both senior management and facility staff where the fixes can be found. UTC facility staff have been able to use this system to accelerate funding of plant-level projects.

(iii) Data Collection and Reporting

Data collection and reporting is a critical element of any corporate energy efficiency strategy. The text below elaborates on the tracking and performance measurement principles described in the "Seven Habits" section (page 25), while also providing specific examples of how these principles are put into practice. Unless otherwise noted, these examples are drawn from the case studies that begin on page 71 of this report.

The system collects data regularly from all business units. In many organizations, energy data simply gets rolled into larger operating cost categories, and thus cannot be seen as a separate element. A corporate efficiency program requires an organization-wide system that tracks units of consumption as well as cost. Companies typically create standardized formats and convert energy consumption to common units. In most cases, these units begin with the physical units reported on energy bills, such as KWH of electricity, or therms of natural gas. However, these physical units are typically converted into standard energy units, most often BTUs. This standardized-energy-unit method is needed to create a consistent basis for performance measurement.

Example: Dow invested significant effort into converting the various flows of energy commodities and intermediate energy in its operations to a standardized set of BTU equivalents. Because natural gas is the dominant source in Dow's energy purchases, all energy forms consumed are translated to equivalent BTUs of natural gas and adjusted to reflect real-world efficiencies and losses associated with energy conversion. This method allows staff across the company to use a common currency in terms of how much natural gas has been or would have to be used to produce the energy consumed at a given plant. It therefore estimates how many BTUs of natural gas equivalent would be saved from a given energy saving opportunity. This provides the company a consistent way to make realistic calculations of primary energy impacts and thus derive better estimates of expected energy cost savings.

The data is normalized and baselined. To be useful as a performance metric, energy use is typically normalized by one or more factors the organization considers critical to its overall performance. Normalized energy data is typically expressed as "BTU per X" (pound of product, square foot of floor space, product unit, etc.). Beyond normalizing energy use, effective systems also develop baseline energy usage, typically expressed as energy performance in a specific year. This baseline becomes the basis of target-setting, and then of measuring progress against the target.

Examples: Toyota normalizes its energy data into million BTUs per vehicle produced, a metric that was initially derived partly to help the company benchmark its performance against other major automakers. Companies that are more commercial in nature, like Best Buy, express energy performance as BTU per square foot of store floor space, while others measure energy use on a per pound of product or dollar of revenue basis. Companies vary in terms of the baselines they set for tracking progress against energy savings targets. Those with a longer history of energy efficiency targets will often readjust their baselines after they achieve a given goal. For example, Dow set an initial target to reduce energy used per pound of product 20 percent by 2005 measured against a 1996 baseline. It overachieved on that goal and set a 2015 target to reduce energy use 25 percent measured against a new (and lower) 2006 baseline.

Veteran energy managers have learned that to really understand energy performance data, it has to be granular enough to pinpoint problems.

Data collection and reporting is as "granular" as possible. Veteran energy managers have learned that to really understand energy performance data, it has to be granular enough to pinpoint problems. A granular data collection system would, for example, be able to report the chilled water inlet and outlet temperatures and flow rates for a cooling system, and its KWH of electricity demand down to the hour or even the minute. But many facilities have access only to a monthly electricity bill that does not distinguish between cooling systems, light fixtures, or computer workstations. Leading companies address this problem by "triaging" information facilities and systems. They do this by assessing which facilities are the largest or most energy-intensive users, and invest more resources in granular data collection in those larger facilities. Smaller facilities may be asked to report only aggregate energy billing data; the smallest facilities may be excused from reporting altogether.

Each company must create its own practices and investment rules to develop the energy information system most appropriate and cost-effective for its needs. It does cost money to get good data; the question is what level of investment, beyond collecting basic energy billing data, is justified for the expected value returned. Some companies are finding that technological advances are driving down the costs of data acquisition and management systems.

Example: IBM operates over 1,100 facilities worldwide. Only 650 are required to participate in the monthly energy tracking and reporting system; the rest are deemed too small to justify the cost of collecting the data. Of the 650 facilities, IBM manages 210 intensively, conducting individual facility assessments to support performance improvement. Only 24 of the company's most intensive facilities, typically manufacturing plants and major data centers, have highly granular monitoring and control systems. These are integrated into an online data system through which system-by-system energy data is continuously visible, enabling sophisticated "continuous commissioning"[32] and similar advanced energy management approaches.

The system includes feedback mechanisms that support corrective action. Effective systems must measure performance against goals in regular reporting cycles with data viewed by senior executives with decision-making authority. But simply reporting information is not enough. The best programs encourage direct and specific feedback, so that leaders not only see performance information, but have practical channels to act on it. In addition to lines of communication, where leaders know whom to call in a lagging facility or other operating unit, facility-level staff are supported with project data or operating checklist guidance to maintain or improve energy performance.

Example: UTC developed an efficiency project database alongside its reporting system for all major facilities. The project database requires entry of a broad range of data on efficiency projects including required investment, potential cost savings, usage reductions (gallons of fuel, KWH, etc.), utility incentives, and GHG reductions. This database has had powerful impacts within UTC. Once energy performance problems are identified, managers can quickly turn to a list of pre-analyzed projects to address the issues. In one case, a business unit president contacted a plant manager whose facility was lagging behind energy goals. The manager showed the president a set of several projects that had been "on the shelf" for several years. The president approved the projects within minutes.

Performance data is effectively visible to senior management. Most well-run companies today are not lacking in data. Some would say today's managers are drowning in data, and rather than more data need *information* tools that quickly raise key data into useful forms. The most effective programs use information dashboarding, or simplified information displays to make performance data readily apparent. Among many of the companies studied for this report, a simple "traffic light" system was applied, in which lagging facilities' data was highlighted in red and those ahead of goals in green. These reports are typically also available electronically through a company intranet system that enables all parties, including senior management, to access them from anywhere at any time.

Examples: IBM's Business Intelligence Energy Management Reporting System (a sanitized version of which is shown in **Table 4**) is similar to that used by several leading companies. The red and green performance indicators give senior leaders an easy-to-digest format to determine which facilities are ahead of (green) or behind (red) energy performance targets. In the table, the smaller box at the top represents aggregated totals from several IBM facilities, while the larger box shows energy use data from individual facilities.

Energy performance data is broadly shared, internally and externally. In the early days of corporate energy management, dedicated energy engineers or other champions typically built their own tracking tools, and the data stayed in a fairly narrow radius within the organization. The data might be seen by like-minded engineers in other facilities, or by senior management as part of a larger report, but it would not likely have been accessible across the organization. Today, modern IT makes data transparency much easier, but it takes a corporate commitment to

Table 4

IBM's Business Intelligence Energy Management Reporting System

As of Date	10/2009	10/2009	10/2009	10/2009	10/2009
Previous Year YTD Usage Total	NA	NA	NA	NA	NA
Current Year YTD Usage Total	NA	NA	NA	NA	NA
Year to Year PCT Chg Total	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%

Rank Num	Locations	Geographies / IOTs	Countries	Previous Year YTD Usage (MWh)	Current Year YTD Usage (MWh)	Year to Year PCT Change	Avg CY Rate ($/MWh)	YTD $K Impact
1	Location 1	North America IOT	United States	438,512	406,926	-7.2%	$80.13	-$2,531
2	Location 2	North America IOT	United States	376,767	343,814	-8.7%	$85.29	-$2,811
3	Location 3	North America IOT	United States	212,888	193,991	-8.9%	$81.24	-$1,535
4	Location 4	North America IOT	United States	118,050	125,481	6.3%	$56.71	$421
5	Location 5	North America IOT	United States	151,824	148,770	-2.0%	$52.05	-$159
6	Location 6	North America IOT	United States	90,099	83,173	-7.7%	$81.45	-$564
7	Location 7	North America IOT	Canada	113,449	104,042	-8.3%	$41.28	-$388
8	Location 8	Southwest Europe IOT	France	47,704	63,622	33.4%	$71.35	$1,136
9	Location 9	North America IOT	United States	64,357	64,954	0.9%	$83.44	$50
10	Location 10	North America IOT	United States	94,564	87,572	-7.4%	$73.70	-$515
11	Location 11	North America IOT	United States	44,031	42,191	-4.2%	$118.21	-$218
12	Location 12	North America IOT	United States	50,148	49,553	-1.2%	$68.50	-$41
13	Location 13	Northeast Europe IOT	United Kingdom	45,023	42,971	-4.6%	$119.66	-$246
14	Location 14	North America IOT	United States	38,308	37,830	-1.2%	$114.23	-$55
15	Location 15	Latin America GMT	Brazil	45,062	52,163	15.8%	$154.74	$1,099
16	Location 16	North America IOT	United States	44,714	47,107	5.4%	$123.49	$295
17	Location 17	Northeast Europe IOT	United Kingdom	42,061	43,418	3.2%	$113.91	$155
18	Location 18	Northeast Europe IOT	Ireland	25,544	21,271	-16.7%	$113.40	-$485

Recreated from image provided courtesy IBM (2009).

develop the data and the system details into an effective energy information platform. To be sure, not all data is fully transparent. Internal systems typically use permission-based access, and most systems post data for external viewing only on an aggregated, company-wide basis. A plant facilities manager, for example, can see energy data for hundreds or thousands of devices within his or her site, but the data posted in the company's annual sustainability report would aggregate all this data into a single BTU-per-unit of product number.

Example: At Toyota's Kentucky facility, managers can access energy data and in some cases even control systems remotely. In one instance, a staffer logged in from home over a long July 4th weekend to make sure his unit's HVAC system was shut down as planned. At a higher level, the companies profiled in this report make energy data publicly available through annual sustainability reports or similar means. This adds an additional layer of accountability as it allows shareholders, customers, and other stakeholders to assess whether a company is living up to its energy and environmental commitments.

The system finds the right balance of centralization and decentralization. Each company needs to strike a balance on how much data to collect, how much to report, and how much information is needed for a given level of management. The best programs have a wealth of data available but report only the indicators most needed to assess performance. As the reports reach more senior levels, they become more aggregated and "dashboarded" to quickly show leadership where performance stands. When performance problems show up, individual facility staff can then drill deeply into the information system for more granular data to locate and fix problems.

Examples: At UTC, business unit leaders look primarily at whether a given facility is ahead or behind on its energy goals; facility managers can drill deeper into the company database to locate the source of performance issues and find projects to improve performance. Similarly, at Dow, centralized energy metrics act as high-level performance indicators while finer-grained information is kept decentralized at individual business units and sites.

The system is linked to a commitment to continuous improvement. The best energy management programs do not treat their data collection and reporting systems as just a compliance requirement, although they also find that an element of compliance is needed to get broad participation, especially at first. Rather, they tap into a broader cultural ethic of continuous improvement, using the energy reporting system as a tool that empowers people to seek new efficiencies and associated innovations. Data collected from the Pew Center survey and the case studies indicate that companies are devoting more resources to the operational side of energy efficiency than the capital side.[33] This could be driven by the effects of the recent recession, but it could also reflect the spread of continuous improvement approaches. In a continuous-improvement culture, the near term and long term are closely related, in that the primary focus is on what can be achieved now regardless of longer-term goals. So in a given year, most of the total effort may go to operational issues, even if capital projects are implemented with some regularity.

Example: Toyota's continuous improvement ethic is known as "Kaizen." At its Kentucky manufacturing plant, Kaizen helped enable the energy team to mobilize the production crews as drivers of the energy performance goals. Shop captains were driven to reduce energy use after energy was added to the KPIs that each shop (paint, assembly, welding, etc.) had to meet. Steps taken ranged from the simple—shutting off compressed air tools at lunchtime—to the sophisticated—recovering heat from the paint shop drying process. This whole process, however, became visible when the company began friendly competitions among shops, shown on a magnetic board in a central bay of the plant. The theme might vary from year to year, from a Kentucky horse race to a NASCAR auto track, but each shop's KPI performance was distilled into a point total, and each shop was represented by a miniature racehorse or racecar on the track. At each month's meeting, Toyota Motor Manufacturing Kentucky's president along with shop captains, facility and energy staff converge for a friendly update on the month's "race results," with the leading teams' pieces moved into the lead positions on the board.

(iv) Financial and Risk Management Assessment of Efficiency Investments

Today's best energy efficiency strategies look beyond the "simple payback" mindset in assessing the value of their energy efficiency investments. Yet finding capital, even for very cost-effective investments, was reported in this study's survey as the top-rated obstacle to progress in advancing efficiency programs. In the recent recession, capital availability has been even tighter, with some companies reporting capital budgets cut by half or more. This has placed more focus on operational and low-cost performance improvement measures, but companies have also found ways to drive investment in efficiency.

Perhaps the single most effective approach companies have used to improve access to capital is simply to set aggressive efficiency goals, make them a priority, and force the organization's decision-makers to reset their investment priorities to favor efficiency. Beyond this brute-force approach, however, many companies have found ways to help efficiency projects get approved even when conventional financial analyses make them appear less favorable compared to other investment options. While most Pew Center survey respondents reported that they want simple paybacks (project cost divided by annual energy savings) of 3 years or less for efficiency investments, they also look at other benefits, including:

- **Productivity**—Leading programs look at total productivity impacts from technology and practice changes, including reduced material waste, reduced production downtime, and improved employee comfort/reduced absenteeism. For example, office lighting upgrades can improve lighting quality and reduce glare and eyestrain, while building retrofits may improve temperature control and comfort.
- **Risk reduction**—Forward-thinking companies consider energy efficiency a risk-management strategy. It can reduce their exposure to rising energy prices and to price volatility effects, which can help stabilize net income and earnings forecasts. Additionally, energy efficiency can help mitigate risk associated with future carbon regulations.
- **Human capital**—Direct human capital benefits include better quality workspaces, greater physical comfort, and reduced safety risks. But perhaps more importantly, leading companies are finding that efficiency, when part of a cultural shift that unlocks innovation by encouraging creativity and risk taking, can help retain and recruit talent and generate additional technology and operational improvements.
- **Corporate reputation**—Energy efficiency is one of the more measurable ways to demonstrate environmental commitments to key audiences. Companies that obtain third-party verification can gain additional credibility and can leverage this reputational value with key stakeholders.

Some companies have put in place explicit budgeting procedures and other mechanisms that help ensure that energy efficiency projects get funded that may not have satisfied traditional payback requirements. Examples include:

- UTC leadership set a goal for its business units of spending $100 million on efficiency projects during its four-year program target period. Though there was no formal application or screening process, the energy team achieved this goal within the first two years as facility managers sent their project requests up the line to business unit leaders for approval and funding.
- In 2007 and 2008, IBM invested an additional $9 million, over and above the routine expenditures needed to operate its ongoing energy conservation project, into projects with good business returns but no available funding. While conservation projects have to meet financial criteria, management focus on their implementation can help assure that viable projects are given consideration when competing for funding with business oriented projects.
- PepsiCo developed an additional process to screen for sustainability attributes for all capital investment projects above $5 million. The screening process evaluates whether the project

contributes to or inhibits progress toward sustainability goals. This screen catches projects with attractive conventional returns but significant environmental risks before they move forward and can lead to project modifications that incorporate energy and water efficiency features.

- Several companies in the Pew Center survey reported experimenting with performance contracting, a financing approach in which a third party invests capital in the customer's facility and executes an energy services agreement in which the energy savings are guaranteed to meet or exceed financing payments. Some companies have found this approach unworkable because such contracts typically are long-term, running 10 years or more, well beyond most companies' planning or decision horizons. They also found that interest costs and overhead add to project costs, making the project less attractive than paying for the measures directly.

Despite these innovations, the Pew Center survey found that financial barriers to energy efficiency remain prevalent. Some companies report focusing on educating their workforce to gain deeper understanding and commitment to the program, looking deeper for operational improvements and identifying projects for the future when economic conditions improve. Since most survey respondents expect energy prices to rise substantially, anticipate climate legislation to further raise energy prices, and see a growing imperative to reduce emissions, it can be inferred that companies expect efficiency investments to attract capital resources more easily over time.

(v) Leveraging Culture Change

Changing an organization's culture is rarely easy, and overcoming this barrier can be a significant challenge. But world-class energy efficiency strategies are helping do just that. When implemented within a total corporate sustainability or social responsibility commitment, energy efficiency is helping to generate waves of innovation that reach beyond the immediate confines of the energy performance objectives. Strategies that get to this level tend to show the following traits:

Moving efficiency outside the "energy box"—In the early days of energy management, engineers were asked to improve the efficiency of the boiler, and perhaps the steam lines, but were rarely invited to ask bigger questions like, "Why are we using high-pressure steam for a low-temperature drying process?"[34] In PepsiCo's program, the energy team began to look beyond the efficiency of steam systems at cooking temperatures and times, reclaiming heat from wastewater coming out of cooking processes, total water use, and other aspects of the process. IBM, in reviewing a high-temperature contaminant removal process in its semiconductor manufacturing, found a new process that operated at lower temperatures and that did not require periodic cleaning shutdowns. This new mindset creates opportunities for energy engineers to expand their influence by engaging with more people across more organizational lines.

Applying change management methods—Some efficiency programs overlook the organizational changes needed to make the program both effective and sustainable over the long term. Simply designing and implementing the "mechanics" of the program, such as the data reporting system, are not enough. A process is needed for helping the individuals and organizational units adapt to these changes, through training, organizational realignments, enhanced communication, and other methods. The best companies spend the time and effort working with the people involved through a conscious process to lead from the current state to the desired future state.[35]

Fostering a culture of innovation—"Fostering innovation" can become a meaningless buzzword. Effective efficiency strategies make it real by forcing production, facility, and other managers to look harder at every aspect of their operations. And because energy is pervasive, touching virtually every operation in most companies, an aggressive company-wide energy performance goal can drive innovation in many aspects of company operations. PepsiCo's efficiency program has involved so many people, and generated so many ideas in energy and related sustainability areas, that it has created a new set of challenges in managing a potentially distracting proliferation of ideas. IBM's internal energy and other sustainability goals developed innovations that have filtered into its Smarter Planet theme of intelligent systems offerings to its customers. IBM uses the Smarter Planet theme to support its marketing goals for a wide range of IT and related solutions.

Encouraging continuous improvement—While the continuous-improvement ethic is driven in a narrow sense by data, with the objective of raising scores on key performance indicators as discussed earlier, there are broader organizational issues involved. Some innovation cultures foster a limited number of high-achieving innovators, and may set them off in "skunk works" or other development units in hopes of creating a few breakthrough innovations, or "killer apps" as they are known in the IT world. Continuous improvement takes a somewhat humbler and more egalitarian approach. The essence of continuous improvement is that every person, regardless of their job, is encouraged to continually look for ways to do things better, improve quality, and reduce waste. This tends to create a broader stream of smaller improvements, which collectively give the organization a large and durable edge in its market. The best efficiency strategies support the continuous improvement ethic; since energy is used almost everywhere in the organization, almost everyone can contribute to meeting efficiency goals.

The essence of continuous improvement is that every person, regardless of their job, is encouraged to continually look for ways to do things better, improve quality, and reduce waste.

Building morale and citizenship—Respondents to the Pew Center survey were surprised at how resonant the energy efficiency goals were with employees across the organization. They saw that efficiency can tap into many employees' intrinsic values, as distinguished from extrinsic values related to compensation, job security, or career advancement. Many people genuinely believe in what their companies are doing and why they are doing it. Many of them become more personally energized, more committed to their work and their companies, when they feel part of something they believe in. PepsiCo observed this from the many positive comments it received from staff who attended its Sustainability Summit. In Siemens' *2009 Greening of Corporate America*[36] survey report, 62 percent of leaders in companies larger than $5 billion said environmental sustainability initiatives will attract more qualified job applications, almost half reported employee retention as a key driver of these initiatives, and 69 percent reported company-wide employee engagement programs. The 2006 book *Good to Green* devotes an entire chapter to "Managing Human Resources to Nurture a Culture of Innovation."[37]

B. Supply Chains

Companies naturally focus their sustainability strategies internally at first—that is where they have most control, can get the quickest results, and see the direct bottom-line benefits. But as they assess their total environmental footprint, examining the total flow of resources in the entire chain of economic activity in which they operate, many learn that much of the company's footprint results from what they buy or sell, outside their own operations. Pew Center survey responses showed that of the companies that measured the energy footprint of their supply chain or their products and services, the majority found that their supply chain and product/service footprints exceeded that of their internal operations.

In this study, the term "supply chain" connotes those activities "upstream" from the company, conducted by the entities that supply products, materials, or services to the company that is assembling either an intermediate or final product. Where a company sits within the supply chain will often affect its motivation and ability to take actions to improve energy efficiency and environmental performance among its suppliers. For example, a bulk-chemical producer like Dow has a relatively limited upstream supply chain, purchasing mostly natural gas and other raw materials. The options for improving energy consumption in such operations are limited. By contrast, a retailer like Wal-Mart or Best Buy, sitting near the end consumer, sees an enormous upstream supply chain. Other companies sit in the middle, buying materials, components, services from a variety of suppliers and selling to other businesses before a finished good reaches

Where a company sits within the supply chain will often affect its motivation and ability to take actions to improve energy efficiency and environmental performance among its suppliers.

the end consumer. Each company's situation on this spectrum influences the intensity of its efforts to manage the energy and carbon footprint of its supply chain.

The Pew Center survey showed that while the majority of respondents (55 percent) had measured the energy footprint of their products and services, only 17 percent had measured their supply chain footprints. Respondents reported that the main barriers to measuring their supply chain footprints were lack of data, high costs, and supplier resistance. Data issues were also commonly reported in the case studies. Collecting a common set of information from a large set of suppliers of different size, business focus, and technical capabilities proved challenging.

"Supplier resistance" was also identified in the Pew Center survey as a significant barrier to improving energy efficiency in the supply chain. A core issue here is business confidentiality. Many companies consider their energy use and cost data proprietary, based on concerns about customers and competitors gaining too much information about their operations and costs. To a large degree these concerns can be addressed by masking, aggregating, and limiting public access to such data, but these techniques also bear costs. Larger companies, to the extent they have leverage with their key suppliers, and have the resources and expertise to manage these data issues, may have better success at getting supplier cooperation.

While companies have only recently begun working with suppliers on energy efficiency and sustainability issues, some trends are beginning to emerge. First, suppliers are increasingly being asked to provide energy and environmental data to their corporate customers. This can be viewed as a first step toward companies eventually requiring suppliers to meet certain energy and environmental benchmarks, though this has not yet emerged as a widespread practice, at least among the companies surveyed for this report. Some companies, however, are encouraging suppliers to set voluntary energy and carbon reduction goals, and participate in third-party energy efficiency and other sustainability programs.

(i) Key Business Drivers for Supply Chain Efficiency Strategies

Based on this project's case studies and survey responses, plus BELC workshop materials and other sources, a number of key drivers for supply chain energy efficiency action include:

- **Sheer size**—Carbon footprinting has surprised many companies by showing how large their supply chain footprint is in relation to emissions from their internal operations. Wal-Mart, the world's largest retailer and one of the largest private purchasers of electricity in the U.S.,[38] estimates its supply chain footprint to be some twenty times it internal footprint.[39] UTC estimates its supply chain footprint to be some five times its internal footprint.

- **Cost reduction**—To the extent companies can help suppliers cut energy costs, this helps manage costs across the overall supply chain. While there are sensitivities regarding disclosing energy cost and performance data, energy efficiency is a sustainability issue that can offer direct cost reduction benefits, whereas many sustainability issues can entail cost increases.
- **Customer and third-party demand for transparency**—In this information-rich era, and with growing public disclosure of sustainability and other social responsibility data, companies' supply chains and their environmental footprints are more visible than ever. Customers are asking to know the full energy and environmental impact of products across the entire supply chain and life cycle. Other stakeholders are increasingly asking companies to act as responsible buyers. Efficiency provides quantified results that can be posted in Corporate Social Responsibility (CSR) reports and elsewhere, whereas progress on other CSR issues can be harder to quantify.
- **Replicability**—Companies' CSR issues, especially at a global scale, can be so varied as to defy a consistent corporate response. Many issues are local in nature, tied to political and cultural factors in specific companies—labor practices, for instance, fall in this category. Efficiency, however, as an organizational process can be implemented widely, can provide objective and immediate benefits, and can be less controversial than other CSR topics.
- **Reputational value**—With companies under increasing public pressure to demonstrate their CSR commitments, efficiency in the supply chain rises to the top as a measurable effort that can be implemented and show results quickly. Environmental advocates and shareholder activists are increasingly sophisticated in their scrutiny and quicker to discount verbal or qualitative commitments. Efficiency provides hard numbers that prove the company's commitment.
- **Co-benefits**—Engaging suppliers through energy efficiency can build relationships that expand into other areas. Energy efficiency initiatives can easily lead to efforts on water efficiency, recycling, and other topics not necessarily related to sustainability, such as product safety and reliability. The channels used to share efficiency information and services can be used to expand supplier knowledge and action on a wide range of topics.

A review of this list suggests that the bottom-line motivation for supply chain efficiency strategies is not as direct as it is for internal operations. But if efficiency investments and practices help a company's bottom line, they are also likely to help its suppliers'. And while none of the companies studied for this project use their sustainability strategies to exert price leverage over suppliers, there is a more generalized case that making suppliers more efficient will help control supply costs over time.

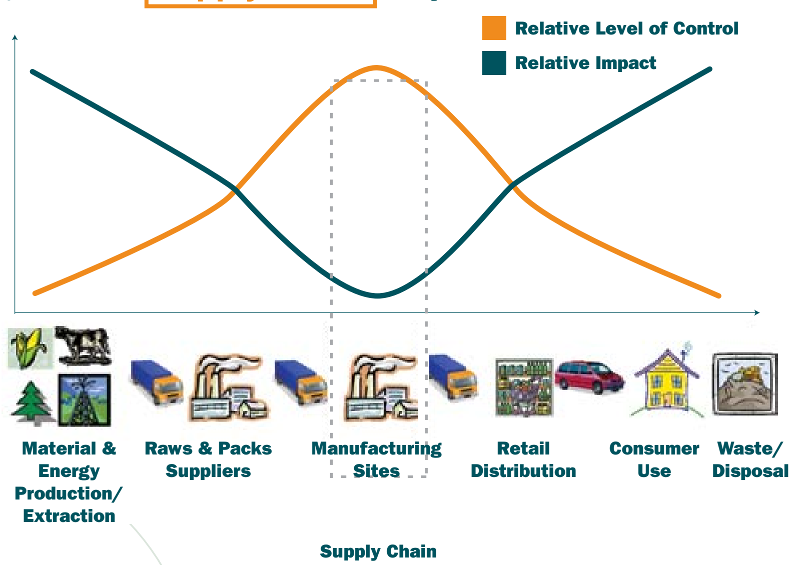
(ii) Mapping the Supply Chain Energy Footprint

In accordance with the GHG accounting protocol, jointly developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), supply chain emissions are categorized under "Scope 3" emissions. Scope 1 impacts are from a company's process emissions and direct, or on-site, energy consumption; Scope 2 impacts come from purchased energy where emissions occur offsite (electricity generation, for example); and Scope 3 is everything beyond that, including supply chain and product use emissions. WRI and WBCSD are currently developing a Scope 3 measurement and reporting protocol, expected to be completed by December 2010.[40]

Companies often map out their supply chain emissions as part of a broader effort to determine lifecycle product impacts—from raw materials extraction all the way through product disposal. **Figure 10** is a conceptual representation of these product lifecycle impacts for Mars, a global food business. The chart demonstrates that the magnitude of the environmental impact is typically inversely correlated with the company's direct ability to mitigate those impacts. In other words, the bulk of the lifecycle impacts occur in the supply chain (from activities undertaken by other companies) and the product use and disposal phase (which the end consumer largely controls). The manufacturing phase, over which Mars has the most direct influence, actually results in relatively small environmental impacts. This same conundrum is apparent in other companies' operations (UTC, for example, uses a similar schematic to illustrate this phenomenon, as shown on page 56). It does not, however, hold for all companies. A diagram for a bulk-

Figure 10

Qualitative Supply Chain Map for Mars, Inc.



Recreated based on image provided courtesy of Mars (2008).

wholesale manufacturer like Dow would look quite different, in that Dow sits fairly upstream in the supply chain, that is, closer to raw materials than to consumer products. Mars is a more typical manufacturer, situated closer to the middle of the chain. A retailer like Best Buy sits closer to the product's end consumer.

(iii) Examples of Company Supply Chain Initiatives

PepsiCo. A sizeable percentage of PepsiCo's products are produced through contract manufacturers, or "co-packers." Realizing that success in reaching its broader sustainability objectives depend in part on its co-packers' behavior, PepsiCo has focused intensively in recent years on bringing the co-packers into its energy efficiency efforts (see PepsiCo case study for more details). Key steps included:

- **Engaging co-packers in the PepsiCo Resource Conservation Model (RECON) reporting system.** By developing a secure online reporting format, with simplified inputs and reporting dashboards, PepsiCo made it easier for suppliers to supply data and understand reports. Participating suppliers are also asked to commit to four percent annual reductions in energy and water usage.
- **Setting goals to get co-packers involved in third-party energy efficiency and related sustainability programs.** PepsiCo created an Outreach Implementation Scorecard to chart suppliers' progress in joining such programs. The company's 2009 goal was to get 75 percent of its suppliers participating in these programs. By the end of 2009, 75 suppliers and all 12 major copackers have joined the ENERGY STAR program, helping win PepsiCo a 2009 Partner of the Year Award.

Figure 11

Nike's Carbon Footprint

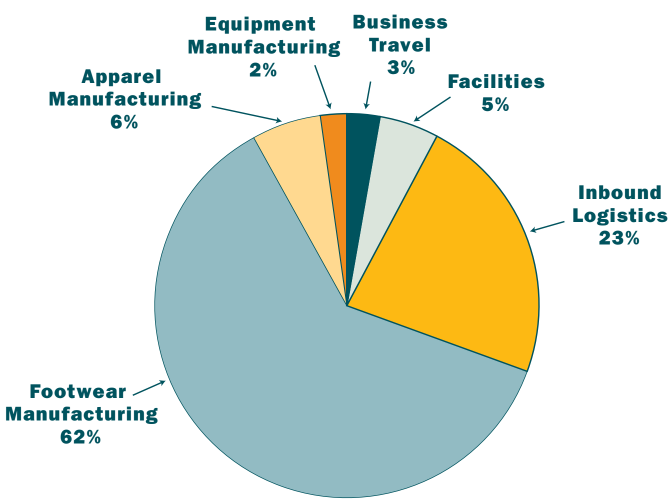


Image recreated based on data available from Nike's 2009 Corporate Responsibility report.

Nike. The majority (70 percent) of Nike's CO_2 emissions come from manufacturing, which would normally be considered internal operations. But since almost all of Nike's manufacturing is conducted by contract rather than through company-owned facilities, what would otherwise be considered internal operations is more appropriately treated as part of the supply chain (**Figure 11** shows a breakdown of Nike's emissions footprint). Because of this, Nike has had a clear motive to focus on its supply chain. Based on this assessment, the company has set a goal of reducing its inbound logistics footprint 30 percent by 2020 below 2003 levels, and launched a program to improve efficiency in its contract manufacturing operations.[41]

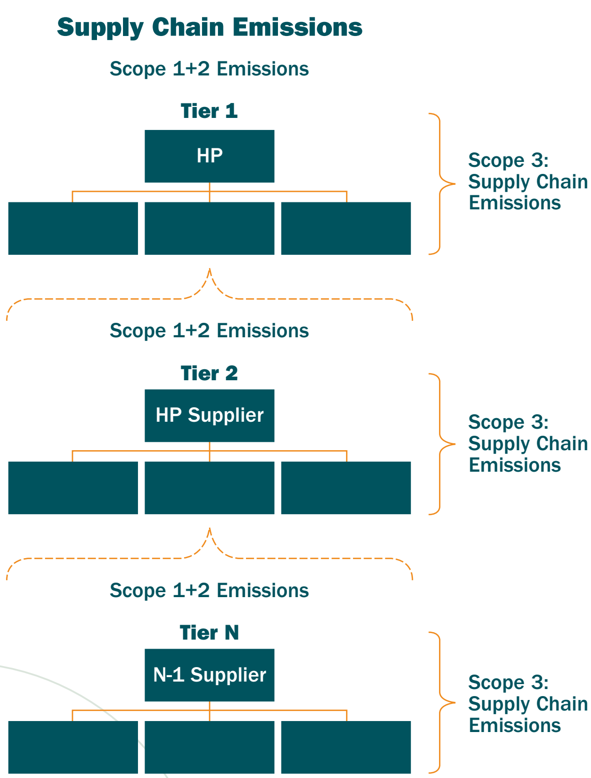
Hewlett-Packard (HP). HP co-led the environmental sustainability work group in the Electronic Industry Citizenship Coalition (EICC)[42] and helped develop a systematic supplier reporting system. The EICC system was created to facilitate one common template and make it easier for electronic industry suppliers to disclose their carbon emissions. In 2008, HP asked its Tier 1 (most direct) suppliers, accounting for over 80 percent of their manufacturing spending, to report GHG emissions. HP was the first major IT company to report its aggregate supply chain footprint in this way.

In 2009, HP asked Tier 1 suppliers to again report emissions, but this time the company also asked suppliers to set reduction goals, and reach out to their suppliers (HP's Tier 2) to report GHG emissions. The results show that HP suppliers have become increasingly committed to reducing energy and emissions in the last two years. The number of suppliers calculating and disclosing emissions increased by a third, two thirds of suppliers reporting to HP have established GHG reduction goals, and about a fifth are estimating the emissions of their own suppliers. **Figure 12** illustrates this model of suppliers reporting to customers, enabling customers to estimate embedded emissions from their supply chain.

HP believes this methodology of supplier-to-customer reporting enables accountability and transparency in the supply chain. If all suppliers report environmental information in a common and consistent manner to their customers, the entire supply chain (no matter how complex) can be accounted for.[43] Additional benefits of this approach include:

Figure 12

HP's Supply Chain Reporting



Recreated based on image provided courtesy of HP (2009).

- The information reported is actual observed data and creates year-over-year accountability with the supplier (what gets measured gets managed).
- Supply chain emissions represent a network problem and require a network solution that enables a logical aggregation of information representing the actual supply chain.
- By focusing on a simple, repeatable process, this methodology avoids over-counting of emissions and high levels of uncertainty.
- Supplier-to-customer reporting avoids confidentiality issues because parties already have a contractual relationship and an obligation to share this kind of information.

(iv) Recommended Practices for Supply Chain Efficiency Strategies

Best practices in supply chain energy efficiency in some ways resemble those applied to internal operations strategies: leading companies will often offer their efficiency expertise to their suppliers, essentially to support replication of those practices. Most of the companies in the Pew Center survey reported sharing information and technical assistance with suppliers. However, expanding into the supply chain creates substantial new challenges in data collection, analysis, normalization, and reporting.

> ***Expanding energy efficiency into the supply chain creates substantial new challenges in data collection, analysis, normalization, and reporting.***

While only 17 percent of Pew Center survey respondents reported measuring their supply chain energy or carbon footprint, this is partly a timing issue. Leading efficiency strategies have often been in place for 10–15 years or more, while supply chain efforts are typically much newer, taking formal shape only in the last few years for many companies and still in developmental stages for many others. The WRI/WBCSD Scope 3 Protocol will likely provide a robust reporting standard that may make it easier for companies to request, produce and receive supply chain emissions data, which in turn could lead to an increase in such reporting.

Based on the evolving experience of the companies in this study, a progression of supply chain practices is outlined on the next page. But two key prerequisites apply: (1) the company must both learn how to run an internal energy efficiency program and demonstrate its commitment by mounting an effective internal operations effort; and (2) the company must work hard to communicate with its suppliers, explaining why it is asking for data and subsequent commitments, and showing them the benefits they will get from the effort.

- **Data reporting**—Ask suppliers to begin reporting at least a few key energy indicators. The Scope 3 Protocol will provide a consistent basis for reporting, but companies will need to specify what indicators must be reported for which products. Twenty-one percent of Pew Center survey respondents in this study reported setting up energy or carbon reporting systems for suppliers, either voluntary or mandatory.
- **Mandatory reporting**—After a period of voluntary reporting, require at least some suppliers for some products to report certain energy indicators. Over time, the list of suppliers, products, and indicators may be expanded.
- **Technical assistance**—Share your operational techniques and technology solutions with suppliers as appropriate without compromising proprietary concerns. Begin with simple document and data sharing; if justified, consider holding webinars with suppliers or sending expert staff to supplier sites for assessments. Sixty one percent of the Pew Center survey respondents reported they had provided suppliers information or onsite technical assistance. Wal-Mart and PepsiCo provide technical assistance to suppliers, each in their own unique ways, and started with the suppliers with whom they have the closest relationships. Wal-Mart's first supplier energy audits were in its private label underwear manufacturer's plant;[44] PepsiCo focused its supplier efforts first on its "co-packer" contract manufacturers.
- **Benchmarking**—Work with suppliers to set performance benchmarks, beginning with a voluntary approach that suppliers seek to meet, perhaps with company technical assistance. Third-party organizations can be useful in the benchmarking process. PepsiCo, for example, actively promotes the ENERGY STAR program to its suppliers and has set a goal for 90 percent of its major co-packer suppliers to become ENERGY STAR participants by 2010.
- **Mandatory standards**—Based on benchmarks identified earlier, consider developing standards that suppliers must meet over a certain time period to remain eligible as vendors. Third-party, robust, transparent standards are typically easier to convince suppliers to meet. In the Pew Center survey, 12 percent of companies reported changing suppliers based on energy or environmental performance, though it is not clear if energy efficiency was an explicit factor. In the near future,

with the development of new emissions accounting protocols and energy management standards, such as ISO 50001, pressure on suppliers to track, manage, and reduce energy use and GHG emissions will likely increase.

Perhaps the most common form of energy use in supply chains occurs in the transport of products and materials. Energy use in transport is salient and consistent enough across all industries to warrant its own focus on best practices. While this study did not focus specifically on shipping issues, many companies are looking at opportunities to reduce energy use in logistics, including through:

- **Shifting to local suppliers, or encouraging suppliers to shorten supply lines—**Wal-Mart has focused on sourcing locally grown fresh foods. Some suppliers are willing to move operations closer to key customers to reduce shipping costs.
- **Supporting development of new vehicle technologies—**Wal-Mart has already met its interim goal of reducing energy use in its transportation fleet by 25 percent, partly through new technologies that limit or eliminate the need for engine idling.[45] EPA's SmartWay Transport Partnership supports advanced technology solutions for a range of shipping needs.[46]
- **Assessing alternative transport modes and intermodal shipping—**Shifting from air to sea, or truck to rail, can create substantial energy and cost savings.
- **Packaging volume and weight reductions—**Retailers like Best Buy and Wal-Mart are especially sensitive to packaging, as they must bear the costs of shipping the products to their stores, and then disposing of the waste material. Less packaging means more product can be shipped in each container, which means less fuel is consumed in the shipping process. Less packaging also results in less waste material that itself needs to be hauled off and disposed of elsewhere.
- **Maximizing efficiency of shipping routes and distribution networks—**Logistics and other supply chain experts are looking harder at finding the operations research solutions, including route optimization software and other technological solutions that can further reduce shipping energy and carbon footprinting.

C. Products and Services

One of the surprising findings in the Pew Center survey was the high percentage of companies (81 percent) that had acted to improve the energy efficiency of their products and services. More than half (55 percent) had estimated the energy or carbon footprint of their products and services (the total carbon emissions from products and services over their useful life), over three times the number that had done supply chain footprinting. Of these, two-thirds found their product and service energy footprint to be larger than their internal operations footprint. Survey respondents' reasons for their product and service efficiency efforts are summarized in **Table 5**.

Table 5

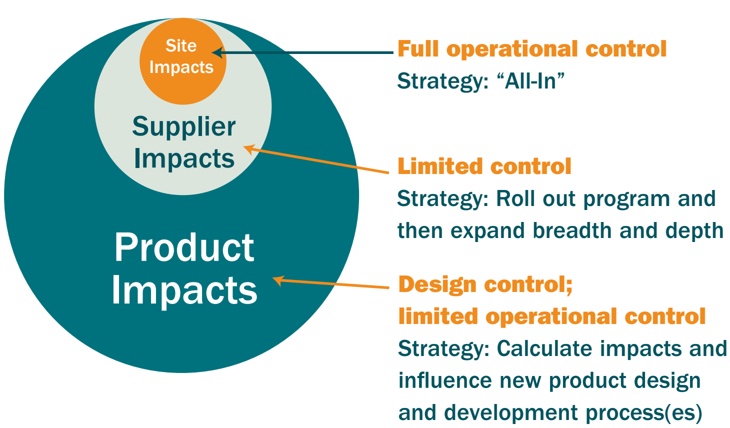
Motivations for Increasing Efficiency in Products and Services

Motivations for Increasing Efficiency in Products and Services	Percent
To take advantage of new market trends brought on by consumer concerns about energy prices	24%
To take advantage of new market trends brought on by consumer concerns about environmental issues	21%
To demonstrate corporate social responsibility	13%
To respond to competitive pressures (our competitors are driving us)	10%
To respond to expected future mandatory federal or state regulations/standards	5%

In the table above, over half the companies were driven by what they saw as consumer demand for efficiency, both in terms of straight energy bill savings and environmental "greenness." And with national branding programs like ENERGY STAR based on energy efficiency, companies have ready paths to follow in responding to these trends.

Figure 13

UTC's Operations/Supply Chain/Products Footprinting



Recreated based on image provided courtesy of UTC (2008).

Many of the companies responding to the Pew Center survey reported the energy/carbon footprint of their products and services to be larger than their internal footprint. UTC's footprinting analysis showed a product and service footprint several orders of magnitude greater than that of its internal operations (see **Figure 13** for a conceptual (not to scale) representation of UTC's carbon footprint). Most of

UTC's product footprint comes from its two largest business units: Carrier air conditioning and Pratt and Whitney jet engines. Both of these companies hold large market shares globally and have been in business long enough that their products use a lot of energy in the aggregate.

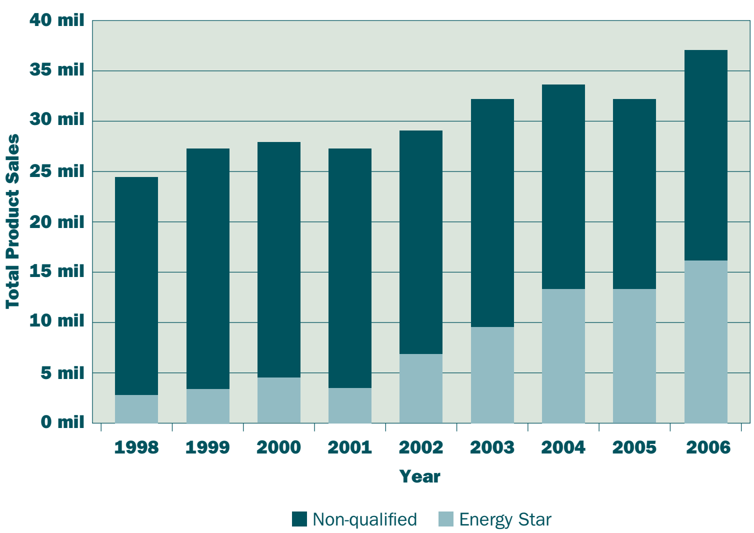
(i) Business Opportunities in Energy Efficient Products and Services

General Electric (GE) offers a glimpse at the size of the business opportunity in energy efficiency and other "clean tech" markets. GE's Ecomagination initiative includes a number of lighting, appliance, power generation, and other energy-efficiency and environmentally-friendly products and services. This line of products and services generated total revenues of some $20 billion in 2009. While not all Ecomagination revenues stem from energy-efficient technologies, GE has clearly demonstrated large profit potentials from the sale of these types of products. It is likely that the upside revenue opportunities from the sale of energy efficient products exceeds the bottom line savings generated by GE's own internal energy efficiency efforts.[47]

Other companies, too, see significant profit opportunities from selling more energy efficient products and services. Best Buy has focused significant efforts on selling ENERGY STAR qualified products (see Best Buy case study, page 144), while Whirlpool has for several years been a leading manufacturer of energy efficient home appliances.[48] With government incentives to promote energy efficiency growing, the business rationale for offering these products will likely continue to strengthen. Already in recent years, ENERGY STAR appliances have demonstrated gains in market share (see **Figure 14**).

Figure 14

Energy Star Appliance Market Share is Growing



Recreated based on data provided by U.S. Department of Energy (2007).

(ii) Key Drivers Behind the Push to Develop and Sell More Efficient Products and Services

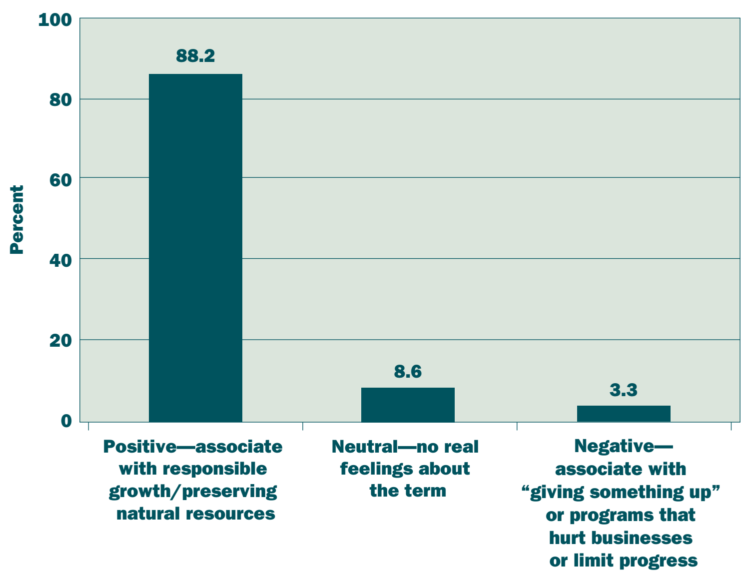
In the Pew Center survey, the most commonly cited drivers for developing more energy efficient products and services were consumer concerns about rising energy prices and consumer concerns about environmental issues. Efficiency does a particularly good job addressing consumer environmental concerns because it is a transparent "green" attribute. It can be measured and identified using established test procedures and labeling methods, whereas other green qualities can be more amorphous. Also, as **Figure 15** illustrates, consumers have a very positive perception of the term "energy-efficiency," making it a safe attribute to highlight in product marketing efforts.

In the Pew Center survey, the most commonly cited drivers for developing more energy efficient products and services were consumer concerns about rising energy prices and consumer concerns about environmental issues.

Figure 15

Consumers' Perception of Energy Efficiency

How do you feel about the term "efficiency," as in "energy efficiency"?



Source: Shelton Group Energy Pulse Survey

Other key drivers pushing companies to develop and market more energy efficient products include:

- **Public agencies and advocates push efficiency**—Programs like ENERGY STAR, while voluntary, bear the federal government's implicit "seal of approval" for companies that participate. By participating in voluntary programs, companies can stay "ahead of the curve" and outperform existing standards without potentially more onerous regulation. Appliance and other consumer and business product manufacturers covered by federal appliance standards sometimes support ENERGY STAR as part of their overall strategy for participating in the public policy sphere. This also reinforces the consumer "green" theme above, in that ENERGY STAR has become a trusted brand name in the U.S. market; it thus gives companies a credible third party basis for showing their products' "greenness."

- **Competition—**Because consumers are demanding more efficient products, companies know that if they do not improve their products, competitors will. UTC competes in the global aircraft business, in which fuel costs can make or break airlines, so every fractional improvement in Pratt and Whitney's jet engine fuel use performance helps the company keep and grow its market share.
- **Revenue and Profit Growth—**As the GE example above indicates, products and services that use less energy can support significant revenue growth. Efficient products can also be positioned as higher-value products that can bring higher profit margins. The Toyota Prius has built a robust market, even though it commands a price premium over comparably sized and featured alternatives. Energy efficient front-loading clothes washers also typically come at a premium price.

(iii) Residential Products and Services Issues

Home appliance manufacturers often describe their product design and marketing efforts as responsive to consumer preferences for product features—the design aspects of the products that convey the attributes consumers want. In this context, efficiency is often bundled with other features to create models or sub-brands that distinguish more feature-rich products from bare-bones "commodity" models. Although home appliances were seen for decades as a predictable, low-growth, low-margin commodity business, the last decade or so has seen a surge in appliance design and features. Energy efficiency has driven this surge to a degree, but more fundamental features still tend to drive consumer preferences.

Sometimes consumer preferences align with increased efficiency, but other times they do not. For example, front-loading clothes washers have surged in popularity in the last 15 years. They excel at saving water and energy, and also include features such as better cleaning performance and higher washload capacity. In this case, efficiency has mostly aligned with other feature advancements. In contrast, many consumer preferences for refrigerator features are at odds with efficient design elements. For example, automatic icemakers, through-the-door ice and water dispensers, automatic defrost, and larger freezer capacity are all features that require greater amounts of energy to run. So while refrigerator efficiency has increased dramatically since the 1970s, these increases could have been much greater were it not for consumer demand for these other energy consuming features.

(iv) Energy Efficiency and the Smart Grid

One feature that has emerged in home appliances in recent years is electronic controls that allow consumer electronic devices to communicate with the electric grid. This opens the door to a next generation of energy performance options known as "Smart Grid" features. "Smart Grid" refers to a broader wave of technology improvements in the electricity industry, wherein electric meters, electric utility communications with customers, and utility program offerings to customers will become more sophisticated.[49] This technology would enable, for example, refrigerators to "talk to" the electric utility system and delay defrost cycles when utility systems are running at peak capacity. Utilities would offer customers incentives to allow this kind of "smart grid" operation. In the past, utilities have offered incentives to customers to buy refrigerators that use less energy overall, but did not address the way customers use the products. This new wave would create new ways to shape how customers use their appliances, saving them more money.

While policy support will likely be needed to fully advance the Smart Grid, many electric utilities are already investing billions in smart meters and other technologies to enable communication between electricity providers and users. Additionally, home appliance manufacturers are gearing up to integrate Smart Grid features in their products. Whirlpool announced that by 2015 it will make all its electronically controlled appliances Smart-Grid compatible, dependent on the development of open, global communication protocols, and policies that encourage consumers, manufacturers, and electric utilities to advance these technologies.[50]

(v) Commercial/Industrial Products and Services Issues

Some companies examined in this study found a direct link between improvements in their internal operations and their products and services. This is particularly true in commercial and industrial energy use markets. IBM's internal data center management experience translated directly into customer offerings, as company-run and customer-run centers had the same basic technology and operations issues, and IBM specializes in combined hardware/software/integration solutions. At UTC, the value flowed in the other direction, in that some of the company's products served to improve internal operations. At UTC facilities needing HVAC improvements, Carrier's products and technical staff were brought in to develop solutions. At its Middletown Pratt and Whitney production plant, the company used a Pratt and Whitney turbine system as the core of its combined heat and power system.

JCI provides another model of extending operational experience into product and service opportunities. A diversified company making automotive components, batteries and power systems, and building automation and control systems, JCI has developed a sophisticated energy efficiency products and services business founded on its building controls products. These products started as basic comfort controls to keep heating and cooling systems operating smoothly, and sometimes providing building security and fire safety functions. As digital technology advanced, JCI's products also became more capable. At the same time, JCI learned more about the systems that its controls were regulating and realized the vast energy efficiency potential that lay within. This knowledge helped the company evolve its energy services business, which today provides not only control systems, but also building operation and maintenance services as well as major building energy upgrades. To help customers finance such upgrades, JCI helped develop the performance contracting business model, in which the company identifies and installs efficiency improvements, and the energy savings are large enough to cover the financing payments for the upgrades.

(vi) The Supply Chain Connection

For some companies, the products and services side of their business connects directly to the supply chain. This is particularly true for Best Buy and other retailers. For Best Buy, most of its sales are in energy-using products like household appliances and consumer electronics. Sitting at the end of the supply chain as Best Buy does, its suppliers are mainly finished-product manufacturers, rather than materials suppliers or component manufacturers. So the products it buys are largely the products it sells, although the energy and carbon footprints of these products are different in their production than they are in their use phase. In many cases, the energy used by the product in service exceeds the energy consumed in its production process. By seeking and promoting these energy-efficient products, Best Buy can show suppliers and customers a clear commitment to energy efficiency as a core sustainability indicator. And because ENERGY STAR engages product manufacturers as well as consumers, Best Buy can gain huge leverage through the program and drive its manufacturers to design and make more efficient products. Best Buy estimates that it has saved customers $90 million in energy bills based on its 2008 ENERGY STAR product sales, while reducing the emissions equivalent of over 100,000 gasoline vehicles (see Best Buy case study, page 144).

Other retailers, notably Wal-Mart, have undertaken similar efforts. For example, in early 2008, Wal-Mart's former CEO Lee Scott announced that Wal-Mart would work with its suppliers to make the most energy intensive products sold in its stores 25 percent more energy efficient.[51] Wal-Mart is also involved in an initiative to create a "sustainability index" to better evaluate the full lifecycle environmental impacts of products sold in its stores.[52] The index includes energy use metrics and could eventually be used to develop labels to help consumers select goods with reduced environmental impact. PepsiCo also conducted a lifecycle carbon analysis of its Walkers Crisps line of products and published the results on a label affixed to individual bags of chips. In addition to providing transparency to consumers, the footprint exercise led PepsiCo to determine that the majority of its carbon impact lay outside its direct operations—in its supply chain. This drove action at the company, which eventually reduced lifecycle carbon emissions 7 percent per pack of chips (see PepsiCo case study page 127 for more details).

Best Buy has also gotten heavily involved in another environmental initiative that demonstrates the links between the supply chain and products and services: product recycling. In 2009, Best Buy launched an all-store electronics recycling program, in partnership with EPA's Plug-in to eCycling program, as part of the company's Greener Together™ initiative that encourages customers to choose efficient products, use them efficiently, and reuse/recycle them. Under the program, Best Buy allows each customer to drop off up to two electronic products per day. Working with certified recycling partners, this program channels salvageable materials and components back to manufacturers. This reduces the energy needed in the manufacturing process, decreasing the total energy and carbon footprint of the next generation of products. These recycling efforts have an indirect effect back up the supply chain to the extent that components or materials can be reclaimed and used by suppliers, reducing the energy and carbon impacts associated with extracting virgin materials or manufacturing product components.

What makes this more ingenious as a business model for Best Buy is that it increases traffic in its stores. And for certain products that are still usable, the company offers a gift card, creating an incentive for customers to bring in products and to make future Best Buy purchases. Best Buy is seeking to further leverage these energy efficiency, recycling, and other "green" themes through its Greener Together™ initiative. This includes testing "green zones" in selected stores, where these kinds of products are concentrated in visible, themed areas.

(vii) Recommended Practices for Products and Services

Defining a list of best practices in the product and service area is more difficult than for internal operations or supply chains. Companies' product and service mixes, and their links (or lack thereof) to internal operations and supply chains are quite distinct. But some common traits of highly effective product and service strategies do exist. These include:

1. **Assess the product and service footprint—**This is essential to understanding how big a part of the company's total footprint products and services comprise.

2. **Assess customer and market trends for the company's product mix—**Find out more about what drives customer interests and behavior, and about the kinds of products and services that are likely to be demanded in the future.

3. **Determine leverage opportunities with internal operations and supply chain partners**—Internal operations experience can translate into customer value in product or service offerings. Talk to suppliers about efficiency innovations they are considering that can be leveraged into company product or service offerings.

4. **Identify third-party partnership opportunities**—ENERGY STAR and other public and NGO labeling, certification, or performance measurement programs can be leveraged to advantage company products and services. Many electronics products manufacturers use the EPEAT[53] certification program, in which ENERGY STAR qualification is one of 23 required "green" attributes.

5. **Develop an integrated marketing/communications/branding strategy**—Link this to the company's overall sustainability or corporate social responsibility program. Make sure key audiences—employees, shareholders, public agencies, and NGOs as well as customers—know about it. UTC, IBM, and Toyota advertisements feature efficiency and related low-emissions themes actively.

VI. Getting Started: Creating a Corporate Energy Efficiency Strategy and Program

For companies early in the process of starting a program, this section provides a condensed guide for how to move forward.

1. **Start at the top**—Senior management, preferably the CEO, should agree to, fully endorse, and actively support and promote the efficiency strategy.

2. **Build the organization**—An effective energy efficiency team needs to have horizontal reach, connecting all key functional and operating units, and vertical reach, engaging people "from the shop floor to the top floor." Most companies place the leadership for the energy team in an existing corporate unit, typically an environment/health/safety, corporate sustainability, or corporate social responsibility unit. But they also include people from within each business unit, all major facility/plant operating units, and key functional disciplines including procurement and engineering. While some hires and transfers may occur, the majority of staff involved in the six case study company programs simply had energy added to their responsibilities.

3. **Obtain and provide the resources**—Make the case to senior management that financial resources are needed to support the program. Then, dedicate the development budget to launch the program and provide for both an operating budget to support program operations and capital for project investments.

4. **Dig into the data**—Do the research to determine what data to collect, how to benchmark it, and what goals to set.

    ○ Use triage and "80–20" rules to determine which facilities to collect data from, and the level of detail or "granularity" of the data required.

    ○ Talk to experts who know what is technically and economically achievable in company operations to help determine realistic and challenging goals.

- Develop technical and operating practice information, at individual facilities if possible, to support action as the plan is implemented. This may require some on-site assessments, or documentation of best practices and establishment of a peer-collaboration network.
- Measure the company's footprint—include internal operations, supply chain, and product and service energy data to the extent feasible. Use footprint data to set a historical baseline for measuring performance in the future.

5. **Design a data collection and reporting system—**Build on existing accounting and performance measurement systems as much as possible; the idea is to integrate the energy data system with mainstream company information systems, not to create a separate, specialized system.
   - Set metrics for energy performance, whether they are total energy use, energy use per square foot, energy use per unit of production, or energy use per dollar of revenue.
   - Translate energy footprint data into baseline performance levels at the business unit and facility level as appropriate.
   - Define reporting and accountability lines—who is responsible for collecting data, filing reports, and reviewing reports at each level and in each operating unit.
6. **Set goals that are a reasonable "stretch"—**Don't be afraid to go beyond what some may be comfortable with.
   - Talk and negotiate with key operating unit leaders—do the diplomatic work; reach out to key people in all relevant units, explain benefits, gain cooperation.
   - Set the targets in hard numbers with target dates.
   - Set performance benchmarks, linked to the corporate goal, for each facility.
   - Make goals SMART: Specific, Measurable, Accountable, Realistic, and Time-Bound.
7. **Announce and launch the program—**Include the goals, the reporting system, the organization structure and process, timelines, and implementation plan.

8. **Monitor performance**—Use the data collection and reporting system to assess performance.
    - Use lagging performance situations as teaching and learning opportunities more than compliance exercises.
    - Use the database to dig deeper into performance. To the degree that the granularity of data and statistical tools allow, use the rich company-wide dataset to look closely at performance data.
    - Identify potential efficiency improvements and use them to correct poor performance.
9. **Adjust and adapt**—Nothing goes perfectly in any new endeavor.
    - Seek and apply user feedback. Use shop-floor experience with the data collection system, and use technology and best practices to refine, adjust and adapt the program.
10. **Communicate success**—Announce successes internally and externally; reward individuals, teams, and other units.
11. **Review and reset goals**—Keep the program going, at least for two to three years, until performance trends become clearer. Reset and increase goals as performance and field experience indicate.
12. **Provide for accountability**—Include an action plan with facility benchmarks. Support the plan with specific technology and practice improvement information accessible to facility staff.
    - Draw accountability lines by defining who receives performance reports and who is accountable for performance at the facility, business unit, and corporate level. Include officer-level employees in lines of accountability.

VII. Conclusions and Future Considerations

Stripped to its essence, the primary motivating factor driving today's leading corporate energy efficiency strategies is a recognition that the energy paradigm has changed. Fossil fuel depletion, global climate change, and related market and political forces have converged to end the era of cheap energy that drove most of the Industrial Age. Companies that want to thrive in the new era must make dramatic shifts in how they use energy, not just marginally shaving costs, but driving waves of innovation across their enterprises in preparation for a carbon-constrained, and likely more volatile energy future. As a proven mechanism for reducing costs and lowering emissions, energy efficiency should form the backbone of any new corporate approach to addressing today's energy challenges. The efficiency programs studied in this report share certain key attributes.

> ***Fossil fuel depletion, global climate change, and related market and political forces have converged to end the era of cheap energy that drove most of the Industrial Age.***

First, energy efficiency has to start at the top. Survey respondents and case study companies repeatedly emphasized the importance of senior management commitment in ensuring the success of their energy efficiency strategy. Senior management must set specific energy efficiency goals, and hold people across the enterprise, including themselves, accountable for results. Performance and compensation must be linked to energy performance, at senior levels as well as facility levels. Senior-level support, up to the CEO, is also a prerequisite for ensuring adequate resources flow to energy efficiency programs and projects.

Second, energy information management systems must be robust. The old adage that you can only manage what you measure is especially apt in the case of energy. Sophisticated data collection and tracking systems allow companies to view how much energy they are using at what times and for what purposes. Patterns can be established and instances of overuse can be identified and rooted out. But it is not enough to simply collect the data. Leading companies also focus on the presentation, and match energy reporting to the needs of the recipients. Highly granular data is made available to facilities managers, whereas senior-level reports contain only high-level performance data aggregated into easy to read charts that allow for quick identification of potential trouble spots.

The system must also be linked to an accountability and action chain, so that business leaders are motivated to work with lagging units to bring their performance back on track, and so that facility operators have the resources they need to act on this information.

Third, to maximize results, energy efficiency initiatives should be expanded across the value chain. Almost all companies initially focus their energy efficiency efforts internally. This is natural and logical: internal operations are easiest to control, plus it is important to gain expertise and build a reputation before expanding efficiency efforts past directly owned manufacturing plants, facilities and buildings. But as companies conduct deeper and more comprehensive evaluations of their energy and carbon footprint, they often find that the bulk of their impact occurs in their supply chains or through the use of their products and services. Reducing energy use in these activities can be more difficult, but the potential benefits are large. Working with suppliers on energy efficiency can lead to better relations with these companies and help control costs over time. Developing and marketing more energy efficient products and services can tap into consumer concerns about environmental issues and lead to revenue growth.

Finally, energy efficiency can be leveraged to achieve broader transformation within the company. Many of the companies profiled in this study have used energy efficiency as a lens to re-examine how the company buys, makes, moves, and sells products. In many instances, process reevaluations that were initially prompted in pursuit of energy efficiency goals led to changes that increased total productivity and product quality. Companies can help this process take root by nurturing a culture of collaboration and innovation within the corporation, and empowering people at many levels and functions to take ownership of energy performance and come up with new ideas for improving energy efficiency. This can also result in important co-benefits like improved worker morale and higher employee retention levels.

While the companies profiled in this report have made impressive gains in improving energy efficiency, challenges remain. Companies cited four key needs to maintain and continue to move their energy efficiency strategies forward:

Better access to capital for efficiency improvements. Companies in this study have experimented with dedicated capital pools, sustainability screens, and including non-energy benefits in project assessments. But the supply of capital is often small relative to the potential investment. Many of the benefits associated with efficiency projects are not typically captured in traditional Return on Investment (ROI) analyses. Innovative financing approaches are needed that help efficiency projects compete with other corporate needs.

More people, with the right skill sets. Extending an energy efficiency strategy throughout a large organization may require additional staff, with the appropriate skills to manage programs, develop and implement projects, and run facilities. Companies profiled in this study primarily met their personnel needs by "reassigning staff," or layering energy efficiency duties on top of employees' existing responsibilities. As programs become more robust and sophisticated, companies may need to bring on more staff with specific expertise in energy issues to dedicate to energy efficiency efforts.

Better management tools. Many of the data collection, measurement, and reporting systems in use today are rudimentary compared to the level of detail and diversity possible with today's sensing, monitoring, communications, and computing technologies. Too many facilities are metered only at the "front gate." To be effective, however, energy managers need to see deeper into individual systems, locations, and time periods, to pinpoint problems and target solutions. Technological advances have brought down the cost of measurement and reporting systems, thereby putting them within reach of more companies.

Better technical information. While the best companies have done well at sharing information on efficiency technologies and practices across the company, many remain challenged to keep up with current information, transfer it to all applicable locations, and apply it in actionable ways. Resources offered by third-party organizations, such as government agencies, electric utilities, and NGOs can be helpful in addressing this need. The Pew Center's corporate efficiency portal (www.pewclimate.org/energy-efficiency), for example, contains a number of useful resources from a diverse range of sources.

The principles, habits, and examples described in this report capture many of today's best practices in corporate energy efficiency. But as companies continue to push ahead with energy efficiency strategies, new technologies and approaches will likely emerge that eclipse today's best efforts. External forces like energy prices and carbon regulations will likely force companies to squeeze ever increasing levels of productivity out of each unit of energy. Ultimately, the companies that succeed in doing this will enjoy a competitive advantage relative to their less efficient peers by way of lowered costs and less exposure to environmental risks. The most successful companies will also engage suppliers and customers in a holistic approach to reducing the overall energy footprint of the corporation. Importantly, successful companies will tap into their workforce and foster a culture of innovation that gets everyone involved in energy efficiency efforts, "from shop floor to top floor."

CASE STUDIES

CASE STUDY

Dow Chemical Company Integrated Approaches	
Headquarters:	Midland, MI
CEO:	Andrew Liveris
Revenues (2007):	$54 billion
Energy Costs (2007):	$27 billion
Energy Savings Target:	20 percent reduction in energy used per pound of product, 1996–2005. 25 percent further reduction in energy used per pound of product, 2006–2015.
Key Efficiency Strategy Successes:	• Since 1994, Dow's energy efficiency strategy has saved 1,600 trillion British Thermal Units (BTUs) of energy—enough to power all the residential houses in California for one year. These energy savings also led to $8.6 billion dollars in cost savings and prevented 86 million metric tons of carbon dioxide equivalents (CO_2e) from entering the atmosphere; • Sustaining savings over a ten-year period, and then strengthening the target for the next ten years; • Finding significant energy savings in an already efficiency-oriented, energy-intensive primary manufacturer; • Leveraging the company's energy business unit to provide a wide range of energy efficiency and related technology and operations services.

Energy Efficiency Strategy Overview

Energy is a small cost for most companies—the 48 respondents to the survey conducted for this project (see Appendix A in main report for details) reported energy costs averaging less than 5 percent of revenues. For Dow Chemical, nothing about energy has ever been small. About half of every dollar the company spends goes toward energy, mostly in the form of natural gas and natural gas liquids, which are the energy feedstock for the company. Not all of that energy is used to power Dow's operations; in fact, two-thirds of the energy molecules Dow buys are used as feedstock, transformed via chemical processes into myriad products. That still leaves 30 percent of Dow's costs as energy to run its plants, making it one of the world's most energy-intensive companies. Dow's energy intensive nature, coupled with its continuous-processing, 24-7 operating mode, makes its energy efficiency strategy somewhat different than some of the other companies studied in this report that use relatively moderate amounts of energy. While certain aspects of Dow's strategy are more applicable to other energy-intensive companies, many elements will hold relevance for a broad range of companies. These include Dow's efforts to organize an effective program, set up a detailed reporting system, and gain cooperation across business units to meet ambitious energy savings goals.

Everything about Dow's energy operations is large in scale. The company's energy purchases (feedstock included) roughly equal Australia's entire energy bill, and are equivalent to 10 percent of all the oil the United States imports. Dow's Freeport Texas site is nothing if not large, taking up several square miles along the Gulf Coast and accounting for over one percent of all the energy consumed in the state.

Energy is so big it constitutes its own business unit at Dow. The energy business sells electricity, steam, and natural gas to other business units. It is also a major player in world, national, and state energy markets, selling as well as buying energy on a wholesale basis. At the Freeport Texas site, Dow operates some 1,000 Megawatts of electricity generation, as much as the largest utility powerplants. From its high-tech control center with its panorama of brightly-colored display screens and switch-studded control panels, Dow buys and sells power among its production units, and with the Texas power grid operator, The Electric Reliability Council of Texas (ERCOT). Dow's power generation is fully interconnected with ERCOT, allowing it to behave like other large generators on the system. Operators monitor market conditions and Dow operations minute to minute, making decisions on dispatching power flows. On relatively rare occasions, when ERCOT prices are high enough, Dow will elect to shut down one or more production units for short periods, and sell power into the grid, because it is more profitable to sell electricity than to make chemicals under those conditions.

This kind of sophistication in its energy business, driven by the essential role of energy at Dow, flows to the end-use level as well. When energy is such a huge part of production costs, reducing the energy needed to make a pound of product is a matter of competitive survival. It's not surprising then that Dow was among the first companies to set quantitative, measured energy savings goals. In 1995, the company set a goal of cutting energy use per pound of product 20 percent by 2005. Dow beat that goal, realizing 22 percent savings as of 2005. But from 2002 to 2007, Dow's energy bill rose from $8 billion to $27 billion as natural gas prices skyrocketed. While these price effects offset the energy intensity improvement, Dow saved almost $8 billion compared to the energy bills it would have paid without the efficiency strategy.

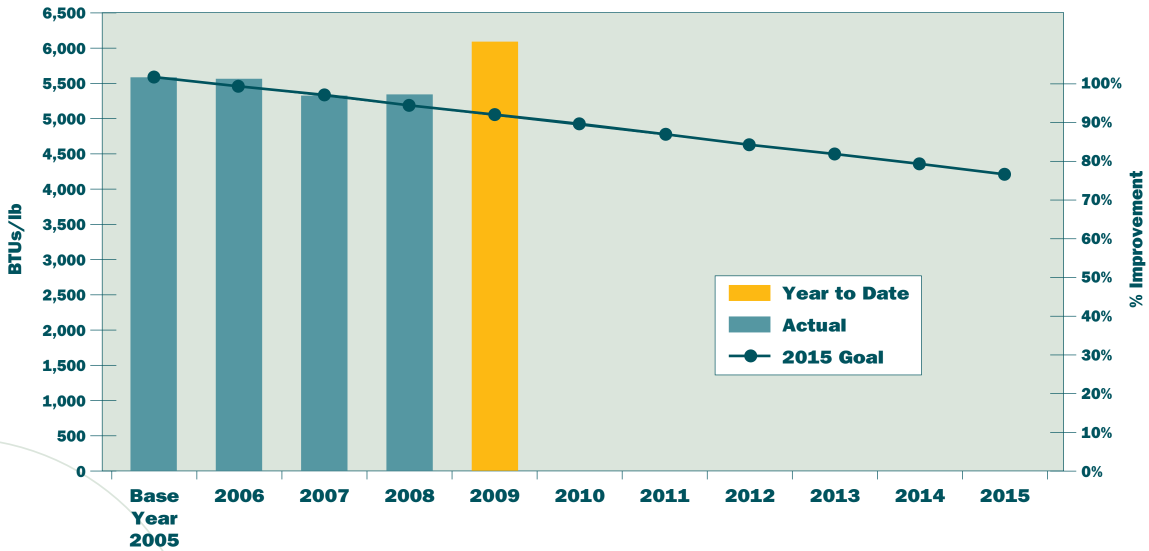
Against the backdrop of sustained high energy prices, in 2006 CEO Andrew Liveris raised the bar, increasing the goal by pledging to slice another 25 percent off the energy needed to make a pound of product. Dow's energy efficiency goal is represented in British Thermal Units (BTUs) per pound of product produced, so natural gas used as feedstock (which does not emit greenhouse gases in the production process) is not included as part of the goal. However, Dow is exploring ways of becoming more efficient in its use of feedstock primarily due to cost concerns. **Figure 1** illustrates the company's goal and progress to date. 2009 usage shows an increase in energy per pound, largely because the economic slowdown has cut production, and energy use cannot be reduced in proportion, but as the economy recovers Dow expects energy intensity to go down again.

The way in which the 2015 energy goal was announced illustrates Dow's commitment to energy efficiency. Rather than simply issuing a press release from headquarters in Midland, MI, Liveris spoke at a special event in Washington, DC, delivering a speech, largely unscripted, that showed a detailed understanding of the numbers and the technologies involved. Dow's extra effort and the CEO's personal and visible involvement indicate that this is a high priority for the company. And the energy savings commitment, with the company's other sustainability goals, are measured and reported on the Dow website on an ongoing basis. The Dow home page includes "Sustainability" as a top-level menu title so visitors are able to easily track the company's progress toward meeting its goals.

Andrew Liveris continues a hands-on tradition of Dow leadership driving energy innovation dating back to Herbert H. Dow's 1897 launch of his bleach business. Even in those early days, energy was critical to Dow's business. As Herbert Dow envisioned today's bulk-chemical production process and business model in the early 20th century, he realized that the energy technologies of the day would not allow him to produce chemicals at

Figure 1

Dow's **Energy Intensity** Performance 2005-2015



Recreated based on image provided courtesy of Dow (2009).

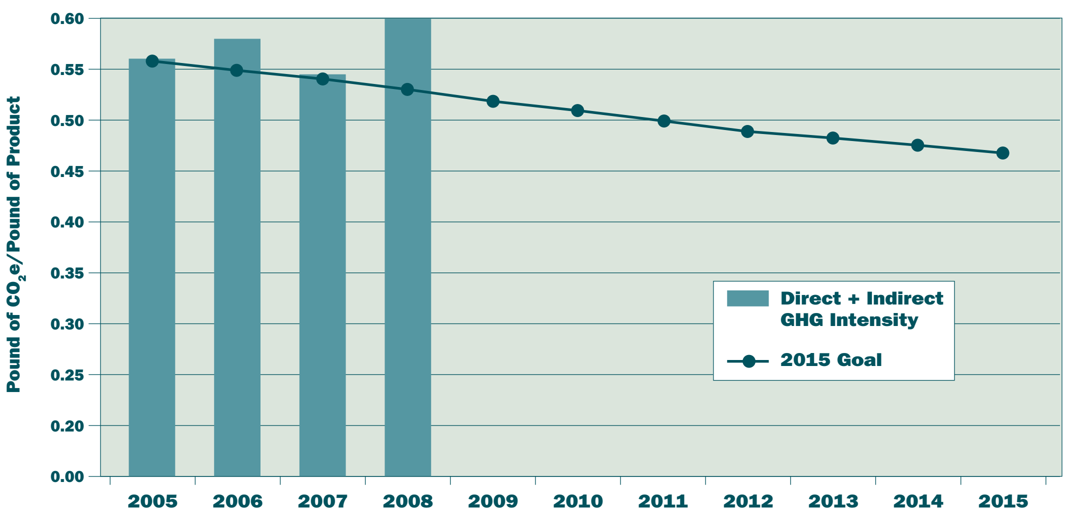
the scale he needed. George Westinghouse, pioneer of the gas power generation turbine among other energy technologies, worked in partnership with Dow to create the specialized electricity and steam technologies that enabled the Dow business model to advance. The fact that Dow leadership and employees remember and tell this story a century later reflects a deep appreciation for the role that energy innovation plays at Dow.

Energy Efficiency and Dow's Climate Strategy

Because energy use is such a major factor in Dow's operations, energy efficiency and GHG reductions are closely linked. Accordingly, the company's 2015 sustainability goals include a 2.5 percent per year reduction in GHG intensity per pound of product. This closely tracks the ten-year, 25 percent energy savings goal. **Figure 2** illustrates the GHG intensity goal. As with energy, recent data show an uptick in GHG intensity caused by the economic slowdown in production.

Figure 2

Dow's **GHG Intensity** Performance 2005-2015



Recreated based on image provided courtesy of Dow (2009).

Internal Operations

Dow's business units are broken out by product type, even as their operations are highly interconnected: Olefins, Chlorine, etc. Energy is such a large part of Dow's operations that it is structured as its own business unit. The energy business owns and operates about 10 percent of all of Dow's assets, making it the second-largest business unit behind the Olefins business, followed closely by the Chlorine business. The Energy Efficiency and Conservation (EE&C)

program leadership team operates from the energy business, engaging some 40 roles overall, about 26 leads in the various business units, plus 14 site leaders, and some individuals at larger individual plants. Like many companies, Dow does not have many people with a full-time energy efficiency job title—that distinction goes to corporate energy manager Joe Almaguer. As Almaguer explains it, the matrixed nature of the EE&C team makes estimating total labor effort involved in the company's energy efficiency efforts an "all and none" paradox. Most EE&C members work on a number of issues including energy; energy might take up all their time some days and little or none on others. The amount of time spent on energy is driven partly by the EE&C team's regular meeting and reporting cycles, and partly by specific actions undertaken at given plants or sites in response to operational changes or project investments.

How the EE&C Program Operates

A note on Dow's terminology for its operating units helps in understanding the EE&C operation. Because of the large scale of Dow's manufacturing, and the many different chemical products involved, its manufacturing centers are termed "sites," within which it operates several individual "plants." A plant is typically defined by its product; so a site might hold an olefin plant, a chlorine plant, a power plant, and others. The Texas site, for example, contains some 75 individual plants of the 328 total U.S. plants Dow operates.

Since 95 percent of Dow's energy use flows through its 14 largest sites, the 14 site leaders play an important role, especially when it comes to energy efficiency opportunities that cut across different plants. For example, all the major sites have extensive steam systems with miles of piping; at the Texas site, one pipe moves steam four miles from the powerplant to a remote production plant. Steam systems need regular maintenance, especially for steam traps, the valvelike devices that remove condensed steam from the line while keeping the live steam flowing. A site EE&C lead will typically develop a site-wide steam trap maintenance contract; plants can opt out, but typically don't because of the cost-efficiency of the larger contract and the operating efficiency benefits. Site leaders also play an important role in the company culture, building relationships with plant operators, providing them help and information, and leaning on them as needed to achieve energy goals.

As in most of the successful energy efficiency programs examined in this report, energy efficiency team members faced challenges in gaining the active cooperation of production plant operators and other site-based staff. Getting participation in the company's data reporting system was not as big a challenge, in that Dow already possessed in most cases the metering and billing information, based on the way the energy business is structured. The company had long used a centralized reporting system, and was able to build the new energy reporting elements into it. More detailed monitoring systems and data reporting occur within each business unit and each operating plant. The energy metrics thus act as a high-level indicator with centralized information; finer-grained information is kept decentralized at individual business units and sites. Since the energy business is a functional unit like others in Dow, it has had the core data it needs to track performance at a high level; setting aggressive energy performance targets motivated business unit and plant site staff to look harder at their finer-grained operating data to look for ways to meet the targets. Other companies with more numerous and disparate operations, such as IBM and UTC, had to go through a longer and more complex process to establish and achieve compliance with the data reporting system. Each company seeks the right balance of centralized and decentralized data.

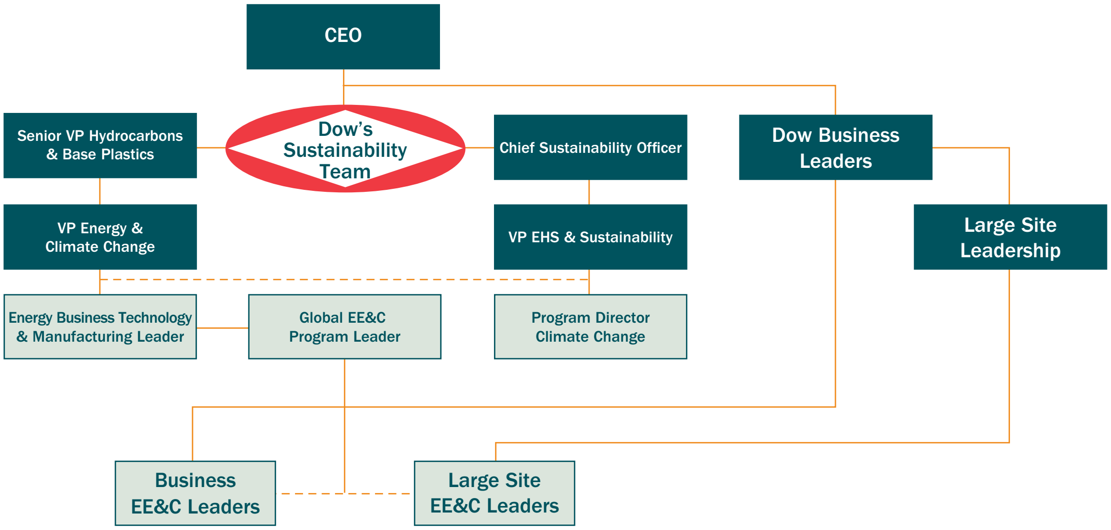
But Dow shares with other companies the challenge of persuading production managers to consider changes in operating practices and technologies. Production staff are focused on product quality, production volume, and reliability of equipment and systems. Energy improvements, be they changes in operating or maintenance procedures or new technologies, pose potential risks to these ironclad principles. Dow addresses the potential conflicting interests of the energy team and the production plants partly through its Tech Centers. Each business unit has a Tech Center, with experts on its particular production technology, and with one or more EE&C experts. These Tech Centers each have a director reporting to the business leadership. As a result, the Tech Centers create focused teams that not only develop technology and operating solutions, they also build trust relationships that help the EE&C team gain the cooperation of product staff. The involvement of Tech Center staff in developing, testing, verifying, and then instituting new practices and technologies is key in this respect, as is the highly interactive nature of the EE&C team. Regular conference calls, webinars, email exchanges, and site visits build trust and help spread technical information.

Dow's EE&C team is part of the larger Dow Sustainability Team, as illustrated in **Figure 3**. EE&C includes team members from each business unit, and each large site. Having an EE&C team member at each large site allows for coordinated and collaborative efforts among the many plants operated by different business units within a given site.

Drilling deeper into the EE&C structure, **Figure 4** shows how EE&C works within a given business unit. Each business's EE&C team leader is sponsored by the respective business Tech Center Leader. The team leader works with people at the individual plants in the business. For example, each olefin plant has a person assigned to work with the olefin plant's EE&C team leader. The Tech Center's role is to provide engineering and technology support for the business, developing new specifications for production equipment and ancillary equipment, and working with plant operators to advance and sustain operating practices.

Figure 3

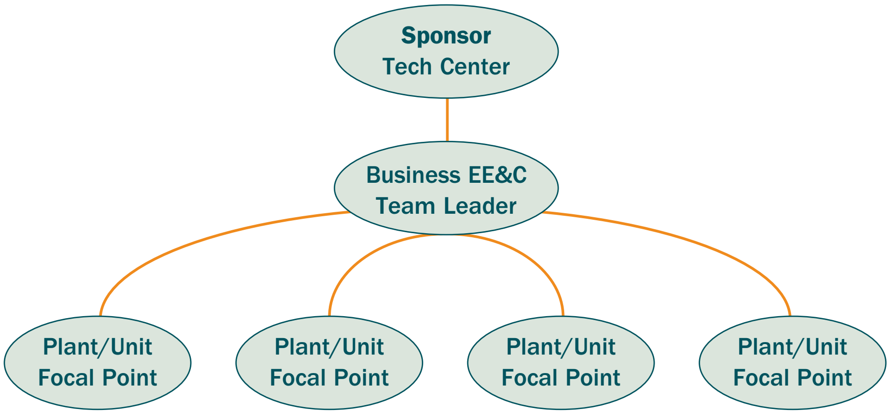
Dow's **Energy Team**



Recreated based on image provided courtesy of Dow (2009).

Figure 4

Business EE&C **Team Structure**



Recreated based on image provided courtesy of Dow (2009).

Data Collection and Reporting: The Global Asset Utilization Reporting System

A key element of Dow's EE&C program is the energy data collecting, reporting, and accountability system built around the company's Global Asset Utilization Reporting (GAUR) system. GAUR collects energy data from the numerous metering and submetering points at each plant, aggregates them up to a total BTU number, and reports the BTU total along with pounds of product per plant. A typical GAUR report consists of rows for each reporting facility, and includes its energy use, production, and energy use per pound of product. The columns show this information by quarter and year, allowing quick visual comparison of performance over time. Plant operators, business unit leaders, EE&C staff, and corporate staff all have access to this information.

GAUR reports look deceptively simple. Developing the calculations needed to produce the BTU totals in GAUR was not simple. A longtime Dow engineer painstakingly developed methods to convert the various flows of energy commodities, and intermediate energy flows in Dow's complicated operations, to a standardized set of BTU equivalents (calculating GHG equivalents added another layer of computational complexity). Dow uses lots of primary (raw) energy, but also converts it into intermediate forms like steam and electricity. Accounting for the conversion and distribution losses, and the energy content of various energy streams as they are delivered to each plant, involves complex calculations, which led Dow to institute a formal, documented procedure to ensure consistency and quality of information across the company.

Because natural gas is the dominant source in Dow's energy purchases, all energy forms consumed are translated to equivalent BTUs of natural gas and adjusted to reflect real-world efficiencies and losses associated with energy conversion. This method allows staff across the company to use a common currency, in terms of how much natural gas has been or would have to be used to produce the energy consumed at a given plant. This methodology also reflects the ability of each energy form to do real work and not just theoretical work. It therefore estimates how many BTUs of natural gas equivalent would be saved from a given energy saving opportunity. This gives the EE&C team a consistent way to make realistic calculations of primary energy impacts and thus derive better estimates of expected energy cost savings. The company knows the price of natural gas, so turning everything into equivalent natural gas units makes it possible to compare energy performance and energy savings across plants, sites, and energy markets.

GAUR reports roll up to business unit and corporate levels, and form the basis of the energy and production numbers in quarterly sustainability reports, which are posted on the Dow website. But GAUR numbers are also used to produce internal reports with much more detail. In addition to the basic energy and production numbers, the internal reports assess actual vs. target performance, discuss issues that explain performance numbers, and suggest action items to correct any sub-par performance levels. These reports go to business unit leadership as well as to plant operators and site leaders, and often become the focus of extended discussions and followup actions.

How Dow Achieves Energy Savings

Dow achieves its energy savings goals somewhat differently than other companies. While all of the case study companies focus on low-cost operating improvements, Dow is much more capital-intensive, and less labor-intensive, than most. One can drive around a Dow site for some time without seeing a human being, whereas in a Toyota or IBM facility, as in most companies, people are everywhere. Dow also typically operates in a continuous processing mode—the chemical plants normally run 24-7. This reduces the opportunities to apply downtime shutdown strategies that companies like IBM and Toyota have used to great advantage to gain "free" energy savings.

Dow plant operators rely on the continuous flow of data they get on energy and other performance indicators to determine whether their operations are on track. This may occasionally include operating adjustments or maintenance actions, but most big efficiency improvements come from process technology changes. For example, Dow's Light Hydrocarbon (LHC)-7 plant at the Freeport Texas site won a 2008 American Chemistry Council (ACC) Responsible Care® Energy Efficiency Award in 2009 for replacement and upgrade of its ethylene furnace capacity. Dow replaced the existing 10 furnaces with five new, larger state-of-the-art furnaces with significantly higher energy efficiency. Interestingly, this investment was initiated for compliance with NO_x emissions regulations, but the additional benefits in energy savings, yield improvements, corporate sustainability, and extended lifetime of the facility made the business case very strong. This investment has improved LHC-7 plant energy efficiency by more than 10 percent, producing energy savings of over 2,000,000 MMBTU/yr, equivalent to the annual electricity use of more than 17,000 homes, and cutting CO_2 emissions by 105,000 metric tons annually.

Across the Atlantic in Antwerp, Belgium, Dow and its partner BASF in 2009 opened the world's first commercial-scale propylene oxide (PO) plant based on the innovative hydrogen peroxide to propylene oxide (HPPO) technology the two companies jointly developed. Producing up to 300,000 metric tons of PO per year for the polyurethane industry, the new Antwerp plant reduces energy use by 35 percent and wastewater by up to 80 percent.

Finding the Funding for Energy Projects

While these projects represent major efficiency gains and provide several streams of business benefits, the capital for such projects is hard to come by, even for a large company like Dow, and especially in the current economic downturn. According to its corporate financial report, Dow spent approximately $2.28 billion in total capital investment in 2008, up from about $1.78 billion in 2006. However, in 2009 capital expenditures will be drastically lower due to the current economic conditions. While even $1 billion is nothing to sneeze at, it gets competition from all the company's investment needs. For context, $1 billion is less than two percent of Dow's total revenue, and less than four percent of total energy costs.

Dow's capital budget must serve many priorities, and meeting energy goals is just one of them. Dow applies various financial criteria to project investment opportunities; including discounted cash flow, net present value, and internal rate of return. Business units use their own analysis and prioritization methods, driven by competitive forces and the norms of their businesses. In many cases, investments that are seen as critical to maintaining or improving competitiveness are moved to the fore; this forces the EE&C team to make a broader business case for energy-related investments, documenting the co-benefits in competitiveness terms. For example, a given efficiency investment might not meet a simple payback criterion; but if it keeps the company competitive in a specific market and avoids the loss of a specific customer or a certain share of the market, such considerations can help justify the investment.

In one sense, energy has long been a key issue for Dow, so energy efficiency competes relatively well when the numbers are compelling. Dow expects to ultimately factor in carbon price expectations in assessing energy projects. But because it does not expect carbon prices to appear in energy markets for several years, except in Europe, carbon prices only have a material effect on larger capital projects, and these tend to be major process changes that involve more than energy as driving forces. Dow does have facilities that are regulated under the European Union's Emissions Trading System. The carbon price created by the trading system is an added cost that Dow incorporates into the evaluation of energy efficiency projects.

Dow has looked at trying to leverage outside capital through performance contracting, but like other case study companies it has found the performance contracting business model hard to match to its own operating models. Energy service companies typically require long-term agreements to make their financing structures work, and most corporations are not inclined to enter such long-term contracts. Performance contracts also tend to require long repayment terms to enable energy savings to exceed payments, because they must roll all of the development costs, interest costs, and other "overhead" factors into debt service payments on top of direct capital costs. Moreover, in a complex industrial operation like Dow's, establishing the critical baseline energy use calculations on which savings are based can be too difficult and uncertain to build into long-term agreements. Dow uses companies like Johnson Controls, which has a large performance contracting business, but tends to use them for more specific technology and service contracts on a traditional sales or fee basis.

Pursuing Operational Improvements vs. Capital Investments

The challenge of raising capital for efficiency investments turns the focus back to operating improvements. Dow works hard at this on an ongoing basis, but EE&C team members also know that the sheer scale of energy and product flows in a continuous processing environment limits the relative impact of operating changes. Using the engineering talent in the Tech Centers and other EE&C team members, Dow sometimes uses Pinch analysis, a methodology evolved in industrial circles in the last three decades. The Pinch method is designed to minimize energy consumption in chemical processes by calculating technically feasible energy targets, and then achieving them by optimizing heat recovery systems, energy supply methods and process operating conditions. In a Pinch analysis, process data is typically represented as a set of energy flows as a function of heat load against temperature. These data are combined for all the energy flows in the plant to give composite curves, one for hot flow and one for cold flow. The point of closest approach between the hot and cold composite curves is called the pinch temperature or pinch point. By finding this point, various heat recovery or transfer solutions can be developed.

Dow engineers constantly use their creativity combined with the variety of energy and material streams in their plants to find new efficiency ideas. For example, at the Texas site, hydrogen occurs as a byproduct in one process. EE&C staff have experimented with blending this available hydrogen with natural gas fuel in their power turbines, taking the mix up to the limits that the turbines will tolerate.

For its efforts, the EE&C team also seeks outside input to find new ways to save energy. It maintains a panel of outside energy and environmental experts to provide technical and strategic input. Dow also participates in national programs: it won a 2008 ENERGY STAR Partner of the Year award from the U.S. EPA, and invited energy auditors from the U.S. Department of Energy's (DOE) Save Energy Now[1] program to review its large US-based facilities. The

1 For more information on DOE's Save Energy Now program, go to: http://www1.eere.energy.gov/industry/saveenergynow/.

Save Energy Now team found several productive ideas, including innovative ways to load pumping systems that enabled Dow to shut down one pump station. In one instance, the potential savings the DOE review identified totaled about 11 percent of plant energy use. Dow in turn supports DOE by participating in several of its sponsored programs and initiatives, such as the development of the ISO 50001, international standard for industrial energy management.

Supply Chain

Dow sits near the top of the energy supply chain; it purchases raw materials and transforms them into bulk materials, and in some business units produces products for business or consumer markets. In this context, there is little energy efficiency opportunity for Dow to exert with its suppliers; its efficiency strategy focuses primarily on internal operations, where most of its footprint occurs. Dow has not conducted a formal analysis of its suppliers' energy or carbon footprint. In the energy arena, with 60 percent of the company's costs incurred as energy and most of that as natural gas, the supply footprint is relatively small compared to the footprint created by the conversion of that energy in Dow's processes.

Dow does, however, focus on supply chain issues in its broader sustainability commitments. In its Sustainable Chemistry commitment, for example, the company works to reduce its impact on water resources, and seeks renewable sources of natural gas, such as landfill gas or sugarcane. The Antwerp HPPO plant described earlier, for example, saves even more water than energy on a percentage basis. The company is using landfill gas at its Dalton, GA facility.

Products and Services

Dow estimates that its products and services have a smaller overall energy and carbon footprint than its internal operations. Nonetheless, it continues to innovate efficient products and other solutions for its customers. Dow's insulation products, mostly sold under the STYROFOAM™ brand, are used to reduce energy use in homes and businesses. One square foot of one-inch thick Dow STYROFOAM™ insulation will save one ton of CO_2 emissions over the average life of a house. Dow building insulation material saves hundreds of millions of metric tons of CO_2 each year. Dow actively supports programs and policies that encourage energy efficiency, in buildings, industry, transportation, and utilities.

Conclusions

Dow is one of the few companies that has not only set and met a 10-year efficiency target, but has gone on to set another, more aggressive 10-year target. This “in it for the long haul” demonstration of commitment is one of the hallmarks of a successful sustainability program. Dow has also set and met its goals in a manufacturing environment where energy has long been a critical factor of production, so the company had been paying attention to energy issues since Herbert Dow pioneered bulk chemical manufacturing a century ago. This means energy savings were not as easily found as they might be in companies where energy has only recently become an issue. Dow has made effective use of its energy efficiency team from its energy business unit, reaching across business units and functional lines to create teams of experts and local site leaders to keep the efficiency program moving forward.

Key lessons learned from Dow’s energy efficiency successes, include the importance of:

- Corporate leadership commitment. In Dow’s case, the CEO has made a very clear and public commitment to achieving the company’s energy savings goals.
- Building the appropriate organizational structure to institutionalize and lead the program. This includes cross-functional teams with clear lines of accountability.
- Robust measurement, tracking, and reporting systems so that management can monitor progress and identify potential problems.
- Establishing clear goals and objectives, and then revising them over time as the initial targets are met.
- Communicating the importance of energy efficiency as a core company value to both internal and external stakeholders.
- Recognizing success by rewarding employees and business units for energy saving innovations.

CASE STUDY

United Technologies Corporation
Integrated Approaches

Headquarters:	Hartford, CT
Chairman & CEO:	Louis Chênevert
Revenues (2009):	$52.9 billion
Energy Costs (2009):	Less than 1 percent of revenues
Energy Savings Target:	In 1988, a UTC Energy Council formed, which set a 20 percent energy cost reduction per square foot goal by 1995 for the top 20 manufacturing sites. Subsequently, UTC set a goal to reduce energy used per dollar of revenue 25 percent below 1997 levels by 2006. This goal was realized in 2001 and reset to a 40 percent reduction by 2006. Actual 2006 savings were 56 percent, representing a 19 percent absolute reduction from 1997 usage. UTC's latest goal is to reduce absolute carbon dioxide (CO_2) emissions 12 percent below the 2006 baseline by year-end 2010.
Key Efficiency Strategy Successes:	• Setting aggressive targets and reaching them ahead of schedule; • Integrating seven diverse businesses through a unified energy efficiency strategy and Environment, Health & Safety (EH&S) accountability system; • Applying products and expertise to improve internal efficiency, and pursuing new business opportunities in the growing green buildings industry.

Energy Conservation Strategy Overview

UTC provides high technology products and services to the building systems and aerospace industries worldwide through seven industry-leading businesses: Carrier air conditioning, heating and refrigeration solutions; Hamilton Sundstrand aerospace and industrial systems; Otis elevators and escalators; Pratt & Whitney engines; Sikorsky helicopters; UTC Fire & Security systems and UTC Power fuel cells. Together, they form one company constantly finding new technologies that make cities more efficient, people more secure and travel more comfortable. While the products and their specific uses differ, common to all of them is the conversion of energy into useful work.

The central role energy plays in UTC's business helps explain why energy conservation and efficiency have emerged as a core element of the company's corporate strategy and culture. Senior leadership, from the CEO down, have stressed the importance of eliminating all forms of waste, and squeezing ever-increasing amounts of useful work out of the same (or less) amounts of energy. As Chairman and CEO Louis Chênevert said in a recent speech at the National Building Museum in Washington:

"The opportunity for improving energy efficiency in buildings is tremendous. Today, the building sector consumes about 40 percent of the energy used in the United States and is responsible for nearly 40 percent of greenhouse gas emissions. With products and technology available today, energy consumption in buildings could be cut by almost 70 percent."

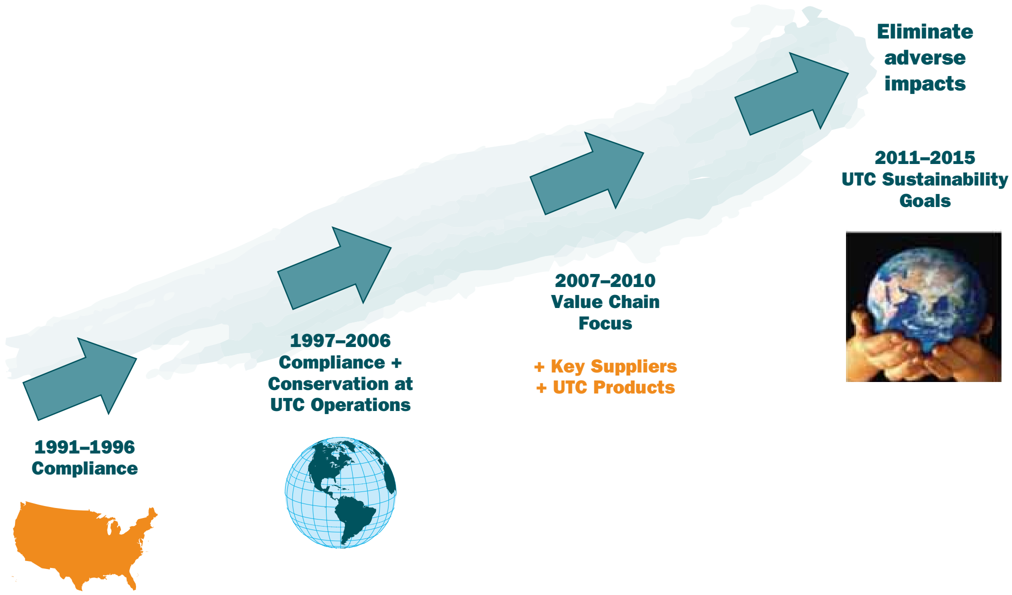
The corporate drive to minimize waste can be seen in the progression of energy efficiency goals UTC has set for itself dating back to the late 1980s when it formed the UTC Energy Council. Members representing the company's 20 largest manufacturing sites targeted 20 percent energy cost savings by 1995 and committed to sharing best practices among the business units. This evolved broadly with EH&S goals beginning in the 1990s. The company first set energy efficiency goals in 1997, aiming to reduce energy used per dollar of revenue 25 percent by 2006. When it crossed the 25 percent mark in 2001, the 2006 goal was raised to 40 percent. In 2006, the company realized a 56 percent reduction in energy use per dollar of revenue, which is equivalent to a 19 percent absolute reduction.

UTC built on its success in outperforming the 2006 goals by setting even more ambitious targets for the 2007–2010 period. At this point, UTC began measuring its targets in CO_2 terms as opposed to energy, to drive efforts to reduce direct greenhouse gas (GHG) emissions as well as energy use. The target is to reduce CO_2 emissions 12 percent by 2010 in absolute terms from the 2006 baseline. Taking into account the 19 percent absolute cut between 1997-2006, UTC's total absolute reductions will be over 30 percent from 1997-2010, or more than two percent per year for nearly 15 years. **Figure 1** illustrates the program's evolution within the larger EH&S context. From 1991 to 1996, UTC focused primarily on meeting environmental regulations. Beginning in 1997, UTC went beyond compliance to voluntarily reducing internal energy use, as demonstrated by its energy efficiency goal announced that year. After 2006, UTC expanded its energy efficiency focus into its supply chain and product impacts and will continue this with an expanded set of sustainability goals through 2015.

Over the last decade, UTC has seen the demand for energy efficient products grow tremendously, along with an ever-rising interest in business processes that are more sustainable in nature. This trend is expected to continue as the world population grows and becomes more urbanized. UTC believes that as a result, large, infrastructure-building manufacturers—those whose products support buildings, cities and air transport—will not only be expected to develop smarter, greener technologies for the future, but also to stand behind an environmentally responsible operational platform. Anticipating this trend, the company has articulated its commitment to sustainability

Figure 1

Evolution of UTC's Sustainability Program



Recreated based on image provided courtesy of UTC (2008).

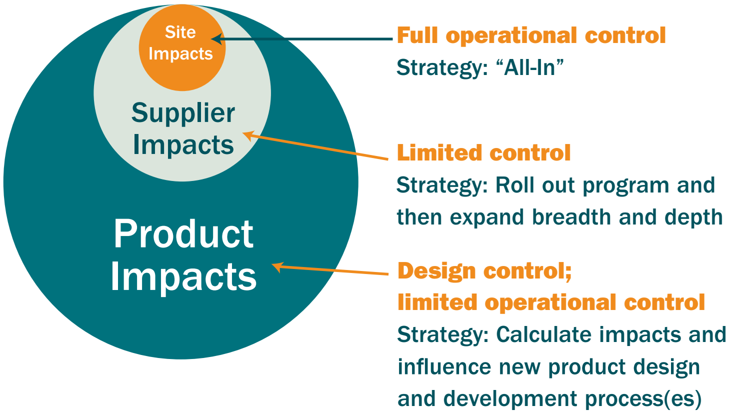
through five themes: efficiency of its products; EH&S impacts of its operations; overall productivity; development of its people; as well as legal compliance and high ethical standards.

Critical to the success of UTC's sustainability strategy has been the development of a sophisticated energy data reporting system that tracks energy use and reduction opportunities throughout its diffuse businesses. The system has been instrumental in putting the right information in front of senior decision makers, allowing them to establish priorities and identify corrective actions.

While most of UTC's efficiency gains so far have come in its internal operations, the company is expanding its efficiency strategy to cover products and services and its supply chain. This is driven by two factors. First, energy is a major cost factor in many of the markets UTC competes in; therefore UTC's energy efficient products have a competitive advantage in the marketplace. The rise in oil prices in the last decade, for example, drove increased demand for more efficient jet engines. Secondly, UTC recognizes that while the GHG impacts from its internal operations are significant, these are dwarfed by the emissions that come from its supply chain and—especially—use of its products.

Figure 2

EH&S Impacts, Control, and Strategy



Recreated based on image provided courtesy of UTC (2009).

UTC is taking action to minimize all of these impacts, but faces the same conundrum many other companies experience: their level of control is greatest in the area with the smallest environmental impact. **Figure 2** (not to scale) illustrates this dynamic. UTC's site GHG emissions are under its direct control, and while the company has invested considerable effort to control these emissions, they are small relative to supplier and products impacts. Supplier impacts are larger than site impacts, but UTC's ability to effect change here is more limited. And GHG emissions from UTC's products eclipse those of both its internal operations and supply chain. UTC can influence product emissions by designing them to maximize efficiency, but the customer ultimately controls the use of the product, not UTC.

Energy Conservation and UTC's Climate Strategy

UTC has reported both energy use and GHG emissions internally since 1996. But in 2006, the company formally combined its energy savings and GHG emission reduction targets for the 2007-2010 goals. While most of UTC's facilities are not large enough to be covered directly by federal climate policies being considered in the U.S., growing government and consumer concern about climate change reinforces the operating approach of the energy and GHG reduction teams at UTC. Further, carbon prices will drive up energy prices, indirectly rewarding efficiency as a cost reduction strategy and as a product competitiveness strategy. The conversion to a GHG reduction target has reinforced UTC's emphasis on conservation, as it is typically the most cost-effective carbon mitigation strategy, with or without carbon prices. One practical effect of the move to a GHG reduction target has been the creation of carbon-equivalent lookup tables and calculations, which are integrated with the energy reporting system. This means that energy can be translated into CO_2 equivalents on a consistent basis company wide. This requires the determination of carbon emissions for electricity used at each location, based on eGrid[1] or other accepted regional or country factors that take into account the generation mix for the applicable power grid. UTC's data reporting system also tracks direct process emissions, on-site natural gas and fuel oil combustion, and vehicle miles traveled, among other sources of emissions.

UTC does not currently plan to sell energy efficiency-based credits into carbon markets; the instances in which efficiency can qualify for CO_2 allowance credits are likely to be few, and the monetary value and verification requirements in applicable markets are too uncertain. Many of UTC's production facilities are in states that participate in the northeast Regional Greenhouse Gas Initiative (RGGI)—a cap and trade program that covers power plants. Under RGGI, savings in non-electric energy use, such as heating or boiler fuels, can be sold as offsets, but RGGI allowance prices are currently low, and the demand for offsets has not yet materialized. UTC does, however, sell efficiency credits in the Connecticut Renewable Portfolio Standards (RPS) market. Connecticut's RPS law requires that utilities acquire energy savings from customer facilities, including CHP projects, equal to four percent of utility sales each year, through 2010. UTC has been able to sell credits from some of its Connecticut combined heat and power (CHP) projects in this way.

Internal Operations

UTC has gone to great lengths to standardize its approach to energy efficiency, through its EH&S Policy, its EH&S Management System, and an Energy & GHG Reduction Standard Practice (known as SP-017). While elements of the Management System and Standard Practice identify "What" is required, a detailed Energy Management Guidebook, first issued in January 2007 provides the more detailed "How-To" guide for energy, facilities, operations and EH&S professionals. The guidebook starts with the basics:

- How to collect, understand, and use energy consumption and cost data;
- How to procure energy smartly; and
- How to manage electric loads.

1 The Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive inventory of environmental attributes of U.S. electric power systems. eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government. Emissions data from EPA are carefully integrated with generation data from EIA to produce useful values like pounds per megawatt-hour (lb/MWh) of emissions, which allows direct comparison of the environmental attributes of electricity generation. eGRID also provides aggregated data by state, U.S. total, and by electric grid boundaries.

The guidebook goes on to provide technical guidance and best-practice lists on key topics including: operating schedules; lighting; compressed air; boilers/steam systems; HVAC systems and controls; cogeneration; and building envelopes.

In developing the guidebook, UTC took advantage of existing publicly available energy management information and coupled that with UTC expertise in several of the subjects covered in the guide including Carrier, which contributed to the HVAC sections, Sullair (a division of Hamilton Sundstrand), which contributed to the Compressed Air sections, and both Pratt & Whitney and UTC Power, which contributed to the cogeneration section.

The guidebook also includes a self-assessment checklist (see **Figure 3**), enabling site managers to determine if they have the essential elements of UTC best practices in place.

Each of the topics outlined in the guidebook references specific chapters of a UTC-branded edition of the "Energy Management Handbook,"[2] a detailed desk reference used throughout industry. These energy management practices fall within UTC's Standard Practice 017. EH&S practices are published in a numbered series; Standard Practice 017 is a formalized version of the practices laid out in the Guidebook and Handbook that provides more detail on best practices for reducing energy use and greenhouse gas emissions. The efficiency practices also exemplify the company's overarching business approach, termed Achieving Competitive Excellence (ACE). Former Chairman and CEO George David developed the ACE program in 1991–1992 while he was President with UTC. It stems from the continuous-improvement techniques developed in Japanese manufacturing that are now widely emulated. ACE embodies the process of seeking out and eliminating waste, while at the same time striving to improve quality, in every aspect of the company's businesses.

While the guidebook, handbook, and assessment checklist are important, perhaps more critical are the leadership, training, data tracking and accountability systems put in place to ensure the operating practices truly are conducted at the highest level. UTC's energy team and corporate energy manager oversaw the energy team's work in developing the data collection and reporting system, organizing the training and technical assistance effort, and supporting the internal communications program. The energy team includes some 10 people in all, including one from each business unit. The business unit leads work directly with the 300 facilities participating in the reporting and savings target effort. The energy team is part of a larger operations-supply management organization that specializes in commodity management. Each team has cost savings goals in a specific general procurement

2 Wayne C. Turner and Steve Doty (2006). *Energy Management Handbook, Sixth Edition.* Taylor and Francis.

Figure 3

UTC Self Assessment Template

Energy Management Plan Self Assessment		
Questionnaire		
Site Name:		
Date:		
Completed By:		
(answer all questions in blue box, Yes or No)		
Data Management		**Yes/No**
1A.1	Are monthly utility bills reviewed for trends, variations in use and mistakes? (electricity, natural gas, fuel oil)	
1A.2	Are monthly consumption and cost data recorded and readily available electronically? (including all pertinent data points, on-peak, off-peak kwh & kw, load factor, power factor)	
1B.1	Are daily electric load profiles analyzed for trends and anomalies?	
1B.2	Are quarterly energy consumption targets set and compared to actual, (electricity, natural gas, fuel oil)?	
1C	Are facilities and operating units held accountable for energy consumption?	
Overall Rating	**Sum of Positive Responses**	**0**
Rate Management		
2A	Has utility company completed a rate review for all accounts? (electric and natural gas)	
2B.1	Have alternate fuels for large energy using equipment been evaluated?	
2B.2	Has co-generation been evaluated?	
2C.1	In locations where supplier choice is available for electricity, are competitive supply offers being solicited?	
2C.2	In locations where supplier choice is available for natural gas, are competitive supply offers being solicited?	
Overall Rating	**Sum of Positive Responses**	**0**
Energy Conservation		
3A.1	Have significant energy consuming systems been identified and quantified?	
3A.2	Are systems appropriately controlled when operating level or load is reduced? “Shut-it-Off” program	
3B.1	Has an energy audit been completed within the past two years to identify conservation opportunities?	
3B.2	Is there a list of completed energy conservation projects documenting cost and savings?	
3C	Is there a prioritized list of planned energy conservation projects documenting cost and savings?	
Overall Rating	**Sum of positive responses**	**0**
Organizational Integration		
4A	Is there a cross-functional site energy team responsible for each of the items listed above?	
4B.1	Does the energy team communicate goals?	
4B.2	Does the energy team track progress against stated goals?	
4C.1	Does the management team review program and progress of the energy management program?	
4C.2	Do you have a forum to participate in regulatory affairs at the Department of Public Utilities on energy issues?	
Overall Rating	**Sum of positive responses**	**0**
Total Score out of 20		**0**

Recreated based on image provided courtesy of UTC (2009).

commodity such as energy, factory supplies, IT-telecom and others. This centralized commodity management organization develops strategic sourcing initiatives and identifies best practices to be shared by all business units. The energy team has a specific focus on procurement savings and energy conservation.

As with most new programs, UTC's efficiency initiative called for education and training of facility staff and staff from key business unit functions. This started slowly—the first meeting consisted of six people—but grew to the point that more than 200 UTC staff members have been trained worldwide. Meetings and workshops happened in such diverse places as North Carolina, France, New Jersey, Italy, and Singapore with representation from facility management, EH&S, and supply management staff.

This training effort was aimed at both gaining participation in the energy reporting system, and in conducting site assessments to identify improvement opportunities. The UT500[3] energy team started with energy audits at the 30 top energy-using sites; these drew on members of the energy team, site management, consultants, utilities and, in some cases, UTC product experts as the situation dictated. They averaged two days per site. In some cases, engineering students and consultants from the U.S. Department of Energy's Industrial Assessment Centers were involved.

Once projects were identified, the energy team typically assisted local engineers, contractors and vendors to implement the projects. The audit results became part of the curriculum for further training events, and helped the energy team move on to the next 30 sites. The goal of the training effort was to build capacity at the major sites and in each business unit, including building relationships with suppliers and outside vendors, such that each site and business unit can become more self-sustaining in its ability to identify and implement improvements.

Like other successful energy conservation strategies, UTC's approach relies on a company-wide, mandatory reporting system for energy use and costs. Every manufacturing site as well as any site with more than $100,000 in annual energy and water costs must report quarterly through the online, enterprise-level data system. For UTC, this puts data from some 300 facilities into the system. For facilities with under $100,000 energy and water spend, the team estimates energy use. Site managers must input data quarterly, which get rolled up into EH&S reports summarized at the business unit level that go to senior management. Each of the company's seven business unit leaders is accountable for reaching energy/GHG goals along with other EH&S goals.

3 UT500 is a company-wide initiative, named for its overall goal of saving $500 million in supply costs across the entire company supply chain. Energy is one of the key costs included in the UT500 initiative.

As this study has found in other companies, the energy reports are "dashboarded" in traffic-light fashion with easy to read features like red highlights for facilities falling behind goals, and green highlights for facilities at or ahead of target. What makes UTC's EH&S reporting system unique is the Project Module it built in alongside its reporting system, which serves as a centralized database for potential energy efficiency projects. The module requires entry of a broad range of data on efficiency projects including required investment, cost saving, usage reduction (gallons of fuel, KWH, etc.), utility incentives, and GHG reductions. At each major site system users can thus see a broad range of project opportunities and measures.

These simple reporting techniques have powerful effects: they enable busy executives to see at a glance where the problems lie. Once those problems are identified, managers can turn to a list of pre-analyzed projects to address the issues. This generates action: business unit leaders at UTC regularly communicate with site managers when a facility shows up in red. Access to details of efficiency projects with less than three-year paybacks already entered into the Project Module can be quickly analyzed and approved. The lesson is that while the project information may have existed before in accounting files or managers' spreadsheets, until it was given visibility and turned into information that a decision-maker could quickly grasp, it may not have been approved.

As part of the company's 2010 goals, a goal of investing $100 million in energy efficiency projects was set. But this was not a "ring-fenced" corporate fund—UTC business units were expected to make these projects a priority and fund them out of their overall business plans. With the energy team's help, by the end of 2009 over 1,200 projects were identified, valued at over $170 million in implementation costs. $116 million worth of these projects were funded, exceeding the 2010 goal early. And while economic conditions have made capital harder to come by, projects continue to be funded as demonstrated by the 788 approved projects. While those projects had an average payback of 2.5 years, paybacks as high as five years have been approved when other factors such as greenhouse gas reduction and energy price volatility were considered. Typical measures include lighting, compressed air, HVAC, process improvements, and cogeneration. See the box on the next page for an example of a cogeneration project UTC undertook in Middletown, CT.

UTC Blends Operations and Products for Major Savings

Two UTC business units, Pratt & Whitney and Carrier, collaborated in the design, planning and installation of the Pratt & Whitney Middletown cogeneration facility project. Carrier provided its expertise in heating, cooling, and powerhouse operations, and served as the lead integrator and installer for the 7.5 Megawatt (MW) co-generation facility in April 2008. The facility can generate about two-thirds of the site's electrical energy and the majority of the steam for winter heating, summer cooling, and manufacturing process equipment. Actual operating practice is not to run the facility continuously at full electric generation capacity, but rather to optimize operations based on the plant's thermal needs. This project is estimated to reduce the plant's CO_2 emissions footprint by more than 12,000 metric tons or 12 percent annually. It also saves energy by using the waste heat from the power generation turbine to make steam while relieving the electric grid of the need to produce more than 60 million kilowatt hours (KWH) per year.

Like many companies, UTC tends to apply simple payback rules to efficiency project investments, typically seeking paybacks of three years or less. Because its business units are independent in their financial management, there is no single, uniform metric applied to all projects. Several factors appear to have driven the recent wave of efficiency investments:

- The effort put into identifying and providing visibility to cost effective energy conservation projects;
- The priority placed by senior management on meeting both the savings targets and the $100 million investment target;
- The accountability for energy performance at both facility and business unit levels, driven by the reporting and tracking system. Energy and GHG objectives are sometimes tied to compensation and promotion plans for relevant employees;
- The co-benefits efficiency investments provide in terms of productivity, competitiveness, environmental impact reduction, and employee morale;
- The strategic and risk management importance assigned to CHP projects, which did not always meet financial criteria;
- Risk management strategy to manage volatile energy prices.

The UTC experience is similar to other companies in that they found no shortage of efficiency investment opportunities. Many energy managers have lists of cost-effective projects; the key is to make efficiency a priority in the company such that it is measured on consistent metrics, becomes visible to senior management, and can compete more effectively with other potential uses of company funds.

The UT500 energy team communicates actively within the company, via quarterly newsletters, conference calls and webinars, training sessions and posters. The company's EH&S awards now have a category for energy and climate, with winners' stories posted on the company's Internet home page, making energy efficiency a more prominent internal recognition factor. The energy team found a lot of enthusiasm among site staff for the efficiency program, and saw a wealth of creative as well as practical ideas come forth, as the savings goals, the reporting system, the training efforts and the project funding came on line.

Products and Services

Fully aware that the carbon footprint of its products outweighs its internal footprint by more than 100-fold, UTC has redoubled its efforts to squeeze more efficiency out of its product line. The company's 2010 goals include a target to improve the efficiency of its products at least 10 percent from their 2006 levels. Since its jet engine and air conditioner products make up the largest part of its product footprint, they get extra emphasis. With world oil prices driving competitive forces in the aircraft business to unprecedented levels, Pratt and Whitney engines are reaching new efficiency heights with the geared turbofan engine, a 12 percent improvement over the previous generation technology. In addition, Pratt and Whitney squeezes extra efficiency out of jet engines with its EcoPower engine wash system, which not only gives engines an efficiency-boosting cleaning, but also reclaims water and avoids harmful chemicals. Carrier's Evergreen chiller line outperforms the American Society of Heating, Refrigerating, and Air Conditioning Engineers efficiency standard by 40 percent. A typical installation at Hartford Hospital is summarized in the box on the next page.

Carrier engineers are quick to point out, however, that the nominal chiller efficiency is only part of the energy performance picture. Chillers are part of complex heating, ventilating, and air conditioning (HVAC) systems in many buildings, with pumps, fans and controls all contributing to the system's real-world performance. This whole-building, systems-oriented philosophy does not stop with chillers or HVAC systems: UTC's marketing efforts revolve around the growing "green building" industry which covers everything from energy use to flooring materials. UTC is a leader in the green building community, supporting the U.S. Green Buildings Council (USGBC), whose CEO is Carrier alumnus Rick Fedrizzi, and the World Business Council for Sustainable Development's (WBCSD) buildings initiative.

Carrier Upgrades Cooling System Efficiency at Hartford Hospital

Carrier recently completed a three-phase project for Hartford Hospital with the goal of increasing patient comfort and increasing energy efficiency by upgrading the 867 bed facility's aging and inefficient cooling system.

Starting in 1998, Carrier made system-wide improvements on the hospital's north campus, installing a Carrier Comfort Network® (CCN) controls system which allowed for automatic adjustments, precisely matching conditioned air delivery to actual building conditions, and saving the hospital $1.2 million in annual operating costs. In 2005, Carrier expanded the chiller plant free cooling system, improved the cooling tower air recirculation, and provided advanced lighting upgrades, which added another $250,000 in annual savings. Most recently, Carrier installed three Evergreen® 19XRV water-cooled centrifugal chillers using non-ozone depleting HFC-134a at a cost of $5 million. Variable frequency drives (VFDs) further increase efficiency by precisely matching motor speed with building demand. In addition, the VFDs reduce mechanical stress and motor wear, requiring less maintenance and prolonging system life.

The WBCSD buildings initiative featured a four-year, $15 million study on energy efficiency in buildings. Co-chaired by United Technologies and Lafarge, with support from a dozen other multinational corporations, the report concluded that while buildings are the largest source of energy use in the world today, substantial and attractive investments to reduce energy consumption and carbon emissions are available now.

UTC's commitment to buildings as whole systems also shows up in its print advertising, which display a "green building of the future" schematic that contains Carrier chillers, Otis ReGen elevators that reclaim energy when they descend, UTC Power fuel cells, combined heat and power systems and advanced controls from UTC's Fire and Security business.

UTC sees tremendous opportunities for improving energy efficiency in buildings. Since it produces many components that can help building owners and operators capture those savings, it also sees significant business opportunities in the movement toward more energy efficient buildings. In support of its internal GHG goals, UTC established in 2008 a policy that all its new construction meet the USGBC Leadership in Energy & Environmental Design (LEED) certification standard with a target of LEED Gold.

In the industrial world, UTC markets combined heat and power systems like the unit it has installed at its own East Hartford location. It also sells Sullair compressed air equipment, whose new AirMetrix line can achieve savings of 15–35 percent compared to the units they replace. These savings are comparable to those Toyota experienced with its new compressor installation at its Kentucky facility.

Supply Chain

UTC has gone to some lengths to quantify its supply chain energy and carbon footprint, estimating on a first-order basis that suppliers account for a footprint five times that of the company's internal operations. UTC's supplier programs have targeted quality and delivery performance and environment health and safety. The initial supplier EH&S program establishes a set of expectations for over 1,000 key suppliers. The expectations include compliance, worker protection, EH&S management systems and EH&S impact reduction including conservation. Suppliers complete a UTC online self-assessment, develop corrective action plans in the UTC system, and report progress. 10 percent of suppliers are audited. UTC has focused first on compliance and worker protection and is not yet asking suppliers to report energy and carbon numbers. Going forward, the company expects to apply the World Resources Institute/World Business Council for Sustainable Development GHG Scope III reporting protocol to supplier reporting.

However, like any large and diversified manufacturing and service organization, UTC has thousands of suppliers on multiple continents which creates data collection and consistency challenges. Other key challenges for UTC have included acquiring data from leased space, fleet fuel usage and business travel. Like other companies operating in the absence of perfect data, UTC focuses on collecting the data that is available and coming up with a best estimate of the rest.

Conclusions

United Technologies has worked hard to unite its seven businesses, its functional groups (EH&S, supply management, engineering, facilities, finance, etc.) and the technologies they make, into an integrated sustainability enterprise. Making its internal operations energy efficiency strategy happen was a challenge, given the diversity of the business units, geography, information systems, operating practices, personnel skills and so on. The diversity and legacy factors were perhaps even more challenging on the supply chain side, as the sustainability team worked through a myriad of supplier relationships that entailed unique or inadequate data systems.

Despite these challenges, UTC's energy efficiency strategy has seen dramatic successes, reaching its original 1997–2006 goal in five years and ultimately more than doubling the 25 percent target, allowing the company to reduce total energy use while growing substantially. This built confidence in the program to the point that 2010 goals have been set as absolute reductions. UTC has also created synergies across the company, both by using its own technologies in its internal operations, and by supporting multiple products through its active engagement in the green buildings industry.

Key lessons learned from UTC's energy efficiency successes include:

- Concerted effort is needed. The energy team must be persistent, patient, and must reinforce the effort frequently.
- Senior leadership support is important. Unless people across the company believe that energy efficiency is important at the highest levels, gaining and maintaining cooperation across organizational lines is difficult.
- Provide tools and training. Do not make the mistake of imposing reporting or performance requirements without giving people the practical support they need to accomplish them. Energy team members should be clear and balanced in defining what is required and how to accomplish it.
- Make identification of projects easy. Developing the project module as part of the company reporting system is an example of ways that the energy team can help facility staff find solutions.
- Ensure visibility of projects. When a project succeeds, it should be publicized within the company, both to reinforce the program's goals, and to encourage others to pursue similar projects.

CASE STUDY

IBM Integrated Approaches	
Headquarters:	Armonk, NY
CEO:	Sam Palmisano
Revenues (2008):	$103.6 billion
Energy Costs (2008):	Undisclosed
Energy Savings Target:	4 percent annual savings target in 1996 with a requisite business process to collect and report company wide data. An enterprise-wide software system for data management was implemented in the 1990's. In 2006, the target was modified to 3.5 percent annual conservation savings.
Key Efficiency Strategy Successes:	• 3.5 percent annual energy conservation target surpassed in 2008. Actual savings were 6.1 percent, leading to $32.3 million in savings, and $16.4 million in cost avoidance; • Instituting a global energy reporting and accountability system across 650 facilities; • Implementing global best practices checklists to assess conservation opportunities; • Leveraging internal operations experience and IT expertise to formulate new customer product and service offerings; • Encouraging key suppliers to disclose their greenhouse gas (GHG) inventory, management plans, and any reduction commitments, through the Carbon Disclosure Project's Supply Chain program & Electronics Industry Citizenship Coalition.

Energy Conservation Strategy Overview

Like many companies where well-trained engineers and dedicated managers work to improve productivity and manage costs, IBM responded to the energy crises of the 1970s by trimming energy expenditures through a mix of good housekeeping activities and technology investment. The company set its first energy conservation policy in 1974, focusing on operations at the individual facility level, with initial efforts directed toward simple, low-tech conservation initiatives. Engineers and facility managers took actions to turn off lights and HVAC systems when they were not needed, and tune up energy systems such as steam, compressed air or chiller water systems to improve their efficiency. Capital investments followed, with energy efficiency competing for funds with other projects subject to the company's payback requirements.

But an important shift occurred in the 1990s. Energy at IBM went from a shop-floor issue to a top-floor issue. Growing commitments from governments to address climate change, combined with basic shifts in energy markets, convinced IBM leadership that the global energy use paradigm was beginning to be transformed. Senior executives saw a shift from cheap, abundant energy based on fossil fuel supply technologies, to expensive energy from shrinking fossil fuel sources overlaid by an imperative to reduce carbon dioxide emissions. IBM management recognized that the company had to redouble its efforts to actively manage energy use and to manage risks associated with potential energy supply disruptions, escalating cost, and climate change regulations. In accord with these developments, IBM undertook voluntary commitments to measure, report, and continue to improve its environmental performance, joining initiatives such as the U.S. EPA Climate Leaders program, the Carbon Disclosure Project, and the Chicago Climate Exchange, which require greenhouse gas emission inventories, reports and reduction goals. These commitments, combined with the rise in energy prices in the past decade, placed a new emphasis on collecting, reporting, and acting on energy usage information on a company-wide basis.

In 2006, in an atmosphere of rising energy prices and an increased public policy focus on energy efficiency and climate change around the globe, IBM took its energy conservation strategy to a new level, by expanding a mandatory energy conservation gap analysis (a comparison between an established list of best practices and conditions at each location) and an energy tracking and reporting system to all its facilities around the globe using more than 2,000 megawatt hours (MWH) of energy annually. While the company had set targets in 1996 to implement conservation projects that reduce or avoid energy use equivalent to four percent of the company's annual energy consumption,[1] the addition of the mandatory energy conservation gap analysis and expanded reporting effort made the company's commitment real and measurable across the global organization. Metrics reporting was expanded to include on-line monthly and quarterly reports of location energy use and performance against conservation targets, providing senior executives on-line access to comprehensive energy data.

These changes increased the number of facilities required to report energy use and perform conservation assessments from 500 in 2005 to 650 in 2008. Mobilizing all of the relevant business units and engaging them in the conservation strategy was a significant undertaking. In some cases, the Real Estate and Site Operations (RESO) organization—the organization tasked with the overall mission of energy management within IBM—had to forge new relationships with business unit teams, such as the data center groups, while in other cases, such as the manufacturing sites, existing relationships were expanded. In many instances, business unit teams had no previous experience dealing with energy metrics, so a degree of education was required. Additionally, the 150 locations that

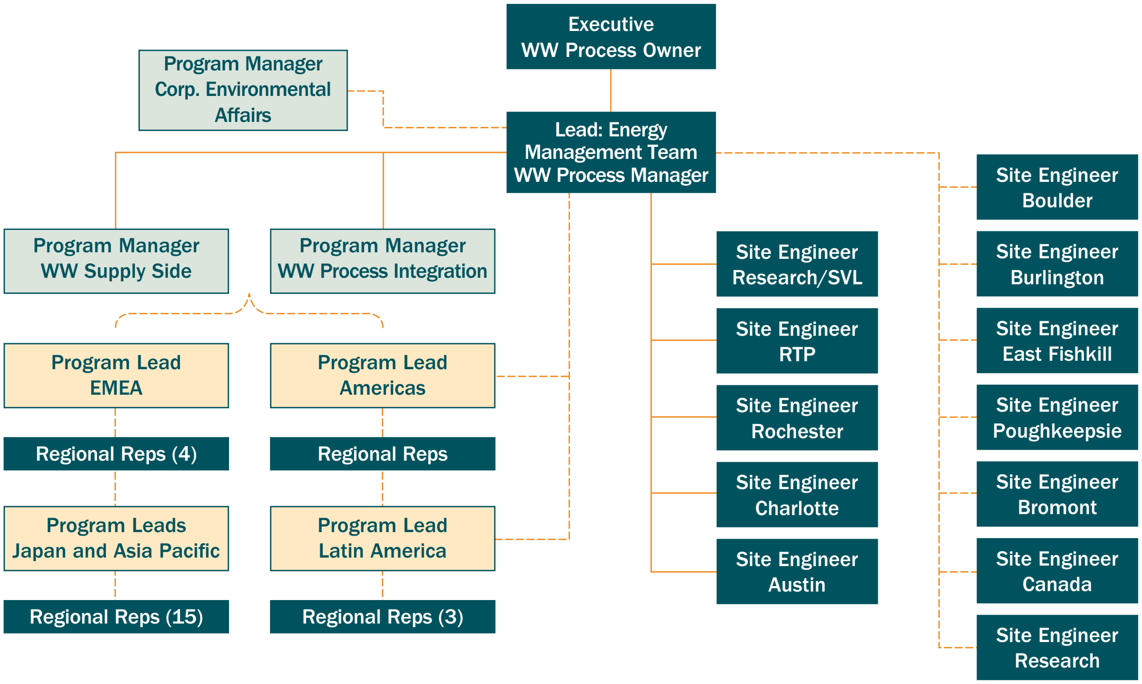
1 IBM's energy conservation target is calculated by summing the annual savings achieved by energy reduction and avoidance projects and dividing that by the total energy use for that calendar year.

had not previously been subjected to a rigorous energy conservation analysis at their facilities needed to expand their technical skills. Further, business units required assurances that conservation technologies and practices would not impact product quality, operational reliability, or production goals.

The corporate energy management team, which focuses on both energy procurement and energy conservation and efficiency, resides in the RESO organization. The team includes representatives from each of the major North American facilities and from designated global regions. Energy issues at smaller locations that use less than 15,000 MWH of energy annually are typically assigned to a regional energy coordinator who works with the location teams to evaluate and implement energy conservation projects. The energy management team also includes energy subject matter expert task groups, focused on lighting, HVAC, controls, etc. This allows the energy team to cut across operating units, and provide expertise across global company operations (see **Figure 1** for an overview of IBM's Corporate Energy Management Team). In the figure, WW stands for worldwide, while SVL and RTP refer to IBM facilities located in Silicon Valley and Research Triangle Park, North Carolina, respectively.

Figure 1

IBM's Corporate Energy **Management Team**



Recreated from image provided courtesy of IBM (2009).

The energy team learned early on that it would need to make some accommodations to get the level of cooperation needed to significantly beef up IBM's energy conservation strategy. For example, the corporate target of conserving energy each year equal to four percent of the company's annual energy use was adjusted down to 3.5 percent, though it was also expanded to cover additional leased spaces. To ensure the corporate level target is met, the four percent energy conservation target has been maintained at the larger facilities that have a greater range of opportunities for conservation savings, driving "overachievement" at these places. These larger locations also received energy use reduction targets, specifically aimed at driving absolute reductions in location energy use, in addition to their conservation targets. Smaller locations were given slightly lower percentage reduction targets and, in some cases, targets are aggregated regionally to allow effort to be focused on the best opportunities. IBM used a variety of means to encourage and sustain active cooperation among some 650 facilities including education, persuasion, technical assistance, program assessments, and competition among sites. Energy team members spent a lot of time one-on-one, in conference calls and emails, and in site visits, helping site operations teams around the world learn the new system.

The energy team has combined its expertise to produce a wealth of operating practices and technology investment opportunities for the energy-intensive facilities. They also translated these findings into standardized best-practice checklists, applicable to IBM's global property portfolio.

While the company's energy savings goals were set for many reasons, actions undertaken to reach the target still needed to make financial sense. When efficiency was a shop-floor issue, companies typically used standard "simple-payback" criteria to screen out projects that took longer than a few years to pay for themselves. In its 21st-century strategy, IBM found it needed to think beyond "simple payback" or other standard measures such as Internal Rate of Return (IRR) as the only financial gauges for efficiency investments. Like many businesses, IBM applies the same financial criteria to its energy efficiency investments as it does to other business investments, typically two to three years payback depending on business conditions. But the energy management team has found that energy conservation projects bring other benefits to the business, such as improved manufacturing productivity, better utilization of assets, the return of "energy capacity"[2] to the business that can be used to generate additional revenue, space use reductions, and other measurable business returns (see text box on the next page for an example of some of energy efficiency's co-benefits experienced by IBM). By working with the business units, the energy

2 Increased energy capacity occurs in situations where energy availability is constrained either by facility system capacity or the capacity of the delivery grid. Implementation of conservation projects frees up energy, making it available for new operations or the growth of existing activities. It can also enable the avoidance of investment in upgraded or expanded facility systems.

Co-Benefits of Energy Efficiency Improvements

Data center energy efficiency improvements can reduce energy use by five to 10 percent within the existing server inventory and application workload. Consolidating workload onto fewer servers and storage systems can further reduce energy use and reduce floor space needs. This freed-up space can then support service sales growth for new and existing accounts. At one IBM data center, this approach freed up 1.5 percent of its floor space for account service growth and avoided IT equipment investment of $2.5 million. The overall savings driven by these additional business benefits make the business case more compelling, providing a stronger justification for implementing these types of projects.

management team can quantify these benefits and improve the investment return to strengthen the business case for the project. Close cooperation with the business units also identifies those projects or energy management/ conservation techniques that can be translated into client offerings. As a result, today, efficiency at IBM is linked to a much larger value chain than it was in the earlier days of energy management.

One of energy efficiency's key ties to this larger value chain, and its ability to drive so much change in large organizations, is its pervasiveness. Virtually everyone in an organization has some influence on energy use, be it the light switch in their office, the power management settings on their computer, or the production process or data center they manage. Other environmental issues tend to be limited to fewer people and fewer locations. Hazardous materials, for example, are typically generated in specific production operations, and are handled by specialized staff and contractors. From an Environmental, Health, and Safety or Corporate Responsibility perspective, such issues tend to be more specialized and do not involve all or even most of the organization.

Energy, by contrast, can get lots of people involved. Companies like IBM have found that employee engagement is a key part of their energy strategies. Beyond posting signs reminding people about switching off lights, employee newsletters, and other routine communications, some IBM locations offer $500 rewards for useful energy efficiency suggestions. While such incentives appear to be generating lots of good suggestions, the energy team finds that what really drives people in this process is the innate desire to solve problems, and to make a difference beyond their specific job description. IBM and other companies have been surprised by how resonant the energy conservation message has been throughout the company, improving morale as well as productivity.

The picture that emerges from a look into IBM's energy conservation strategy could be termed "data driving information driving action." As energy use has increased in importance as a business imperative, IBM has improved its data collection and management system from a spreadsheet system used decades ago to an enterprise wide data collection system. The energy conservation team has expanded, from a location-centric focus to a global energy team. And the team has established detailed global energy conservation and efficiency best practices and standards to dictate energy performance at operating locations worldwide. Progress toward the energy savings goals is tracked using a monthly/quarterly/annual reporting process, which goes to senior management, which drives deeper scrutiny and empowers efficiency actions at the facility level. The energy team reports that business unit and division leaders, once they began to see individual facilities' performance in the red and green performance indicator colors, began calling and emailing managers at facilities that had fallen behind to find ways to improve performance. See **Table 1** for a sanitized screen shot of the Business Intelligence @ IBM (BI@IBM) Energy Management reporting system. Red highlights indicate facilities or regions that are lagging on energy performance; green highlights show progress ahead of targets. In **Table 1**, the smaller box at the top represents aggregated totals from several IBM facilities, while the larger box shows energy use data from individual facilities.

IBM's overall Corporate Responsibility efforts provide transparency into the company's environmental performance, with the energy reporting system being a core element of that effort. IBM has reported the company's energy and/or carbon dioxide emissions targets, and its actual performance through the company's annual Environmental Report without interruption since 1990. It emphasizes that saving energy is not just an engineer's job—it is everyone's job. Similar information has also been disclosed through IBM's Corporate Responsibility Report.

Energy Conservation and IBM's Climate Strategy

IBM's energy conservation strategy is the cornerstone of its overall climate strategy, with efficiency and conservation projects providing the majority of the company's direct and indirect CO_2 emissions reductions. Over 80 percent of IBM's energy use results from purchased electricity. The CO_2 emissions associated with this energy use depend on the fuel sources of the generating portfolio of the country or regional electricity grid.

Like many of the other companies studied in this report, IBM does not expect to sell energy efficiency as a tradable commodity in carbon markets. Concerns about double counting have so far precluded these "indirect" emissions reductions from qualifying as carbon credits in legislation establishing greenhouse gas cap-and-trade systems being considered at the federal level.[3] There may, however, be opportunities for IBM to participate in the demand reduction/energy efficiency markets that are being established in some states and countries. Regardless of the applicability of regulatory programs, efficiency continues to justify itself on sound business grounds, while also

3 For a more detailed description of this issue, please see page 11 of the body of the report.

Table 1

IBM's Business Intelligence Energy Management Reporting System

As of Date	10/2009	10/2009	10/2009	10/2009	10/2009
Previous Year YTD Usage Total	NA	NA	NA	NA	NA
Current Year YTD Usage Total	NA	NA	NA	NA	NA
Year to Year PCT Chg Total	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%

Rank Num	Locations	Geographies / IOTs	Countries	Previous Year YTD Usage (MWh)	Current Year YTD Usage (MWh)	Year to Year PCT Change	Avg CY Rate ($/MWh)	YTD $K Impact
1	Location 1	North America IOT	United States	438,512	406,926	-7.2%	$80.13	-$2,531
2	Location 2	North America IOT	United States	376,767	343,814	-8.7%	$85.29	-$2,811
3	Location 3	North America IOT	United States	212,888	193,991	-8.9%	$81.24	-$1,535
4	Location 4	North America IOT	United States	118,050	125,481	6.3%	$56.71	$421
5	Location 5	North America IOT	United States	151,824	148,770	-2.0%	$52.05	-$159
6	Location 6	North America IOT	United States	90,099	83,173	-7.7%	$81.45	-$564
7	Location 7	North America IOT	Canada	113,449	104,042	-8.3%	$41.28	-$388
8	Location 8	Southwest Europe IOT	France	47,704	63,622	33.4%	$71.35	$1,136
9	Location 9	North America IOT	United States	64,357	64,954	0.9%	$83.44	$50
10	Location 10	North America IOT	United States	94,564	87,572	-7.4%	$73.70	-$515
11	Location 11	North America IOT	United States	44,031	42,191	-4.2%	$118.21	-$218
12	Location 12	North America IOT	United States	50,148	49,553	-1.2%	$68.50	-$41
13	Location 13	Northeast Europe IOT	United Kingdom	45,023	42,971	-4.6%	$119.66	-$246
14	Location 14	North America IOT	United States	38,308	37,830	-1.2%	$114.23	-$55
15	Location 15	Latin America GMT	Brazil	45,062	52,163	15.8%	$154.74	$1,099
16	Location 16	North America IOT	United States	44,714	47,107	5.4%	$123.49	$295
17	Location 17	Northeast Europe IOT	United Kingdom	42,061	43,418	3.2%	$113.91	$155
18	Location 18	Northeast Europe IOT	Ireland	25,544	21,271	-16.7%	$113.40	-$485

Recreated from image provided courtesy IBM (2009).

providing the largest and most consistent basis for reducing IBM's GHG emissions inventory. The energy team expects efficiency to stay at the center of IBM's energy and climate strategy. And as carbon prices raise the cost of fossil fuel and associated energy sources, the financial attractiveness of efficiency investments will increase.

Internal Operations

IBM's energy bill is only a small fraction of the company's $103.6 billion 2008 revenue. This is not unusual—energy has been a relatively small cost factor for most companies, except for the most energy-intensive manufacturers. When viewed this way, it's easy to understand why energy has rarely risen to the top of management priorities.

But context can change everything. IBM's energy bill is a small fraction of its operating costs, but accounts for most of its GHG emissions. In a CO_2 context, energy suddenly becomes the biggest piece of the puzzle. Add to this the fact that the company's energy costs rose more than 60 percent from 2000 to 2007, and it becomes easier to understand IBM's intensified focus on energy conservation.

IBM's energy bill splits roughly among building operations (about 47 percent), manufacturing (about 20 percent), and data centers (about 33 percent). The energy management team, in partnership with the business units, has developed efforts to rein in costs in all three areas. **Table 2** shows how these percentages work out by facility type and by end use. The first four columns of numbers represent the distribution of facility types' end-use consumption: e.g. 20 percent of manufacturing energy use occurs as HVAC versus 25 percent as central utility plant. The fifth (far-right) column shows the total distribution of end-use energy, across all facility types, by total spend. The first five rows show the distribution of end-use consumption by facility type: e.g. 20 percent of HVAC usage occurs in manufacturing versus 10 percent in data centers. The bottom row shows the distribution of energy spend by facility type.

Table 2

Distribution of Energy Use within IBM Operations

	Clusters: Space Types				
Energy Drivers	Manufacturing	Data Centers	Office Spaces	Labs & Research	Total Spend
HVAC	20%	10%	50%	30%	27%
Data Center Equipment	- - -	65%	- - -	25%	22%
Central Utility Plant (CUP)	25%	20%	- - -	20%	16%
Manufacturing Processes and Tools	45%	- - -	- - -	- - -	14%
Lighting	10%	5%	25%	10%	13%
Plug Load	- - -	- - -	25%	15%	8%
Total Spend	30%	28%	28%	13%	

Recreated from image provided courtesy of IBM (2009).

Manufacturing. Making semiconductors means being clean: clean-room environments are a must for these high-tech products. As one example, IBM's Burlington, VT production plant has been finding ways to make the process energy and material efficient as well as clean. Part of the energy conservation gains come from the cleaning process itself. John Aldrich, a 40-year IBM veteran and Burlington energy manager, knew that the site's two production units ran vacuum pumps used by cleaning crews 24-7, like most of the systems that support core production processes. But when he asked the cleaning crews how they actually used the equipment, he found out they only clean a few hours a day. That enabled Aldrich to shut down the vacuum pumps for most of the day, saving over 80 percent of energy use for that system at no capital cost.

But Aldrich's microscope, once focused, discovered much more, including production technologies ripe for change. Semiconductor chip manufacturing involves depositing up to 11 layers of metal on the silicon wafers, each of which is etched into precise patterns that become the chip's electronic circuits. IBM uses dozens of specialized "LAM" (lamination) tools for this critical process, which requires both precise cooling for temperature control and vacuum pumping to remove contaminants. Aldrich's review turned up several technology solutions, including:

- The cooling chillers were expensive to run, and they failed a lot. Aldrich worked with the equipment maintenance team to replace them with solid state models that cost less to run and are very reliable. While it was the energy savings effort that brought this solution to light, it led to product quality and productivity improvements.
- The vacuum exhaust contaminants were destroyed through a heating process, which used lots of energy, and had to be shut down often for cleaning. The energy and equipment maintenance team devised an unheated, chemically-based trap system that used almost no energy and didn't need a cleaning shutdown cycle. Again, the efficiency initiative uncovered a solution that saved energy while improving total performance and productivity.

A clear lesson from IBM's experience is that energy efficiency will be viewed with caution when it introduces uncertainty into a work environment where product quality, production line reliability, and output are the core objectives, and energy management is at the periphery. In these instances, energy efficiency is viewed as part of the support infrastructure, one that might reduce costs on the margin but also poses large and unknown risks if it involves modifying proven practices and technologies. But a surprising find, made by IBM and others in this study, is that the reverse is often true. Instead of detracting from core manufacturing processes, energy efficiency can be like a flashlight that looks inside processes and practices to turn up ideas that not only save energy and money, but also improve product quality, production reliability, and total productivity.

These co-benefits of efficiency are often invisible, until the company's processes, and the minds of those who run them, are opened up to think of energy as just one factor in the total operation. Too often, energy efficiency projects are examined narrowly, on an incremental basis; but when a company like IBM encourages "out-of-the-box" thinking and creates cross-functional teams trained and empowered to look beyond the ordinary, surprising things can happen.

Data Centers. IBM intensified its focus on data centers in 2007 based on its analysis of energy use over the past three years which showed that data center electricity use was responsible for one third of IBM's total electricity use. Around the same time, the Green Grid[4] published a paper on data center efficiency metrics. The paper identified significant opportunities to increase data center energy efficiency and proposed two simple metrics to evaluate the effectiveness of power delivery to support IT operations: Power Use Effectiveness (PUE) and its mathematical reciprocal, Data Center Infrastructure Efficiency (DCiE). These two metrics assess the amount of energy used to run the IT equipment as compared to the total energy consumed by the facility (DCiE). A higher percentage indicates that more power is being directed to the IT equipment to generate useful work. The new Green Grid metrics helped IBM's data center operators evaluate their energy use and assess the opportunities for improvement. When IBM's energy savings goals and reporting system were expanded in 2006, operators were challenged by the fact that data centers and their energy use were growing rapidly, raising concerns about their ability to reach the company's savings goals. Operators said they needed specific metrics to measure efficiency, tools for applying those metrics, and technical help to make improvements.

As a board member of Green Grid, IBM was able to quickly engage these Green Grid metrics, as well as the tools and resources available from the organization and the company's own experts, to help its data centers make efficiency improvements. In the process, the energy team had to address three kinds of data centers: large, central IBM facilities with separate electricity meters; small-to-medium sized centers often embedded in other facilities, typically without separate metering; and client-owned facilities with various metering arrangements. Metering is a threshold requirement for using the Green Grid metrics: to calculate either PUE or DCieE, there must be metering for

4 The Green Grid is a global consortium of IT companies and professionals seeking to improve energy efficiency in data centers and business computing ecosystems around the globe. The organization seeks to unite global industry efforts to standardize on a common set of metrics, processes, methods and new technologies to further its common goals. For more information on the Green Grid, see: http://www.thegreengrid.org/about-the-green-grid.

the total data center, and for the IT equipment separate from the power supply, cooling, and other energy systems in the facility.

The details of measuring and analyzing data center energy performance can be complex. The IBM research team developed a tool, the Mobile Monitoring Technology (MMT), to simplify these efforts. The MMT measures three-dimensional temperature distributions within data centers, using a color-coded display system to identify hot spots that require attention. Other cross business unit efforts in areas such as IT equipment efficiency and virtualization[5] technologies developed other innovations to deliver more computing work for a reduced energy input. The data center team, one of several technical-expert teams within the energy conservation effort, has achieved several successes to date, including:

- The MMT tool has been used in nine of IBM's 60 large strategic data centers, identifying efficiency improvements that would reduce peak demand by seven percent and total energy use by 10 percent. All 60 of IBM's strategic data centers are slated for assessment over the next few years.
- At IBM's Poughkeepsie, NY data center, one of the company's largest, MMT results were used to change equipment configurations, airflow patterns, and air conditioning demand such that one-third of the AC units were able to be shut off. The PUE fell from 1.78 to 1.58, an 11 percent improvement. IBM's goal is to get average PUE's down to 1.42 (DCiE .7), and to build new data centers in the 1.1-1.6 range.
- IBM also applies virtualization techniques in its data centers, redeploying IT workloads to consolidate tasks in fewer servers. In one facility, IBM used virtualization to consolidate workload from servers supporting single applications to servers supporting many applications, reducing the number of servers required to support the workload by 45 percent, freeing up data center infrastructure capacity to expand IT workload capability by a factor of eight with little impact on total energy usage. And when virtualization shifts workloads from older, less-efficient servers to high-efficiency units, additional energy savings are gained.

5 Server virtualization is the practice of shifting from dedicated servers (e.g. one for payroll, one for Internet firewall functions, etc.) to "virtualized" server capacity, where these functions can be handled securely on "virtual" servers, whose data is actually managed across a variety of physical servers. This practice can save energy in two ways: by shifting tasks to newer and more efficient servers, and by loading servers more fully, reducing the amount of energy needed per computing operation.

- IBM is offering MMT, virtualization and consolidation services, and other data center resources to its customers as well, driving substantial improvements in data center operations outside the company.

Building operations. Unlike a heavy manufacturer, where most of the energy is used in a few larger facilities, much of IBM's energy use happens in smaller facilities. The company operates approximately 1,100 facilities in total, including a handful of major manufacturing facilities and over 300 standalone and co-located data centers. To get a better handle on energy use and opportunities in this many facilities of all sizes and vintages, some owned and some leased, the RESO organization began in 2002 to build an energy management organization matrix that cuts across geographic regions—Eastern U.S., Western U.S., Canada, Asia Pacific, Japan, and two regions covering Europe, Africa, and parts of the Middle East. After the expanded reporting and goals program came into effect in 2006, teams were created in technical specialties including lighting, HVAC, central utility plant, compressed air, data centers/IT operations, cafeteria, and office systems. This matrix approach creates both an accountability structure by assigning leads by geography, and a support structure by creating expert teams by technology area. All teams report results to the top RESO executive responsible for energy management. Each team has a technical lead and management lead, with responsibilities to prepare and maintain best practices checklist, research and advise on new energy efficient technologies in the technical specialty and provide technical assistance to site teams.

The technology teams' mission early on zeroed in on developing standardized checklists for operating practices and technology performance. Based in part on team expertise and part on facility energy audits and improvement projects, these checklists leveraged the teams' limited size to provide effective technical assistance for IBM's large real estate portfolio. IBM also follows the "80-20" rule by focusing its most intensive scrutiny on the 210 facilities that account for over 80 percent or more of energy use, putting a limited focus on the remaining facilities. These 210 locations receive detailed onsite assessments using company experts and consultants, are asked to follow energy management checklists in great detail through an online, enterprise level database, and participate in frequent phone and email discussions with the energy team. A snapshot page from the checklists is shown in **Figure 2**.

The checklists are also used to identify projects. To support this effort, RESO invested approximately $9 million, over and above its routine expenditures to operate its ongoing energy conservation efforts, in 2007 and 2008 for energy efficiency projects to supplement the budgets available to individual sites. Results from projects benefiting from this fund are summarized in **Figure 3**.

Figure 2

On-line **Global Database**

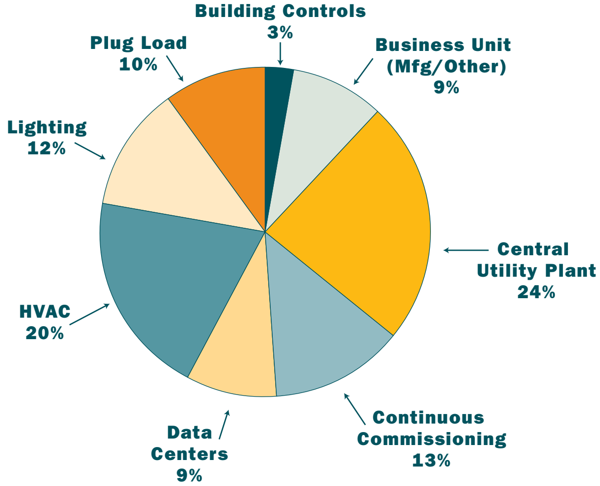
Low to no cost Items are written in Orange

Interior Lighting	Answer	Comments
Have all corridors/aisles, offices, common areas and lobbies been delamped as much as possible?	Yes	
Has a process been implemented to prevent installation of lamps in light fixtures that have been delamped for conservation?	Yes	
Have all incandescent bulbs/lamps been replaced?	Yes	
Have lighting fixture lenses been cleaned (during bulb replacement) to provide maximum illumination?	Yes	
Are exterior window aisle fixtures off during the day to take maximum advantage of daylight harvesting?	Yes	
Do all maintenance areas have lighting timers or sensors installed?	No (in progress)	No. In process. Partially complete.
Have all lighted Exit signs been changed to light emitting diode (LED) type?	Yes	
Is the emergency lighting system for the site designed and operating with the minimum number of fixtures on the emergency system?	Yes	
Do all raised floor and/or lab spaces have lighting control systems or occupancy sensors?	No (not feasible)	No. 24x7 operation
Are lights on to the minimum degree during "after hours cleaning"?	Yes	
NOTE: The conversion of Exit signs to LED types saves $25 per year per sign.		
Exterior Lighting	**Answer**	**Comments**
Are exterior/parking lot lights scheduled for the minimum hours? List the current hours of operation.	Yes	Astronomical timer, hours vary throughout the year. 30 minute buffer.
Have parking lot lighting levels been reviewed recently?	Yes	Reviewed lighting & usage. Disconnected several fixtures.
Are photocells and/or modern astronomical timers installed and working correctly on all exterior parking lot lighting?	Yes	
Have parking lots been consolidated and closed when possible?	Yes	

Recreated from image provided courtesy of IBM (2009).

Figure 3

2008 Energy Conservation Savings by Driver ($K, %)



Total Savings: US$ 3200K

Preliminary Numbers Pending Final Quality Check

Recreated from image provided courtesy of IBM (2009).

Products and Services

IBM's efficiency learning curve, especially in its IT product designs and data center operations, helped the company sell energy efficiency as both a product feature and as a service offering. In the 1950s, company skeptics opposed IBM's move into computers, but IBM President Thomas J. Watson, Jr. persisted, and the company developed some of the most powerful computers in the world, building a business model around the large, central mainframe computer. Today, the business model has evolved into a much broader vision of intelligent systems building a "Smarter Planet" based on pervasive computing ability. This model integrates electronics as small as the microchips in our cell phones, the blade servers that act as the brain cells in the data centers that host much of the Internet, and IBM's Blue Gene supercomputers that support the leading edge of scientific research.

The Blue Gene is the kind of supercomputer that makes electric utilities take notice. In large research institutions like Los Alamos National Laboratory it draws peak power demands above two megawatts. But Blue Gene and other IBM technologies have helped cement IBM's place as the global leader in supercomputer energy performance. IBM-built systems hold 22 of the top 25 spots on the "Green 500" list of most efficient large computers, maintained by nonprofit industry group Green500.org.[6] Its best system, at Forschungszentrum Juelich (FZJ), produces over 720 megaflops per watt of power demand (a megaflop is one million instructions per second). At full power, this system drives 43.4 teraflops (trillion instructions per second) of computing capacity—almost 40 million times better than its early-1970s ancestor, the IBM System 370, which was considered groundbreaking technology for its day at one megaflop.

6 From the November 2009 "TOP Green 500 List": http://www.green500.org/lists/2009/11/top/list.php?from=1&to=100.

But for all the dazzle in IBM computers' energy performance, the company's hardware products, accounted for only about 20 percent of the company's 2008 revenue. IBM's portfolio of customer offerings go far beyond hardware, into integrated hardware, software, and service solutions that cut customers' energy costs while solving their computational, business process and data management challenges. Under its "Smarter Planet" campaign, the company aims to build intelligence into societies' systems—from public health to agriculture, from traffic management to the electric power grid—in order to enable integrated solutions.

Energy efficiency is a core value of several IBM solutions. It starts with product design: IBM's longstanding commitment to research and development keeps it actively engaged in expanding the computing power of its products while reducing energy use. This is driven not just by IBM's product stewardship goals, but also by product performance needs. Heat is an enemy in electronic circuitry: too much heat harms performance and can lead to failures. IBM's product development team works relentlessly, through simulations and physical tests, to reduce "hot spots" in microcircuit designs, and to refine today's multiple-core chips that allow energy use to scale up in proportion to changing computing needs.

IBM product engineers readily admit, however, that the hardware is not the whole solution. While "cooler," multi-core chips can produce servers that are 10 times as efficient as older units, it is how the whole system is used that drives actual energy use. This effect shows up dramatically in customer use of servers, the brains of today's data centers. As servers have evolved, many customers have kept certain functions running on single servers, and in the process accumulated a collection of servers, many older and less efficient, each running at only part of its capacity. But with today's hardware-software integration capabilities, IT functions can be loaded onto various servers in a more intelligent fashion, using the concept of "virtualization," which puts more computing operations onto fewer servers.

Virtualization allows more optimal loading of server capacity, running many fewer servers to meet total enterprise needs. This saves energy, and server capacity, reducing both hardware and operating costs. In its ultimate form, virtualization merges into the "cloud computing" realm, where data is no longer stored on specific hard drives or servers, but on an Internet-based storage network spread over data centers worldwide. By reducing the number of physical storage devices and increasing utilization of high-efficiency data centers, this approach can continue to increase the energy efficiency of personal computers and larger IT systems alike.

IBM markets advanced data center solutions across many markets: a recent TV advertising campaign shows hard-nosed corporate executives seeing animated birds and flowers after they are told that this kind of solution can cut their energy costs up to 40 percent. In these product and service offerings, it is possible to detect some of the same core principles IBM applies to its internal energy conservation strategy: make the system more intelligent by collecting the right information from the right points in the system; scale energy use to only the amount needed to support the work; and apply technology as part of larger, integrated solutions.

Supply Chain

In 2008, IBM's Global Procurement spend was $38.5 billion. The company's supply chain is one of the world's largest and most complex, consisting of more than 30,000 supplier locations spread out over more than 60 countries. Supply chain management is part of IBM's Corporate Responsibility program. IBM tracks environmental performance of its suppliers and regularly audits suppliers against its supply chain principles.

IBM's production supplier base has shrunk in relative terms as the company's business mix continues to transform to include not only manufactured products but increasingly software and service solutions. But the company continues to be a supplier of electronic components to other manufacturers and sells computer servers, storage products and retail solution products. Because it recognizes its ability to influence supplier performance, IBM has been active in developing the electronics industry's supply chain sustainability practices. These efforts are channeled through the Electronics Industry Citizenship Coalition (EICC). Along with other major component and product manufacturers, IBM has invested substantial time and resources in co-developing and adhering to the EICC's Code of Conduct.

The EICC Code of Conduct covers a wide range of social and environmental responsibilities, including energy efficiency. IBM employees participate in EICC's Environmental Sustainability Working Group (ESWG), which is working to establish specific supplier environmental review items or metrics. The group's first assignment resulted in development of the EICC carbon reporting system launched in June 2009. This is an on-line, packaged system through which Tier 1 (or direct) suppliers can disclose their GHG emissions inventory for use by all EICC companies who purchase from that supplier. The intent is to create a system in which suppliers can provide their data once in a standard format for use by its full set of customers. Each company using the system will ask its Tier 1 suppliers, the direct suppliers to that company, to disclose their enterprise level GHG emissions inventory. These "Tier 1" suppliers are then asked to reach out to their direct suppliers to also disclose their inventories through the system. The system is also capable of collecting information down to the facility level. EICC members are not requiring more detailed disclosure at this time, but the energy and GHG emissions reporting system creates a framework in which additional data could be disclosed in the future.

IBM has also surveyed its Tier 1 suppliers in 2008 and 2009 as a participant in the Carbon Disclosure Project's (CDP) Supply Chain Project. In 2009, IBM invited over 120 of its major suppliers, representing 80 percent of its expenditures with production-related suppliers and 30 percent of spending with services/other suppliers, to respond to the CDP Questionnaire. IBM got a 73 percent response rate, up from 63 percent the year before. IBM wanted to work with critical suppliers to understand their operational impacts and assess where they are with GHG emission inventories and reduction plans. The survey responses for the 2008 year showed that about one-third of production suppliers had reduction plans, and about one-half of non-production suppliers had plans.

Conclusions

As a leader in the 21st-century information economy, IBM has used information tools to drive its efforts in environmental management, including energy efficiency. Some of these innovations, especially in data centers and other IT operations, have enabled IBM to develop solutions to help its clients improve their operations and environmental and energy performance. Part of the company's Smarter Planet campaign relates to resource conservation in areas like energy, water and environmental performance improvement. Like other companies in this study, IBM also found out that people are as important as technology in an effective efficiency strategy. Even in its highest-tech clean room semiconductor manufacturing, some of the largest energy savings came from collaborating with people inside the operation, evaluating and pursuing opportunities, and adjusting energy systems based on actual operational needs. The energy team also found that people responded with surprising enthusiasm to the energy savings effort, and in many cases came up with innovative technology and operating ideas that not only saved energy, but also improved productivity and morale.

Key lessons learned from IBM's energy efficiency successes include:

- Encouraging outside the box thinking on energy efficiency can lead to unforeseen business benefits. In IBM's case, energy efficiency served as a flashlight that led engineers and others to reevaluate existing processes and make improvements that not only saved energy but also led to production and quality improvements.
- Leverage internal energy efficiency expertise to exploit new business opportunities. IBM's success in reducing energy use in its own data centers helped put it in a position to offer new products and services to clients seeking similar results.
- Take advantage of the fact that energy use is something that all your employees have some influence over. Employees have shown themselves willing to rally around energy efficiency as a way to solve problems and be a part of something bigger than what their specific job description calls for. Efficiency can also act as a strong social glue within the corporation, and lead to improved employee morale and greater worker retention.

CASE STUDY

Toyota Motor Engineering & Manufacturing North America, Inc. Internal Operations	
Headquarters:	Erlanger, KY
President/COO:	Tetsuo Agata
Revenues (2008):	$94 billion
Energy Costs (2008):	$155 million
Energy Savings Target:	29 percent reduction in energy consumption per vehicle produced. Goal set in 2002 to be achieved by 2011.
Key Efficiency Strategy Successes:	• Engaging people across multiple levels and job functions to implement the energy efficiency strategy and sustain results; • Moving beyond supplying energy efficiently to production shops, to engaging shop staff in rethinking operating practices to drive down energy needs.

Toyota-TMMK—Internal Operations

On a wall in an open bay in the middle of the Toyota Motor Manufacturing Kentucky (TMMK) plant hangs a mockup of a NASCAR racetrack. Instead of mile-markers, the track is marked off in months. To its magnetic surfaces cling model cars, most—but not all—Toyotas. Taped on top of each car is a tiny face—the shop captains from Paint, Assembly, Power Train, Body Welding… 10 in all. In the pit area at the center of the track are pictures of each shop's "pit crews."

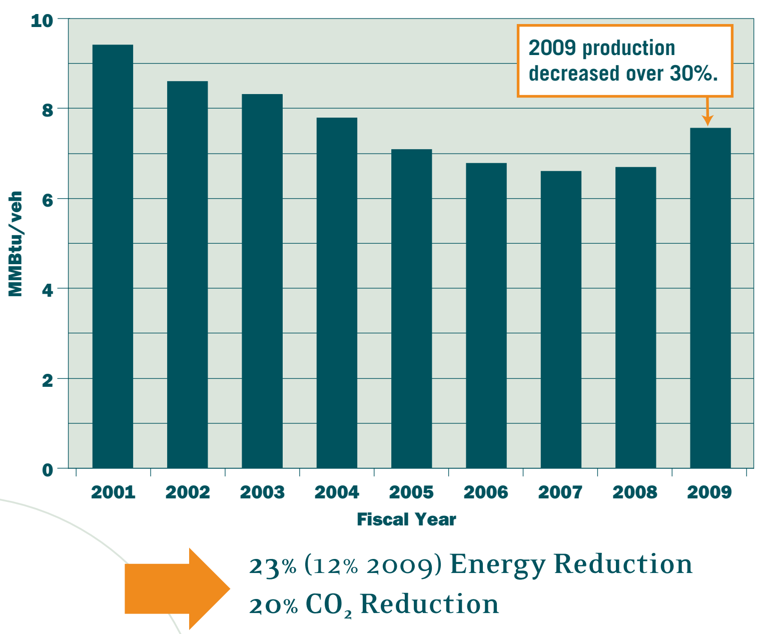
On a Wednesday morning in July, some 40 people gather in front of the magnetic track-board, from TMMK President Steve St. Angelo to the site's Energy Management Organization (EMO) lead, Roger Wallin, to shop captains and other team members. This meeting marks the start of the 2009 "Race for the Greenest." Roger places the tiny cars in order on the track-board, based on the points they earned in the previous month and year to date from energy, water, compressed air, and steam efficiency. Now in its third year, this friendly competition (earlier years used a horse-racing theme called "Greenland Stakes," based on the nearby Keeneland racetrack) not only gets good attendance, it appears to be getting results. TMMK beat the Toyota goal of using less than 6.3 million British Thermal Units (BTUs) per vehicle produced, having driven its usage down below six million.

The Race for the Greenest competition epitomizes Toyota's energy efficiency strategy. Energy is a key performance indicator that is measured and reported regularly, and the process engages the whole organization, from senior management to individual shop staff. But beyond the mechanics of the process, energy performance is part of the company's culture. There's a certain amount of fun that is palpable in these monthly gatherings: so it's not just about numbers, it's about how people see themselves, what they take pride in, what they hold to be important. Imposing new requirements on employees in an organization is not something that is always embraced with open arms; but at Toyota, the Race for the Greenest reveals a culture that is not only about performance by the numbers, but also about engaging people's pride and ingenuity for collective gain.

Energy as a formal performance indicator was first measured in Toyota North American operations in 1996, around the time that the Toyota Motor Engineering and Manufacturing North America (TEMA) corporate structure was formalized. In 2000, Toyota used over 9 Million BTUs per vehicle produced. The 6.3 million BTU target represents about a 30 percent improvement. Originally set in 2002 to be achieved in 2011, TEMA was close to realizing its goal in 2007, as shown in **Figure 1**. Since then, production slowdowns driven by the global recession have caused the per-vehicle number to creep up, as some energy uses cannot be throttled back in proportion to production. To illustrate the production slowdowns, in 2007, TMMK made over 500,000 vehicles; in 2009, it expects to make about 366,000.

Figure 1

North America **Energy Consumption** Per Unit



Recreated based on image provided courtesy of Toyota (2009).

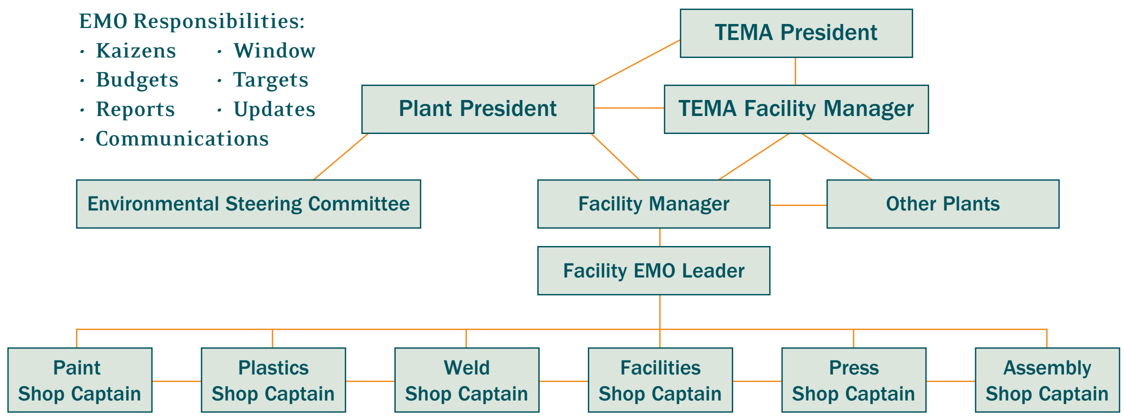
"Race for the Greenest" also shows a critical link in the Toyota EMO—between the facilities staff and the production teams. In a large manufacturing organization like Toyota, facilities is a service organization to the product units; it provides them the electricity, compressed air, steam, chilled water, natural gas and other services they need to produce quality products. But the facilities team does not own, and is careful not to dictate, how the product units or "shops" run their operations. The production shops—assembly, paint, welding, stamping, etc.—have two primary mandates: (1) product quality and (2) production volume. Shop captains don't easily embrace ideas that might put either of these goals at risk. They need to be shown that meeting the energy and other Key Performance Indicators (KPIs) will help them, not hinder them, in meeting their quality and production goals.

The EMO has found that one way to overcome production shops' reluctance is through the use of pilot projects. EMO will commission one small project in one plant, document its success, and then engage the production staff in sharing their experience with others in the company. Peers from other shops and other plants inherently bring a greater comfort level to their counterparts than do facilities staff seeking to advance the EMO goals.

At TMMK, the magnetic board for "Race for the Greenest" covers only one wall of the meeting bay. The other two are covered with tables and charts showing the shops' KPI data. These walls, each perhaps 25 feet long, show how data-intensively Toyota's energy and other resources are managed. Charts like these seem to be posted everywhere at TMMK—in the production shops, facilities offices, and the power plant. They convey how visible these KPIs are to everyone who works there.

Figure 2

TEMA Energy Management **Organization**



Company Wide Energy Program

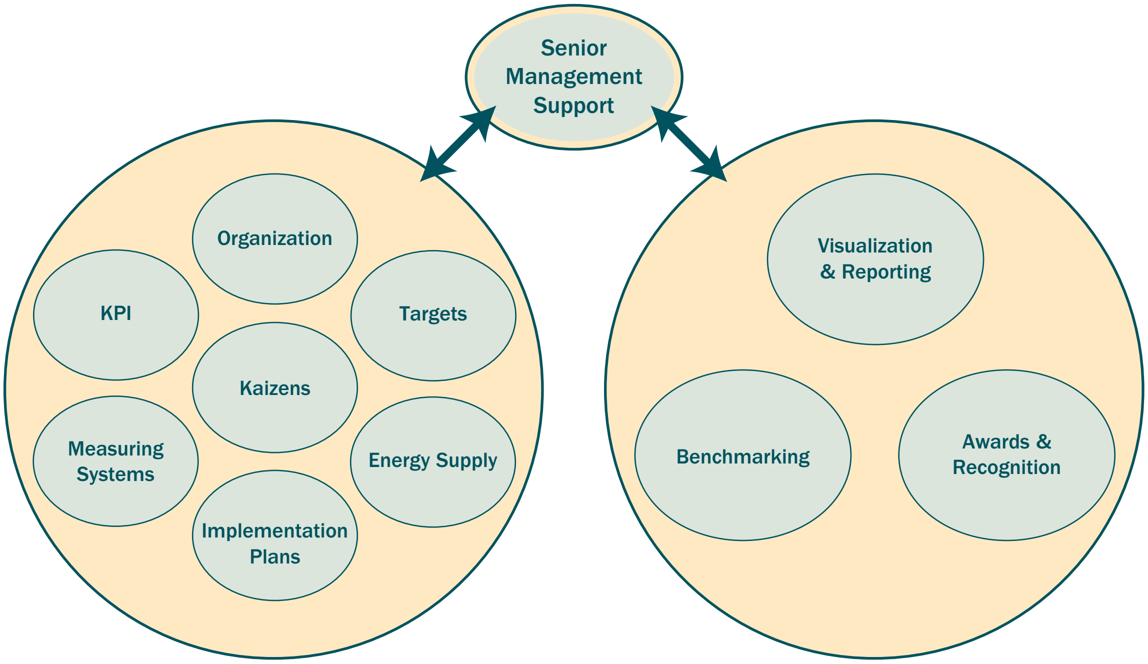
Recreated based on image provided courtesy of Toyota (2009).

Figure 2 charts the EMO's relationships in North America, from the President of TEMA to the individual production shops at each TEMA facility. The term "Kaizens" in this figure refers both to Toyota's overall Kaizen philosophy and to the practical application of the term as a database of efficiency technology information.[1]

Figure 3 elaborates on the EMO's several roles in supporting the various elements of the energy program. Reporting to and receiving support from senior management, the EMO focuses on the six internal activities on the left side of the figure, from KPIs to target-setting. It also maintains the three more outward-facing activities on the right side—creating visually-interesting reports for senior management, benchmarking performance against competitors and third party programs, and pursuing awards and recognition, both inside the organization and with third-party programs like ENERGY STAR.

Figure 3

TEMA Energy Program **Key Elements**



Recreated based on image provided courtesy of Toyota (2009).

1 The Japanese term *kaizen* means "improvement." Within Toyota, it describes a philosophy as well as specific practices aimed at continuous improvement in manufacturing, business in general, and even life overall. In the workplace, kaizen typically refers to activities that continually improve any or all functions of a business, from manufacturing to management and from senior management to shop-floor workers. By improving and standardizing various practices, technologies, and processes, kaizen aims above all to eliminate waste.

Like other successful energy management programs, Toyota's EMO maintains a monthly/quarterly/annual data collection and reporting system, and an accountability system that operates at all levels, from individual shops to senior executives. **Figure 4** illustrates a typical graphic from such a report, though the full reports contain a multitude of tables and graphs.

What sets large manufacturers like TMMK apart from the average company, however, is the added levels of data monitoring they apply to their operations. TMMK staffer Bill Pulliam manages the plant's Enterprise Building Integrator (EBI) software, through which he can monitor up to 30,000 data points in the 1,300-acre complex. EBI enables him to look deeply into HVAC units, individual shop equipment, and other operations. EBI can generate very detailed reports, with data measured down to one-minute intervals or less, for individual units or shops, so shop captains can diagnose issues as needed. Shop captains pay attention to this information because they must meet specific KPI targets, and if their weekly or monthly reports deviate from those targets, they will often follow up with facilities staff for data and assistance. For example, Roger Wallin highlighted an email from a shop captain, asking for a weekly report on six HVAC units in that captain's shop. Pulliam can access this system from home, and can even manage some units remotely. On the Friday morning of a July 4th weekend, he logged in to be sure the main HVAC units were shut down as planned. Sure enough, the data curves for that long weekend stayed flat.

The NASCAR racetrack imagery in "Race for the Greenest" also shows how TMMK has adapted the Toyota kaizen philosophy in its own uniquely American way. As a practical tool, kaizens are specific proposals, entered into standard forms and loaded into an enterprise-wide database. Individuals are encouraged to develop and submit kaizen ideas into this system, and the database is available to Toyota worldwide to share these innovations throughout the company.

Figure 4

Recreated based on image provided courtesy of Toyota (2009).

Ultimately, it is the sum of Kaizen ideas developed in each facility that drives future goal setting. Both operations changes, and capital investment recommendations, are summed and translated into energy use and cost per vehicle, and the summed potential savings are applied to future years' energy savings targets (see the Pew project web site[2] for examples of Toyota's Kaizen reports).

Facilities staff work as hard as production shops to drive down energy usage and costs. Historically, they focused on running utility plants, in separate buildings from production units, and piping steam, compressed air, and chilled water to the various shops through miles of pipes. Facilities staff and equipment systems were physically and organizationally somewhat distant from production. But as the company's energy goals per vehicle pushed both facilities and production staff to rethink their ways, this pattern changed. Facilities staff began finding ways to bring energy supplies closer to production units. Rather than generating steam in a bank of huge boilers, and piping high-pressure steam for long distances, with all the attendant losses at each step of this process, facilities staff began placing smaller, hot water boilers at production unit locations. This saves energy first by allowing lower temperature and pressure in the system, second by eliminating the step-down losses from running high-pressure steam through pressure reducing valves to serve process loads, and third by eliminating the thermal losses from long pipe runs across the plant. At TMMK, facilities staff have reduced central boiler needs from six units to two, and plan to shut down these remaining units soon.

The other way that TMMK reduces steam demand is through reducing heating loads, and through heat recovery, in the paint shop operations. The easiest step was to experiment with elimination of the first water rinse tank through which the auto bodies pass to remove surface dirt. After being satisfied that unheated water worked just as well for this step, the next target was heat recovery. The paint shops are the biggest energy users in the plant partly because they must incinerate exhaust air to burn off the hydrocarbons and other residues of the painting process. This produces 640-degree air; by applying heat exchangers, TMMK staff was able to recover a large fraction of this heat and pump it back into the steam loop. This first reduced loads on the boiler system and made localized hot water units more efficient.

But the most overlooked energy use at Toyota, as is the case in many manufacturing operations, was compressed air. Steam boilers, cooling systems, electric motors, and sometimes lighting have typically received the greatest focus in most efficiency programs. This has changed as efficiency programs look harder into all aspects

2 http://www.pewclimate.org/energy-efficiency.

of plant operations. Such examinations quickly show that compressed air runs many of the assembly and other production tools, keeping electricity and fuels away from critical production steps, where a spark or a gas leak could be a health and safety risk, not to mention the risk of stopping the production line. TMMK generates compressed air at the central utilities plant through a bank of huge compressors. Facilities staff save energy by replacing compressors as funds and opportunities permit. Their most recent Atlas-Copco compressor saves 25 percent or more energy than its predecessor, paying for itself well within the company's three-year payback guideline. But it is also quieter and maintains pressure more reliably than earlier generations.

The view from the utilities plant compressor control booth shows another way that TMMK saves compressed air energy. As the first shift goes to lunch at 11:30 a.m., the compressor load drops like a rock, falling 40 percent in a matter of minutes. In the past, this would not have happened; but facilities worked with production staff on a shutdown routine that takes air tools offline during lunches, breaks, nights, and weekends. The practice in the past had been to leave tools on, partly because shop-level staff were not aware of the energy needed to keep the system pressurized even when tools were not in active use, and partly because there was a perception of performance risk in shutting off and restarting tools. Facilities staff worked with shop captains to show them the energy impacts of leaving tools on, and to reassure workers that the reliability of the tools would not be compromised and that restart times would not be a problem. In addition, production crews and facilities staff alike watch religiously for air leaks, the Achilles heel of compressed air systems. Leaks are inspected and repaired regularly, and it is the KPI reporting system that allows staff to see when compressor energy use is drifting up, triggering a deeper look.

TMMK's management of compressed air energy use is emblematic of the way Toyota implements its energy efficiency strategy company-wide. One of the most effective methods the EMO uses to drive operational improvements in plants is to conduct unannounced "Treasure Hunts" that seek low-cost efficiency opportunities. A departure from the "energy audit" terminology of traditional energy management, "Treasure Hunts" connotes opportunity, with a hint of fun, as distinct from the compliance-based implications of the word "audit." In a typical Toyota Treasure Hunt, a team of energy experts from other facilities visits a plant, with their presence known in advance only to senior managers. The Hunt typically starts on a Sunday, and focuses primarily on finding equipment that is left on and other operational improvements. The team then observes the first shift on Monday, compares its practices with the second Monday shift, prepares a report, and presents it to plant leadership and shop captains on Tuesday. Because the Treasure Hunt team is composed of Toyota peers, its findings tend to bear weight, and with senior management hearing the recommendations, they tend to get implemented. The final report is reviewed by the plant, action items are prioritized, and then the kaizens are scheduled for implementation based on resources. These activities are then followed up, confirmed and best practices are shared with other plants.

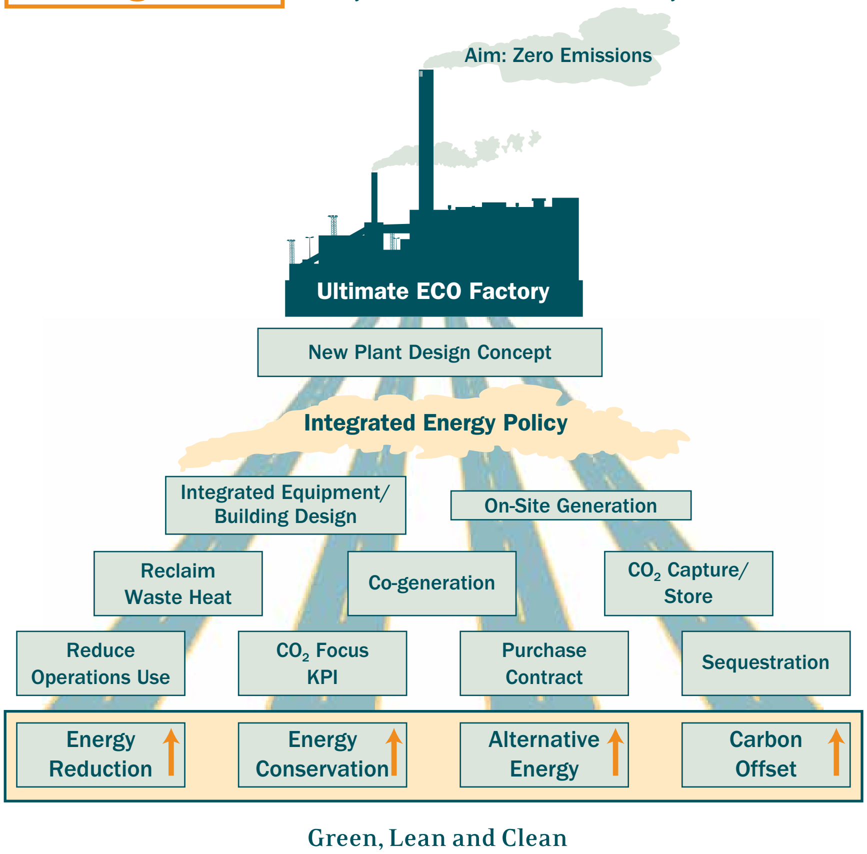
The summary effect of TMMK's management systems, investments and practices won it membership in the U.S. EPA National Environmental Performance Track program (recently phased out), which was designed to recognize and drive environmental excellence by encouraging facilities with strong environmental records to go above and beyond their legal requirements. TMMK qualified because of the company's past achievements, continuous commitment to environmental compliance, and implementation of a strong Environmental Management System. Admission into the Performance Track program was selective, based on a company's history of environmental excellence. TMMK was one of only seven facilities in Kentucky to achieve Performance Track acceptance, and was one of four Toyota plants in North America to be accepted into program. Toyota has also won EPA ENERGY STAR Partner of the Year award and individual plant awards several years running, qualifying it for a Sustained Excellence Award for 4 consecutive years.

While the EMO's day to day work is intensely focused on running existing equipment at peak efficiency, eliminating waste, and looking for individual Kaizen opportunities, the company also has a larger vision. The Toyota plant of the future will be a zero-emission facility. Although none yet exist, elements do, as illustrated in **Figure 5**. The intent is to minimize emissions at all plants. Current energy efficiency activities are shown in the green boxes, along with broader carbon emissions strategies like buying carbon offsets or sequestering carbon. Moving "down the road" toward the Ultimate Eco Factory, Toyota envisions designing advanced energy efficiency with supply strategies like onsite renewable energy and combined heat and power (or cogeneration) systems. If the company can drive down its energy needs to a minimum, purchase or generate non-emitting energy supplies, and use other strategies to offset any remaining carbon emissions, it can reach the goal of a zero-emission factory.

For example, Toyota is committed to buying or making renewable energy. However, the business case must still be made. TEMA's EMO has looked at innovative solar photovoltaic financing structures, which can bring the effective cost of solar power down to 14 cents per kilowatt hour. However, at TMMK, electricity can be purchased from the grid at a much lower cost, so the solar Kaizen will have to wait until those two cost curves are more realistic. TEMA's new Mississippi plant, temporarily mothballed until the auto market recovers, is planned to incorporate several of these elements.

Figure 5

Building Blocks to Toyota's Ultimate ECO Factory



Recreated based on image provided courtesy of Toyota (2009).

Increasing use of renewables is just one of Toyota's challenges. Any large investment is hard to justify in the current economy, making some of the more capital-intensive kaizen ideas harder to bring on line. Major production technology changes also fall in this category: reducing carbon emissions in energy markets that do not reflect carbon prices is another ongoing challenge. If future climate policies drive up electricity prices in U.S. power markets as many expect, for example, this would help justify solar and other higher-cost items. But until those prices become real, it is hard to justify the capital cost in an extremely competitive consumer market and a soft economy.

Conclusions

Toyota has developed one of the world's most thorough and integrated energy efficiency strategies, building on its cultural as well as technical assets. Culturally, the Kaizen philosophy helped engage individuals across many levels of management and many functional units in the common cause of driving down energy waste. This application of individual responsibility in service of collective goals has helped the program establish itself within the organization quickly, and increased the likelihood of sustained success. As people take ownership of the goals and the practices needed to reach them, the efficiency strategy becomes part of the company culture. Technically, Toyota's strong engineering talent was able to tap its physical assets to support the strategy. Toyota plants have very fine-grained data monitoring and reporting systems that enable staff to pinpoint performance issues down to individual shop and equipment levels. Years of engineering experience have produced Kaizen project information in the company database, making its technical knowledge available across the organization. And the company's "Treasure Hunt" practice of bringing in experts from peer facilities to examine improvement options at other plants keeps plant staff on their toes, and increases the credibility of the findings, coming as they do from Toyota peers. The success that flows from these efforts is recognized and reinforced regularly at the highest levels, as evidenced by the plant president coming to monthly Race for the Greenest festivities.

Key lessons learned from Toyota's energy efficiency successes include:

- Work hard to make your Kaizens permanent. Temporary improvements are of limited value. Remove old methods, equipments, and processes after improved versions are developed.
- Look at new technologies and try to build them into the design and production process. Pilot projects can be helpful in demonstrating success and overcoming resistance from production staff and others more focused on product quality and volume.
- You can never report too much information. At the same time, it is important to recognize that different company officials will require different types of information. A deluge of data can be costly and cumbersome to sift through, especially for senior managers with limited amounts of time on their hands. Toyota goes to great lengths to gather and report vast amounts of data, but equally important is the effort the company puts into rolling this data up into more streamlined reports that senior management can easily digest and act upon.
- Awards and recognition—both internal and external—are important. These have the effect of motivating facility staff to go beyond strict compliance with environmental laws and regulations and instead reach for a higher level of energy efficiency and sustainability.

CASE STUDY

PepsiCo Supply Chain	
Headquarters:	Purchase, NY
CEO:	Indra K. Nooyi
Revenues (2008):	$43.25 billion
Energy Costs (2007):	$1.1 billion
Energy Savings Target:	Company-wide targets are for 2015 using a 2006 baseline: • Electricity—20 percent • Fuel—25 percent • Water—20 percent
Key Efficiency Strategy Successes:	• Reducing carbon dioxide (CO_2) emissions per unit of production 4.5 percent over the two-year period covering 2006–2008, avoiding 170,000 metric tons of CO_2 equivalents, and saving about $100 million in avoided costs. Since inception of its energy efficiency program in 1999, Frito-Lay manufacturing has cut energy intensity by 36 percent; • Using energy efficiency goals to drive innovation in reducing other resource consumption, especially water, and in improving productivity across many facets of company and supplier operations; • Engaging major suppliers in performance measurement system, goal setting, resource conservation and other sustainability initiatives; • Utilizing lifecycle carbon footprint analyses of products to drive both energy efficiency goals and supply chain engagement.

PepsiCo Overview

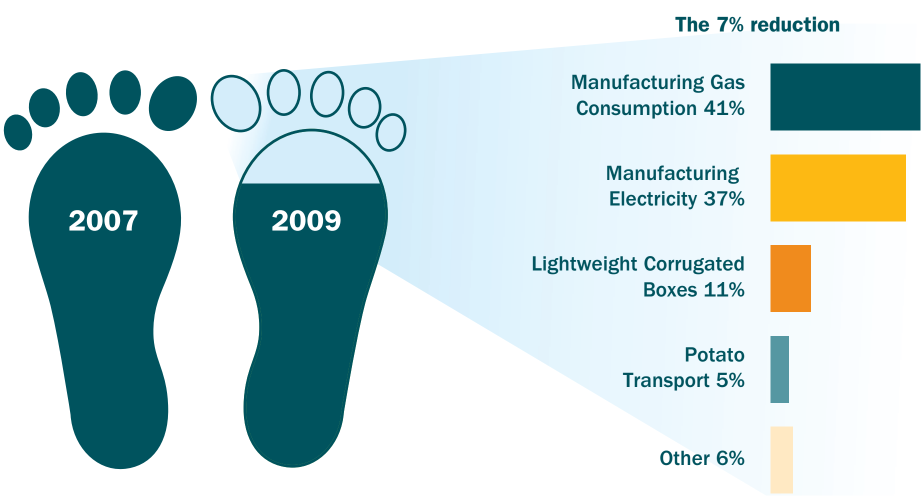
Sustainability leaders at PepsiCo have known conceptually for some time that the company's supply chain energy and carbon footprint was large. But their initial energy and carbon efforts were almost all internally focused—partly because internal operations are the easiest to measure and to affect, and partly because they felt it was necessary first to demonstrate the company's commitment to environmental sustainability before asking suppliers for similar efforts.

As is true for most companies, energy is not a big cost factor for PepsiCo, accounting for less than three percent of revenues. What has made energy a priority driving innovation across the organization is that it accounts for most of the company's enterprise carbon footprint. As revealed by PepsiCo's carbon footprint analyses, energy use shifted from a minor operating cost to a major environmental focus. And because energy is a pervasive supply element throughout the company, looking for energy efficiency improvements has paid large dividends by uncovering a wealth of productivity, operational improvement, and other innovations that produce returns far beyond just cost savings.

As the company's efforts to determine its product-level carbon footprint progressed, it quickly became apparent that the majority of PepsiCo's footprint falls outside its own operations, primarily in its upstream supply chains. This was first demonstrated in 2005 when, in partnership with the University of Bath and the Carbon Trust, PepsiCo UK and Ireland completed the Walkers Crisps carbon footprint analysis—PepsiCo's first detailed, life-cycle assessment-style analysis of a product from field to store, to post-consumer. The study showed that only about 30 percent of the Walkers product carbon footprint came from the manufacturing. In 2007, Walkers and the Carbon Trust published the results of a much-updated assessment on product packaging; the world's first on-pack use of the Carbon Trust Reduction Label. In 2009, Walkers became the first brand to meet the reduction commitment, having driven a seven percent reduction in lifecycle carbon emissions per pack. **Figure 1** is a breakdown of the seven percent per pack emissions reduction.

Figure 1

Walkers Crisps' Lifecycle **Carbon Footprint Analysis**



Recreated from image provided courtesy PepsiCo (2009).

As the company ramped up its supply-chain focus in response to this realization, it faced two key issues: (1) PepsiCo needed to demonstrate its ability to reduce its internal operations footprint, both to be credible and to offer concrete solutions to its suppliers; and (2) the company needed to broaden its resource focus beyond energy, especially to include water. Fortunately, the company had built a strong core of energy efficiency expertise, especially in the Frito Lay snack food operations.

The Energy-Water Connection

Like energy, water is not a big cost issue for PepsiCo companies, but it is a critical supply chain issue. It is not hard to grasp that a large percentage of the beverage brands' makeup is water; but the food products also use large amounts of water, in crop irrigation, washing, cooking, and other processing steps. Energy and water are linked in another sense by the fact that the company, and its water utility suppliers, use lots of energy to pump, purify, heat, and clean the water that flows through its many operations.

Water availability is a very real and present challenge for some PepsiCo operations, where drought or other conditions limit supplies. As one company employee puts it: "no water, no product." For example, the recent southeastern U.S. drought led Georgia's Governor to call for a 10 percent reduction in water use. This forced the Atlanta Gatorade plant to focus on reducing water use, which also spurred energy efficiency improvements. Some of the steps taken by the Atlanta plant include the introduction of dry lubrication of bottle conveyors and elimination of in-line post fill bottle washers. In addition, the plant established green teams to flag wasteful practices, and held daily plant floor resource use review meetings. Today, that plant is used as a best-practices teaching example companywide. And there can be larger political water-related risks: in some countries, keeping a license to operate for a company like PepsiCo can depend on demonstrating stewardship of local resources.

The Southeastern drought points out another water-energy nexus: because electric power plants draw their cooling water from the same watersheds that serve agricultural and industrial needs, every kilowatt hour saved through electric efficiency reduces cooling water withdrawals. And every gallon of water saved at the Gatorade plant reduces the energy needed for pumping, cooking and other uses, so the efficiency efforts are symbiotic.

Energy and water also each bear significant climate change risks for PepsiCo. The company expects energy costs to rise with carbon prices and fossil fuel depletion, and is already seeing climate-related chronic drought affect its supply chain in several parts of the globe. Reducing energy use in this context is both a cost reduction and a climate mitigation strategy, and water efficiency reduces costs while supporting PepsiCo's climate adaptation strategy.

PepsiCo also views energy, water and related sustainability performance indicators as reputational issues. Especially during economic downturns, sales of the beverages and snack foods PepsiCo sells can suffer along with other discretionary purchases. Anything the company can do to demonstrate its sustainability and corporate responsibility commitments can help maintain customer loyalty.

Building the Core Efficiency Strategy in Internal Operations

PepsiCo's energy and water efficiency efforts date back to the early 1990s, at Frito-Lay, when volunteer Green Teams began. While these efforts were initially driven by environmental compliance, once they opened the lid on the operational and technology issues, Green Teams found themselves digging into ideas for reducing costs and otherwise "greening up" company operations. In 1999, these efforts were formalized into the Frito-Lay Energy Department, and later became a model for the PepsiCo corporation-wide effort.

Then-CEO Steve Reinemund organized the Sustainability Task Force in 2004 as PepsiCo's global organization. The Environmental Sustainability Leadership Team (ESLT) has since been formalized to focus primarily on water, energy and packaging issues.[1] The ESLT's biggest initial challenges included:

1. What metrics to track;
2. How best to measure them; and
3. What performance targets to set.

Leaders also realized that while their supply chain was the ultimate target for their sustainability efforts, they first had to establish reporting, targeting, and best-practice technology and operations internally, both to show PepsiCo's leadership commitment, and to develop the practical tools they would need to offer suppliers.

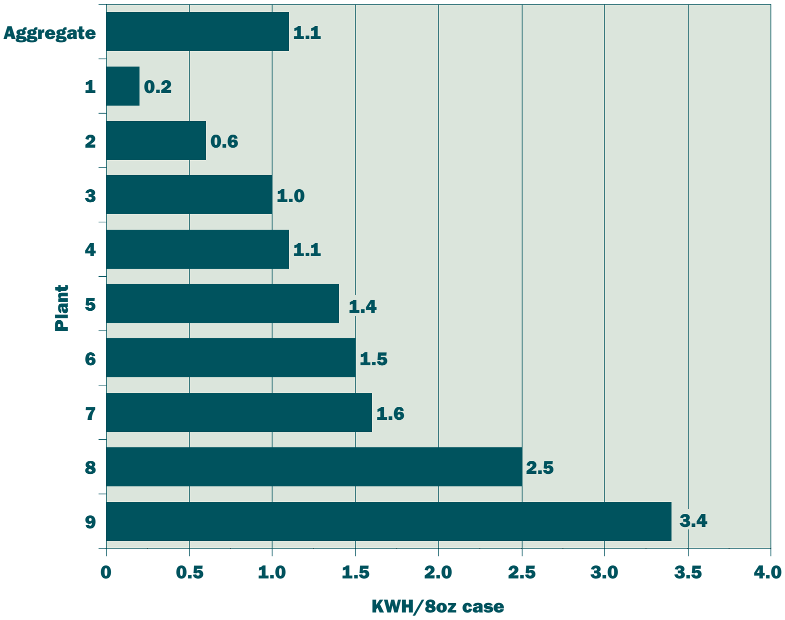
Targets and Measurement

Developing an enterprise-wide system for tracking and reporting energy, water, and other key indicator data was a core element of the sustainability program. After years of effort, the company's Measure Up tracking and reporting system developed into an online platform for company facilities as well as selected suppliers to report data and retrieve information. The Measure Up system can generate and show numerous report types for individual plants as well as higher aggregations. **Figure 2** is an example of one of the higher-level aggregations produced by the

1 While raw materials and manufacturing account for the great majority of the product footprint, packaging accounts for more than 10 percent of the total, and is also very visible to the consumer, especially as a disposal/recycling issue.

Figure 2

PepsiCo's 'Measure Up' Energy Performance **Tracking System**



Recreated from image provided courtesy of PepsiCo (2009).

Measure Up system. It shows energy performance (on a kilowatt hour per package basis) for nine different plants that all produce similar products. Note the significant disparity in energy performance among the plants; the system allows managers to quickly identify this disparity and take necessary corrective action.

The sustainability team did not shy away from goal-setting. They embraced the challenge, terming the targets Big Hairy Audacious Goals (known as BHAGs; this concept came from the James Collins book *Built to Last*[2]). BHAGs were partly based on experience from Frito-Lay's efforts and other limited analyses, but were intentionally set as stretch goals, meaning that not every step needed to reach them was known in advance. PepsiCo leadership believed that setting "stretch" goals like this was important to force creativity and innovation across the company, as *Built to Last* and other books in the corporate-excellence literature suggest. Company-wide reduction targets were set for 2015 using a 2006 baseline:

- Electricity—20 percent
- Fuel—25 percent
- Water—20 percent

2 Collins, James. 2004. *Built to Last: Successful Habits of Visionary Companies.* HarperBusiness.

So far, PepsiCo has made significant progress toward these goals, racking up more than $60 million in savings since 2000, realizing better than a 20 percent internal rate of return. Examples of energy saving steps taken include:

- **Tortilla chip baking.** In Frito-Lay's tortilla chip baking operation, the company started by installing damper draft controls on the ovens. This not only reduced heat loss, it also improved the evenness of heat distribution, which improved the quality of the chips. The sustainability team then added heat recovery technology, further reducing energy use, and also increasing total throughput. So energy efficiency not only reduced costs, but also improved product quality and total production. In the past, production staff focused only on production and quality, and with energy staff not engaged in the process, efficiency was assumed to compromise these key goals. But since setting company-wide energy and water savings goals, production staff were forced to look at these resources across their operations. The result has been a reversal of the past pattern; energy/water efficiency is helping drive production and quality improvements.
- **Total energy and water strategies.** At the company's Casa Grande, AZ facility, the first-generation sustainability action was to treat wastewater and apply it to adjoining croplands to grow alfalfa. The next wave is to upgrade treatment to the point that water can be reused for plant supplies, freeing up the cropland for higher-value use in the form of renewable energy production. In a dry climate like Arizona, water supply is not only expensive, it is uncertain in the face of long-term drought and continued development. So this multi-wave strategy went far beyond cost reduction; it helped reduce supply risks for water and energy.

Financing Efficiency and Other Sustainability Projects

PepsiCo takes an innovative approach to quantifying and funding energy and water efficiency projects. It applies a basic payback criterion as a standard method. But beyond that, the company applies other filters to project evaluation processes to support energy and water sustainability efforts:

- Two percent of the company's capital budget is targeted to a Sustainability Investment Fund (SIF), creating a defined source of funds for sustainability projects. Projects funded by the SIF include a "waste-to-value" project in Turkey that converts organic waste to fertilizer and biogas, leading to 1,350 megawatt hours (MWH) of electricity generation and 550 MWH of heat recovery per year.

- Every PepsiCo investment project of $5 million or greater is subject to a sustainability screening, which evaluates whether the project contributes to or inhibits progress toward sustainability goals. This screen catches projects with attractive conventional returns but significant environmental risks before they move forward, and can lead to project modifications that incorporate energy and water efficiency features.
- PepsiCo takes risk assessment into account in its sustainability investments. Where projects reduce risk of production interruption, be it from water supply shortages or equipment failure, those factors will advantage a project. As the company has gone through rounds of project implementation and best-practice sharing, it has gained a growing understanding of how energy and water efficiency improvements boost total productivity, and hedge against future energy and water price or supply problems.

Thinking Outside the Energy Box

PepsiCo sustainability team members report that one of the biggest breakthroughs in developing and then working to implement the sustainability goals was to "think outside the energy box." In the "old days," energy management in many companies, PepsiCo included, was a narrow set of efforts focused only on equipment or systems that were solely seen as providing energy for plant or building operations: boilers to produce steam or hot water, lighting systems, cooling equipment, etc. The task for energy managers in the old days was to make those energy systems efficient, on an incremental basis, but to leave other aspects of plant operations alone. So, for example, the boiler operator's job was to tune up the boiler, insulate steam pipes, maintain steam traps, but first and foremost to deliver steam to the process at the volume, temperature and pressure required.

In the "old days," energy managers typically were not allowed to look outside energy systems into production processes or other core operations. But in PepsiCo's case, the aggressiveness of its BHAG targets quickly led the sustainability team to realize that they could not reach the goals without "touching the process," or reassessing the entire range of resource, technology, and operational aspects. Once the team understood this, "thinking outside the energy box" became an accepted norm.

Getting out of the energy box led the sustainability teams to ask more fundamental questions, like: "do we really need that much steam, at that high a temperature and pressure, to cook the product?" This is an expanded mindset that looks first at the intended outcome of the job, and then seeks to identify the most resource-efficient way to accomplish it. This "paradigm shift" has been recognized by leading energy efficiency strategists as key to changing energy efficiency strategies from small, incremental efforts to large, transformative forces that drive change across the organization.[3] In this new paradigm, energy managers ask not "how much can we save?" but rather "what's the minimum energy needed to accomplish this job?"

In PepsiCo's case, this new approach led to larger and more game-changing solutions than would have occurred in the old incremental-energy-savings mindset: for example, when asked what it takes to cook corn for a particular product, Frito-Lay staff found that the job could be done with 30 percent less water and 45 percent less energy, saving money through reduced energy and chemical costs needed to treat wastewater. This approach has spread across the company, driving much greater savings than would have occurred if the older, narrower view of energy efficiency had prevailed.

To support this kind of thinking, PepsiCo has held sustainability summits, including a 2009 event that brought some 400 employees from 14 countries to Chicago for four days. Workshops were held on all manner of topics, from heat recovery to water recycling, with both internal engineering staff and selected outside experts leading the workshops. This process, known in the company as "plants teaching plants," leans heavily on peer interaction. Using both in-person meetings like the summits as well as conference call/webinars, electronic forums, and internal project databases, the ESLT has been able to engage large numbers or people across the various business units.

Moving the Energy Efficiency Strategy Out to Suppliers

PepsiCo has taken the Walkers life cycle analysis model to other branded products. When Neil Campbell, whose division commissioned the Walkers study, moved to Tropicana in 2008, he launched a similar study of Tropicana orange juice, with company staff working again in partnership with the Carbon Trust. After a few rounds of analysis, staff were surprised at the size of the orange-growing share of the footprint, based largely on the natural gas used in producing the fertilizer for the trees. In 2009, PepsiCo began publishing carbon footprint numbers on its website for Tropicana orange juice.

Like other leading companies pushing the envelope of carbon footprinting and reporting, PepsiCo admits to the challenges as well as the opportunities in getting the numbers right, and in making them meaningful. Director of Environmental Sustainability David Walker said in the spring of 2009:

3 Global Business Network."Energy Strategy for the Road Ahead: Scenario Thinking for Business Executives and Corporate Boards." EPA. 2007. Available at: http://www.energystar.gov/ia/business/GBN_Energy_Strategy.pdf.

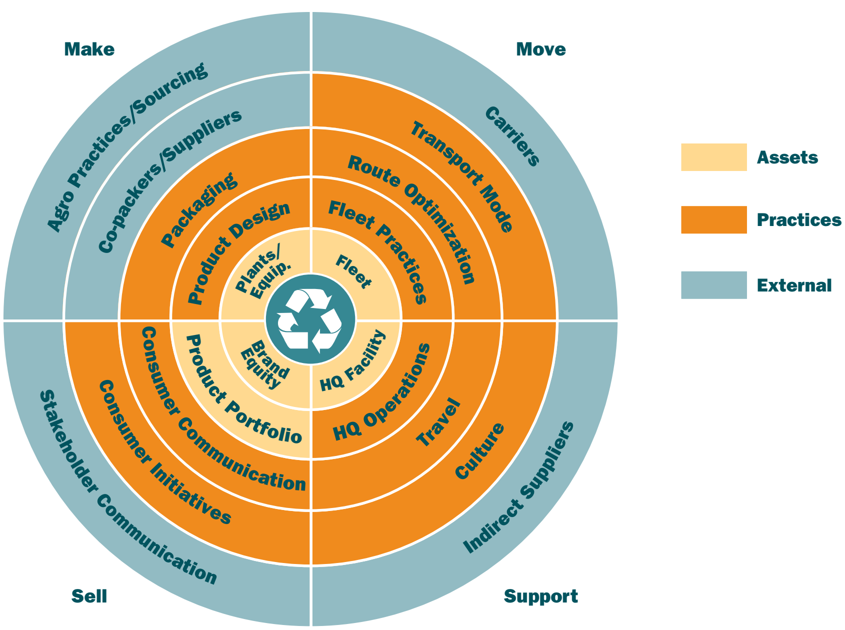
"…measuring footprints at the product level presents a number of challenges….Product level data can be difficult and expensive to gather, with secondary data potentially leading to inaccurate results. When faced with these obstacles, companies can easily shy away from undertaking this type of research.

But product level footprinting sparks a potent combination of sustainability gains, financial returns and innovation. Efforts to establish the carbon footprint of a basket of products representative of a company's business can help tailor sustainability strategies more effectively while generating awareness among peers, employees and consumers about the significance of carbon reduction efforts."

Building on the Walkers and Tropicana individual-product footprinting efforts, PepsiCo has devoted substantial time and resources to understanding the sustainability of its entire supply chain. **Figure 3** illustrates the sophistication that has gone into characterizing and affecting the supply chain. Breaking its influence into four quadrants—manufacturing (the "Make" quadrant), shipping (the "Move" quadrant), marketing (the "Sell" quadrant), and the support quadrant—Pepsico further distinguishes between assets (where it can make direct operational

Figure 3

Scope of PepsiCo's **Sustainability Strategy**



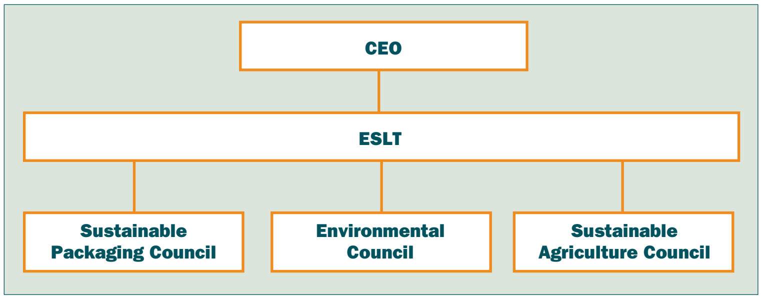
Recreated based on image provided courtesy of PepsiCo (2009).

changes and technology investments), practices (where it can exert a mix of direct and indirect influences), and external elements (where PepsiCo's influence must be indirect). This taxonomy produces 20 potential areas of focus for the sustainability team.

Given the complexity of its operations and the multiple dimensions of its sustainability program, PepsiCo embedded its energy efficiency strategy within its ESLT, the structure of which is illustrated in **Figure 4**. The ESLT and three councils are staffed by personnel within the business units. Each group has members from all of the business units, making them a place for collaboration and best practice sharing.

Figure 4

PepsiCo's Environmental Sustainability Leadership Team



Recreated based on image provided courtesy of PepsiCo (2009).

The ESLT is chartered by and responsible to PepsiCo's Chairman, CEO and Executive Committee. It is specifically tasked with:

1. Developing and maintaining PepsiCo's environmental sustainability strategy;
2. Developing goals and timelines consistent with the environmental sustainability strategy;
3. Enabling strategy execution through resource commitment, accountability, and cross-division collaboration;
4. Developing, administering, and maintaining PepsiCo wide environmental sustainability policies;
5. Assessing the gaps and strengths of performance relative to the company's aspirations and external benchmarks;

6. Partnering with human and talent sustainability leadership teams to assure comprehensive corporate social representation for PepsiCo;
7. Advising and informing the Chairman and CEO, the PepsiCo Executive Committee and the Board of Directors on matters of environmental sustainability.

The energy efficiency strategy operates within the ESLT structure. Because the Frito-Lay energy efficiency efforts date back to at least 1999, the energy efficiency strategy has helped shape the other aspects of ESLT's program plan and operations. Reporting and dashboard systems, technical assistance methods, and other elements developed for energy efficiency purposes have in many cases been expanded to support water, packaging, agriculture and other dimensions of the ESLT portfolio.

Bringing the Supply Chain Inside the Sustainability Program

PepsiCo has begun bringing its efficiency strategy full circle: building on its initial 1990s efficiency efforts at Frito-Lay, it has taken these successes company-wide through various channels and organizational moves, and more recently has been integrating bottlers and some suppliers into its performance measurement and goal setting systems. Like many global companies, PepsiCo uses contract manufacturers, or "co-packers," for several products. Because their operations are typically similar to PepsiCo's internal operations, the sustainability team found it both important and attainable to gain co-packers' active involvement. The supplier initiative built on Frito-Lay's Resource Conservation Model (RECON), which evolved in the 10 years since Frito-Lay pioneered PepsiCo's energy efficiency efforts beginning in 1999. RECON comprises several elements:

- Data collection on a weekly basis from utility meters, and from internal submetering of specific systems or equipment where available;
- Data reporting on current and Year Ago (YAG) energy performance;
- Benchmarking performance against goals, which are set as a percentage of YAG energy use;
- Data analysis tools that allow energy usage breakdowns by individual end uses;
- Diagnostic tools for all major energy systems that can detect performance problems and identify efficiency opportunities.

PepsiCo's sustainability team supports the RECON system with suppliers by:

- Providing onsite technical assistance at supplier sites;
- Inviting suppliers to the Sustainability Summit;
- Conducting targeted training events;
- Providing ongoing staff assistance and networking support via telephone and email.

The company has also begun to include selected suppliers in its online RECON system. To make the RECON approach more user-friendly for these suppliers, PepsiCo developed a reporting and dashboard framework that summarizes results and progress toward goals. This framework includes both quantitative and qualitative goals. On the quantitative side, participating co-packers are asked to achieve four percent annual reductions in energy and water usage. This approach makes participating suppliers "virtually" part of the PepsiCo effort, and enables the company to measure their performance right alongside its own business units.

On the qualitative side, suppliers are given "green" ratings for taking a defined set of qualitative steps. Each step has an individual rating, but to achieve the overall green rating, the suppliers need to be green on each of the steps. These include:

- Measure and track energy, water use and solid waste metrics weekly and agree to make these metrics available to PepsiCo upon request;
- Make an upper management commitment, identifying resources available at the corporate and site level. Build resource conservation teams and increase awareness, driving results through a balanced approach using teams, processes and technology;
- Develop and implement annual and long-term goals, integrating these goals into the business plan;
- Perform regular assessments of energy and water users at each site. Schedule a free Department of Energy Industrial Assessment Center energy audit with the nearest assessment center to be completed within one year of joining the outreach program if available;
- Complete the SEDEX (Supplier Ethical Data Exchange) self-assessment questionnaire;
- Agree to take full advantage of governmental and nongovernmental resources in support of sustainability. For example, U.S. companies are encouraged to join ENERGY STAR;

- Work diligently to implement these objectives within 12 months of joining the program.

From the suppliers' perspective, the incentive to participate in these programs is the opportunity to maintain good relations with a major customer. For its part, PepsiCo makes it easier for suppliers to pursue environmental sustainability by making its reporting system user friendly, facilitating peer-to-peer technical assistance, and using third party programs like ENERGY STAR, which give companies a lot of help and tools to improve energy efficiency. "

Results in the ENERGY STAR area for the fourth quarter of 2008 are summarized below. This Outreach Implementation Scorecard is the graphical representation of the company's supplier reporting system. **Figure 5** shows the percentage of PepsiCo suppliers in each area that has joined the EPA's ENERGY STAR program as a partner.[4] The dark blue bar is the percentage of companies that joined in 2007, the light blue bar is the incremental percentage that joined in 2008, the orange bar represents the gap between the actual participation rate versus the participation goal PepsiCo set for itself for 2008, while the light orange bar is the cumulative participation goal for 2009. The "confidence indicators" signify the level of supplier participation PepsiCo believes will be achieved by the end of the year.

Figure 5
PepsiCo's Implementation Outreach Scorecard:
Energy Star

Recreated based on image provided courtesy of PepsiCo (2009).

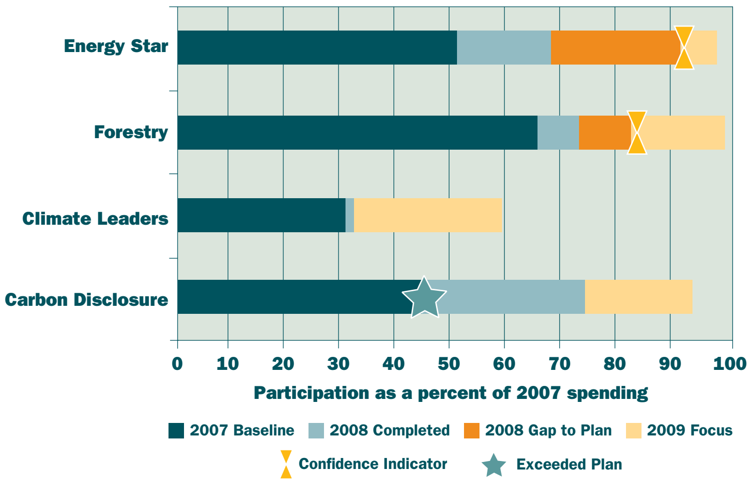
Progress toward the qualitative goals is further illustrated in the Outreach Implementation Scorecard in **Figure 6**. It shows the percentage of PepsiCo spending on packaging suppliers involved with the ENERGY STAR, Sustainable Forestry, Climate Leaders and Carbon Disclosure Project initiatives. The dark blue bar represents the 2007 baseline spending amount, light blue is

4 Along the y-axis, the label "Swt/CO_2" refers to sweeteners (like sugar and zero calorie sweeteners) and CO_2 suppliers. "Indirects/A&M" refers to indirect suppliers, such as office supplies and energy, while A&M stands for advertising and media. "Indirects/ME" is a specific indirect category for manufacturing equipment.

Figure 6

PepsiCo's Implementation Outreach Scorecard:

Packaging



Recreated based on image provided courtesy of PepsiCo (2009).

2008 incremental spending, orange shows the gap between the PepsiCo 2008 goal versus actual spending, and light orange is the goal for 2009.

In 2009, the company's qualitative goal is to get to a 75 percent "green" rating for its suppliers on the Outreach Implementation Scorecard.

Highlights of PepsiCo's supplier efforts include:

- The program has identified more than $6 million in energy and water related productivity improvements;
- 75 suppliers have joined the ENERGY STAR program, a fact noted in PepsiCo's 2009 Partner of the Year Award;
- 18 major copackers are engaged in the program;
- Key supplier success stories include:
  - A major Frito-Lay copacker realized better than 95 percent attainment of its 10-year goals to reduce fuel consumption by 20 percent, electricity by 22 percent, and water use by 30 percent. Copackers have achieved over $2 million in combined savings from energy and water efficiency in 2009;
  - Another copacker hosted RECON trainings that led to a companywide rollout of the program, a BHAG of 40 percent reduction in energy/water use, and $1.1 million in productivity improvements.

Like many corporate energy and sustainability initiatives, PepsiCo's effort met with its share of initial resistance. Additional reporting requirements added to workloads; goal setting required another set of priorities to be factored into busy people's schedules. And like most manufacturing operations, there was skepticism about the value of the energy focus, as it was seen as a minor cost item in most places.

Yet like other companies in these case studies, PepsiCo has been surprised by the resonance its efforts generated among most of the people it engaged. They discovered that the energy and water effort helped spread a sense that "we are innovating, we are rethinking how we do our business, we are looking deeper at the details of our operations and costs." It is that ethic that seems to drive an "esprit de corps" around the sustainability goals, which in turn drives a larger wave of productivity, and a more positive sense of PepsiCo's human capital. As this process unfolds, the sustainability team is seeing that the combination of external reputational value with internal innovation and morale improvement is worth the effort, beyond the narrower benefits that can be quantified as saved kilowatts of energy or gallons of water.

Success is not without its own issues, of course. Sustainability staff are finding new challenges as the effort broadens and matures. These include:

- **Complacency with results.** It can be tempting to point to successes and cut back on the pressure to keep going. To meet the 2015 goals, PepsiCo has to maintain high performance in all areas while developing new opportunities. Sometimes the second wave of improvements can be harder to implement, as the "low-hanging fruit" has already been harvested. And in some cases, the "low-hanging fruit" grows again if teams fail to focus on the fundamentals of maintaining a proper resource conservation process with a capable team.
- **Expense cutting.** Even in a stable economy, most managers feel pressure to reduce expenses related to "managing" ongoing programs. In today's economy, maintaining operational excellence with fewer resources for making site visits, holding meetings, or other activities is very challenging.
- **Consistency of vision.** As energy conservation and sustainability become "mainstream" topics in the organization, several different points of view and directional strategies start to emerge. When the energy and water effort was smaller and limited to one business unit, maintaining focus was easier. But with diversity comes complexity, and keeping focus on the core energy and water goals, and the actions that support them, becomes more of a challenge.

Recognizing these challenges, the ESLT has been reviewing goals and results for all of its performance indicators, and revisiting its forward-looking aspirations in the process. This is helping to move past any sense of complacency as the team contemplates new and aggressive goals across a broad spectrum of indicators. The situation nonetheless remains challenging in a corporate environment with limited capacity for additional resources, and there is continuing pressure to "do more with less."

Conclusions

PepsiCo's efficiency strategy exemplifies the path energy efficiency has followed in the corporate world, from a discrete cost management issue to a major carbon footprint reduction issue that cuts across business units and operations. In the process, the efficiency effort has brought water and other key resources along with it into the sustainability performance measurement system. As one of the first companies to perform a rigorous third-party, life-cycle carbon footprint assessment of an entire product, PepsiCo was able to quantify the notion that energy was a major part of its internal footprint. More importantly, the assessment showed that PepsiCo's supply chain accounted for more of its footprint than did its own operations. That realization drove the company first to share its more than ten years of efficiency experience with key suppliers, and then to bring selected suppliers into its performance measurement system.

PepsiCo's efficiency strategy has also helped to change the mindset and culture in which energy management happens. Setting up a company-wide structure and setting aggressive BHAGs for all business units forced plant managers to look outside energy systems, where energy managers traditionally were confined, into production processes and other core operations. The aggressiveness of the BHAGs meant that facilities could not reach the goals without "touching the process," looking at all resource, technology, and operational aspects. This helped make "thinking outside the energy box" an accepted norm.

Key lessons learned from PepsiCo's energy efficiency successes include:

- Setting challenging goals as a rallying point is important. It is okay not to know exactly how the goals will be achieved. In fact, if you know exactly how to get there, it probably means that the goal is not challenging enough.
- Audacious energy efficiency goals can drive progress in other areas of the business. PepsiCo found that setting stretch goals on energy forced company staff to "think outside the energy box," and led to process and product quality improvements.

- Understand the linkages between energy and water and pursue strategies that maximize efficient use of both resources. Like energy, water is not a high cost item for PepsiCo, but potential supply disruptions pose a significant threat to the company. Water saving measures will also often have many of the same cost, innovation, and reputational benefits as energy efficiency measures.
- Extend your energy efficiency efforts out to your suppliers, but make sure you provide them with the tools and resources to be successful. Leverage third-party programs like ENERGY STAR to provide additional technical assistance to suppliers.
- Looking at investment in energy conservation projects in a different way from normal business investments is important. Longer project life and more reliable long-term savings should allow for longer returns on capital. The relative lack of risk involved in energy conservation projects make them good bets.

CASE STUDY

Best Buy Products and Services	
Headquarters:	Richfield, MN
CEO:	Brian J. Dunn
Revenues (2007):	$36 billion
Energy Costs (2007):	More than $100 million
Energy Savings Target:	Best Buy, in partnership with the EPA Climate Leaders program, set a carbon dioxide (CO_2) emissions reduction goal of 8 percent per retail square foot by 2012, using 2005 as a base year.
Key Efficiency Strategy Successes:	• In 2008, Best Buy's sales of ENERGY STAR qualified products resulted in customer savings of over 785 million kilowatt hours of energy, equal to about $90 million in electric utility bill savings, while preventing over 600,000 tons of CO_2 from entering the atmosphere; • Earning 2008 ENERGY STAR® Excellence in Appliance Retailing Award; and 2009 ENERGY STAR Excellence in Appliance & Consumer Electronics Retailing Award; • Expanding efficiency strategy to encompass smart grid technologies and electric vehicles; • Using Leadership in Energy & Environmental Design (LEED®) rating system for new stores; • Applying ENERGY STAR labeling to drive efficiency gains in the supply chain.

Best Buy Overview

Best Buy works hard to stay close to its customers, employing some 160,000 people in over 1,000 stores in the U.S., plus some 2,500 in Europe and 170 in China (overseas operations are mainly under other company brands via acquisition). As a retailer, Best Buy interacts directly with consumers and over the years has strengthened its efforts to promote products that conserve energy. It does this mainly through its partnership with EPA's ENERGY STAR program, as well as its initiative to help consumers choose more energy efficient products, use those products more efficiently at home, and then recycle the products in the safest way possible. Going forward Best Buy is rolling out new green and energy-efficient products and services, including home energy management and renewable energy systems that take advantage of technological shifts and the growing interconnectedness of consumer electronics and appliances.

This case study focuses on Best Buy's efforts to promote more energy efficient products and services. As a retailer, the majority of Best Buy's energy and carbon footprint resides in the use phase of the products it sells, as opposed to inside its own stores, or in the product manufacturing phase. But the company's energy efficiency strategy also illustrates the interrelatedness of efforts to reduce energy use in internal operations, the supply chain, and products and services. As a consumer-facing company with a very visible retail store and online sales presence, and a large, ongoing consumer advertising effort, Best Buy must stay very close to its customers, their in-store experience, what they buy, how they use the products, what they think of the products, and of the company itself. This pushes the focus of the company's energy efficiency strategy toward its customers and the products they buy. But Best Buy's supply chain strategy also adopts key features of its product and service strategy. In the consumer marketplace, the company uses co-branding methods through programs like ENERGY STAR and EPEAT®[1] to support both product sales and supply chain strategies: the more consumers demand ENERGY STAR qualified products, the easier it is to encourage Best Buy product partners to make them.

At the same time, Best Buy has invested time and resources into setting an internal CO_2 reduction goal of 8 percent per retail square foot by 2012, measured against a 2005 baseline. Best Buy plans to meet the goal through energy efficiency improvements in existing stores and by building new stores to LEED standards. The company's internal operations strategy is driven by a desire to "walk-the-talk" and demonstrate to its customers and employees that it is taking a leadership role in sustainability.

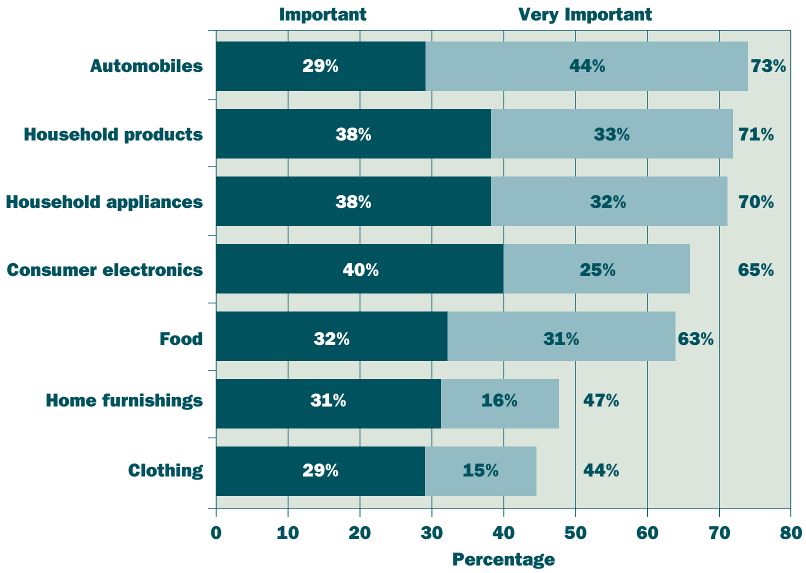
Best Buy's commitment to emphasizing energy efficiency and other green attributes in the products it sells are driven by three main forces:

- The growing consumer demand for environmentally friendly products—Best Buy is attuned to providing the products customers want;
- The business growth and profit potential from "green" products;
- The company's commitment to reducing its environmental footprint, while its employees help customers make smarter technology choices as the digitally-connected world expands.

1 EPEAT is a system that helps purchasers evaluate certain electronics products based on a series of environmental criteria. More information on EPEAT can be found here: http://www.epeat.net/.

Figure 1

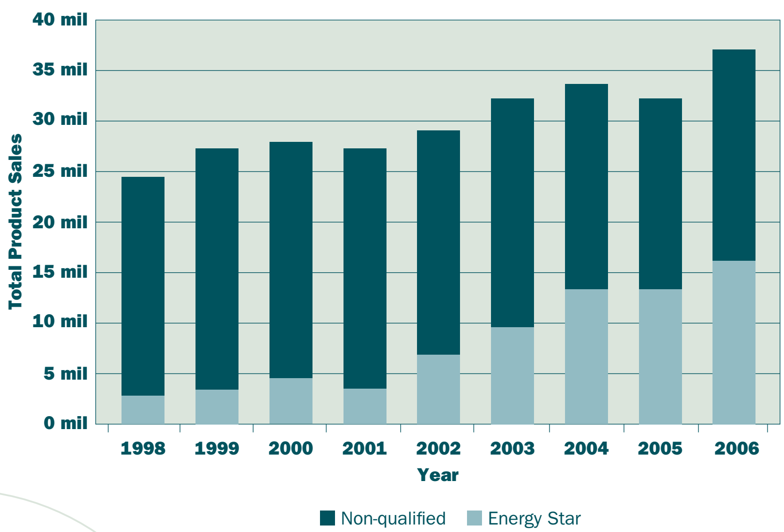
Product Types for Which **Green Attributes** are Important



Recreated based on image provided courtesy of CEA (2008).

Figure 2

Energy Star Appliance Market Share is Growing



Recreated based on image provided courtesy of Department of Energy (2006).

Market Trends

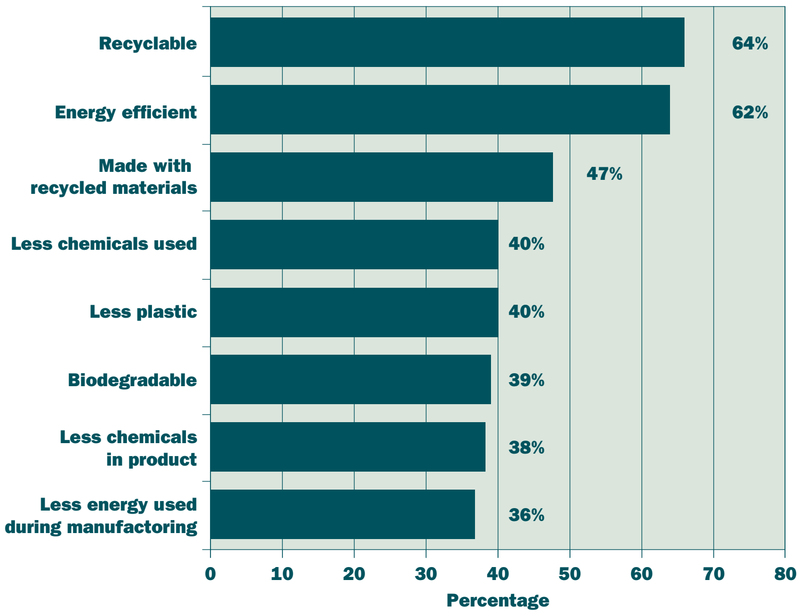
Research by the Consumer Electronics Association (CEA) shows that consumers are looking for green attributes in home appliances and consumer electronics. While there is typically a gap between consumer preference statistics and their buying behavior, in the energy efficiency market ENERGY STAR qualified product sales have gained substantial market share. **Figure 1** shows the CEA data, while **Figure 2** shows Department of Energy data on the growing market share for ENERGY STAR qualified products.

CEA research also reveals the specific attributes consumers recognize most often as green, demonstrated in **Figure 3.**

Taken together, the research shows a clear business case behind Best Buy's efforts to sell more energy-efficient products. Consumers want the

Figure 3

Attributes Associated with Green Consumer Electronics Products



Recreated based on image provided courtesy CEA (2008).

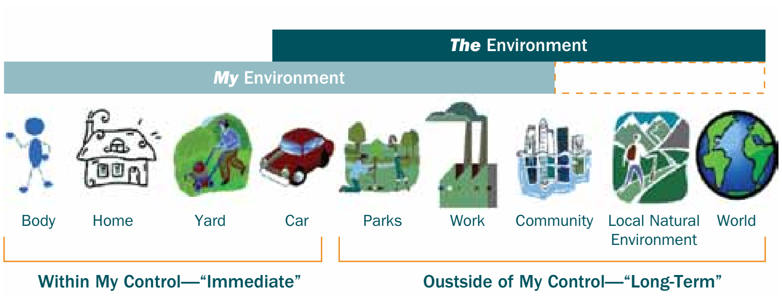
products Best Buy sells to have environmentally friendly attributes, and the top two environmental attributes valued by consumers are recycling and energy efficiency. This helps explain why efficiency—as branded through ENERGY STAR—and recycling—as the company's newest customer offering—are two of Best Buy's most visible sustainability efforts. It also helps explain Best Buy's initiative to step up energy efficiency and recycling training and promotion efforts among sales staff, as well as the electronic waste (e-waste) recycling program that was expanded to all U.S. stores in February 2009. Best Buy's overall sustainability initiative encompasses recycling for technology products, the effort to bring more energy-efficient products and packaging into the market, reduction of Best Buy's internal carbon footprint, and building new stores to meet green building standards. It also makes it easier for customers to choose "greener" products, helps customers use electronic products more efficiently, and offers more convenient ways to recycle and trade in products.

Because Best Buy takes its cues from its customers, it also invests a lot in its own customer research. One of the key issues its research investigates is the way customers perceive environmental issues. **Figure 4** shows a key distinction between "my environment"—the products and actions customers feel directly connected to and able to act on—and "the environment"—the more abstract ideas that customers connect to only indirectly or under certain conditions.

This kind of research informs Best Buy's strategy to sell products that connect on the "my environment" level, while making a secondary connection with "the environment." However, Best Buy's proprietary customer research shows that most customers have had little or no awareness of Best Buy's environmental efforts, even

Figure 4

Consumer Definition of "My" Environment vs "The" Environment



Recreated based on data provided courtesy of Best Buy (2009).

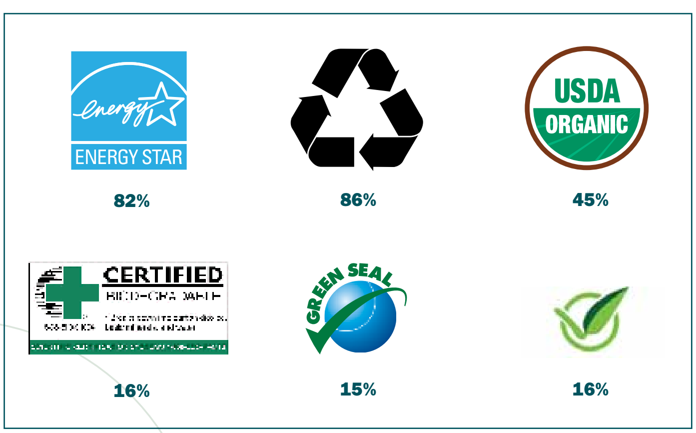
though they want environmental information on products, and state that that information would make a difference in terms of their purchasing decisions. Partly in response to the low customer awareness, Best Buy has created the Greener Together initiative, which includes its recycling program, and is experimenting with "Green Zone" store layouts featuring green products in a single themed location. These initiatives are further described below.

ENERGY STAR Partnership

The gap between customers' limited awareness of Best Buy's environmental commitments, and their desire for environmental guidance in buying products also helped motivate Best Buy's vigorous involvement with third-party programs like ENERGY STAR. The ENERGY STAR brand enjoys among the highest consumer recognition rates of any environmental brand (see **Figure 5**) and the federal government sponsorship gives it an official sense of credibility.

Figure 5

Brand Recognition: % of Consumers That Have Seen the Following Logos



Recreated based on image provided courtesy of CEA (2008).

Illustrating the growth opportunities and profit potential it sees from green products, Best Buy has become one of the most active ENERGY STAR retailer partners. **Table 1** summarizes the environmental and financial benefits derived from sales of ENERGY STAR products from Best Buy stores in 2008.

Table 1

Best Buy's 2008 Energy Star Product Benefits

	Energy Savings (kWh/yr)	Carbon Savings (lbs CO_2/yr)	$ Savings
TVs	278,124,132	428,311,163	$29,453,346
DVDs	11,502,642	17,714,069	$1,218,130
Digital-to-analog converters	37,126,170	57,174,302	$3,931,661
Receivers	3,835,525	5,906,709	$406,182
Home theaters	270,419	416,445	$28,637
Battery chargers	536,658	826,453	$56,832
Desktop computers	117,943,425	181,632,875	$12,490,209
Laptop computers	42,957,024	66,153,817	$4,549,149
Monitors	60,341,952	92,926,606	$6,390,213
Printers & multi-function devices	174,530,849	268,777,507	$18,482,817
Telephones	19,620,023	30,214,835	$2,077,760
Refrigerators	8,553,701	13,141,900	$903,719
Clothes washers	24,244,245	37,336,137	$9,234,339
Dishwashers	4,199,680	6,467,507	$902,771
Freezers	117,312	180,660	$12,423
Room air conditioners	3,585,701	5,522,120	$379,735
Total	787,489,458	1,212,703,105	$90,517,923

Recreated based on data provided courtesy of Best Buy (2009).

Best Buy's ENERGY STAR commitment can be seen most vividly in its exclusive-brand products. For example, the entire Insignia™ line of LCD TVs manufactured after November 1, 2008, met the new ENERGY STAR® V 3.0 requirements, including six models that outperformed the new specification, making Best Buy the first company to have an entire line of LCD TVs meet the ENERGY STAR specifications. The new 3.0 specification was a landmark for TVs, because for the first time it covered energy use with the TV on, whereas previous specifications addressed only standby power (electricity used when the set is off). ENERGY STAR qualified TVs now use about 30 percent less total energy than standard models.

The company's ENERGY STAR leadership has been recognized by a 2009 Excellence in Appliance and Consumer Electronics Retailing Award partly because qualified electronics products now account for a good portion of the company's $40 billion in revenue. The award also recognizes Best Buy's work with its product suppliers to make ENERGY STAR central to environmental improvements across the spectrum of consumer electronics and appliances.

Best Buy is partnering with state energy agencies and utilities on its ENERGY STAR qualified product offerings. For example:

- Best Buy helped PG&E develop the first ENERGY STAR consumer electronics program, in California in 2009 and is also working with Xcel Energy in Colorado on an ENERGY STAR electronics program. These programs involve partnerships between the utilities and Best Buy, in which Best Buy provides promotional support for targeted ENERGY STAR qualified products, and utilities provide incentives to Best Buy to offer rebates or other sales inducements to accelerate sales of targeted products. Electronic data exchange is an important element of these efforts, and can involve a lot of effort to get key data verified and data exchange systems to work correctly.
- In New York, Best Buy is working with the state energy agency to test the market for "smart strips" and similar power management devices. Because these products are fairly new, their energy savings performance and customer acceptance must be tested in limited ways before making any larger commitments. A smart strip looks like the typical power strip most households use for their home entertainment and home office products. However, it allows the consumer to automatically shut off some devices when another device is turned off: for example, it can automatically shut off a printer whenever the computer goes off, or shut off a DVD player when the TV goes off.

Best Buy's Emerging Vision for Efficient and Sustainable Products and Services

While ENERGY STAR qualified products continue to be an important part of Best Buy's core business, it is actively pursuing a broader vision of delivering energy efficiency and other sustainable products and services to its customers. This vision was articulated at Best Buy's October 2009 Utility Summit, which involved electric and gas utilities and other stakeholders in a day-long meeting to discuss Best Buy's emerging strategies.

The Summit framed some key background issues, including:

- **"Digital connectivity"**—Best Buy expects some 240 million consumer electronic devices to be connected through various networks by 2012, an average of more than two per household.

- **"Techno-stress"—**Best Buy is well aware of the challenges its customers face in using the products it sells, especially in trying to get them to work together via universal remotes, home networks, etc. The company sees reducing this "techno-stress" as a key element of its mission going forward, under the theme of "people, technology, and the pursuit of happiness."
- **Connecting home energy efficiency to wider energy issues—**Best Buy wants to offer consumers options for clean energy supply technologies, for clean energy transportation technologies, and for utility system efficiency. Company customer research indicates that to gain the interest of the greatest number of customers as well as its utility partners, it needs to expand its value proposition along these dimensions.

These points suggest that digital connectivity, especially as it relates to advanced energy metering and related technologies, holds promise for energy efficiency. But techno-stress works against this goal, making it harder for customers to make effective use of energy-saving technologies. Best Buy hopes that by bringing greater connectivity and reduced stress to customers with product and service packages that include energy savings benefits, it can overcome these barriers and expand its green business offerings.

Against this background, Best Buy leaders described several emerging products and services they are offering now or testing for future release:

- **Home energy management—**Best Buy is working with home automation companies to develop networked energy management systems that will allow residents to see the actual energy use of connected devices, and to control their operation to save energy and reduce peak loads. These services could be bundled with other options including home security and entertainment, and with utility load management programs, to provide greater total customer value.
- **Renewable energy technologies—**Best Buy has installed small wind turbines at some stores, and plans to offer sales, installation, and financing services for wind and solar energy systems on customers' homes.
- **Electric transportation—**The company is selling rechargeable electric bicycles at some locations, and plans to expand such offerings to larger vehicles and more stores. Best Buy seeks to work closely with utilities to provide electric charging facilities to support the use of electric vehicles.

Best Buy is also experimenting with in-store display and promotion approaches that could encompass many or all of these emerging product and service strategies. One such effort is the “Green Zone” display area recently installed in the Chicago market. The “Green Zones” include ENERGY STAR qualified appliances, ENERGY STAR qualified Compact Flourescent Light Bulbs (CFLs), reusable shopping bags, ENERGY STAR qualified thermostats, and could potentially include any number of product and service offerings.

Walking the Talk Through Efficient Buildings and Store Operations

Like other cost-conscious companies, Best Buy has managed its internal energy use since 1994 with a centralized energy management system that collects energy data from all of its stores. But over the last four years, as the company has implemented its sustainability plan, internal operations has been caught up in the new ethic to measure and reduce its environmental footprint. To support this effort, the energy management system was upgraded in 2009 to an Ethernet-based communication and data acquisition system. This allows for deeper analysis in researching store usage; a third party company monitors the system and sets the schedule for lights and HVAC systems according to the store requirements.

Best Buy’s energy team produces Retail Energy Reports, in which each store location is scored based on two factors: usage compared to the previous year, and usage per square foot. Stores’ performances are compared at three levels: within their district, within their territory and within the entire U.S. The higher a store ranks in each of those categories, the higher their score will be, with 100 being the highest possible level.

Stores that lag in energy performance receive added attention from the energy team: the team reviews their data and operating schedules and discusses details with store management for operational improvements. It also considers lighting and HVAC upgrades; Best Buy has retrofit about 150 stores in the last two years to high-efficiency metal halide lighting. HVAC replacement specifications require heating and cooling equipment to exceed federal standards. These existing-store energy efficiency improvements are part of Best Buy’s 2008 commitment to reduce its carbon emissions eight percent per square foot of floor space by 2012. The remainder of the gains are expected to come through state of the art efficiency designs for new stores. For new construction, Best Buy designs to the U.S. Green Building Council’s LEED standards.

Best Buy’s new store prototype achieved LEED pre-certification in 2008, earning 24 points for the Silver level on the LEED for Retail commercial interiors rating scale. As of the end of February 2009, only six other companies had achieved this. Best Buy’s goal is to reach pre-certification at the Gold level. Seven new stores that opened in February 2009 were built according to the new LEED design. Two other locations (Manahawkin, NJ and Kimball & Belmont, IL) were designed and built independently of the company's precertification program, but are expected to attain LEED certification in 2010. Key LEED design features include:

- Installing skylights to reduce the need for artificial lighting;
- Installing photo cells and a dimming system to reduce artificial light when adequate natural light is in the space;
- Encouraging alternative transportation by installing bicycle racks and offering preferred parking for employees who carpool.

Experience at other retailers indicates that skylights and the natural lighting they bring into the store not only save energy, they improve sales. Customers appear to spend more time and make more purchases per visit in stores with such lighting systems. Best Buy is also participating in the Department of Energy's National Renewable Energy Lab project, "Net Zero Commercial Building Initiative," which has a goal of reducing energy use in new and existing stores.

Best Buy has also achieved ENERGY STAR label status for its headquarters in Minnesota, when it moved in 2004 into a brand new corporate campus consisting of four buildings connected by a common hub. Some of the campus' energy efficiency features include compact fluorescent, light emitting diodes and programmable lights with occupancy sensors that shut off when no one is around. Heating, ventilation and air-conditioning systems are also highly efficient. Chilled water for air conditioning is required year round, but the system detects when the outside air temperature drops below 43 degrees Fahrenheit and switches to a "free cooling" mode. All of the energy using equipment is optimized through the use of an Energy Management System.

Although its energy management operations are very centralized, Best Buy engages its employees in its energy and other sustainability activities. The Environmental Affairs team maintains a dedicated email box for suggestions, and gets 50-100 emails a day from Best Buy staff with ideas on how to advance sustainability goals. Using the more detailed and real-time data available through the newly updated energy management systems, the Environmental Affairs team plans to involve store-based staff more actively in fine-tuning operating practices to further drive down energy use.

This training and education effort also supports Best Buy's products and services strategy: one of the goals is to train store staff on all aspects of its green initiatives, from ENERGY STAR qualified products to recycling.

Better-educated staff members are encouraged to help customers make "greener" choices, in product selection, product usage, and product recycling. Sales staff are trained on the benefits of ENERGY STAR products, so that when customers ask, they are prepared to answer and explain. On the other hand, Best Buy does not train staff to actively steer customers to more efficient products, instead the company uses display placements, print ads, online search features and Green Zone layouts to make sure customers are aware of the efficient product choices.

Leveraging the Supply Chain

Because Best Buy purchases products that are fully manufactured and usually fully packaged, its supply chain and its products and services strategies closely mirror each other. The company does invest substantial effort in minimizing all environmental impacts across the product life cycle, through recycling, packaging, and shipping strategies. Through its participation in the EPA SmartWay transportation partnership, Best Buy is asking all of its shipping companies to be SmartWay-certified by 2010. The company also has instituted a "no-idle" policy for its company vehicles, and is specifying fuel-efficient vehicles for its Geek Squad fleet, which numbers about 5,000 vehicles.

Best Buy specifically advances energy efficiency with its product suppliers in two main ways. For its exclusive brand manufacturers, such as Insignia™ electronics products, the company conducts regular audits on a set of sustainability criteria, and also requires applicable Insignia™ products to meet ENERGY STAR standards. For other product suppliers, Best Buy encourages participation in the ENERGY STAR program. This creates substantial leverage, in that ENERGY STAR serves both as a customer- and a supplier-facing brand.

Conclusions

As a retailer, Best Buy focuses first on what its customers want, and customers increasingly want "green" products. Because the company sells primarily home appliances and consumer electronics, many of which can use substantial amounts of energy, the energy efficiency of those products is the strongest and most common "green" metric Best Buy uses to position itself as a "green" retailer. The federal ENERGY STAR brand supports this strategy very well, and Best Buy has won ENERGY STAR honors in both 2008 and 2009 for its appliance and electronics retailing efforts.

In 2009 Best Buy unveiled the Greener Together™ theme for its environmental initiative. Based on a three-part "choose—use—reuse" theme, Greener Together™ encourages customers to "choose" the right products through ENERGY STAR, "use" them efficiently through the ENERGY STAR @home educational software, and "reuse" electronics products through the company's recycling and tech trade-in programs. Looking forward, the company is also exploring advanced home energy management via "smart grid" wireless networks, providing customers renewable energy systems, and selling electric vehicles beginning with two-wheel options (e.g., bicycles).

While Best Buy's customer offerings are its most visible green initiatives, the company also "walks the talk" by managing its store operations to achieve an eight percent reduction in carbon dioxide emissions by 2012 as part of its commitment under the EPA Climate Leaders program. It also specifies advanced energy and environmental design in new stores by gaining certification for its designs from the U.S. Green Buildings Council's LEED program.

Because Best Buy purchases finished goods for retail sale, it is able to leverage the ENERGY STAR program as a supply chain initiative. By including more and more ENERGY STAR qualified products in its annual assortments, the company sends a clear signal to its suppliers to qualify their products for ENERGY STAR labels. The company also reduces its supply chain energy and carbon footprints by participating in the EPA SmartWay® transportation program, through which it is asking 100 percent of its shippers to be SmartWay qualified by 2010.

Key lessons learned from Best Buy's energy efficiency successes include:

- Energy efficiency efforts should grow from the company's core business. Best Buy's core focus is to provide customers products and services that help technology live up to its promise. From there, it is encouraging its customers to make smarter decisions on energy efficiency and environmental sustainability.

- Take advantage of technological advancements to provide new ways of delivering energy efficient and sustainable products and services to your customers. At the same time, recognize that "techno-stress" can prevent consumers from making optimal use of these technologies. In addition to offering the technology, make sure you are providing customers with the tools and know-how to use these technologies and connect them with existing devices and systems.

- Work to continually improve your understanding of your customers' mind-set. Consumer research is critical in grasping customers' attitudes and needs with respect to the environment. Those attitudes and needs should then drive the marketing and sales strategy.
- Make sure you are "walking the talk" on energy efficiency before making demands of suppliers and customers. Best Buy's efforts to reduce CO_2 emissions from its own stores provide it with greater credibility in persuading suppliers and customers to adopt more environmentally sustainable behavior.

Endnotes

1. The Pew Center's BELC is the largest U.S.-based association of companies dedicated to business and policy solutions to climate change. The 46 companies in the BELC represent $2 trillion in revenues and nearly 4 million employees. For more information, see: http://www.pewclimate.org/companies_leading_the_way_belc.

2. The most commonly cited definition of sustainability comes from the 1987 Report of the World Commission on Environment and Development, which defined the term as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs." (Brundtland, G. (1987). *Report of the World Commission on Environment and Development: Our Common Future.* Oxford, Oxford University Press. Available at: http://www.un-documents.net/wced-ocf.htm, viewed Jan. 30, 2010). Within a business context, sustainability is often used as a blanket term covering a range of corporate efforts to reduce environmental impacts stemming from operations and activities.

3. See Granade et al (2009). *Unlocking Energy Efficiency in the U.S. Economy.* McKinsey Global Energy and Materials, multi-client study; and Kutscher, C.F., ed. (2007). *Tackling Climate Change in the U.S.: Potential Carbon Emissions Reductions From Energy Efficiency and Renewable Energy by 2030.* American Solar Energy Society.

4. See Granade et al (2009). *Unlocking Energy Efficiency in the U.S. Economy*; National Action Plan for Energy Efficiency (2009). *Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions.* Prepared by William Prindle, ICF International; Electric Power Research Institute [EPRI] (2009). *Assessment of Achievable Potential From Energy Efficiency and Demand Response Programs in the U.S. (2010–2030);* and Intergovernmental Panel on Climate Change [IPCC] (2007). Summary for Policymakers. In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, eds. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom, and New York, NY: Cambridge University Press.

5. Global Business Network (2007). *Energy Strategy for the Road Ahead: Scenario Thinking for Business Executives and Corporate Boards.* Funded by the U.S. Environmental Protection Agency.

6. U.S. Department of Energy. Energy Information Administration (2009). *Annual Energy Outlook 2009.* Available at: http://www.eia.doe.gov/oiaf/aeo/index.html.

7. Aldy, J. and Pizer, W. (2009). *The Competitiveness Impacts of Climate Change Mitigation Policies.* Pew Center on Global Climate Change: Arlington, VA.

8. See U.S. Department of Energy, Industrial Technologies Program, Energy Intensive Industries web page, available at: http://www1.eere.energy.gov/industry/technologies/industries.html.

9. Granade et al (2009). *Unlocking Energy Efficiency in the U.S. Economy.*

10. The U.S. Department of Energy's 2009 Annual Energy Outlook projects a 2014 price of about $104/barrel for crude oil imported by U.S. refiners. Survey respondents' estimates are thus consistent with the U.S. official forecast. Moreover, prior to the 2006 Annual Energy Outlook, U.S. official oil price forecasts for 2014 did not exceed $27/barrel. Price expectations have thus risen rapidly in just four years. See DOE. EIA (2009). *Annual Energy Outlook 2009.*

11. For more information on state climate change initiatives, see the U.S. States & Regions section of the Pew Center on Global Climate Change's Web site: http://www.pewclimate.org/states-regions.

12. A blade server typically includes a chassis housing multiple thin, modular electronic circuit boards, known as server "blades." Blade servers are usually designed to minimize physical space, and are typically mounted in racks within "data centers" housing multiple servers and providing IT services on a high-volume basis.

13. See Pew Center BELC, Energy Demand Solutions, http://www.pewclimate.org/what_s_being_done/in_the_business_community/energy_demand.cfm.

14. Hoffman, A. (2006). *Getting Ahead of the Curve: Corporate Strategies That Address Climate Change.* Pew Center on Global Climate Change: Arlington, VA.

15. Server virtualization involves hardware-software solutions that operate IT functions across multiple physical servers, using software to optimize the use of computing space and energy use. Virtualization is intended to increase overall utilization rates for physical servers, reduce the total need for physical IT equipment, and reduce energy use per IT operation.

16. One BTU is the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit. One BTU is also equivalent to 1,055 joules in metric units.

17. Innovest Strategic Value Advisors (2002). *Energy Management & Investor Returns: The Retail Food Sector.*

18. Food Lion, LLC: In Practice. EPA ENERGY STAR Web site: http://www.energystar.gov/index.cfm?fuseaction=partners_in_practice.showStory&storyID=1000000.

19. USAA Real Estate Company: In Practice. EPA ENERGY STAR Web site: http://www.energystar.gov/index.cfm?fuseaction=partners_in_practice.showStory&storyID=1000031.

20. Owens Corning GHG Reduction Strategies. Climate Leaders Web site: http://www.epa.gov/stateply/casestudies/index.html.

21. Siemens (2009). *The Greening of Corporate America: The Pathway to Sustainability from Strategy to Action.* McGraw-Hill Construction.

22. Economist Intelligence Unit (2009). *Countdown to Copenhagen: Government, Business, and the Battle Against Climate Change.* Survey published by *The Economist* magazine.

23. Johnson Controls, Inc. (2009). *Energy Efficiency Indicator: 2009 Findings.* Survey co-sponsored by the International Facility Management Association.

24. Some companies have set absolute reduction goals. For example, UTC, after setting and achieving its energy intensity goals, moved to an absolute greenhouse gas reduction target in 2006. IBM also set a goal to reduce absolute GHG emissions 12 percent below 2005 levels by 2012.

25. SenterNovem. (2007). Long-Term Agreements on energy efficiency in the Netherlands. http://www.senternovem.nl/lta/publications/_publicationdatabase/longterm_agreements_on_energy_efficiency_in_the_netherlands_results.asp, viewed Feb. 5, 2010. SenterNovem is an agency of the Dutch Ministry of Economic Affairs, promoting sustainable development and innovation within the Netherlands and abroad.

26. IRR is a financial assessment method for capital investment which takes into account the time value of money and expected cash flows to determine financial returns from a given investment. Simple payback calculates the amount of time needed for an investment to pay for itself. In the context of energy efficiency, a payback period is the number of years needed for an investment in energy efficiency to pay for itself in energy savings. Simple payback does not discount energy savings (cash flows) based on the time value of money, but simply divides capital costs by annual energy savings in dollars.

27. The ENERGY STAR guidelines, plus self-assessment matrices for company programs and individual facilities, can be found at http://www.energystar.gov/index.cfm?c=guidelines.guidelines_index.

28. For more information, see http://www.superiorenergyperformance.net/.

29. SMART is an acronym referring to Specific, Measurable, Accountable, Realistic, and Time-bound.

30. "Treasure Hunt" is Toyota's name for the traditional "energy audit." According to Toyota, the term audit sounds too punitive, while treasure hunt conveys a more positive impression.

31. In the principal-agent problem, the principal (the company's bottom line manager, nominally the CFO) depends on an agent (such as an equipment purchasing agent) to make the best economic choices. However, traditional purchasing practices are based on low-bid, first-cost criteria, typically overlooking simple payback or lifecycle costs. The first-cost incentive of the purchasing agent is misaligned with the company's bottom-line economic interest.

32. Continuous commissioning means regular (monthly, daily, even hourly) monitoring of energy performance data, and making operational settings or calibration adjustments to keep energy performance of specific energy systems, or whole buildings, within desired ranges.

33. The notion that firms are devoting more resources to the operational side is further supported by the JCI 2009 survey that found that more organizations were planning efficiency activities funded from their operations budgets than from their capital budgets (61 percent versus 56 percent).

34. Questioning how much steam or other inputs is needed for a specific process is an example of matching the "quality" of energy to the task. Generating steam at high temperatures and pressures can be useful for distributing steam across a large plant for a lot of different uses, but it can be more efficient to generate lower-temperature energy at the point of use for a specific task.

35. See Heifetz, Ronald (2009). *The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization and the World.* Harvard University Press; Kotter, John (1996). *Leading Change.* Harvard Business School Press; Worren, N.A.M.; Ruddle, K.; and K. Moore (1999). "From Organizational Development to Change Management: The Emergence of a New Profession," *The Journal of Applied Behavioral Science.* 35 (3): 273-286; Hiatt, John (2006). *ADKAR: A Model for Change in Business, Government and the Community,* Learning Center Publications, Loveland, CO.

36. Siemens (2009). *The Greening of Corporate America: The Pathway to Sustainability from Strategy to Action.*

37. Phyper and McLean. (2009). *Good to Green: Managing Business Risks and Opportunities in the Age of Environmental Awareness.* John Wiley and Sons.

38. Testimony of Charles Zimmerman, Vice President, International Design and Construction Wal-Mart Stores, Before House Select Committee on Energy Independence and Global Warming, Feb. 26, 2009. http://energy.senate.gov/public/_files/ZimmermanTestimony022609.PDF, viewed Jan. 30, 2010.

39. Hoffman, A. (2006). *Getting Ahead of the Curve: Corporate Strategies That Address Climate Change.*

40. This effort is coordinated through the Greenhouse Gas Protocol Initiative. For more information, see http://www.ghgprotocol.org/standards/product-and-supply-chain-standard.

41. Nike 2009 Corporate Responsibility Report. http://www.nikebiz.com/crreport/content/environment/4-3-4-footwear-manufacturing.php?cat=climate-and-energy, viewed Feb. 3, 2010.

42. The EICC is an industry-led coalition that works on advancing corporate social responsibility across the information and communications technology industry. EICC formed in 2004 with the development of an industry-designed code of conduct for environmental and social standards. For more information, see http:www.eicc.info.

43. Information stems from author and Pew Center correspondence with HP (Nov. 19, 2009 and Jan. 30, 2010).

44. Wal-Mart 2007-08 Sustainability Progress to Date. http://walmartstores.com/sites/sustainabilityreport/2007/documents/SustainabilityProgressToDate2007-2008.pdf, viewed Feb. 3, 2010.

45. Wal-Mart 2009 Global Sustainability Report. http://walmartstores.com/sites/sustainabilityreport/2009/en_logistics.html, viewed Feb. 3, 2010.

46. For more information on EPA's SmartWay Transport Partnership see http://www.epa.gov/otaq/smartway/index.htm.

47. In 2007, GE reported improving energy efficiency by 33 percent. GE 2007–2008 Citizenship Report: Investing and Delivering Every Day. http://www.ge.com/files_citizenship/pdf/GE_07_08_Citizenship_Report.pdf, viewed Feb. 3, 2010.

48. Whirlpool has been named EPA ENERGY STAR Partner of the Year seven times since 2008. See Whirlpool web site for additional details: http://www.whirlpool.com/content.jsp?sectionId=782.

49. For more information on the "Smart Grid," see the Pew Center fact sheet: http://www.pewclimate.org/technology/factsheet/SmartGrid.

50. "Whirlpool Sets Smart Grid Compatibility Goal by 2015." *Environmental Leader.* May 11, 2009. Available at: http://www.environmentalleader.com/2009/05/11/whirlpool-to-make-smart-grid-compatible-appliances-by-2015/.

51. Remarks as prepared for Lee Scott. "The Company of the Future." Wal-Mart U.S. Year Beginning. Jan. 23, 2008.

52. Wal-Mart Sustainable Product Index Fact Sheet. http://walmartstores.com/Sustainability/9292.aspx, viewed Feb. 4, 2010.

53. EPEAT is a system that helps purchasers evaluate certain electronics products based on a series of environmental criteria. More information on EPEAT can be found here: http://www.epeat.net/.

X. Appendices

Appendix A: Pew Center Survey Methodology

The Pew Center survey is an important piece of the broader report, *From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency*. The principal goal of the survey was to gather quantitative data and identify broad trends in corporate energy efficiency strategies among leading businesses. The Pew Center developed the survey in partnership with ICF's Survey Research Center and distributed it via e-mail to 95 companies in January 2009. Prospective participants received a link to the online survey instrument, unique user names and passwords, and a pdf copy of the questionnaire. Later, some companies requested Microsoft Word versions of the survey to type their responses directly into the questionnaire. In all, a total of 48 companies completed the survey, a response rate of approximately 53 percent.

To target industry leaders, the survey sample was drawn from major companies with a demonstrated commitment to climate and energy issues. To gauge "demonstrated commitment," the Pew Center evaluated whether the company was a member of any business-NGO and/or government-NGO partnership program on climate change or sustainability. Included in the sample were all of the companies (44 at the time) in the Pew Center's BELC, as well as an additional 51 companies pulled from such organizations as the U.S. Climate Action Partnership, Climate Group, World Wildlife Fund's Climate Savers, U.S. Environmental Protection Agency's Climate Leaders, and the World Business Council for Sustainable Development. Most of these companies are U.S.-based, though many operate globally.

The Pew Center survey contained 65 questions split into the following sections: general company information; overall strategy; risk management and finance; specific initiatives (internal operations, supply chains, and products and services); and lessons learned. Key questions centered on organizational issues, such as who were the most important champions in establishing efficiency programs; financial questions, such as how are efficiency projects funded, and how do they compete with other priorities; and broader "lessons learned" questions, such as what were the challenges in developing efficiency programs, and how were they overcome. Most responses were collected in mid-March of 2009, though a few trickled in later.

For data validity purposes, additional follow up work was conducted in August 2009 to reach out to the 46 of 95 companies that did not respond to the survey when it was first sent out in January. Of the 46 non-respondent companies, two stated that corporate policy prevented survey participation, three electric utility companies and one oil and gas company felt that the scope of the questions was inappropriate for their industry, 18 other firms indicated an interest in participating but were unable to do so during the data collection period, and 22 did not respond to any survey-related communications. The Pew Center conducted a non-response study of the 40 firms that had either expressed interest in the survey or had not responded at all to the initial outreach. The purpose of this "non-response" study was to determine how, and to what extent, those who did not participate in the survey differed from, or were similar to, survey participants on key characteristics or measures that would affect the overall generalizability of the survey findings.

The non-response study consisted of an email request for limited, key information. The body of the e-mail message included seven questions about the companies' energy efficiency strategy or initiatives to be answered by return e-mail. To allow for a comparison of responses, these questions were similar to the questions asked in the original survey. Twelve firms supplied this information. Their responses closely mirrored those of survey participants. For example, 91 percent (10 of 11) reported that their firm had an overall energy efficiency strategy or specific initiatives compared to 96 percent of survey respondents, and 60 percent (6 of 10) reported that the firm had a designated full-time corporate energy manager compared to 58 percent of survey respondents. Based on the similarities between the information supplied by survey participants and non-respondents, the Pew Center believes the survey findings well represent the energy efficiency strategies of all firms invited to participate.

Appendix B: Energy Savings Goals—Averaging Methods and Caveats

Companies that responded to the survey question number six on energy savings targets provided data with a lot of variability for a relatively small sample size (n=21). This limits the statistical validity of any inferences one may wish to draw from this data. Moreover, the savings targets comprised at least three types of data: the total energy savings goal; the attainment period; and the normalization basis. How these three data elements are used in calculating aggregate numbers for the sample introduces other complexities.

To illustrate: the reported quantitative targets ranged from 5 percent to 60 percent, and the attainment periods ranged from one year to 34. To provide a consistent basis for reporting these results, the project team calculated a simple annualized target for each company, and then averaged these annualized numbers. However, the actual annual improvement that a given company would have to make to reach its overall goal would depend partly on the length of the attainment period.

The normalization issue further complicates the annual savings question. Almost all savings goals reported in this study were normalized by (typically) square footage of floor space, units of product, or dollars of revenue. This adds another factor to the estimation of annual savings needs. For example, if production falls, as it has in the recent recession, energy use per unit of product or dollar of revenue increases. This is because when company production slows down, energy use typically cannot fall in a 1:1 ratio, as some energy systems such as lights or HVAC must remain on. This makes meeting the intensity target that much harder during economic slowdowns.

For all these reasons, readers should not seek to over-interpret the average energy savings goals in this report. Even if the statistical and other analytical issues with this data were not important, each company's business conditions, technology issues, and other factors make each energy efficiency goal-setting process somewhat unique. This data, therefore, should be interpreted only in the limited context in which it appears: a simplified, annualized average of 21 companies' energy efficiency goals.

This report documents best practices in business energy efficiency and provides guidance to other companies seeking to develop new, or strengthen existing, energy efficiency programs. The Pew Center on Global Climate Change was established by the Pew Charitable Trusts to bring a new cooperative approach to the global climate change debate. We inform this debate through wide-ranging analyses that add new facts and perspectives in four areas: policy (domestic and international), economics, environment, and solutions.

Pew Center on Global Climate Change
2101 Wilson Boulevard
Suite 550
Arlington, VA 22201
Phone (703) 516-4146

www.pewclimate.org