THE MULTIPLE PATHWAYS TO INDUSTRIAL ENERGY EFFICIENCY

Appendix

February 15, 2011

Lukas C. Brun and Gary Gereffi

Contributing CGGC researcher: Gloria Ayee

CENTER ON GLOBALIZATION
Governance & Competitiveness
DUKE UNIVERSITY

This report was sponsored by the Energy Program of the Environmental Defense Fund and prepared by CGGC. Errors of fact or interpretation remain the exclusive responsibility of the authors. The opinions or comments expressed in this study are not endorsed by the companies mentioned or individuals interviewed. We welcome comments and suggestions. The corresponding author can be contacted at lukas.brun@duke.edu.

Table of Contents

List of Figures

List of Tables

I. The Barriers to Energy Efficiency

The main discussion referred to extensive research on the barriers to energy efficiency conducted by scholars interested in why companies, as profit-maximizing rational actors, are not quicker to adopt cost-saving energy efficiency investments. Readers interested in additional information on the barriers to energy efficiency may find the information provided below helpful in understanding why companies do not adopt cost-saving energy efficiency improvements.

The research into what barriers exist to energy efficiency has found that companies are not doing so for the following reasons (see Table A-1).

TABLE A- 1: BARRIERS TO ENERGY EFFICIENCY

Barrier	Claim
Cost of energy	• Energy costs as proportion of operating costs are low, which results in insignificant savings of energy efficiency projects to the firm • Uncertainty in energy costs makes payback calculations difficult to evaluate
Investment barriers	• Insufficient payback • Insufficient access to capital • Growth bias of manufacturing firms • Cyclicality of industrial investment decision-making
Imperfect information	• Lack of information • Lack of expertise • Lack of time/ other priorities
Split incentives	• Landlord/Tenant: neither the landlord nor the tenant have incentives to invest in energy efficiency because they do not realize its returns • Buyer/User: buyer of industrial equipment is concerned with purchase price and reliability of capital rather than energy operating costs
Organizational barriers	• Separate capital and operating budgets • Lack of built-in incentives (bonuses and other pay structures) to reward energy efficiency • Lack of ownership for energy/carbon emissions within the company/ no departmental accountability • Managers stay in posts only for a short time

Source: Adapted from Sorrell et al., 2004; Schleich, 2009

Energy cost barriers – energy is a small proportion of the costs of owning and operating a factory, typically accounting for less than 10% of operating costs in most industries (Brown, 2001). Energy efficiency investments are overlooked because the anticipated cost savings from investing in improved energy efficiency in absolute terms are generally expected to be low. For industries that are energy intensive, this does not hold true since cost savings can be significant.

A second barrier related to energy costs is energy price uncertainty. Energy price uncertainty, especially in the short term, makes it difficult for companies to invest in energy efficiency because it is difficult to estimate the profitability of an investment. Uncertainty in future returns leads to higher perceived risk of an investment and higher hurdle rates imposed on energy efficiency investments (Hasset & Metcalf, 1993; *contra*, Sanstad et al., 1995).

Investment barriers – Barriers to investing in energy efficiency have also been noted in the environmental economics and energy management literature. Investment barriers include:

- Insufficient payback of energy-efficiency investments – Investments in energy efficiency may not meet the investment criteria of companies, and as a result, are not funded. How companies evaluate capital projects affects the level of investment in energy efficiency projects. Companies tend to evaluate energy efficiency investments using rate of return and payback, rather than discounted cash flow analyses like net present value. This leads to the underinvestment of projects with positive expected cash flows in the long run (Train, 1985; Sorrel et al., 2004; Schleich, 2009).

- Hidden costs - Investments in energy efficiency are often evaluated to take longer periods for payback than other capital investments because of hidden costs. Hidden costs include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analyzing, and applying information (Sorrel et al, 2004). The result is that even when energy efficiency improvements meet the formal investment criteria of the company, the evaluation of energy efficiency projects is less trusted than other capital improvement projects because of these hidden costs. Companies sometimes double or triple the estimated costs of energy efficiency projects during the formal evaluation phase of energy saving capital investments because of past bad experiences with hidden costs (Duke, 2010).

- Insufficient access to capital – When the firm has capital constraints, investments in energy efficiency may suffer because hurdle rates are increased beyond what is possible for most energy efficiency projects. This increased stringency affects smaller projects, like energy efficiency projects, disproportionately (Ross, 1986) because the transactions costs of determining the profitability of such investments represent a larger portion of the expected savings (Sorrell et al., 2004; Schleich, 2009).

- Improvements in reducing operating costs are perceived as less important by senior management than investments that increase revenue. The preferred routes to expanding profits in the manufacturing sector are increased output and market share, not reductions in operating costs (Ross, 1990; Sassone & Martucci, 1984).

- The level of investment in energy efficiency may be determined not only by factors such as rate of return or payback, but also on "soft" factors such as strategic priorities, the status of energy efficiency in the firm, or the relative power and status of those responsible for energy management within the firm (Morgan, 1985; DeCanio, 1994; Sorell et al, 2004, Schleich, 2009).

- Cyclicality of industrial investment decision-making – Major capital investments increasing the energy efficiency of a plant are affected by the level of wear, changes in product mix, and adoption of new technology at a plant. Investment decisions to improve energy efficiency coincide with these operational cycles, which last on average 4-7 years (Elliott et al., 2008). Capital improvements or "re-fits" outside of these investment cycles are more difficult to achieve unless they are part of routine maintenance or the design of new plants.

Capital investment decision-making in the industrial sector

Capital investment cycles are industry specific, but on average run four to seven years. The lengths of the cycles are a function of changes in technology, product, product mix, and the need for operational maintenance due to wear and tear of machinery at a particular facility. Investment cycles in industries with a stable level of technology and product, such as glass manufacturing, can extend for ten or more years, while industries with rapid technological and product change, such as consumer electronics, can be less than three years (Elliott et al., 2008).

Market and macroeconomic factors also affect capital investment cycles. Market factors influencing the capital investment decisions of industrial firms are the current and anticipated market demand for the products produced by a firm and the price of feedstocks. Capital investments are positively related to product prices; investments are often high when product prices are high relative to historic levels (ibid.).

A facility's position within the company's overall production capacity also affects the capital investment decision of firms. Necessary but less financially attractive investments are frequently made at "flagship" plants, while even some highly financially attractive investments are less likely to receive funding at marginal facilities. This apparently anomalous behavior results from the likelihood of the flagship facility's continued operation during economic downturns, while marginal facilities will be closed (Steinmeyer, 1998).

Imperfect information – Lack of information about energy consumption or the efficiency of new technology acts a barrier to adopting process and capital improvements that increase the energy efficiency of a plant. Imperfect information about energy consumption patterns can persist because detailed metering of energy is either not available or feasible, or because of the lack of expertise or time about energy issues in a company. The information costs of collecting energy data, or of selecting and installing new energy-efficient equipment, compared to the ease of simply buying energy may prohibit cost saving investments from being realized (Brown, 2001). This may be particularly a strong barrier for small and medium enterprises (SMEs) (Reddy, 1991). Technical or engineering staff trained in energy issues is lacking in many firms, particularly SMEs and "lean" firms (Brown, 2001). As a result, information about energy efficiency opportunities may not be gathered. Time may not be devoted to searching for information about energy use in a company because senior management regards energy efficiency as a routine maintenance issue that is assigned a lower priority than either essential maintenance projects or strategic investments (Sorrel et al., 2004). Studies of investment decisions determined that the strategic nature of investments is more important to senior management than its profitability. Upper management does not value information about energy use highly because it is seen as related to an organization's material resources rather than its strategic direction (Schleich, 2009). Sorrell et al., 2004 note that if agents lack the time, interest, or capacity to use existing information, then there is little point in providing more information about energy efficiency. This point is important because policy interventions are often aimed at providing more information rather than imposing performance standards through regulations. "In practice, standards may be more effective in some circumstances as they bypass the problem of bounded rationality" (79). The point is illustrated with the experience of the U.S. Department of Energy's Industrial Technologies program in which only 19% of companies implemented energy efficiency opportunities identified by the program (DOE, 2010). Companies had a variety of reasons for why energy efficiency opportunities were not implemented, including:

- Yet another document to consider
- Good ideas at the wrong time
- No responsible person
- Unit does not retain savings
- Remote decision maker

These reasons point to limits of simply supplying better information, and the role of organizational and behavioral barriers to implementing energy efficiency.

Split incentives (principal-agent problems) – Misaligned incentives between actors can lead to suboptimal outcomes regarding energy use. These types of problems, commonly referred to as principal-agent problems, occur when someone acting on behalf of another has different incentives than the person on whose behalf they are acting. Two principal-agent problems are commonly referred to in the literature on energy efficiency:

- Owner/Occupant – when the occupant of a property has different incentives to use energy than the owner of the property.
- Designer/User – when the designer of an industrial system has different incentives than the user of the property

In the owner/occupant variant of the principal-agent problem, neither the owner nor the occupants of the building have incentives to invest in energy efficiency. The owner has little incentive to invest in energy efficiency because the investment costs cannot be passed to the tenant benefitting from lower energy costs. Similarly, building occupants will not invest in energy efficiency if they are likely to vacate before realizing their return on investment.

In the designer/user variant, industrial equipment buyers choose technology used in the production process and are mainly concerned with availability and the known dependability of standard equipment. They have strong incentives to minimize initial costs of the equipment, rather than to evaluate the operating costs of different technologies over the life of the capital equipment. Similarly, if the energy requirements of production systems cannot easily be observed, developers may “get away with” cheaply installed systems that the purchaser discovers to be sub-optimal afterwards (Brown, 2001; Schliech, 2009).

Organizational barriers – Bureaucratic routines can cause under investment in energy efficiency. Organizational barriers to energy efficiency include:

- Separate capital and operating budgets
- Lack of built-in incentives in bonuses and other pay structures that reward energy efficiency
- Lack of ownership for energy/carbon emissions within the company
- Managers stay in posts only for a short time

Separate capital and operating budgets have been reported to be a significant barrier to implementing energy efficiency improvements in manufacturing firms. This factor came up repeatedly in our interviews, and has received attention in the academic literature as a barrier to greater investment in energy efficiency. The issue is that capital investment decisions are conducted separately from the decision about operating budgets. Capital investments are often made according to specific decision rules that undervalue savings in out years, and most companies prefer paybacks of two years or less (DeCanio, 1998). In practice, most energy efficiency improvements have implicit paybacks of less than one year because of forced borrowing from the same year's operating costs within the company (Meier, 2010). The result of this division of labor within the firm is that operational costs are not included in the evaluation of capital investments.

Even if operational budgets and capital budgets were decided on simultaneously, there is little incentive to reduce operating costs because there is no transferability between capital and operating budgets in most firms. If for example, reductions in operating costs could be transferred to the department's capital budget, it would provide incentives to reduce operating costs so that the department could invest in energy efficiency or other capital priorities. Sorrell et al (2004) note that an alternative to departmental accountability for energy costs is to create a company-wide energy services team responsible for identifying and initiating energy efficiency improvements.

In addition, if managers – because of job rotation – remain in their post only for a short time, they may have limited incentives to invest in energy-efficient projects, which have a longer payback time than their tenure at a plant. Plant managers stay in their positions for only two or three years before rotating to other positions within the firm (DeCanio, 1993). The performance incentives for plant managers are to find projects with rapid returns even though a fuller analysis would reveal projects with more significant, but longer, returns to the firm. In addition, if departments are not accountable for their own energy costs, plant managers may have no incentive to invest in energy efficiency because the benefits accrue to the corporate entity but not the individual plant.

A widely referenced study on the barriers to energy efficiency by Sorrell et al., 2004 concluded that additional research into the barriers to energy efficiency is likely to be less productive than the investigation into how specific companies overcome barriers in their internal operations and supply chains. A goal of the main body of the report was to provide this needed perspective.

II. Case Studies

The purpose of the case studies was to discover the "pathways to energy efficiency" taken by selected companies. The research team reviewed annual reports and corporate sustainability reports to develop preliminary answers to the questions listed in Figure A-1. These responses, in turn, provided the basis for discussions with company representatives knowledgeable about energy efficiency. Each case study contains background information about the company and a narrative of the answers to the questions uncovered. DuPont and Bridgestone actively participated in the report, while Nissan referred us to existing case studies and company materials on the company's practices in energy efficiency.

FIGURE A- 1: COMPANY CASE STUDY QUESTIONS ABOUT THE ENERGY EFFICIENCY PROCESS

Goal-Setting	Identification	Financing	Implemen-tation	Measurement, Benchmarking & Reporting
• Who sets the goal for energy efficiency? • How did the goal get set? • What was the goal?	• Who identified the opportunities for energy efficiency? • How were they identified?	• How were capital improvements financed? • What criteria or financial hurdles did capital improvements have to meet?	• Who implemented? • How did they implement? • What incentives exist?	• How is energy use measured? • Is energy use reported in corporate reports? • What industry benchmarks are used to measure success? • Are benchmarks used to set new goals and identify new opportunities?

Table A-2 below provides a summary of the "pathways to energy efficiency" taken by the case study companies. The case studies illustrate how companies choose among a range of feasible options at each phase of the energy efficiency process to become more energy efficient.

TABLE A- 2: SUMMARY OF "PATHWAYS TO ENERGY EFFICIENCY" TAKEN BY CASE STUDY COMPANIES

	Bridgestone	**DuPont**	**Nissan**
Motivation	Environmental impact of operations; efficiency of operations	Environmental impact of operations; cost savings	Environmental impact of operations
Goal Setting			
top-down (corporate-level mandate)	X (2010)	X	X
bottom-up (goals primarily at plant-level)	X (1990-2009)		
Identification			
inside-out (internal energy services lead)	X	X	X
outside-in (external actors take lead)			
Financing			
capital set-aside	X	X	
parity competition			X
Implementation (primary responsibility)			
company-wide energy services	X	X	
plant energy team			X
Measurement, benchmarking, and reporting			
SKU level		X	
Company level	X		X
Use of industry benchmarks			X
Internal reporting	X	X	X
External reporting		X	X
Supply Chain	no engagement	no engagement	
Energy Monitoring & Capacity Building			X (capacity building)
Scorecards			
3rd Party Certification			

Source: CGGC, Duke University

The three case studies do not illustrate the full range of pathways taken by companies adopting energy efficiency practices. Excellent case study materials developed by the Pew Center (Pew,2010a), EPA's Climate Leaders, WWF Climate Savers, and the Duke Energy Efficiency conference (Duke, 2010) provide a broader range of company's experiences in adopting energy efficiency practices. Table A-6 (p. A-35) illustrates how the "energy efficiency process" developed in this report can serve as the basis for the systematic coding of company experiences in adopting energy efficiency in their organizations.

Bridgestone

Company Name: Bridgestone Americas, Inc.
Corporate Headquarters: Nashville, Tennessee, USA
Industry: Tire Manufacturing
Employees (Worldwide): 50,000
Annual Revenue: $350.9 million
Established (Incorporation Date): 1900
Locations (Worldwide): Bridgestone Americas is made up of an international family of enterprises with 52 production facilities.

Overview

The Bridgestone family of companies is a leading manufacturer of tires and tire-related technologies. Bridgestone Americas traces its roots to the establishment of the Firestone Tire & Rubber Company in 1900. Bridgestone Corporation purchased Firestone in 1988, transforming the companies' combined operations into the world's largest tire and rubber company (Bridgestone, 2010b). Bridgestone Americas, Inc has two manufacturing operating units. Bridgestone Americas Tire Operations is engaged in the manufacture and sale of different types of tires and tubes. The Diversified Product segment provides automobile related products, construction related products, and sports products such as golf balls and golf clubs, and bicycles. Firestone Diversified Products also provides financial services. Bridgestone sells more than 80,000 different types and sizes of tires, and tires account for approximately 75% of Bridgestone Americas' annual revenue (Bridgestone, 2009).

TABLE A- 3: BRIDGESTONE AMERICAS, INC – OPERATING UNITS AND SUBSIDIARIES

Operating Units	Businesses
Bridgestone Americas Tire Operations, LLC	Tire manufacturing and wholesale and original equipment sales operations across a broad line of products, including consumer, commercial truck and bus, agricultural, and off road tires.
Bridgestone Retail Operations, LLC	Consists of a family of over 2,000 company-owned vehicle service and tire locations across the United States, including Firestone Complete Auto Care™, Tire Plus ™, ExpertTire™ and WheelWorks™ store locations. Credit First National Association and Firestone Complete Fleet Care™ operations.
Firestone Diversified Products, LLC	Building and industrial products, natural rubber, and industrial fibers and textiles businesses. • Building products: commercial roofing systems, insulation and

Operating Units	Businesses
	accessories • Air springs: automotive, heavy duty truck, agriculture, and industrial conveyors • Natural and synthetic rubber: tire applications, flooring, conveyor belting, and molded goods • Fibers and textiles: key component in tires, belts, military tents, hose and roofing

Source: Bridgestone, 2008; Bridgestone, 2010b

Bridgestone, the industry leader in tire manufacturing, has also taken steps to become the leader in ecologically responsible manufacturing practices. The company has applied its technology toward the development of energy efficient manufacturing processes and environmentally sensitive products (Land, 2009).

Employees at Bridgestone Americas are committed to working together to improve the company's environmental footprint, as well as helping its customers and consumers to improve their environmental footprint. This commitment involves a focus on waste reduction, energy efficiency, water conservation, and nature preservation (Bridgestone, 2008). Bridgestone recognizes that saving energy benefits both the company and consumers by saving money, reducing emissions, and reducing the burden on the power infrastructure (Bridgestone, 2009).

Energy use at Bridgestone comes from two primary sources: electricity and natural gas. Electricity is used for boilers and gas heating, to power motors, and for lighting buildings. Natural gas is used for boilers and gas heating (Deschamps, 2010). The tire manufacturing plants are the greatest energy consuming facilities in the company.

Motivation

Bridgestone Americas' rationale for improving energy efficiency stems from environmental concerns, a desire to minimize CO_2 emissions and reduce other greenhouse gas emissions, and a strong commitment to energy conservation and having a positive impact on the community (Deschamps, 2010). Reducing energy requirements at manufacturing and production facilities also has a positive impact on the company's bottom line because it promotes cost savings. At Bridgestone, emphasis is placed on managing facilities well, and the focus on energy conservation is consistent with this management goal (Deschamps, 2010).

The major barrier to identifying and implementing energy improvement projects at Bridgestone was that energy efficiency has traditionally not been viewed as a priority for the company. While saving energy is understood to be an important issue for Bridgestone, the main focus of the company is to manufacture products. Saving energy during the manufacturing process is perceived to be an added benefit, but not the company's primary goal (Deschamps, 2010). Energy efficiency goals at Bridgestone were established once senior leadership and individual plants within the company understood the importance of making energy performance and improvement a priority.

Goal Setting

Bridgestone has an annual goal of 1% to 5% energy efficiency improvement for each of its facilities. The corporate office in Tokyo supports this energy efficiency goal. Energy teams at plant locations are primarily responsible for setting energy efficiency goals at the facilities, although Bridgestone has announced goals in 2010 to reduce carbon emissions company-wide by 2020. Average annual results are about a 2% improvement in energy efficiency at Bridgestone Americas facilities.

Goals for energy efficiency were first developed at the plant level, which then became a "top-down" initiative once cost-saving and implementation success were realized. Single plant initiatives began in the 1970s, which were re-emphasized in the 1990s and, particularly, in 2000.

Identification

Bridgestone uses a company-wide energy services team to identify energy efficiency projects at individual plants. The energy services team visits plants every two years to help individual plants develop and coordinate their energy efficiency projects. The energy services team formulates project ideas as the result of energy surveys at individual plants (50-100 projects on average), provides them to the plant, and then challenges plant managers and employees to come up with techniques for achieving these improvements.

Financing

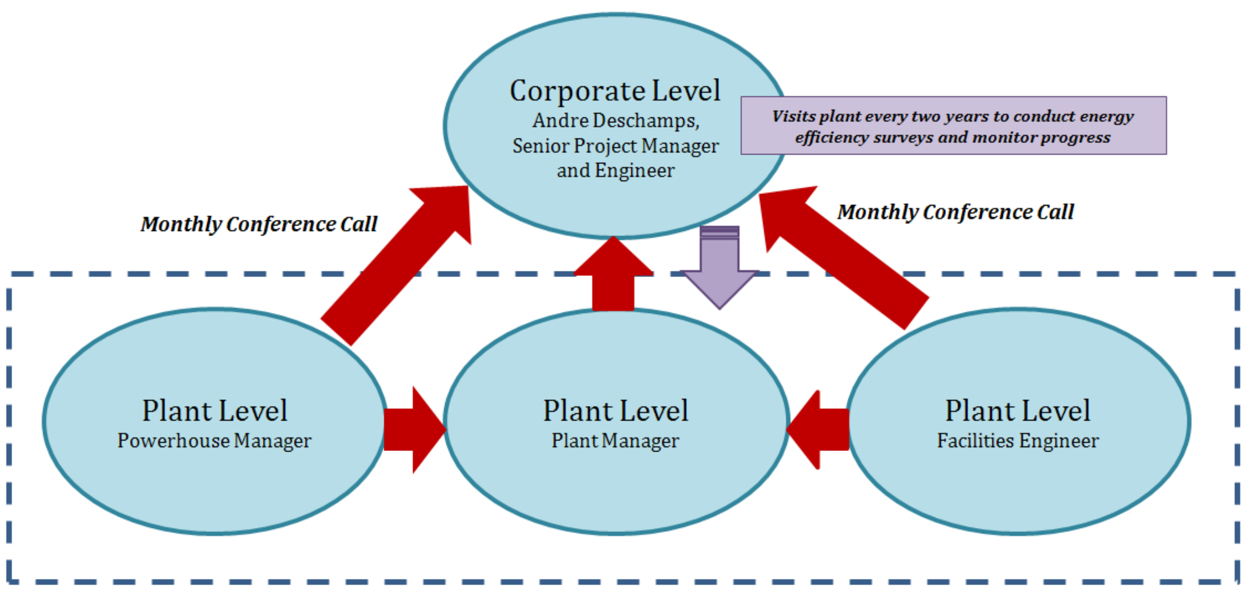
Bridgestone Americas has a capital set-aside for financing energy efficiency improvement projects. The company budgets between $3 million to $8 million per year for energy reduction projects at its main plants. This company budget is supplemented by state subsidies for special energy efficiency projects (Deschamps, 2010). Individual facilities can put out funding requests for approval. Projects are evaluated based on simple payback methods. Projects with a payback less than 2 years are almost always funded, while projects with 2-5 years of payback may be funded if special funding is available. In general, most projects are approved because the comprehensive process that plants go through to identify energy efficiency projects with the assistance of the corporate energy efficiency division enables them to provide reasonably accurate estimations of how much funding they will need to successfully complete an energy efficiency project (Deschamps, 2010).

Implementation

Plant engineers are responsible for implementing energy efficiency projects at Bridgestone. Any energy projects that the plant has the money to finance are placed into the itemized implementation plan (IIP) with the investment required, and MMBTU reduction goal (Deschamps, 2010). The itemized implementation plan (IIP) details the key activities that plant managers will perform on a daily, weekly, and monthly basis to achieve company goals, including energy efficiency projects. The IIPs are submitted at the beginning of the year for review and approval, and once approved, formal meetings are held quarterly between supervisors and plant employees to monitor progress and verify status. At the end of the year, results from all the activities in the IIP are included in an annual performance appraisal (Walker, 2007).

To promote organizational and behavioral changes that will help the company meet its energy efficiency goals, Bridgestone has put a number of incentives in place to encourage employee support. Every year the company gives recognition awards to employees who have made the greatest energy efficiency improvements at their facilities (Deschamps, 2010).

FIGURE A- 1: ENERGY EFFICIENCY PROJECTS IMPLEMENTATION AND REPORTING

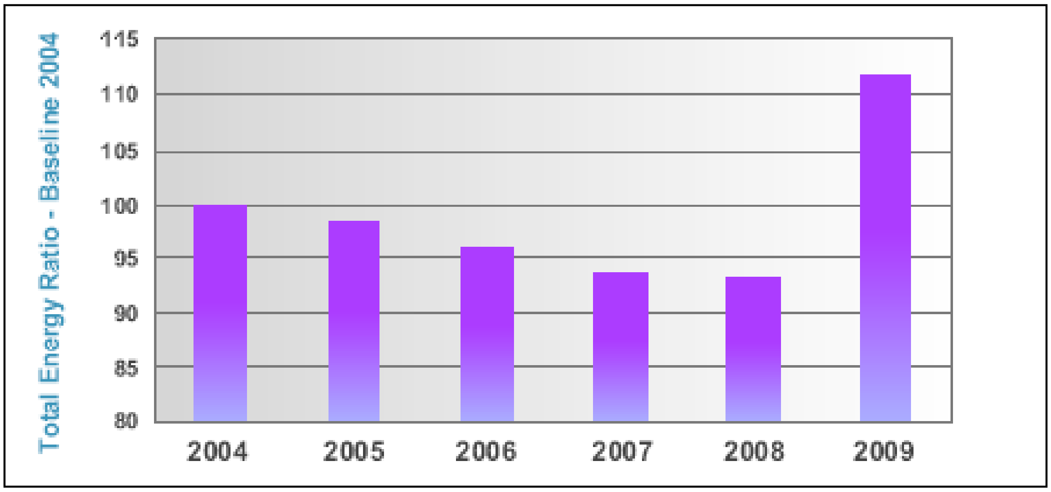


Source: CGGC, Duke University

Measurement, Benchmarking and Reporting

Bridgestone uses Tracker, an electronic system, to measure and report energy use for all the company's facilities. The Tracker records energy-use in kWh. Plant sites update the data in Tracker on a monthly basis (Deschamps, 2010). Compared to 2004 energy use levels, Bridgestone Americas' products required about 12% more energy to produce on a MMBTU/pound basis, as illustrated below in Figure A-2. The higher energy ratio was a result of a significant drop in production after the 2008 financial crisis and the inability of simple ratio measures to capture the difference between per-unit energy requirements and base energy requirements at a facility.

FIGURE A- 2: BRIDGESTONE ENERGY USAGE



Source: (Bridgestone, 2009)

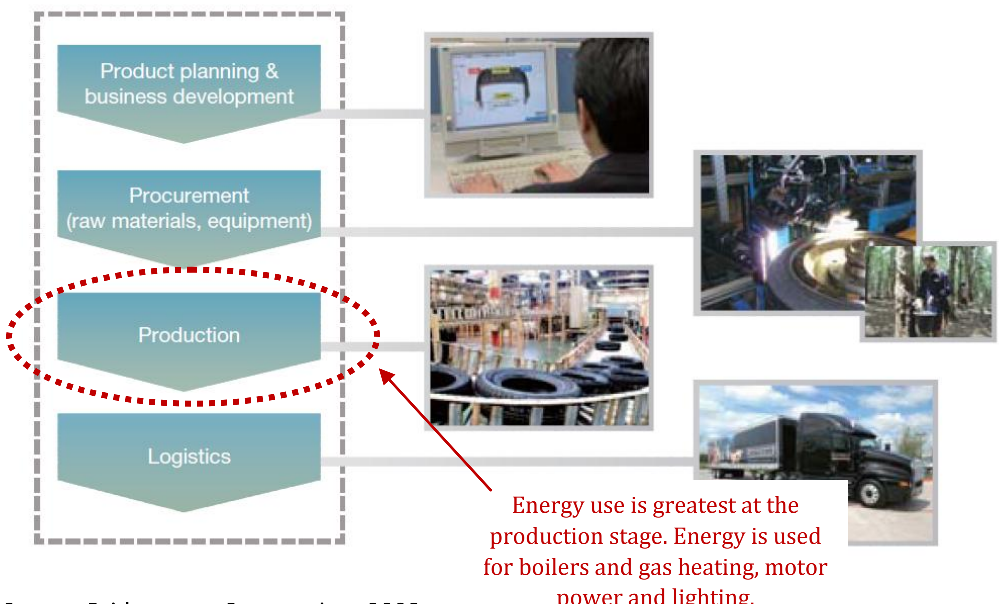
Bridgestone Americas requires all of its manufacturing facilities to obtain ISO 14001 certification (Bridgestone, 2007). By 2000, Bridgestone Americas had implemented ISO 14001 –the international standard for environmental management system – at 24 of its major facilities across the Americas. The company is also a leader in the tire and rubber industry globally regarding ISO 14001 certification. Today, all of Bridgestone's major facilities are ISO 14001 certified (Land, 2009). Since November 2008, Bridgestone's tire manufacturing facilities in Warren County, Tennessee and Aiken, South Carolina completed the Leadership in Energy and Environmental Design (LEED) certification process (Bridgestone, 2007).

Bridgestone America Tire Organization is one of seven companies participating in a series of training sessions organized by the U.S. Department of Energy's Industrial Technologies Program (ITP). The three-part training program is aimed at manufacturers in the Southeastern United States that are working to demonstrate energy management systems that meet the highest standards in energy efficiency. The demonstration project is being conducted through ITP's broader *Save Energy Now* initiative, and supports ITP's mission to promote energy efficiency programs throughout the manufacturing industry (U.S. Department of Energy, 2010). Participating demonstration sites are testing the ANSI-accredited Superior Energy Performance certification program requirements and are working to meet future energy challenges by developing skills that will enable them to effectively manage their energy resources. Manufacturing facilities will receive assistance from demonstration support teams to implement an energy management system that will conform to the forthcoming International Organization for Standardization (ISO) energy management system standard 50001. Manufacturing facilities that demonstrate their success at meeting the ISO 50001 energy management standard show that they are able to manage their energy use effectively, improve energy performance, and use accredited methods to measure and validate energy efficiency and energy intensity improvements (U.S. Department of Energy, 2010).

Supply Chain

Bridgestone does not monitor the energy use of its suppliers (Deschamps, 2010).

FIGURE A- 3: BRIDGESTONE GROUP SUPPLY CHAIN

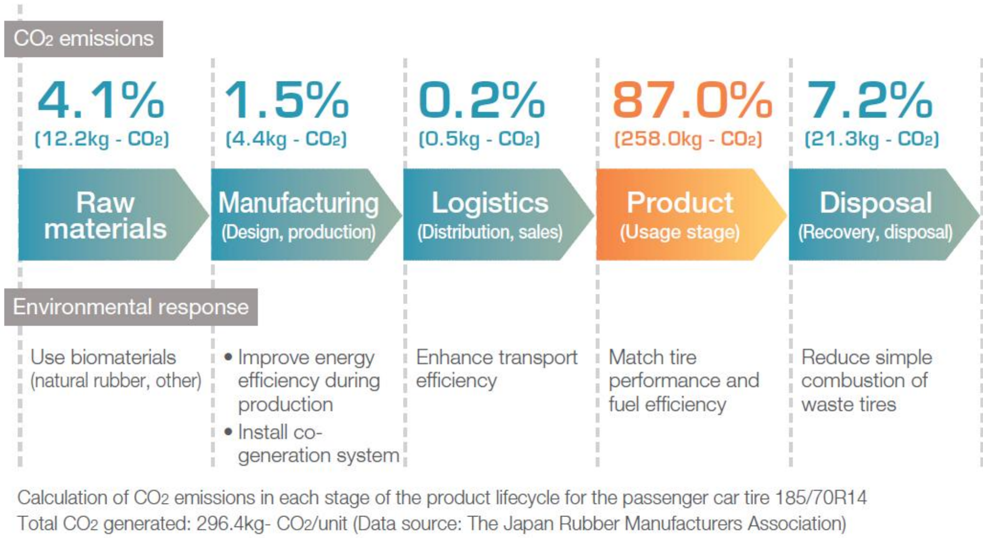


Source: Bridgestone Corporation, 2008

Footprint

Tire use by consumers accounts for 87% of the overall lifecycle CO_2 emissions of the product. Bridgestone Group – Bridgestone Americas' parent company – has actively taken measures to reduce CO_2 emissions from tires in the non-usage lifecycle stages as well, by boosting the energy efficiency of the manufacturing and distribution processes, as well as through tire collection and recycling programs (Bridgestone Corporation, 2008). The company is also involved in research and development efforts to create new products that have a lower environmental impact.

FIGURE A- 4: TIRE LIFE CYCLE ASSESSMENT



Source: Bridgestone Corporation, 2008

DuPont

Company Name: E. I. du Pont de Nemours and Company, Inc.
Corporate Headquarters: Wilmington, Delaware, USA
Established: 1802
Industry: Chemicals Manufacturing
Employees (Worldwide): 58,000
Annual Revenue: $27,328 million (2009)
U.S. Locations: DuPont operates over 60 manufacturing plants in the United States. 175 plants and 80 R&D facilities in 70 countries
Average Energy Usage: 129 Trillion Btu, about $1 billion in annual energy costs.

Overview

DuPont is a science-based products and services company that has a 204-year legacy of core values that are rooted strongly in safety, health, and environmental stewardship. DuPont is one of the largest chemical manufacturers in the United States – the company produces tens of thousands of products – and is heavily dependent on fossil fuels for energy and feedstock in its industrial chemicals, polymers, and high performance materials production business.

DuPont Industries:

- Agriculture
- Business and Construction
- Electronics
- Energy and Utilities
- Government
- Health Care and Medical
- Manufacturing
- Packaging and Graphic Arts
- Plastics
- Safety and Protection
- Transportation

DuPont Business Units:

- Applied BioSciences
- Building Innovations
- Chemicals & Fluoroproducts
- Crop Protection
- Electronics & Communications
- Nutrition & Health
- Titanium Technologies
- Packaging & Industrial Polymers
- Performance Coatings
- Performance Polymers
- Pioneer Hi-Bred
- Protection Technologies
- Sustainable Solutions

DuPont uses about 129 trillion BTUs of energy in its 175 worldwide plants, and 75% to 80% of that total energy use is in facilities in the United States (Bailey, 2010a). DuPont considers energy use – on which it spends over $1.1 billion annually – to be part of its global operations footprint (DuPont, 2010b).

Motivation

DuPont's initiative to improve its energy efficiency was initially part of its public sustainability commitment. DuPont's company goal in the sustainability arena is "sustainable growth", which it defines as "increasing shareholder and societal value while decreasing the footprint of operations, and along the value chains in which they operate." DuPont defines its "footprint" as injuries, illnesses, incidents, waste, emissions and depleteable forms of raw materials and energy. Since energy is part of DuPont's footprint, goals have been set to reduce energy use at the company (DuPont, 2010b).

When oil prices in the U.S. increased in late 2007 to above $100/barrel, cost considerations quickly became the most important reason for DuPont to become serious about energy management. "We can't control energy prices", stated DuPont's CEO Chad Holliday in 2007, "but we can 'out-reduce' our competition." Energy management at DuPont moved from being primarily a sustainability issue to being a competitive issue. This became the perspective of upper management and employees throughout DuPont (DuPont, 2010b).

Goal-setting

Setting goals for reducing energy usage at DuPont occurred in three phases. The first phase occurred in 1989 when DuPont committed to improving energy use (as measured in BTUs per pound of finished product) by an expected 15% reduction by the year 2000. In 2000, the company reported that it held total energy use flat at 1990 levels despite a 35% increase in production (DuPont, 2008).

The second phase began in 1999 when DuPont announced that by year-end 2010 it would 1) hold total energy use flat, as measured from a 1990 baseline, 2) reduce greenhouse gas emissions by 65% from the 1990 baseline, and 3) supply 10% of total energy from renewable resources. After reaching the 65% GHG reduction in 2004 (goal 2), DuPont announced a 15% reduction of 2004 levels by 2015.

Reflects Bill Bailey, Engineering Fellow and Energy Center of Competency Lead for DuPont:

> When that goal was announced in 1999, I would say the vast majority of people who work in our plants would have asked the question, 'What's our part of that goal?' And it really was not communicated to them, in 1999 when the goal was announced, what was expected of them in terms of energy efficiency improvement. It was primarily the corporation that was trying to raise the awareness of everyone in the company, that this was an area that we were going to work on, that we were serious about working on it, and we were so serious that we were actually announcing a goal to the public that we didn't even know how we were going to achieve.
>
> We gave ourselves 11 years to hit the target, and I think the senior leadership would have said in 1999 that would be plenty of time for us to figure out how to do this. So by the time 2010 rolls around we've actually got a very granular process for driving improvement, and we've made significant improvements along the way. They just trusted that our people would be able to put the right things in place to make it [work], rather than doing the reverse, which is, after doing two years

> of work are you able to say, "Here's what we think we can deliver, because here's all the work we think we can do. (Bailey, 2010a).

The third phase was the announcement in late-2007 of the Bold Energy Plan (BEP). The BEP was a 5-year strategic plan guided by senior leadership at DuPont to save $230 million over 5 years and reduce energy use and CO2 emissions by 20% (DuPont, 2010b). The BEP was initiated because the company recognized that it needed a more programmatic approach to energy management. The ad hoc approach yielded good results, but stagnated (DuPont, 2010b). The BEP was implemented to make energy management at DuPont focused, accountable, and measurable.

Goal-setting at the plant level is the responsibility of the plant manager working with the site energy champion to develop specific projects that can be completed annually.

Identification

DuPont created an "Energy Center of Competency" in 2004 to develop materials and training sessions for site energy champions at plants to improve energy efficiency. The goal of the Center was to "help the plants help themselves." Bill Bailey describes how energy efficiency opportunities are identified at DuPont,

> Within our engineering department, we have probably about two-dozen energy specialists. We are experts in everything related to the conversion of energy, to the production of utilities, to the distribution of those things, to virtually every type of manufacturing equipment that would use energy. But, you know, there's not nearly enough of us to go around to each of these 100 largest energy-consuming plants. And we recognized that if we were going to drive a lot of improvement, we needed to educate a lot of people at the plant so that they understood the fundamentals of how to improve energy efficiency. So, our group of energy engineers and our corporate engineering department spent a lot of time developing best practices, developing a set of tools, actually going to plants and conducting on-site assessments to help identify defects that might cause energy use to be higher than it otherwise should be. You know, probably the last seven or eight years, we had a program of producing, at least quarterly, webinars on energy efficiency improvement topics. Some years we actually do monthly training sessions that were designed to get operators, mechanics, engineers, and individual manufacturing areas more knowledgeable about how to look for defects, how to quantify the dollar benefit of eliminating them, and actually how to go about eliminating them.
>
> And I would say that, it is my belief that companies that do not have central resources like that, probably are at a disadvantage. Because then you would have to expect people in every single one of these plants to have world class skills in energy efficiency improvement in order to have a comprehensive improvement strategy. It can be done. But I think you can do a lot more faster if you've got a small cadre of experts whose primary job is to figure out how to get their knowledge into the heads of a lot of other people.

Financing

Capital is managed by business units, and each business unit decides which projects will be implemented. DuPont business units are oriented toward revenue growth. "The people who have control of the capital purse strings want to invest all of the available capital in projects that grow the business" (Bailey, 2010).

In the past, energy efficiency projects were required to be cost competitive and compete with all the other capital projects for funding (Hoffman, 2006). DuPont ruled out lowered hurdle rates, internal carbon shadow pricing, or setting a budget for energy efficiency projects (Hoffman, 2006). As Bill Bailey explains,

> There is a limited pool of capital available for each business in DuPont. There are certain projects that [business units] have to do to stay in business. It might be in a safety related project, it might be an environmentally related project that is mandated by regulations. After [business units] fund those, what I call 'staying in business investments', whatever is left over they will devote to their growth strategy and anything that is left over after that, they will look to do discretionary projects that have really good returns. Unfortunately, the trough is almost always empty by the time they finish executing their growth projects each year.
>
> Never mind, that [business units] might be able to invest a million dollars and get an 80% internal rate of return by doing an energy efficiency project. If it doesn't grow the business, they are much less interested in doing it, regardless of whether it has even got a better return. The limited availability of capital in the business drives it to spend the limited capital on projects to drive growth, because that is what Wall Street is expecting them to do. That is really more responsible for us not doing these [energy efficiency] projects, as opposed to our energy projects not being able to meet some artificially imposed hurdle rate. … It was very hard to get a good energy project funded, absent some corporate, overarching corporate initiative that has as one of its core elements this provision of capital that we would make available for efficiency projects that no one else could touch.

DuPont considered ESCOs for project financing, but ultimately chose not to use them. ESCOs were considered because projects with high rates of return were not funded by business units.

> [W]e talked to a number of firms. We actually got pretty far down the road with one or two of them, and each time we would reach a point of decision where we had to go to our corporate finance folks. And each time they would say, 'Now tell me again why we are using someone else's money here?' And we would tell them, 'Because we have these projects with really good returns and our businesses don't want to execute…' They reminded us that our money is cheaper than anyone else's money and that if these projects really are a good thing for us to be doing, then we ought to be able to find a way to do them ourselves. We were never able to overcome that barrier.
>
> By the time Enron imploded and its aftermath, any thought that our finance department might have had towards using other people's money disappeared. We've gotten very strong signals from them that we will not use energy service companies or third party financing to implement these types of projects (Bailey, 2010a).

The Bold Energy Plan in 2007 created the Energy Capital Fund that invested $60 million in energy projects that reduced annual energy costs by $70 million, reduced CO_2 emissions and energy use by 6%, and delivered $170 million in NPV and achieved a 60% IRR. The capital set-aside program was approved in 2007. Although a difficult sell at the beginning, discussions with IBM, Anheuser Busch, and Corning led to the conclusion that if these companies were effectively using capital set-asides for energy efficiency projects, it could work also at DuPont. Bailey recalls,

> All three of them had recently been successful in getting corporate support for energy capital set-aside. And when I went to our Senior VP [of Engineering responsible for capital budgeting] and told him, 'Hey, these companies are doing it.' He got a lot more interested in looking at it for DuPont because he works with people in these other companies as well, and he knew that I wasn't just blowing smoke (Bailey, 2010a).

Despite the success of the Energy Capital Fund, it was discontinued as a result of the collapse of the global economy in 2008. Cash flow concerns prompted the company to stop capital spending, including spending for the energy capital set-aside. Company leadership has since struggled to return to its internal mandate to make capital available for all its good energy projects. In part this is because of a shift in senior management's thinking about the appropriateness of making some capital investment decisions at the corporate level, rather than holding business units accountable for reaching targets in energy and carbon emission reductions (Bailey, 2010b).

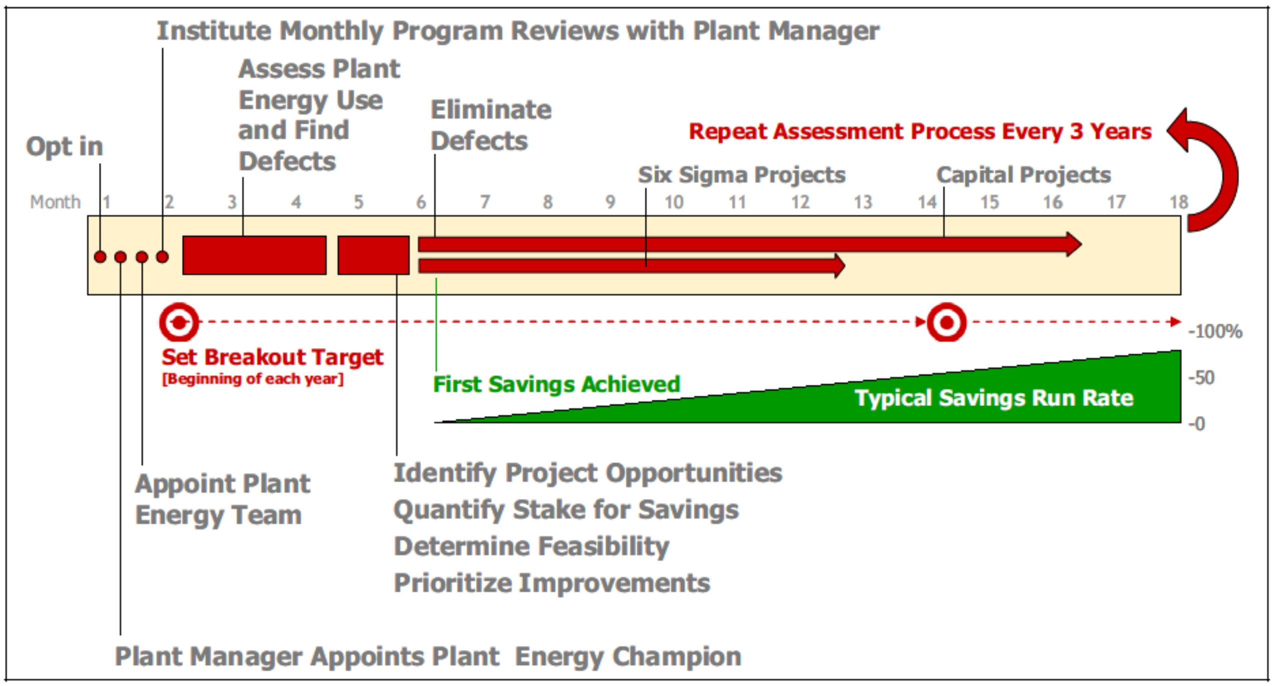
Project analysis at DuPont for capital projects greater than $7 million includes a price for carbon. The inclusion of a carbon price began with DuPont's European operations where a price for carbon emissions exists. The decision to extend this to all capital projects at DuPont occurred because of future regulatory risk in the U.S. of carbon emissions. The decision to include a carbon cost in capital project analysis has not resulted in the cancellation of any projects.

Implementation

Until 2005, most of DuPont's U.S. plants did not have a dedicated site energy champion or an energy team that represented all the major energy consuming areas of its facilities (Bailey, 2007). At this time, approaches to energy efficiency within DuPont were largely ad hoc and relied on Six Sigma practitioners to identify and eliminate obvious defects in equipment and production processes that would increase energy use in the company's facilities (Bailey, 2007). With the ad hoc approach there was not an overarching corporate initiative that worked with all the company's major energy consuming sites to encourage them to adopt best practices, to put individuals in place who could monitor progress, and to drive improvement on energy efficiency projects. The company did not pursue improvement projects as part of a structured energy efficiency program, with dedicated leadership, specific financial goals, or broad educational programs (Bailey, 2007). Rather, with this ad hoc approach, individual plants developed ideas on their own. Plant managers had opportunities to invest capital into projects that would expand manufacturing capability and also promote their energy efficiency goals (Bailey, 2010a). In February 2005, DuPont launched an Energy Breakout Initiative to promote energy efficiency and reduce costs in its U.S. operations.

As part of this initiative, 40 manufacturing plants set specific targets for improving their energy efficiency; an "Energy Center of Competency" (CoC) was established to provide expertise, tools, and training; and site energy champions were established to lead programs and promote savings (Bailey, 2007). By the end of 2005, the plants that participated in the Energy Breakout Initiative had implemented over 160 energy efficiency projects. Collectively, these projects reduced energy consumption in U.S. operations by 4 trillion BTUs, and CO_2 emissions by over 232,000 tons. The success of the Energy Breakout Initiative prompted senior leadership within the company to launch follow-up campaigns in 2006 and 2007. The program has since been expanded to include 50 sites around the world, including nine of the largest energy-consuming sites in Europe (Bailey, 2007).

FIGURE A- 5: PROCESS MAP AND TIMELINE FOR TYPICAL PLANT ENERGY BREAKOUT PROGRAM



Source: Bailey, 2007.

With the development of the Bold Energy Plan in late 2007, a more structured approach to implementing energy efficiency began at DuPont. To ensure that energy efficiency goals are met, DuPont has various personnel throughout the company involved in managing and implementing energy efficiency projects. Regional directors, business unit leaders, plant managers, and site champions all play an active role in implementing energy efficiency within DuPont. Regional directors have a monthly conference call with plant managers to discuss energy efficiency issues, and calls with the corporate office take place once a month as well. This communication approach guarantees that personnel throughout DuPont are informed of the company's progress in energy efficiency. DuPont will soon place achievement of annual energy savings targets on plant managers' report cards. Reflects Bill Bailey of DuPont:

> We have asked the plant manager to be the ones to be held accountable at the site for meeting the site's annual improvement target and to work closely with the energy champion and the energy team to make sure that the improvement program stays on track. You know, the program is basically the plant manager and the energy team deciding at the beginning of the year what improvement, specific improvement opportunities they are going to work on, when they think they can implement them, and what annual savings can be expected from them, based on when they think they can complete it.
>
> When they put that item on the report card, we got the kind of attention that we needed from the plant manager, and in turn that drove the kind of attention that we needed from the site energy champion. If we didn't have a senior vice president asking the plant managers what their target is, and how are they doing versus that target, then the energy champion probably wouldn't have a target to work on, wouldn't have an annual improvement program they were trying to drive, and they would go out and work on all of the other things that someone else had convinced them were really their top priorities.

Over 100 DuPont plants now have Site Energy Champions. DuPont's energy champions serve in the capacity of advocates for placing continued emphasis on improved energy efficiency in the company's operations. Energy champions are responsible for repeatedly communicating the value of energy efficiency projects to ensure that they receive the appropriate priority (Hoffman, 2006). Site Energy Champions report to plant managers.

Senior leadership within the company has also played an important role in DuPont's commitment and ability to meet its energy efficiency goals. For example, when some business units within the company were reluctant to push hard to reach the company's first round of greenhouse gas reduction goals, CEO Chad Holliday personally stepped in to emphasize the importance of DuPont's sustainability efforts, stating that failure was unacceptable (Hoffman, 2006). The Senior VP of Operations and the VP of Operations ensure that goals are met and that accountability mechanisms are in place.

Measurement, Benchmarking and Reporting

DuPont measures energy use at the SKU-level. This level of detail is required because of the diversity of products produced by DuPont. A broad measure like BTUs per pound is not used at DuPont other than for broad reporting purposes. As Bill Bailey explains,

> DuPont is maybe unique among the large manufacturing companies in terms of the huge diversity of the different products that we make. We make some products like automotive paint which is not very energy intensive when you look at the quantity of paint that is produced. We make other products like white pigment that takes a huge amount of energy to produce, for a comparable quantity of pigment compared to paint. So, if we were to use a metric like BTUs per pound of product, corporately it would not have much meaning because a lot of different kinds of pounds of products that have a lot of different kinds of energy efficiency profiles would go into that overall number. Even within a product category like white pigment, you would have to look at individual

> grades of pigment sold. Some products require a lot of energy to grind down to a very small particle size. Other SKUs don't require nearly as much, because the customer isn't looking for a fine particle size. So even if you measure BTUs per pound within a product category, like white pigment, the number BTU per pound wouldn't mean a whole lot.
>
> The other problem that we have with BTUs per pound is that there are many factors outside of our control that affect the numerator and denominator. For example, in some of our products the amount of energy that we use depends on what the weather is like. We can't control the weather. There are other products where, again, depending on things like customer demand, you may still have more pounds one year than you do the next. Our plan is to be more energy efficient when they are running flat out, compared to when, you know, they are running at only 75 or 80% capacity, as many of them were doing over the last 18 months. So, it becomes very difficult to take a number like BTUs per pound, and to say that it absolutely indicates whether we are doing a good job improving energy efficiency.
>
> So we asked ourselves, when we got into this corporate initiative about 5 years ago 'Is there a better way for us to measure improvement so that we can have confidence that the numbers that we communicate are meaningful and will convince someone that we really are making meaningful and measureable improvement?' And what we came down to was, 'Hey, why don't we track every single improvement that someone had to actually do something in order for us to be more energy efficient.' The result of this thinking was a detailed, SKU-level measurement of energy (Bailey, 2010a).

At DuPont, progress on projects directed at monitoring energy efficiency and reduction of GHG emissions is tracked at the business-unit level through the company's Corporate Environment Plan (CEP), a database that captures annual performance information on energy use at company facilities worldwide, as well as GHG and other emissions (Hoffman, 2006).

DuPont developed a benchmarking project in the early 1990s, but ultimately abandoned it because the variety of production at its plants made it too difficult to implement effectively. With the exception of one product, titanium dioxide, DuPont does not use industry benchmark standards for recording and reporting its energy efficiency progress. External benchmarks are not useful for understanding how to improve energy efficiency within the company because DuPont makes a wide variety of products and it is difficult to compare energy use among different facilities that manufacture different products.

Energy management goals and achievements are shared with internal and external audiences. Internally, annual reports on the Bold Energy Plan's progress toward established goals are provided to senior leadership. A data management system, the CEP, supports the information provided in the report and can track performance on energy efficiency at the business-unit level. Externally, DuPont uses a number of different reporting mechanisms to keep audiences informed about the company's overall progress in achieving its energy efficiency goals. DuPont's annual corporate sustainability report provides information on how the company reduced greenhouse gas emissions, met goals on renewable energy use and achieved progress on the company's goal to keep total energy use flat from 1990 (see Table A-4).

TABLE A- 4: ENERGY EFFICIENCY REPORTING AT DUPONT

External Reporting	• DuPont's progress in energy efficiency is highlighted in the company's annual corporate sustainability report. • Total energy use for the year is measured and reported against the company's flat goal (from the base year 1990). • GHG emissions reductions are also reported as part of DuPont's sustainability efforts. • Percentage energy use from renewable resources, contrasted with percentage energy use from non-renewable sources is highlighted and reported at DuPont.
Internal Reporting	• Annual reports on the Bold Energy Plan show the company's progress on achieving energy efficiency improvements and areas for improvement. • DuPont maintains a Corporate Environmental Plan (CEP) database that includes energy efficiency improvement information for all the company's facilities and business units. • Data on energy efficiency progress for all facilities and business units is recorded and reported to DuPont's senior leadership.

Source: Bailey, 2010b

Supply Chain and Life Cycle Assessment

DuPont strategic thinking on environmental issues is beginning to include the "footprint" of its supply chain. The Safety, Health and Environment group of DuPont is conducting life cycle analysis (LCA) of its products. DuPont is conducting LCA for two key reasons. First, DuPont is interested in how it would comply with government regulations requiring it to document the environmental footprint of its products. Second, DuPont is being pushed to conduct LCA by large U.S. retailers interested in knowing the environmental footprint of products sold on their shelves. LCA has assisted DuPont in reassessing the design of products and the manufacturing process.

DuPont has not identified energy efficiency opportunities in the operations of its supply chain companies, required certifications related to energy efficiency, or mandated energy efficiency improvements in its supply chain. DuPont is working, however, with one of its customers to identify efficiency opportunities in lieu of product price reductions.

Nissan

Company Profile

Company Name: Nissan North America Inc.
Corporate Headquarters: Franklin, Tennessee, USA
Industry: Auto and truck manufacturing
Employees: 6,500
Annual Revenue: $10,445.5 million
Established (Incorporation Date): Nissan North America – Smyrna was founded in 1981.
Locations: Nissan North America has several facilities around the country that are involved in research and development activities, design and manufacture of Nissan products.

TABLE A- 5: NISSAN NORTH AMERICA MANUFACTURING SITES IN THE UNITED STATES

Plant Location	Operation commenced	Annual Production Capacity	Major Products
Smyrna, Tennessee	1983	550,000 vehicles	Nissan Altima, Nissan Maxima, Nissan Xterra, Nissan Frontier and Nissan Pat
Canton, Mississippi	2003	400,000 vehicles	Nissan Altima, Nissan Quest, Nissan Armada, Nissan Titan and Infiniti QX56
Decherd, Tennessee	1997		Production of engines and transmissions

Source: Nissan, 2010b

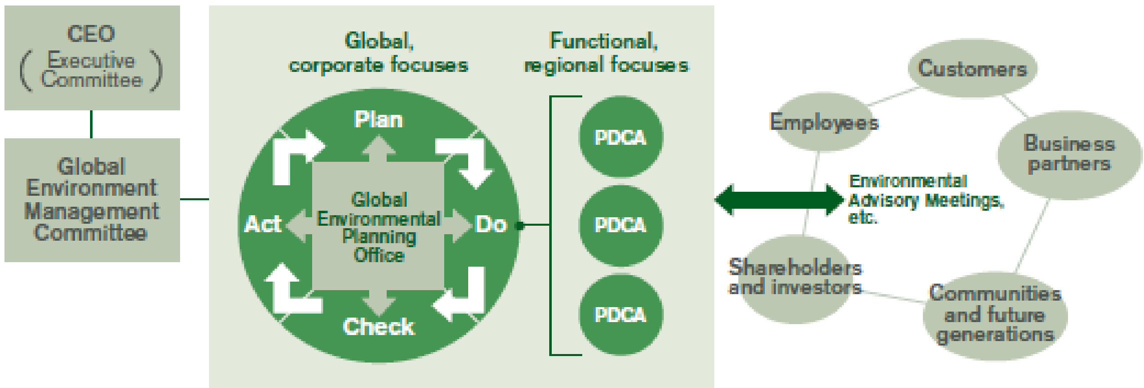
Overview

Nissan Motor Company, founded in 1933 with its headquarters in Japan, is engaged in manufacturing, sales and related business of automotive products, industrial machinery and marine equipment. It has significant operations in Japan, North America, and Europe. The company employs about 175,000 staff members and has 16 production sites globally (Nissan, 2010a). Nissan is partner with Renault for automobile manufacturing and sales, as well as automotive financing.

Established in 1960, Nissan Motor Corporation, U.S.A. (NMC), first began making vehicles in the United States. In 1990, Nissan North America, Inc. was established to coordinate Nissan activities in North America. Subsequently, the two organizations merged operations under the Nissan North America, Inc., name in 1998. Headquartered in Franklin, Tennessee, Nissan North America coordinates all operations in the United States, Canada, and Mexico. Nissan North America has three production plants in the United States – in Smyrna and Decherd, Tennessee, and Canton, Mississippi.

At Nissan, environmental management objectives are embedded in all business activities and receive support of senior leadership at the corporate level. Nissan has a Global Environment Management Committee which is headed by its chief operating officer. Its Global Environmental Planning Office oversees the planning and implementation progress based on the cycles of planning, doing, checking and acting (PDCA).

FIGURE A- 6: NISSAN'S GLOBAL ENVIRONMENTAL MANAGEMENT ORGANIZATION SYSTEM



Source: Nissan Motor Company, 2010

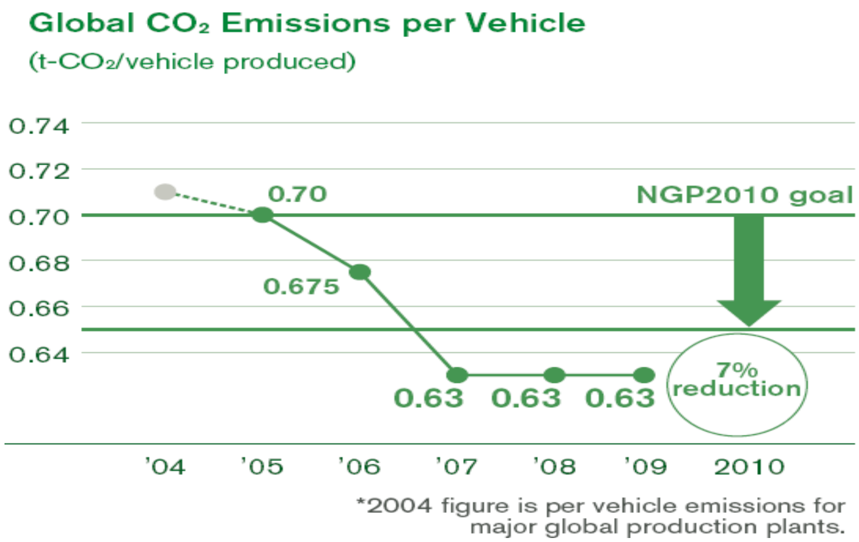
The company defined CO_2 reduction targets in all areas of business by introducing a management index (QCT-C) which places CO_2 reductions alongside traditional indices of quality, cost, and time.
Nissan has established strong partnerships and holds annual environmental advisory meetings with environmental experts and other stakeholders to enhance goals and activities. In addition to audits by third parties, every year Nissan carries out its own internal audits of its environmental systems and performance.

Energy Efficiency Targets:

a) Global Corporate Level

In 2006, Nissan launched its medium-term environmental management action plan, Nissan Green Program 2010, which sets environmental targets and frameworks for company operations.
The strategy is focused to achieve three priorities: reduced CO_2 emissions; reduced other emissions to protect the air, water and soil; and increased recycling of resources.

FIGURE A- 7: PER VEHICLE CO_2 EMISSIONS FROM MANUFACTURING



Source: Nissan Motor Company, 2010

Nissan recognizes that most CO_2 emissions in its manufacturing process are from the consumption of energy generated with fossil fuels and this drives the company's engagement in a variety of energy-saving activities. The Nissan Green Program target is to reduce the company's manufacturing process CO_2 emissions by 7% below the FY 2005 level by FY 2010 as measured by "CO_2 emissions per global vehicle" (total emissions generated from global Nissan vehicle manufacturing sites divided by the total Nissan vehicle production volume). Nissan achieved 10% reduction in its global manufacturing CO_2 emissions per vehicle by 2008 compared with FY 2005 levels (Nissan Motor Company, 2010).

b) Nissan North America

In 2006, Nissan North initiated its corporate energy management plan and since then it has made considerable progress in energy saving initiatives. Becoming a *Save Energy Now* LEADER in October 2009, Nissan North America committed to reducing its energy intensity by 25% over the next 10 years (U.S. DOE EERE, 2010b).[1] Strong partnerships with agencies supporting energy efficiency have noticeably assisted Nissan's efforts in energy management. Nissan North America has partnered with both the Environmental Protection Agency's ENERGY STAR™ program and the U.S. Department of Energy's (DOE) Industrial Technology Program (ITP). These partnerships offer multiple energy management tools and communications support resources.

Motivation

In the motor vehicle manufacturing industry in the United States, energy consumption comprises a small fraction of production cost, approximately one percent of total production costs (U.S. Environmental Protection Agency 2007). This reality minimizes incentives for discretionary investment for energy efficiency projects as they must often compete with other higher-priority investment projects. The resulting outcome would,

---

[1] *Save Energy Now* LEADER is a national initiative of Industrial Technologies Program of U.S. Department of Energy.

therefore, tend to be energy-efficiency initiatives which are incremental and operational-oriented process improvements.

The assessment of U.S. manufacturing industries commissioned by Environmental Protection Agency, process improvement has been the only area ranked high in terms of its potential offering no-cost or less capital-intensive energy-efficiency opportunities. According to research conducted by the Lawrence Berkeley National Laboratory (LBNL), due to the complexity, process, and technological variation in the automotive assembly industry a wide array of opportunities exist for energy efficiency and pollution prevention for paint, welding, and cross-sector practices (e.g., utilities, lighting, stamping, etc.) (U.S. Environmental Protection Agency, 2007).

At Nissan North America, energy efficiency initiatives in the manufacturing process are inspired primarily by senior leadership commitment at the corporate level, as well as by concerns over the growing body of national and international environmental management laws and regulations. Nissan recognizes that most of the CO_2 emissions of its automotive production process are from consumption of energy generated by fossil fuels.

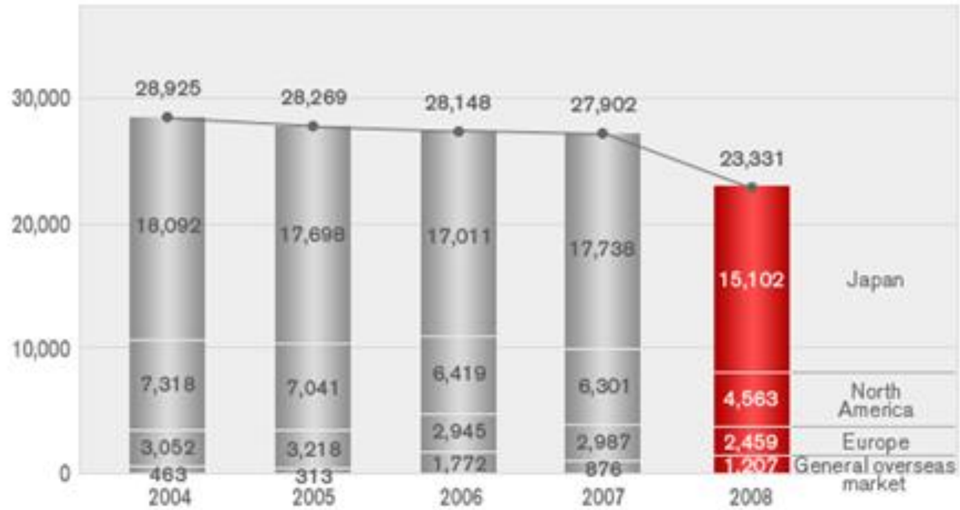
Nissan views its energy management efforts as part of the recipe for good business. It considers its energy-efficiency efforts as wise utilization of the opportunity to decrease its carbon footprint, while also reducing costs of doing business.

Identification

To improve energy efficiency in its manufacturing process, Nissan North America has adopted a comprehensive assessment and identification approach, utilizing both internal and available external resources. Access to external technical expertise and support was facilitated, for example, through its partnership with both the U.S. Environmental Protection Agency's ENERGY STAR program and U.S. Department of Energy's *Save Energy Now* initiative. Nissan North America's three plants have received a series of energy assessments under the *Save Energy Now* initiative, Industrial Technologies Program (ITP). Implementation of several of those recommendations has resulted in an overall reduction of energy consumption by more than 30% since 2006 and enabled saving of more than $11.5 million per year in energy costs (U.S. Department of Energy, 2010a).

Major end uses of energy in the motor vehicle manufacturing industry include painting system, facility lighting heating, ventilating, and air conditioning, compressed air and welding systems (U.S. Environmental Protection Agency, 2007). This demands company-wide efforts across different functions. Nissan North America has established a cross-functional energy management team tasked with identification of energy efficiency opportunities across its production activities. The team draws upon support and expertise from various sections and is headed by the director of the company's paint plant, which is within the division consuming the major share of energy used in the automotive manufacturing process.

FIGURE A- 8: NISSAN'S GLOBAL ENERGY INPUT (1,00GJ)



Source: Nissan, 2010c

A data driven energy management program has facilitated effective and targeted energy efficiency initiatives and assisted in measurement of progress over time. At Nissan North America, each of its three plants has an extensive energy-usage measurement and verification system which supports data gathering on various manufacturing activities. To optimize energy use, disaggregated data on fixed and variable energy use has been gathered on an hourly basis and over time. Nissan North America recognizes the issue of inefficient fixed-energy consumption when plants operate below their potential scale. A large plant can operate at larger volumes more efficiently; however, it becomes problematic when the same large plant operates at low volumes but with the same fixed usage.

Financing

Nissan North America has leveraged government programs through its partnerships to overcome financial barriers against its major capital-intensive energy efficiency projects. For example, The U.S. Department of Energy awarded US$1.4 billion to Nissan North America to retrofit the Smyrna plant and build a lithium-ion battery plant onsite to assessable the Nissan LEAF electric car in 2010.

Implementation

In pursuit of its 2006 energy management plan targets, Nissan has notably established a systematic implementation approach by utilizing internal potentials and partnering with agencies supporting energy efficiency in the industrial sector.

At Nissan North America, senior leadership's commitment to sustainability issues has facilitated the creation of an energy-conscience culture through the establishment of a company cross-functional Energy Management Team. The team leader was appointed by the senior vice president of Nissan North America, which indicates a strong commitment from corporate leadership (U.S. Department of Energy 2010a).

The team was given flexible and selective membership, with participants from manufacturing, engineering, legal, environmental, finance, communications, maintenance, and purchasing, which has empowered staff at every level to fulfill their responsibility and provided them with the most effective functional capacity. The company has also established an internal recognition and reward system to compensate high-performing employees in each of the three plants.

Nissan North America's Energy Management Team initially started its activities by identifying and addressing no-cost operational process improvements. The team, with support from the company's senior leadership, communicated the importance of energy management goals, highlighting the connection to elimination of waste and job security. The improvements resulted in saving 11.4% in absolute energy usage in the first year. In 2007, the Energy Management Team set another goal of 30% reduction in energy consumption, as the target over the next four years. The team was able to achieve this target by the end of 2008 (U.S. Department of Energy, 2010a).

The energy saving projects included the following:

- Installed variable-frequency drives
- Reduced number of air compressors
- Sub-metering and monitoring
- Upgraded and replaced chillers
- Upgraded lighting and controls
- Air recirculation

Nissan is working on a sustainability project directed by the vice president of Nissan's two Tennessee Plants. The project titled "The 21st Century Sustainable Manufacturing Project" is aimed at making Nissan's facilities as green as possible to further drive the energy efficiency culture within the company, by making its products and processes sustainable. Employee engagement is the core of Nissan's energy efficiency achievements and it drives the sustainability of those achievements.

Measurement, Benchmarking and Reporting

A key element of an effective energy management strategy is determining an appropriate level of energy performance for a plant through comparison with similar plants in the industry. Nissan's Canton and Smyrna auto assembly plants are partners with the U.S. Environmental Protection Agency's ENERGY STAR program which supports energy use benchmarking within industries.

ENERGY STAR's "plant energy performance indicators (EPIs)" was introduced as a statistical model measuring plant-level energy use and supporting benchmarking of energy use in the automobile industry. The first EPI was developed for automobile assembly plants using data from the year 2000, and was updated in a second EPI with 2005 as the base year (Boyd, 2010).

The model assigns a score for the plant that reflects the relative energy efficiency of the plant compared to that of the industry based on the following information (Boyd, 2005):

- Annual energy use for the current year and a baseline year as defined by the user
- Number of vehicles produced in the current and baseline years
- Line speed: the number of vehicles produced per hour, which is used to compute annual plant capacity
- Wheelbase of largest vehicle produced at the plant
- Whether or not the air in the plant is cooled, or tempered
- Five-digit zip code for the location of the plant if the default 30-year average HDD and CDD data are used –otherwise the user provides actual annual HDD and CDD for that year

The automobile assembly EPI applies only to automobile assembly plants that housed the painting operation (a major use of energy in automobile manufacturing), vehicle assembly, and body weld. It is a percentile score on a scale of 0–100. Plants that score 75 or better are classified as efficient. A score of 75 means a particular plant is performing better than 75% of the plants in the industry. Nissan North America has qualified in the top 25% for energy efficiency, which is indicative of an efficient manufacturing process according to the model (U.S. Department of Energy, 2010c).

Nissan North America is one of seven companies that are participating in a series of training sessions organized by the U.S. Department of Energy's Industrial Technologies Program (ITP). The three-part training program is aimed at manufacturers in the Southeastern United States that are working to demonstrate energy management systems that meet the highest standards in energy efficiency. The demonstration project is being conducted through ITP's broader *Save Energy Now* initiative, and supports ITP's mission to promote energy efficiency programs throughout the manufacturing industry. Participating demonstration sites are testing the ANSI-accredited Superior Energy Performance certification program requirements and are working to meet future energy challenges by developing skills that will enable them to effectively manage their energy resources. Manufacturing facilities will receive assistance from demonstration support teams to implement an energy management system that will conform to the forthcoming International Organization for Standardization (ISO) energy management system standard ISO 50001. Manufacturing facilities that demonstrate their success at meeting the ISO 50001 energy management standard show that they are able to manage their energy use effectively, improve energy performance, and use accredited methods to measure and validate energy efficiency and energy intensity improvements (U.S. Department of Energy, 2010).

Supply Chain

As an automobile manufacturing company, Nissan Motor Company has a diverse set of suppliers upstream. The company is committed to reducing the footprint of its products through closely monitoring its supply chain. In April 2008, Nissan issued the Nissan Green Purchasing Guidelines as standards for the environmental efforts of their automobile parts and materials suppliers; the guideline is being expanded to cover their operations globally.

Nissan and Renault entered into an alliance in 1999. The Nissan and Renault purchasing divisions have laid out their approach to dealing with suppliers in a booklet titled The Renault-Nissan Purchasing Way. In 2010, they created the Renault-Nissan CSR Guidelines for Suppliers (Nissan Motor Company, 2010)

Foot Print

At the corporate level, Nissan has introduced a new set of management indices, Nissan Global CO_2 Management Way, which incorporates CO_2 reductions concerns alongside traditional indices of quality, cost and time. At Nissan, emissions reduction is among the highest priorities for the company. As a global automobile manufacturer, Nissan is working to reduce CO_2 emissions at every stage of the life cycle of its products: from production to transportation and operations.

FIGURE A- 9: NISSAN'S FOOTPRINT

Source: Nissan Sustainability Report, 2010

TABLE A- 6: PATHWAYS TO ENERGY EFFICIENCY: ADDITIONAL COMPANY CASE STUDIES

	DOW	IBM	Johnson & Johnson	PEPSICO	Toyota	United Technologies
Motivation	Cost savings; environmental impact of operations	Cost savings; risk reduction	Environmental impact of operations	Consumer preferences; cost of energy; employee recruitment	Environmental impact of operations; efficiency of operations	Efficient operations; cost reductions
Goal Setting						
top-down (corporate level mandate)	X		X	X (2004 - present)		X
bottom-up (plant level goals are dominant)		X		X (1990's)	X	
Identification						
inside-out (internal energy services takes lead)		X	X	X	X	X
outside-in (external actors take lead)	X					
Financing						
capital set-aside (special energy-efficiency fund)			X	X		
parity competition	X	X			X	X
Implementation (primary responsibility)						
company-wide energy services	X			X		
plant energy team		X	X		X	X
Measurement, benchmarking, and reporting			NA			
SKU level	x	X		X	X	X
Company level						
Use of industry benchmarks					X	NA

	DOW	IBM	Johnson & Johnson	PEPSICO	Toyota	United Technologies
Internal reporting	X	X		x	X	
External reporting	X	X		X	X	
Supply Chain	no engagement		NA			no engagement
Energy Monitoring & Capacity Building		X (monitoring only)		X	X	
Scorecards						
3rd Party Certification						X (planned)
	Source: Pew, 2010a	Source: Pew, 2010a	Source: WWF Climate Savers	Source: Duke,2010 & Pew, 2010b	Source: Pew, 2010a	Source: Pew, 2010a

Source: Summarized from existing company case studies, as cited

References

Bailey, William F. (2007). "DuPont Energy Breakout Initiative." *Proceedings from the Twenty-ninth Industrial Energy Technology Conference*, New Orleans, LA, May 8-11, 2007. Retrieved July 23, 2010 from http://repository.tamu.edu/bitstream/handle/1969.1/87967/ESL-IE-07-05-04.pdf?sequence=1

Bailey, William F. (2010a). Principle Consultant and Energy Fellow, DuPont. Personal Communication with CGGC Research Staff. June 30, 2010.

Bailey, William F. (2010b). Principle Consultant and Energy Fellow, DuPont. Personal Communication with CGGC Research Staff. August 5, 2010.

Boyd, A. Gale. (2005). "Development of a Performance-based Industrial Energy Efficiency Indicator for Automobile Assembly Plants." Argonne National Laboratory. Retrieved August 26, 2010 from http://www.energystar.gov/ia/business/industry/AutoEPIBackground.pdf

Boyd, Gale. (2010). "Assessing Improvement in the Energy Efficiency of U.S. Auto Assembly Plants." Duke Environmental Economics Working Paper Series. Retrieved August 26, 2010 from http://www.nicholas.duke.edu/institute/Duke_EE_WP_10-01.pdf

Bridgestone Americas, Inc. (2007). "Operations: Resource Conservation and Emissions Reduction." Retrieved August 11, 2010 from http://demos.icomstec.com/bridgestone/run/report-operations.html

Bridgestone Americas, Inc. (2008). "One Team, One Planet: Bridgestone's Global Call for Environmental Teamwork." Retrieved August 16, 2010 from http://www.state.tn.us/environment/ea/pdf/eo_tp2r_bsfs_oneteam.pdf

Bridgestone Americas, Inc. (2009). "Environmental Report 2009." Retrieved August 9, 2010 from http://demos.icomstec.com/bridgestone/run/download/full-report.pdf

Bridgestone Americas, Inc. (2010a). "Manufacturing Facilities: Bridgestone Americas Tire Operations, LLC." Retrieved August 9, 2010 from http://www.bridgestone-firestone.com/mfglocations_index.asp?id=about/directory_tireplants

Bridgestone Americas, Inc. (2010b). "Who We Are: About Bridgestone Americas Inc." Retrieved August 9, 2010 from http://www.bridgestone-firestone.com/about_bg_index.asp

Bridgestone Corporation. (2008). "Moving Into the Future: Bridgestone Corporation Corporate Brochure." Retrieved August 16, 2010 from http://www.bridgestone.com/corporate/profile/pdf/bs_profile.pdf

Brown, M.A. (2001). "Market failures and barriers as a basis for clean energy policies" *Energy Policy* 29, 1197–1207

DeCanio, S.J., (1993). "Barriers within firms to energy-efficient investments" *Energy Policy* 21(9) 906-914.

DeCanio, S.J., (1994). "Agency and control problems in US corporations: the case of energy-efficient investment projects" *Journal of the Economics of Business* 1(1) 105-123.

DeCanio, S.J., (1998). The efficiency paradox: bureaucratic and organizational barriers to profitable energy saving investments. *Energy Policy* 26, 441–454.

Deschamps, André. (2010). Senior Project Manager and Engineer, PSD Bridgestone Firestone. Personal Communication with CGGC Research Staff. August 3, 2010.

DuPont. (2008). *2008 Sustainability Report*. Retrieved July 23, 2010, from http://www2.dupont.com/Sustainability/en_US/assets/downloads/DuPont_2008_Sustainability_Progess_Report.pdf

DuPont. (2010a). "A Continuing Global Challenge." Retrieved July 23, 2010, from http://www2.dupont.com/Sustainability/en_US/index.html

DuPont. (2010b). "Improving Energy Efficiency and Profitability with DuPont: Bold Energy Plan Drives Results through Real World Experience." Retrieved July 23, 2010, from http://www2.dupont.com/DuPont_Sustainable_Solutions/en_US/assets/downloads/DuPont_Energy_Efficiency_Case_Study.pdf

DuPont. (2010c). "Welcome to DuPont Products and Services." Retrieved July 23, 2010, from http://www2.dupont.com/Directories/en_US/Products_Services_Index/index.html

DuPont. (2010d). "DuPont Worldwide." Retrieved July 28, 2010, from http://www2.dupont.com/Our_Company/en_US/worldwide/us_country.html

Duke (2010). "Capturing the Energy Efficiency Opportunity: Lessons from the EDF Climate Corps," Conference on lessons learned about energy efficiency from the EDF Climate Corps. Durham, NC. September 17, 2010. Duke University. Electronic access: http://cggc.duke.edu/events/energy_efficiency_conf/overview.php

Elliott, N., Shipley, A., & McKinney, V. (2008). "Trends in Industrial Decision Making" Washington, D.C.: ACEEE.

Hassett, K. and Metcalf, G. (1993). "Energy Conservation Investment: Do Consumers Discount the Future Correctly." *Energy Policy*, 21(6):710-716.

Hoffman, Andrew J. (2006). *Getting Ahead of the Curve: Corporate Strategies that Address Climate Change.* Prepared for the Pew Center on Global Climate Change.

Land, Bob. (2009). "Bridgestone." *America's Greatest Brands: An Insight into Many of America's Strongest and Most Valuable Brands, Volume VII*. Retrieved August 16, 2010 from http://www.americasgreatestbrands.com/volume7/assets/AGB%20pdfs/AGB%20Bridgestone.pdf

Meier, A. (2010) "Managing Energy Efficiency in Companies" A presentation to the Energy Efficiency National Partnership (Singapore) Available at www.e2singapore.gov.sg/docs/Meier_Managing_EE_in_firms.pdf. Accessed February 12, 2011.

Morgan, G. (1985). Images of Organisation. Sage: London.

Nissan. (2010a). "Corporate Information." Retrieved June 20, 2010 from http://www.nissan-global.com/EN/COMPANY/PROFILE/

Nissan. (2010b). “Corporate Information: Facilities Oversees.” Retrieved August 26, 2010 from http://www.nissan-global.com/EN/COMPANY/PROFILE/EN_ESTABLISHMENT/NORTH_AMERICA/

Nissan. (2010c). “Environmental Activities.” Retrieved August 27, 2010 from http://www.nissan-global.com/EN/ENVIRONMENT/LIBRARY/DATA/GLOBAL/

Nissan Motor Company. (2010). *Sustainability Report 2010*. Retrieved August 26, 2010 from http://www.nissan-global.com/EN/DOCUMENT/PDF/SR/2010/SR10E_All.pdf

Pew Center on Global Climate Change. (2005). “Energy Supply Solutions.” Retrieved June 24, 2010 from http://www.pewclimate.org/what_s_being_done/in_the_business_community/energy_supply.cfm

Pew (2010a). “From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency” (by William Prindle). Washington, D.C.: Pew Center on Global Climate Change.

Pew (2010b). ““From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency” Conference on corporate energy efficiency and release of in-depth research report. Chicago, IL April 6-7, 2010. Pew Center of Global Climate Change.

Reddy, A.K.N. (1991). “Barriers to improvements in energy efficiency.” *Energy Policy* 19, 953-961.

Rittenhouse, Dawn G. (2010). Director of Sustainability, Environment and Sustainable Growth Center DuPont. Personal Communication with CGGC Research Staff. August 9, 2010.

Ross, M. (1990). Capital Budgeting Practices of Twelve Large Manufacturers. In: Philip Cooley (Ed.), Advances in Business Financial Management. Dryden Press: Chicago, pp. 157-170.

Sanstad, A., C. Blumstein and S. Stoft (1995). “How High are Option Values in Energy-Efficiency Investments?” *Energy Policy* 23(9):739-744.

Sassone, P.G., and Martucci, M.V. (1984). Industrial energy conservation: the reasons behind the decisions. *Energy* 9, 427-437.

Schleich, J. (2009). “Barriers to energy efficiency: A comparison across the German commercial and services sector” *Ecological Economics,* 68, 2150–2159.

Sorrell, S., O'Malley, E., Schleich, J., Scott, S., (2004). The Economics of Energy Efficiency — Barriers to Cost-effective Investment. Edward Elgar: Cheltenham.

Steinmeyer, D. (1998). Trading Capital for Energy , ACEEE report IE984. Washington, D.C.: American Council for an Energy-Efficient Economy.

Train, K. (1985). Discount rates in consumers’ energy-related decisions: a review of literature. *Energy* 10(12) 1243-1253.

U.S. Department of Energy EERE. (2010). “DOE Kicks off Training for Manufacturers in the Southeast Region to Demonstrate Energy Standards.” (August 6, 2010). Retrieved August 16, 2010 from http://apps1.eere.energy.gov/news/progress_alerts.cfm/pa_id=378

U.S. Department of Energy, EERE. (2010a). “Nissan Showcases the Results of an Energy-Wise Corporate Culture.” Save Energy Now Leader Program, Nissan Energy Assessment Case Study. Retrieved

August 26, 2010 from http://www1.eere.energy.gov/industry/saveenergynow/pdfs/nissan_case_study.pdf

U.S. Department of Energy, EERE. (2010b). "Save Energy Now: FY 2010 Program Developments."Industrial Technologies Program. Retrieved August 26, 2010 from http://www1.eere.energy.gov/industry/saveenergynow/pdfs/sen_fy2010_program_developments.pdf

U.S. Department of Energy, EERE (2010c). "Save Energy Now Information Bulletin." Retrieved July 20, 2010 from http://www1.eere.energy.gov/industry/saveenergynow/pdfs/save_energy_now_leader_program.pdf

U.S. Environmental Protection Agency. (2007). "Energy Trends in Selected Manufacturing Sectors: Opportunities and Challenges for Environmentally Preferable Energy Outcomes." Retrieved August 26, 2010 from http://www.epa.gov/sectors/pdf/energy/report.pdf

Walker, Robert B. (2007). "An Outsider's Thoughts on Strategic Planning." Vision: Teamwork Newsletter for Department of Labor & Workforce Development Employees (January 2007). Tennessee Department of Labor & Workforce Development. Retrieved August 16, 2010 from http://www.state.tn.us/labor-wfd/teamnews/january2007/TeamwrknewsDWJan07.html

World Wildlife Fund Climate Savers (2009). "What does it take to get projects off the ground? Johnson & Johnson's Capital Relief Funding for CO2 Reduction Projects" (By Corey Billington, Aileen Ionescu-Somers and Tania Braga). IMD-2-0146. Retrieved March 12, 2010 from www.ecch.com/imdfreecases.