MAKING BUSINESS SENSE OF ENERGY EFFICIENCY AND POLLUTION PREVENTION

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ACRONYMS

ACEEE	American Council for an Energy-Efficient Economy
DOE	United States Department of Energy
E2	Energy efficiency
EPRI	Electric Power Research Institute
EPIC	EPRI's Partnership for Industrial Competitiveness program
IAC	Industrial Assessment Center
IRR	Internal rate of return
NIST	National Institute for Standards Technology
$NICE^3$	National Industrial Competitiveness through Energy, Environment and Economics
NPV	Net present value
P2	Pollution prevention
ROA	Return on assets

INTRODUCTION

> ***"Far from being a soft issue grounded in emotion or ethics, sustainable development involves cold, rational business logic."***
> — Robert Shapiro, CEO, Monsanto (HBR 1997)

Sustainable development is just one of the many names given to the concept of growing the economy while protecting the environment. Industrial ecology is another name for using resources efficiently as part of good business practices. Energy efficiency and pollution

E2/P2 Project Achievements

- < reduce, reuse, recycle, re-sell waste
- < recover usable materials from wastes
- < reduce solvent evaporation
- < reduce emissions
- < eliminate solvents use
- < eliminate release of hazardous sludge
- < reduce energy use
- < produce a renewable source of energy
- < reduce transportation
- < increase production efficiency
    - < reduce operations downtime
    - < increase productivity
    - < reduce failure rates
- < reduce operating expenses
    - < reduce water usage
    - < reduce disposal costs
    - < reduce chemical treatment liability
    - < reduce sewage expenses
- < increase sales
- < reduce capital costs
- < improve product quality
- < increase plant capacity
- < reduce space requirements
- < preserve and increase jobs
- < reduce noise level
- < "re-use" brownfield site
- < free up capacity at municipal treatment plants

prevention[1] involve the efficient use of resources, which is key to sustainable development and industrial ecology. Com-panies not only prevent pollution but can also enhance profits by reducing energy and material use. Companies save the direct costs of these resources, as well as reducing disposal costs, avoiding fines, and minimizing bad publicity. In addition, resource efficiency often enhances productivity, streamlines production, and improves workplace conditions. Com-panies come out ahead by helping the en-vironment, their employees, and their bottom line.

This paper presents a number of examples of projects that have successfully combined energy efficiency and pollution prevention technologies and strategies to enhance the environment, productivity, and the bottom line. The box at right lists types of environmental and business achievements realized in the case studies summarized in this paper. (This paper will be posted on the web at aceee.org/p2. The web site will be expanded to include additional case studies as they become available.) This paper also discusses the role of energy efficiency in preventing pollution and reducing global warming gases, including energy savings potential and economic benefits. Barriers to energy efficiency are also discussed along with strategies to overcome barriers, including the integrated P2/E2 approach. This paper also discusses how to make a compelling case to business management by understanding the financial analysis of energy efficiency and pollution prevention.

Some believe that protecting the environment will hurt the U.S. economy and put us at a disadvantage with foreign competitors who have less rigorous environmental standards. This may have been true years ago when "tailpipe" technologies were the primary solution to minimizing pollution. Today, however, we know how to protect the environment by using resources more efficiently: through energy efficiency (E2) and pollution prevention (P2). E2 and P2 are just two types of efficiency, and efficiency has always been recognized as being good for business. As more businesses begin to realize the profitability of resource efficiency, E2/P2 will grow in importance as a strategy to stay competitive and maximize shareholder value.

For many years, efforts to promote energy efficiency and pollution prevention traveled on separate, parallel paths. Many energy efficiency proponents considered only energy savings aspects of their projects, and many P2 proponents did not include energy as a pollution source. More and more, however, the synergies between energy efficiency and P2 have become more apparent. Energy efficiency projects often have non-energy P2 benefits and P2 projects often save energy. In addition, both E2 and P2 projects often have benefits that extend to include enhanced productivity and improved product quality. When looking at E2/P2 projects from a business perspective, all benefits — direct and indirect — must be taken into account to show how such projects impact the bottom line.

[1] The author acknowledges that energy efficiency is one type of pollution prevention, and uses the term "pollution prevention" in this paper to refer to all non-energy types of pollution prevention.

ENHANCING SHAREHOLDER VALUE

The primary responsibility of business management is to *increase shareholder value*. Shareholder value can be increased in many ways, including, but not limited to:

- cutting costs,
- increasing revenues,
- increasing productivity,
- improving product quality,
- reducing risk, and
- enhancing reputation.

Energy efficiency and pollution prevention have been shown to do all of these things. Several studies document a positive correlation between a company's environmental performance and its shareholder value:

> Two management professors studied 243 firms over a two-year period (1991/92), comparing environmental ratings (including compliance records, expenditures, waste reduction, support for environmental groups, etc.). Using return on assets (ROA) as a dependent variable, they found a positive correlation between ROA and environmental ratings (Russo and Fouts 1997).

> Innovest Group International, an environmental and investment advisory firm in Toronto, developed an analytical tool that predicts how a company's environmental performance translates into financial terms. Innovest found that environmental ratings correlate closely with financial performance and that the companies with the highest environmental ratings outperformed their competitors by as much as five percent. Besides being an indicator of strong financial performance, environmental performance also correlates with more sustainable earnings quality (Green Business Letter 1998).

> A study conducted by two economics professors at Dickenson College in Pennsylvania (Stephen E. Erfle and Michael J. Fratantuono) found a positive correlation between a group of 84 companies' financial performance and several aspects of social performance, including environmental record.[2] Companies with top-rated environmental records, compared to those with the worst records, faired significantly better financially, including

[2] Ratings by Council on Economic Priorities based on ten key social issues, including environmental performance.

a 3.9 percent higher return on investment, a 4.4 percent higher earnings-to-assets ratio, and a 16.7 percent higher operating income growth (Makower 1994).

Since these studies show a correlation and not causation between environmental and financial performance, further evidence is required to show whether: (1) financial performance is enhanced by good environmental performance; (2) companies that are stronger financially are better able to be more proactive environmentally; or (3) each kind of improvement supports the other. Case studies presented in this paper support the hypothesis that environmental performance — specifically energy efficiency and pollution prevention — enhance shareholder value. For example, a 1992 study of 75 case studies of pollution prevention across a variety of industries found an average payback of 1.6 years (Fischer and Zachritz 1992) — these investments certainly would enhance shareholder value.

Critics may claim that there are a limited number of E2/P2 projects that have a favorable financial return. This is what Dow Chemical thought when the its Louisiana Division, in response to rising energy prices, created an Energy Contest to reduce energy use with projects that provided a minimum of 100 percent return on investment (ROI). In the first year (1981), the 27 (out of 39) projects that survived the review process cost $1.7 million to implement, but paid off with a 173 percent ROI. These impressive results left employees feeling like all opportunities had been tapped, however, the following year's contest had 32 winners, at a cost of $2.2 million and an ROI of 340 percent. In the third year, the contest was expanded to include waste reduction, and 38 winning projects had an ROI of 208 percent on a capital investment of $4 million. Dow's contest was eventually formalized as "WRAP" — waste reduction always pays. Over a 12-year period, Dow implemented 936 projects with ROIs averaging between 97 percent and 470 percent. Of these projects, 575 projects were audited, verifying savings of more than $110 million per year and an average ROI of 204 percent. Dow attributes its success with energy and waste reduction to creating an environment of teamwork and cooperation among plants that continually builds momentum towards bigger and better projects with higher ROIs (Nelson 1993).

ECONOMIC ENERGY-SAVINGS POTENTIAL

A 1997 study performed by the Alliance to Save Energy, American Council for an Energy-Efficient Economy (ACEEE), Natural Resources Defense Council, Tellus Institute, and Union of Concerned Scientists shows energy efficiency can be good for the economy, strengthening our competitive edge and creating jobs. *Energy Innovations, A Prosperous Path to a Clean Environment (Energy Innovations)* shows that, by following the proposed "Innovation Path," the U.S. could cut carbon dioxide emissions to ten percent below 1990 levels (Figure 1) while saving consumers money and creating additional jobs. Specifically, by 2010, national energy costs can be reduced by $530 per average household and nearly 800,000 additional jobs can be created (Figures 2 and 3). Following the "Innovation Path" would allow the industrial sector to reduce its primary energy use by 14 percent by 2010 compared to the present path.

By 2030, the industrial sector could become a net electricity producer rather than a net consumer. *Energy Innovations'* Executive Summary is available on the web at: www.tellus.org/ei.

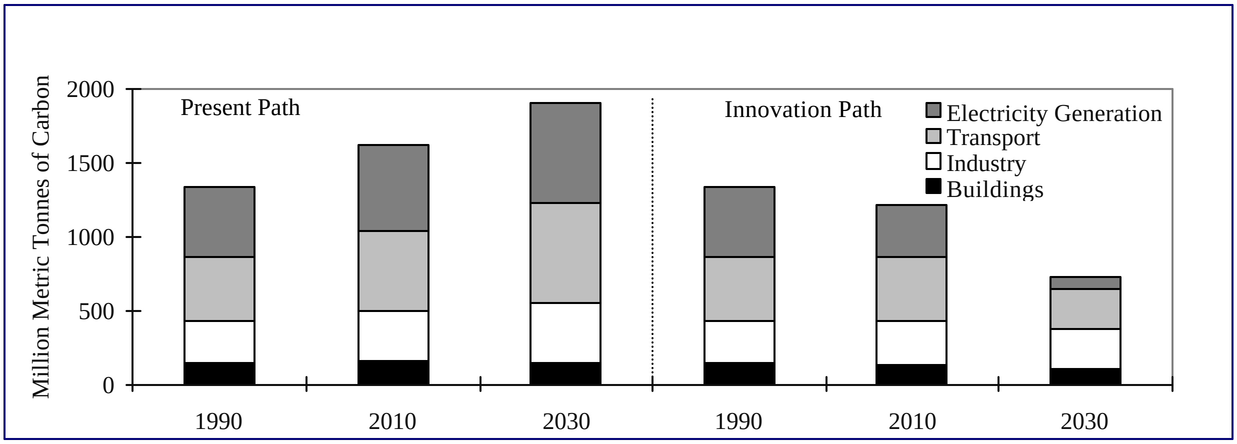

Figure 1. Total Carbon Emissions from Direct Fuel Use by Sector, Present Path vs. Innovation Path

These benefits can be attained through policies that stimulate the introduction and use of energy efficiency measures and renewable energy sources, such as combined heat and power, fuel cells for powering vehicles, high efficiency heat pumps for space and water heating, new bioenergy conversion techniques, and industrial process improvements such as membrane separation technologies and advanced sensors and controls. *Energy Innovations* also proposes new market mechanisms such as emissions performance allowances and revenue-neutral financial incentives, energy efficiency standards on buildings, appliances, and vehicles, renewable energy standards on power generation, research and development initiatives, and other cost-effective policies for stimulating greater energy efficiency and renewable energy use (Alliance to Save Energy et al. 1997).

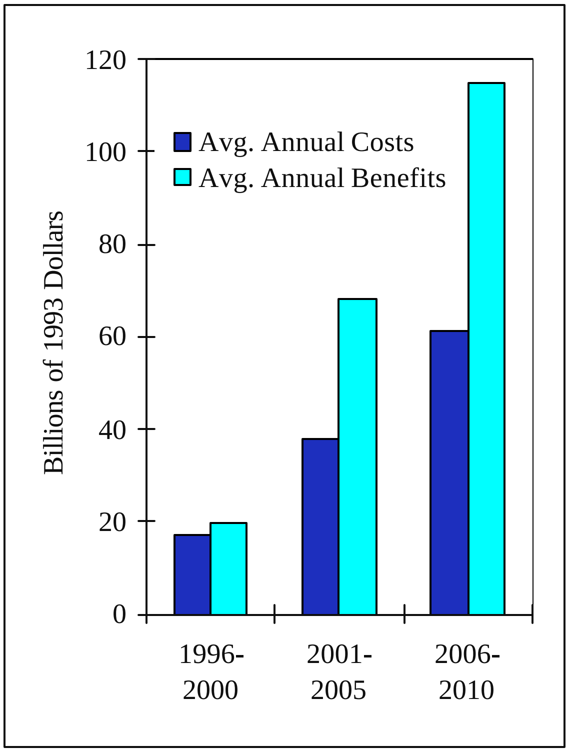

Figure 2. Costs and Benefits of the Innovation Path

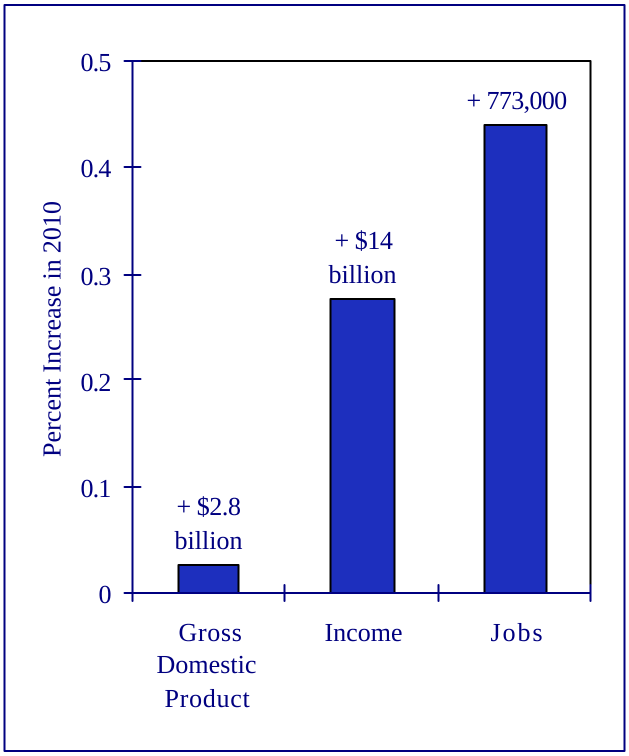

Figure 3. Macroeconomic Benefits of the Innovation Path

ENERGY EFFICIENCY IN THE INDUSTRIAL SECTOR

Industry accounts for 36 percent of U.S. primary energy use. The industrial sector is diverse, with a wide range of processes, energy requirements, and pollution issues. Although for some industries (e.g., primary aluminum, hydraulic cement and industrial gases) energy accounts for more than 20 percent of value of shipments, for most of the manufacturing sector, energy expenditures are a small part of operating costs, averaging less than two percent of value of shipments (Census 1992). The fact that energy is cheap and is not a major cost component for most industries, makes energy efficiency a low priority for most industries. In addition, most industries do not perceive energy as a discrete issue, but as a component of broader issues such as cost of manufacturing, environmental compliance, safety and productivity. A 1996 survey of 40 corporate energy managers from large companies indicated that only 12 percent of these managers focus solely on energy, with the majority also responsible for issues such as water, waste, environmental compliance, facility design and management, fire and safety (Shepard 1996). Since most projects that save energy impact some of these other issues, the decision-making process will involve an evaluation of all these issues together (Elliott, Pye, and Nadel 1996).

Energy efficiency competes with other issues for limited resources within a company. While capital is the most often cited resource, staff time may be of equal or greater importance. Corporate downsizing has resulted in less staff available to address all issues. Since energy is a component of most processes and these other processes merit greater attention from management, it makes sense to understand the interrelationships among these variables in order to promote energy efficiency more effectively to management. Studying these interrelationships shows that energy efficiency projects often have benefits that extend beyond energy savings to include pollution prevention, process efficiencies, and increased productivity. Conversely, energy savings often accompany projects that focus on pollution prevention, process efficiency, or increased productivity. Thus, when making a case for any of these types of projects it makes sense to present *total* benefits. Only by understanding the total costs and total benefits of a project can a business evaluate its financial impact on shareholder value.

THE INTEGRATED APPROACH TO POLLUTION PREVENTION AND EFFICIENCY

Programs to reduce industrial pollution have evolved from prescriptive, measure-based regulations that focus on the "tail pipe," to more flexible programs that focus on reducing pollution by minimizing waste and redesigning processes. The success and cost effectiveness of this approach have been proven. ACEEE's analysis supports the integrated assessment approach (Elliott, Laitner, and Pye 1997). Conventional measure-based, energy efficiency assessments focus on increasing the efficiency of existing processes, while P2 assessments focus on restructuring processes to eliminate waste and more efficiently use raw materials. In many cases, the portion of the product that is wasted has required significant energy to produce. This is particularly true if the waste occurs late in the production process. If waste is reduced, the energy and other resources required to produce the *waste* product can be redirected to produce *salable* product, and the energy and other costs associated with waste disposal can be avoided. P2 programs also have been noted for reducing production cost and improving product quality. Examples of programs that take the integrated approach to manufacturing efficiency follow.

EPRI's (Electric Power Research Institute) (www.epri.com) Partnership for Industrial Competitiveness (EPIC) program focuses on maximizing energy efficiency, pollution prevention and industrial competitiveness through integrated industrial process assessments, looking at the entire facility, rather than focusing on specific technology applications. The program reports that industries value safety first followed by environmental compliance and then productivity. EPRI sees EPIC as a path for moving utility programs from prescriptive, broad-based programs targeted at the entire industrial class, to targeted programs that develop and demonstrate technologies and techniques that enhance customer competitiveness (see example in box).

In 1994, the Industrial Assessment Centers expanded from the Energy Analysis and Diagnostic Center program (started by DOE in the 1970s) by adding a waste minimization audit component to the energy audits. IACs are managed by universities, sponsored by DOE Office of Industrial Technology, and operate at 30 accredited engineering schools across the country. Guided by experienced faculty, engineering student teams conduct free audits for small- to medium-sized industrial companies in 43 states. Assessment teams recommend specific actions to optimize energy efficiency, waste minimization and productivity improvements, and provide cost estimates, potential savings, and payback time (see box for IAC example). In addition to free assessments, the IAC web site (www.oit.doe.gov/Access/iac) provides a database with results of over 6,000 energy audits and around 1,000 industrial assessments, as well as a do-it-yourself assessment workbook, training manual, and productivity manual (Medina et al. 1997).

In addition to these two programs, there are hundreds of manufacturing assistance programs that include an E2/P2 component. For example, the following resources exist throughout the country:

EPIC Team Survey of a Foundry Customer

The wide range of energy efficiency, productivity, and environmental improvements that EPIC typically recommends is exemplified by a survey of one of its foundry customers. Recommendations include: a scrap reduction program, computerized rigging, demand control, sand reclamation, improved refractory practice, new gas regulator, adjustable speed drive on dust collector, interlock rotoblast, and upgraded ladle preheat. The payback for each of these recommendations is two years or less (EPRI 1996).

IAC — Texas A&M University, Kingsville

Between its establishment in November 1993 and July 1996, Texas A&M, Kingsville performed 65 industrial assessments, recommending 388 energy conservation opportunities and 53 waste minimization opportunities. The IAC estimated potential energy savings of almost 159 billion Btu/year (7.6 percent of total energy use), valued at $1.9 million. Waste assessment audits estimated over 10 percent waste reduction, valued at $1.1 million, with a payback of less than three months (Jewell and Chavez 1997).

< The U.S. Department of Commerce's National Institute for Standards Technology (NIST) sponsors more than 80 manufacturing assistance centers throughout the country through its Manufacturing Extension Partnership program. These centers offer cost-shared services to local manufacturers in various technical and technology transfer areas (Alliance to Save Energy 1998).

< The Association of Research and Technology Transfer Institutions (ASERTTI) has 19 members in 16 states and the Virgin Islands. These institutions offer programs that provide technical assistance to local manufacturers to promote economic development, environmental protection, and enhanced productivity. The New York State Research and Development Authority (NYSERDA), for example, offers several programs, including Flextech and Industry & Applications, geared toward the integrated approach (Pye and Nadel 1997).

< Approximately 30 state-sponsored technology programs have regional centers that help industry adopt new technologies (e.g., Florida Manufacturing Technology Center, Ohio Edison Technology Center, and Ben Franklin Technology Center in Pennsylvania) (Alliance to Save Energy 1998).

< Other such programs are sponsored by EPA, National Science Foundation, and Small Business Administration (Alliance to Save Energy 1998).

National Inventory of Manufacturing Assistance Programs, including more than 300 manufacturing assistance programs and centers (by state), has been prepared by the Alliance to Save Energy (1998) and will be available on the web (www.ase.org/NIMAP2) in mid-1998.

THE INTEGRATED APPROACH: CASE STUDIES

The following case studies show how a range of industries have implemented projects or overall corporate strategies that profit from the synergies of energy efficiency, pollution prevention, process efficiency, and increased productivity.

AAP Saint Mary's
Aluminum Recycling

AAP Saint Mary's (AAP) produces original and after-market aluminum automotive wheels. The process takes raw aluminum ingots and melts, casts, machines, and polishes finished aluminum wheels. During the machining process, up to 40 percent of a wheel's aluminum is lost, resulting in 6,000 tons of aluminum shavings per year. Traditionally, these chips were trucked to a third-party recycler, who cleaned, re-melted and reformed them into ingots, which were returned to AAP where they were re-melted and reused.

With the help of Ohio Department of Development (ODOD) and a $300,000 grant from DOE's NICE[3] program, AAP moved chip reclamation in-house, eliminating the need to transport and re-melt their waste aluminum chips. AAP's advanced furnace improves the recovery of aluminum and produces fewer pollutants than the equivalent off-site melting process.

Achievements:

< Reduced transportation and melting the aluminum once instead of twice reduces energy use by 15.6 billion Btus.
< Aluminum waste was reduced to 1.5 percent from the old process's 8 percent waste rate.
< Cuttings oils are now also recycled.
< Cost savings are $1.60 per wheel — more than $1.9 million per year — for a payback of around 18 months.

Contacts: Dan Hosek at AAP St. Mary's, or Susan Covey or John Greenway at ODOD
Source: DOE 1997

A. Finkl & Sons Co.
Innovation in the Die Steel Forging Industry

A. Finkl & Sons Co. is one of the largest custom die steel forgers in the U.S., with $80 million in sales and 400 employees as of 1995. This fully integrated steel production facility in Chicago produces die blocks for the closed die forging industry, plastic mold and die casting die steels, custom open die forgings, and forge shop and steel mill repair parts.

Finkl's long-term program to reduce costs and improve productivity include: upgrading and computerizing equipment and building new, more efficient furnaces, including a Vacuum Arc furnace, and solid-waste recycling. All of the steel made is produced from premium scrap metal.

Achievements:

< Energy use has declined 36 percent from 165 therms to 105 therms per ton.
< 99.7 percent of solid waste is reused or recycled.
< Production efficiency (in terms of man-hours worked) has doubled.
< Partly because of its success in pollution prevention and energy efficiency, the City of Chicago and Finkl have created a new urban manufacturing campus adjacent to an affluent residential neighborhood, preserving 10,000 jobs in the city.

Source: DOE 1997

Anheuser-Busch Companies, Inc.
Bio-Energy Recovery

In response to rising fuel prices in the late 1970s, Anheuser-Busch looked for ways to gain control over energy and other utility costs. The company began exploring anaerobic treatment of organic nutrients in wastewater, in which bacteria consume organic compounds under water, releasing biogas that bubbles to the top of the tank. The biogas (mostly methane) is collected and used for fuel (bio-energy recovery), and solid waste is reduced. In addition, constructing and using a bio-energy recovery system requires less capital and operating expenses than expanding conventional treatment facilities. Anheuser-Busch plans to be using this process in eight of its facilities by 2000.

Achievements:

< The process produces a renewable source of energy that provides 10-15 percent of a brewery's fuel needs.

< The process reduces wastewater by about 80 percent, allowing municipal plants that treat the remaining wastewater to use 80 percent less electricity to accomplish this task, reducing emissions by 80 percent and enhancing regional air quality.

< Solid waste is reduced by 50 percent, freeing up capacity at local municipal treatment plants, and increasing brewery capacity.

< By the year 2000, it is estimated that eight facilities with bio-energy recovery systems will save more than $40 million annually.

Contact: Bill Sugar, Anheuser-Busch, phone: (314) 577-3730
Source: Sugar 1997

Bowter Inc.
Mechanical Vapor Recompression Heat Pump Recaptures Steam

Bowater Inc., a Climate Wise Partner, manufactures market pulp, newsprint, and coated magazine paper. During the processing of green wood chips, which are half water and half fiber, the water is converted to steam as the fibers are separated, processed, and pumped to paper machines to be converted to paper stock. The company wanted to capture the energy lost in this low-pressure steam it vented from its seven thermomechanical pulping (TMP) refiner lines.

To convert the steam to energy, Bowater installed two mechanical vapor recompression (MVR) heat pumps that efficiently converted the 19-psig steam at 250ºF to 57-psig steam at 470ºF. The converted steam could then be used to power the drying stage of the paper production operations. The MVR compressor also has a turndown of 50 percent, allowing it to adapt to changing amounts of steam, which optimizes energy use.

Achievements:

- Annual energy savings of $1 million paid back the $1.5 million investment in 1.5 years.
- About 200 gallons of turpentine (a TMP byproduct) is recovered daily for re-sale, reducing atmospheric emissions and providing additional income.
- By preventing steam from escaping, 100 gallons of water per minute is saved, which saves about $144 per day.
- Controlling the steam vapor once it is released into the atmosphere reduces the plant's noise level.

Contact: EPRI Pulp and Paper Office, Atlanta, Georgia, phone: (404) 853-9511
Source: DOE 1996

Chaparrel Steel Company
Waste Re-use

Each year, Chaparrel Steel uses more than 700,000 used cars as scrap in the production of 1.6 million tons of steel, using electric-arc furnace technology. The company generates wastes in the form of electric-arc furnace slag, mill scale, and baghouse dust from its air pollution control systems. Because the mill scale was rich in iron oxide, Chaparrel had no problem finding a buyer for it. Chaparrel had been selling the slag mixed with baghouse dust for a low price to highway construction firms, however, they believed there might be a more lucrative use for the slag. Chaparrel created an internal task force (STAR, Systems and Technology for Advanced Recycling) that teamed with a neighboring cement plant to create a patented process called CemStar, which adds slag to the raw material cement mix. CemStar processes the crushed slag through a magnetic separation system to recover valuable metallic substances that are then cycled back into the electric-arc furnaces. The remaining lower-grade slag is used in the cement kilns as a substitute for limestone in the manufacturing process.

Achievements:

- Cement manufacturing energy requirements were reduced almost 15 percent (five million Btus saved for every ton of slag substituted for limestone).
- Existing kiln capacity increased 9 percent for a low capital investment, which was paid back in the first year of operation.
- The value of the slag increased 20 times over the previous market price offered by road contractors.

The STAR task force also introduced a cleaning and source separation system to reduce landfill-destined waste. The sale of recovered non-ferrous metals (primarily aluminum and magnesium) is expected to recoup the capital investment within one year. The sale of clean plastics (non-chlorinated) from the separation system will generate additional annual revenues of $500,000. Recycling plastics lowers the demand for petrochemical feedstocks used to make virgin plastic.

Contact: Andrew Mangan, Business Council for Sustainable Development — Gulf of Mexico. Phone: (512) 794-8813; fax: (512) 794-8815; e-mail: andy_mangan@radian.com

Source: World Business Council for Sustainable Development and the International Chamber of Commerce 1997

Colorado State University Industrial Assessment Center
Fabricated Metal Products Manufacturer — Industrial Audit

The Colorado State University Industrial Assessment Center (CSU IAC) conducted an energy efficiency/waste minimization audit at a company that manufactures screw machine products for hydraulic systems. The company has 140 employees who produce about 38 million parts per year, creating gross sales of $8.5 million. Energy expenses amount to about 2.5 percent of gross sales. The major hazardous waste is spent ion exchange resins from the wastewater treatment area.

CSU IAC made eight energy-saving and waste minimizing recommendations to the manufacturer, who implemented four recommendations: (1) High-efficiency lamps and ballasts replace the present ones as they burn out (IAC recommended replacing *all* existing standard lamps and ballasts with high-efficiency lamps and electronic ballasts). (2) High-efficiency motors and insulating of hot tanks in the brazing area and plating lines save energy. (3) Installation of a spring-loaded lid on the parts washer reduces the potential for leaving the lid open, which, in turn, reduces the evaporation of cleaning solvents. (4) Floor dry was replaced by absorbent pads and a wringer, eliminating solid waste.

Achievements:

< Installing high-efficiency lamps and ballasts as replacement is needed saves $4,460 annually.
< High-efficiency motors and insulated hot tanks save $3,500 per year, with an 11-month payback.
< Reduced solvent evaporation resulting from the spring-loaded lid on the parts washer reduces solvent air emissions by more than 20,000 pounds and saves $5,400 in solvent costs annually.
< Replacing floor dry with absorbent pads and a wringer saves $800 and reduces plant waste by 48,500 pounds annually.
< Total annual savings equal $14,250

Source: DOE 1996

Cominco America, Inc.
Re-engineered Fertilizer Production

Cominco produces ammonia for fertilizer, which uses water and gas fuel to generate steam. Process condensate is generated as wastewater, which is managed by a holding pond and injection wells. Cominco retained an engineering consultant, M.W. Kellogg Co., to re-engineer its ammonia plant to reduce fuel and make-up water consumption.

Fuel consumption was reduced by replacing existing plant parts with newer material that improved heat transfer. Convection section and heating coil modules were replaced with more efficient units that reduced heat and improved heat transfer, which reduced NOx emissions and fuel consumption. The ammonia converter reactor was modified with new equipment to reduce steam consumption. These new designs not only reduced fuel consumption but also increased productivity. New equipment installed in the new convection section allows wastewater to be recovered for conversion to steam, reducing both make-up water and fuel consumption.

Achievements:

< Natural gas consumption declined 22 percent (1 billion ft^3 per year), saving over $1.7 million per year.
< NOx emissions declined 35 percent.
< Average annual water usage for steam production was reduced by more than 110 million gallons, saving $65,000 per year.
< Additional savings came from reduced disposal costs of wastewater into injection wells.
< $16 million in capital costs are anticipated to be recovered in approximately six years.

Contact: Larry Wood, Cominco, phone: (806) 274-5204
Source: EPA 1996

Dana Corporation
Industrial Heat-Treating

Dana Corporation is the largest original equipment manufacturer of automotive and heavy equipment axles, transmissions, and brakes for the North American automotive industry. Dana, and an estimated 4,500 facilities in the U.S., use a heat-treating (carburizing) process that hardens and increases the wear resistance of steel surfaces on products such as gears, bearings, drive shafts, piston rings, universal joints, hand and machine tools, gas turbine blades, and steel fasteners. Conventionally, the carburizing process treats parts in a 1750^{o} (F) atmosphere composed of carbon monoxide, hydrogen, and nitrogen, which are discharged when the process is completed. New federal standards will soon require these facilities to purchase air emission permits and install discharge monitoring equipment.

In 1995, with support from NICE[3], Dana began testing a full-scale prototype of a membrane-based technology developed by Atmospheric Recovery, Inc. (ARI). The technology recovers and reuses discharged furnace atmosphere gas rather than exhausting it to the air. The process is economically advantageous because it allows a facility to avoid installation of expensive pollution control equipment, reduces operating expenses, and increases productivity.

Achievements:

< Emissions were reduced 90 percent.
< Operating expenses reduced by two thirds.
< Energy use was reduced at least 25 percent.
< Increased productivity.
< Reduced furnace downtime and fewer part rejects.

Contact: Paul Koehn, Dana Corp., phone: (612) 559-6233
Source: Koehn 1997

Decatur Foundry, Inc.
Infrared Drying

Decatur Foundry, a Climate Wise Partner, is a small-run jobbing foundry in Decatur, Illinois, which specializes in iron castings for electric-motor frames and parts as well as pump components. The castings industry has been moving away from quick-drying, solvent-based coatings to slow-drying, environmentally safer water-based coatings, creating a bottleneck in the production process. At the same time, Decatur's customers were moving to just-in-time inventory systems, placing pressure on suppliers to provide quick turnaround on orders. A third variable putting pressure on turnaround time was Decatur's short production runs, which require molds to be formed and made ready for casting as quickly as possible.

With the help of Illinois Power (now Illinova Corp.) and EPRI's Center for Materials Production, Decatur identified the infrared/forced air unit as a replacement for the conventional electric-resistance ovens. Instead of warming the air in contact with the mold's surface, the new short-wavelength infrared systems radiate heat directly to the surface of the mold, quickly driving out moisture. In addition, the system requires no warm-up time, so it is only on when in use. The new system was also equipped with precision instrumentation, which allows more control in the drying process. All of these advantages resulted in decreasing drying time by 85 percent.

Achievements:

< Replacement on the first production line (cost: $12,000) reduced annual energy consumption by 120 MWh, or $9,000. New infrared units were subsequently installed on two new lines.
< Organic solvents were eliminated.
< Improved product quality virtually eliminated the need for additional polishing.
< Mold failure rates fell.
< New units freed up floor space.
< Eliminating the drying bottle neck reduced labor costs and increased productivity, allowing Decatur to offer a very competitive turnaround time.
< Enhanced efficiency and productivity allowed Decatur to add two new lines, increase employment by 13 percent, and increase sales from $5.9 million to $10 million.

Contact: Terry Young, Decatur Foundry, phone: (217) 429-5261
Source: DOE 1996; 1997

Ilco Unican Corporation
Aqueous Cleaning System

The Ilco Unican facility in Rocky Mount, North Carolina, produces over 1.5 million blank keys daily. The facility had been using 1,1,1, trichloroethane in a vapor degreaser to remove a medium-grade residue from the keys, but designed an aqueous cleaning system to eliminate the use of the organic solvent. The chemical-free, aqueous cleaning system uses a high-pressure, hot-water spray to wash the keys and high-pressure air to dry them. The water in the system is recirculated and cleaned by an oil skimmer.

Achievements:

< The plant's water usage has been reduced 50 percent.
< Energy used in the cleaning phase was reduced by almost 95 percent ($25,000 savings/year).
< Unican's annual consumption of almost 200,000 pounds of 1,1,1, trichloroethane was completely eliminated ($60,000 savings/year).
< $25,000/year savings from reduced water and labor.
< The $120,000 investment in the new washer was repaid in a little over a year with $110,000 in annual cost savings.
< Reduced liability from elimination of chemical treatment.

Contact: Brian Wells, Project Engineer, phone: (919) 725-1331
Source: DOE 1996

Nisshinbo, California, Inc.
Variable Speed Drives

Nisshinbo, California, Inc. is a textile manufacturer that produces yarns and threads from the initial spinning process to finishing. With performance-based financing from Energy Capital Partners, Nisshinbo installed variable-speed drives (VSDs) throughout their manufacturing facility as part of the textile spinning and weaving processes. The VSDs allow for energy consumption to more adequately track energy requirements, adjusting for varying load requirements, using less energy more efficiently.

Achievements:

< Measured energy reductions of 1,314 MWh save about $140,000 annually.
< VSDs improve spinning and weaving process performance, which enhances product quality and increases productivity.
< Payback of 1.3 years on investment, or 70 percent rate of return.

Source: DOE 1997

Quad/Graphics, Inc.
Innovation in the Printing Industry

Since Quad/Graphics started in 1971, the company has grown more than 20 percent per year to become the largest privately held printing company in North America, with annual revenues exceeding $1 billion, ten manufacturing sites, and over 8,000 employees. Quad provides full production services, including design, photography, finishing, mailing, and distribution.

Quad has an overall environmental mission to make the best possible use of all resources, asking two questions when making business decisions: Is it good for business? Is it good for the environment? Management feels that its proactive environmental strategy gives Quad a competitive advantage. Quad, which is a Climate Wise participant, has achieved much in the way of cost-effective energy efficiency and pollution prevention.

Achievements:

< Recycled over 146,000 tons of paper, saving $12.6 million in landfill fees in 1995.
< Reduced ink waste by almost 50 percent between 1989 and 1993, despite steep increases in production. This ink conservation saved $400,000 over this four-year period.
< Recycled over 287 tons of plastic in 1995 by creating markets and uses for the recycled material. Earned $33,000 from selling used plastic and saved over $15,000 in landfill fees.

- Repaired and reused 110,000 wooden pallets in 1995, saving $375,000 in new pallet costs and saving $453,800 in landfill tipping fees.
- Replaced 3 8-hour shifts with 2 12-hour shifts, resulting in one-third fewer trips to work, and provided discounted bus service to employees.
- Located a new facility in an existing structure, saving 50,000 MMBtu (energy to build a new structure), and due to its more urban location, decreased average commuting distance by 20 miles for each of its 700 employees, saving 20,000 MMBtu annually.

In addition, Quad's R&D division, Quad/Tech, with the assistance of the Wisconsin Energy Bureau and a $400,000 NICE[3] grant, developed and commercialized a new technology that captures both energy savings and non-energy pollution prevention benefits. This closed-loop ink-jet supply and printer solvent recovery system captures 80 percent to 90 percent of methyl ethyl ketone (MEK) vapor and condenses it for reuse instead of emitting it into the air; and eliminates the need for ventilation systems and MEK production and transportation, saving at least 2.3 trillion Btus by the year 2010.

Achievements:

- Reduced the amount of ink and solvent used by at least 50 percent.
- Reduced materials costs by $552,000 annually.
- Reduced energy costs by $72,900 annually.

Contact: Tari Emerson, Quad/Graphics
Sources: DOE 1997; EPA/DOE 1997

Republic Engineered Steels, Inc.
Scrap Metal Recycling and Water Reuse

Republic Engineered Steels, a Climate Wise Partner, manufactures special quality bars of carbon steel, stainless steel, tool steel, and various alloy steels at ten plants in six states. Due to economic pressures, Republic was forced to cut costs significantly, and began by soliciting suggestions from all employees. Melt shop staff at the Canton, Ohio plant made two recommendations: sorting scrap steel before remelting it, and changing from live steam cleaning to a dip rinse system as well as other water-saving recommendations.

Republic uses electric arc furnaces to melt scrap steel from various sources (e.g., autos, appliances, steel plant scrap) and form it into new product. Prior to this project, scrap of high and low quality (i.e., varying impurity levels) were not sorted, resulting in the high-quality steel losing its value when melted with the low-quality scrap. With sorting, Republic could now sell an additional 90,000 tons of high-quality steel at $106 per ton rather than at the scrap price of $85 per ton. In addition, by dedicating each melt to different grade of steel, it is easier for metallurgists to remove impurities from the melt, saving labor costs. Sorting also reduces the time it takes to adjust the chemical composition, so less energy is required to keep it hot.

Changing from a live steam cleaning to a dip rinse system reduced wastewater and energy costs. After emerging from an acid pickle liquor that removes scale and oxides, the steel bars are sprayed with recycled water, which is returned to holding tanks and reused until it no longer cleans adequately. Washwater life is extended with a chemical inhibitor, Kleanrite 50. Bars are then rinsed with fresh water, which is subsequently used to dilute the pickle liquor.

Achievements:

< Sorting saved almost $1.9 million a year, and cost only what it took to train employees for one week.
< Wastewater was reduced 26 percent in the first year.
< Changing to a dip rinse system from a steam system reduced energy needs.
< Water savings (primarily from rinse changes) reduced water costs by $20,000 per year.

Contact: Harold Kelly, Republic Engineered Steels, phone: (216) 837-6000
Source: DOE 1996

Sandia National Laboratories Microelectronics Development Laboratory Water-Use and Wastewater Reduction

Sandia National Laboratories (SNL) is a multi program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy. Sandia's Microelectronics Development Laboratory (MDL) in New Mexico (NM) has over 30,000 ft^2 of clean room space, with state-of-the-art equipment for processing wafers up to 150 mm in diameter. MDL conducts R&D in a range of micro technologies, including advanced packaging and interconnection, micro sensors, compound semiconductors, advanced nonvolatile memory, micro machining, and advanced materials and process development for the semi-conductor industry. Many operations conducted at MDL require high purity water. Incoming water from the City of Albuquerque (COA) and well water obtained from Kirtland Air Force Base (KAFB) is processed through a water treatment facility that includes: carbon absorption, reverse osmosis (RO), vacuum degassing, and ion exchange.

Using a team approach, MDL sought to reduce water consumption and wastewater discharges to the COA sewer system. The MDL water treatment system was modified to meet this goal: new stainless steel control valves were installed for precise control of water flow; a new manifold was added to the RO pump converting it to a more efficient two-stage pump; high surface area RO membranes were added; and the existing PVC piping was replaced with industrial, water production piping.

Achievements:

< SNL/NM reduced overall water usage by 8 percent and waste water by 11 percent (143.6 m^3/yr), for a cost savings exceeding $100,000 per year.

< Annual energy savings of $22,000 resulted from the more efficient RO system operating fewer hours.

< Total project cost of $107,113 gives a payback of 0.8 years with a simple ROI of 108 percent.

Contact: John Jewell and Javier Chavez at Sandia Labs, Albuquerque, NM
Source: Jewell and Chavez 1997

Shaw Industries
Automated Dyebath Reuse

Shaw Industries served as a test facility for a NICE^3 project that showed how carpet manufacturers can reduce pollution and save energy through automated dyebath reuse. In the conventional batch dyeing process, water is pumped into a dyeing machine, where fabric is placed and saturated with water. Chemicals and dye are then added and the bath is heated and held at dyeing temperature until dyeing is complete, at which point the bath is emptied, discharging large quantities of water, chemicals and energy. The machine is then refilled and the process is repeated for the next batch.

By automating the process, low-cost precision pumping systems allow a small volume of dyebath chemicals to be reused for numerous dyeing operations. Innovative monitoring instruments can analyze the dyebath and communicate results to a computer which calculates the amount of chemicals that need to be added for the next dyeing operation. This process could also prove valuable for the textile industry.

Energy is saved by reducing the need to reheat dyebaths, eliminating the energy used to produce additional dyes, chemicals and water, and reducing energy needed to treat wastewater. If fully implemented nationally, throughout the carpet and textile industries, an estimated seven trillion Btus could by saved annually by 2010 — enough energy to supply the needs of 70,000 homes for a year.

Achievements:

< Resource reuse: 6 percent of the dyes, 60 percent of the auxiliary chemicals, and 42 percent of the water are reused and therefore removed from the waste stream. Nationwide, waste would be reduced by 36 million pounds of chemical per year.

< Total cost of $833,000 (including NICE[3] grant) is recovered in about six months with savings of $1.6 million per year.

Contact: Eric Hass, DOE, Golden Field Office, phone: (303) 275-4728
Source: EPA 1996

Sulzer Chemtech AG
Saving Energy in the Chemical Industry

Sulzer provides supplies and services to the chemical industry. One of its more popular services is a "layer crystallization" process used to separate and purify chemicals. The process is energy intensive, so to reduce operating expenses, Sulzer spent 18 months developing a process to reduce energy intensity while maintaining quality. The less energy-intensive approach used a crystallizer under pressure, as both the condenser and evaporator of a cooling unit. The new process has several improved features: no intermediate liquid heat-transfer medium; no buffer vessels; fewer and smaller pumps, piping, and valves; lower temperature differentials; and less space requirement.

Achievements:

< Energy requirements were reduced 30 percent.
< Solvent use and heat-carrier fluids were eliminated.
< Space requirements were reduced 50 percent, which reduces demands on materials and natural resources because it is more compact.
< Capital costs were reduced more than 25 percent.
< Operating expenses (e.g., utilities, materials) were reduced.

Contact: Peter Gebhardt, Sulzer Technology Corporation. phone: 0041-52-262-2088; fax: 0041-52-262-0022; e-mail: peter.gebhardt@sulzer.ch
Source: World Business Council for Sustainable Development and the International Chamber of Commerce 1997

Trailblazer Foods, Inc.
Water Recycling and Treatment System

Trailblazer Foods, a small Portland, Oregon company, specializes in the production of fruits, jams, and syrups. Employees proposed, designed and installed one of the most innovative water recycling systems for heating and cooling in the food process industry. The system uses recirculated water to pasteurize and cool food products, using the heat capacity and thermal integrity of water to control temperatures reliably. Recirculating water reduced the need to heat and cool the water, cutting gas and electricity used by the boiler and fans. After using the water many times, the water is treated, and hazardous sludge is eliminated, discharging effluent that meets environmental standards. The Water Treatment project cost $40,000.

Achievements:

< Water use was reduced 50 percent — 1.5 million gallons per year.
< Electricity use was reduced 50 percent.
< Gas use was reduced 10 percent.
< The release of hazardous sludge was eliminated.

Source: DOE 1997

Wacker Siltronic Corporation
Multi-Wire Saw for Silicon Slicing

Wacker Siltronic, in Portland, Oregon, manufactures silicon wafers used in the semiconductor industry. Wacker has a history of commitment to proactive environmental management. In the past 12 years, Wacker has reduced air emissions by 89 percent, hazardous waste by 99 percent, toxic chemical use by 86 percent, and overall chemical use by 47 percent. As a result, the company saves about $2 million in operating expenses a year, and almost all projects help the bottom line.

In 1996, Wacker installed a new multi-wire saw silicon slicing technology that increased productivity and reduced wastewater. This new process, however, created new waste streams, so Wacker developed alternative, recyclable cutting fluids, and began reclaiming the cutting slurry from its wire saw operations. Using a water-based cutting fluid instead of oil eliminated solvent cleaning and reduced water-rinsing steps. The process has also significantly reduced use of solvents, oils, and water.

On this particular project, Wacker was assisted by the Environmental Assistance Project (EAP), a joint project between the Oregon Department of Environmental Quality, the City of Portland Bureau of

Environmental Services, and the Portland business community. EAP evaluated environmental impacts and provided regulatory guidance.

Achievements:

< The new multi-wire saw increases silicon wafer production by 20 percent.
< Water usage is reduced by 37 million gallons per year.
< Water and sewage expenses are reduced by $400,000 per year.
< Prevention of 2,400 barrels/year of used oil and solid waste disposal reduces disposal costs by 75 percent ($640,000 per year).
< Recovering usable materials from wastes (e.g., cutting fluid) saves $1.5 million annually.
< Hazardous air emissions (solvents), created when changing cutting fluids, were reduced by 36 tons per year.
< Project investment ($2 million) is paid back in 1.4 years.

Contact: Tom McCue, Environmental Manager, Wacker
Source: DOE 1997; McCue 1997

MAKING A COMPELLING E2/P2 CASE TO BUSINESS

The primary responsibility of business management is to *increase shareholder value*. In order for management to accomplish this goal, they must understand *all* of the costs and benefits associated with an investment in efficiency, and make decisions based on whether the company's total net benefits are greater than total net costs. I intentionally refer to an investment in *efficiency*, rather than specifically in energy efficiency or pollution prevention, because of the interrelatedness of these subsets of efficiency. It is critical that all savings related to such projects — energy and non-energy — be included in the financial analysis so that management understands the complete financial ramifications of an efficiency project.

The financial analysis of an efficiency project is the basis for making the investment decision. The financial analysis may range in sophistication from a simple payback (investment/annual net savings) or rate of return (average annual net savings/total investment) to more accurate calculations, such as net present value (NPV) or internal rate of return (IRR), which take into account the time value of money. Regardless of which calculation is used, *the most important part of a financial analysis is the estimation of project costs and benefits*, as discussed below.

Calculating Costs

There are numerous phases in a project, each with several cost components:

- project identification,
- technology identification and project design,
- financial analysis,
- purchasing and procurement,
- financing,
- installation,
- startup and training, and
- ongoing maintenance.

If investment incentives are offered to the company (e.g., investment tax credits or utility or government incentives), they reduce the company's total cost and therefore should not be included in costs to the company when performing a financial analysis.

When estimating project costs, only those costs that are *incremental* as a result of the project should be included when determining the financial ramifications of the investment on the company. In other words, count only those costs that arise as a result of the project and would not exist if the project were not pursued. These costs are, in general, dominated by direct costs, such as:

- engineering fees,
- equipment purchases,
- supplies,
- installation contractor fees,
- costs of off-site training for employees,
- lost production resulting from disruption of production during project installation and learning curve, and
- ongoing maintenance of new equipment.

Costs that do not change as the result of an investment decision are irrelevant to the decision. For example, overhead costs that may be allocated to a project, but which would exist regardless of the project should *not* be included in a financial analysis because they are not incremental costs. Examples of these costs are internal staff time to:

- identify and evaluate the project and its design,
- win management approval for the project,
- finance the project either internally or externally,

< identify, select, contract, and coordinate with engineers and contractors, and
< identify sources for and procurement of project equipment and supplies.

The internal staff that performs these functions will exist whether or not the investment is made. Although these non-incremental overhead costs, often referred to as transaction costs, are not included in a financial analysis, they are still barriers to efficiency because there is an opportunity cost associated with taking staff time away from other projects. *Therefore, to the extent that efficiency advocates — whether they be government or non-government organizations, or even corporate environmental managers — can minimize these barriers by making efficiency easier to understand and implement, more efficiency will occur.*

Another type of cost that should *not* be considered in an investment decision is a "sunk cost." A sunk cost is one that has already been incurred and will not go away if the investment is not made. For example, if $10,000 were spent on a feasibility study that recommends an additional $50,000 investment in efficiency, the $10,000 sunk cost is not part of the costs that are included in a financial analysis that will determine the investment decision. Thus, the investment decision is based on costs going forward, not looking back.

Calculating Benefits

As with project costs, project benefits should reflect any and all net benefits that are *incremental* to the project. For industry, benefits can come in several categories:

< energy savings,
< reduced costs of environmental compliance,
< improved worker safety (resulting in reduced lost work and insurance costs),
< reduced production costs (including labor, raw materials, and energy),
< reduced waste disposal costs,
< improved product quality (reducing scrap and rework costs and improving customer satisfaction)
< improved capacity utilization, and
< improved reliability.

The importance of quantifying all benefits is exemplified by many of the cases presented here in which energy efficiency projects' non-energy benefits far exceed energy savings. Since each project is unique and uniquely interacts with other aspects of the manufacturing operation, it is difficult to accurately estimate average total benefits that result from energy efficiency projects. *However, it is a critical step in the corporate capital-investment decision-making process to estimate all costs and benefits related to a proposed investment before the investment is made.* Enhanced corporate image is one benefit that a company will probably not attempt to quantify, but it will still be taken into account qualitatively when making decisions with environmental benefits.

Tax Implications

Many financial analyses of efficiency projects erroneously neglect tax implications. Both costs and benefits need to reflect tax implications when making an investment decision. For example, if a project saves $4,000 a year in lower energy costs and $16,000 from improved operations and maintenance, a company's taxable income increases by $20,000. The result is that it pays more taxes and the cashflow benefit is reduced accordingly.

Taxes also affect costs by way of depreciation. Although depreciation is a noncash charge, it is treated as an expense, which lowers taxable income. Thus, depreciation must be subtracted from incremental pre-tax profits to arrive at the taxable income, and then be added back to after-tax profits to reflect actual cashflow. Because each company's tax rate differs and depreciation calculations can be complex, involving issues such as early write-offs of old equipment, it is best to leave this portion of a financial analysis to a financial analyst.

Incremental Cashflow Analysis

The culmination of gathering all of a project's costs and benefits is to input these data into an incremental cashflow analysis (see box example for project with seven-year life). Incremental costs and benefits are taken into account over the life of a project (e.g., life of efficient equipment installed), with capital investments normally taking place up-front (time zero). After-tax cashflows, which reflect the depreciation tax shield, are used to calculate a Net Present Value or Internal Rate of Return. The complexity of these calculations merit the attention of a financial analyst.

However, *the most important component of a cashflow analysis is the calculation of costs and benefits*, which are best estimated by technical and engineering staff. Granted, the process of estimating costs

Incremental Cashflow Analysis

	Time (years)							
	0	1	2	3	4	5	6	7
Revenues (increased productivity)		+	+	+	+	+	+	+
Operating Savings:								
Energy		+	+	+	+	+	+	+
Materials		+	+	+	+	+	+	+
Labor		+	+	+	+	+	+	+
Reduced scrap/rework		+	+	+	+	+	+	+
Improved reliability		+	+	+	+	+	+	+
Operating Expenses:								
Engineering fees		-						
Training		-						
Disruption of production		-						
Maintenance (new equip.)		-	-	-	-	-	-	-
New equipment depreciation*		-	-	-	-	-	-	-
Pre-tax Profits		x	x	x	x	x	x	x
Tax		-	-	-	-	-	-	-
After-tax Profits		y	y	y	y	y	y	y
New equipment depreciation*		+	+	+	+	+	+	+
Capital Expenditures (equipment)	-							
After-tax Cashflow	Z	Z	Z	Z	Z	Z	Z	Z
Net Present Value (NPV)	$$							
Internal Rate of Return (IRR)	%							

and benefits may not be an easy one, however, it is a necessary exercise that will add value to the company and further environmental goals.

CONCLUSION

When efficiency advocates understand the business decision-making perspective and can communicate with management using financial and strategic arguments for energy efficiency and pollution prevention, the case for E2/P2 is greatly strengthened. Making business sense of E2/P2 reduces its perceived risk to management, which may, in turn reduce the hurdle rate (or payback period) that a company requires of an E2/P2 investment. There are no guarantees that management will implement E2/P2 projects even if they make sense from a financial perspective. Other investments or projects may have greater financial returns than E2/P2 projects, capital may be unavailable, or certain projects may not fit with a company's strategic plan. However, if advocates do not make business sense of E2/P2, it may continue to be perceived by many business people as a warm and fuzzy but costly and unnecessary extravagance.

Since businesses make most decisions based on bottom-line impact, it makes sense to look at energy efficiency and pollution prevention as part of overall 'efficiency' (e.g., process efficiency, enhanced productivity) in order to account for *all* the savings that a business will realize from E2/P2 projects. In order to make a more compelling case for energy efficiency and pollution prevention, it is critical to understand the decision-making process of business management. This means understanding the interrelationships of various forms of efficiency, and measuring costs and benefits so that the financial ramifications of our proposals are fully understood and can be communicated to management in terms with which they can identify. Probably the most effective way to get management's attention is to not even mention energy efficiency or pollution prevention, but to call it simply "efficiency," since efficiency has always had a positive connotation in the business community. Combining the strengths of energy efficiency and pollution prevention and viewing them simply as efficiency is an opportunity for both business and environmental advocates to achieve their goals.

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