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Industrial Demand Side Management: A Status Report

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Abstract

This report provides an overview of and rationale for industrial demand side management (DSM) programs. Benefits and barriers are described, and data from the Manufacturing Energy Consumption Survey are used to estimate potential energy savings in kilowatt hours. The report presents types and examples of programs and explores elements of successful programs. Two in-depth case studies (from Boise Cascade and Eli Lilly and Company) illustrate two types of effective DSM programs. Interviews with staff from state public utility commissions indicate the current thinking about the status and future of industrial DSM programs. A comprehensive bibliography is included, technical assistance programs are listed and described, and a methodology for evaluating potential or actual savings from projects is delineated.

Executive Summary

Industrial demand side management (DSM) programs, though not as developed or widely implemented as residential and commercial programs, hold the promise of significant energy savings—savings that will benefit industrial firms, utilities, and the environment. The Office of Technology Assessment estimates 154 utilities are conducting 417 industrial sector DSM programs.

In 1991, the industrial sector consumed about 820 billion kWh of electricity, about one-third of all electricity sold in the United States. Based on electricity demand values from the Manufacturing Energy Consumption Survey and estimates of potential savings in various end uses, it is projected that savings are on the order of 100 to 200 billion kWh. Electricity for motors is by far the largest end use application in manufacturing, accounting for as much as two-thirds of total use. Lighting, another major potential source of savings, accounts for about 6% of total manufacturing use. Within manufacturing, the chemicals, primary metals, and pulp and paper industries together account for over half of all electricity use.

Estimates of savings, however, do not include potential savings from process redesign and optimization, which could add substantially to the figures. Of the potential savings, the amount that could be achieved in practice at a given plant depends on site-specific conditions and economic factors, especially first costs. Savings in costs of energy use (kWh) are the obvious benefit to industrial customers, yet DSM often yields additional benefits such as process improvements, reduction of waste generated, and good public relations.

Smooth and effective implementation of energy efficiency improvements can be hindered on the industrial side by a decision-making process that pits energy-saving projects against more obviously profitable ones. Although the added incentives provided by utility DSM programs should help industrial firms to adopt energy-saving measures, some industrial firms have a generally negative view towards DSM and may, in fact, believe DSM programs increase their electricity prices and give assistance to their competitors. In addition, the time required for installation of energy efficiency measures can disrupt production facilities. Utilities, too, face barriers, principally in not being knowledgeable enough about their customers' processes to design customized programs or to accurately estimate and measure savings. Overcoming difficulties to effective program implementation is worthwhile, however, given the substantial potential for electricity savings.

Partnering with utilities for DSM can be an incentive to change technologies, processes, and practices, all of which make the company more profitable. This partnering can substantially change the economics of installing energy efficiency measures. For some industries, DSM can increase economic competitiveness. For instance, by participating in utility DSM programs, Boise Cascade Corporation expects to save $133,000/year on electricity bills and Eli Lilly and Company will save approximately

$1 million over the next three years. For utilities, industrial DSM can help defer or obviate the need to construct additional generation (kW), transmission and distribution capacity, while helping them meet environmental regulations, keep their industrial customers, and improve their load factor and their public image.

Various types of DSM programs for industrial customers have attempted to stimulate energy savings through financial incentives, education, and technical assistance. Financial programs include rebates, loans, shared savings, leasing, dedicated funding, incentives for energy management, and market pull programs. Education and technical assistance programs include energy information, bidding, comprehensive one-stop services, subscription services, and brokering. In addition, several federal and state agencies and nonprofit organizations offer assistance such as information, auditing, and analysis. Common features of successful programs are a customer focus, personalized marketing techniques, program flexibility, program analysis and evaluation, and partnerships.

Successful programs vary widely because they are attuned to the specific needs and interests of particular industries and companies, because rate structures and business climates differ from state to state and region to region, and because individuals with unique skills are typically catalysts in applying DSM programs in particular circumstances. At Boise Cascade, for example, a highly specific process improvement (in treatment of waste water from recycled products) was adopted for a number of reasons: because the new system reduced environmentally regulated levels of waste; because it reduced electricity use; and because the utility provided an acquisition payment to reduce the first cost and, thus, the payback period. At another manufacturing company, Eli Lilly and Company, management is environmentally conscious enough to encourage continuing improvements in energy efficiency; with the added advantage of a comprehensive set of DSM program options from its utility, such improvements meet Lilly's criteria for investments.

Interviews with staff from state public utility commissions indicate support for industrial DSM programs and reinforce these elements as facilitating success. According to commission representatives in 10 key states, successful programs used an innovative, comprehensive approach and had significant nonenergy benefits. All but one of the state commission personnel interviewed indicated the future of industrial DSM to be in greater customer service orientation. Many of those interviewed recommended that federal and state energy offices promote industrial energy efficiency through demonstration projects in their states.

All public utility commission staff interviewed are in states that have active industrial DSM programs. All staff interviewed noted benefits to utilities through load retention and load management and benefits to industry through reduced cost of energy. All those interviewed reported companies that objected to sharing the cost of utility DSM programs for other customer classes and other industrial customers. A few states are moving toward subscription or optional DSM cost-sharing schemes and performance-based incentives. Retail wheeling, though not uniformly seen as inevitable, is most often perceived as a potential threat to rates and services now enjoyed by core customers.

A number of non-utility programs provide technical assistance to industrial electricity users and utilities; these include federal programs, federally funded state programs, industry collaborative programs, university-funded programs, regional energy office programs, and state-funded programs.

Effective industrial DSM programs combine energy awareness, personal attention from decision-makers, the ability to couple energy savings with other benefits (such as process improvements), appropriate program vehicles, and the expertise to analyze and apply custom solutions. Though the mix of attributes may be difficult to orchestrate, successes provide benefits to all immediate participants and to the nation.

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1.0 Introduction

Demand side management (DSM) is the implementation by utilities of any number of energy efficiency measures and services aimed at altering the level and timing of energy demand in a given service area. DSM programs consist of utility activities established to influence a customer's use of energy. From a utility's perspective, DSM programs are most valuable when they focus on load leveling objectives, such as peak load shaving, and other demand (kW) reduction or shifting strategies. DSM program measures may affect the customer's usage, as well as the utility's demand profile, however. From the industrial customer's view, energy consumption (kWh) is a significant component of their electric utility bill, and so they are interested in conserving energy and leveling their peak demand.

This report discusses industrial DSM as having both conservation and load management components. Demand side management programs offer many benefits to the utility, its customer, and the public. For instance, utilities offer such programs to enhance their service and, thus, retain their industrial customers. Additionally, energy efficiency measures reduce the need to construct new power plants, as well as decrease pollution and use of natural resources (e.g., coal, natural gas, and water).

Many utilities have focused DSM efforts on residential and commercial customers because those sectors tend to be relatively uniform. Standardized energy efficiency packages, such as increased use of building shell insulation, replacement windows, and high-efficiency light bulbs, can be fairly easily marketed to the general population of residential and commercial customers. In industry, however, electricity is used in such a wide variety of ways that no standard set of measures can be universally applied.

Because industry uses about one-third of the electricity consumed in the United States, energy saved in this sector can be viewed as a resource. Taking advantage of this potential DSM resource can prove worthwhile. DSM resources gained from reductions in energy use may be included in estimating total resources (both demand and supply) needed to meet future demand. This consideration of both demand side resources and traditional supply side resources is known as integrated resource planning (IRP). The remaining potential resource from energy savings in industry is considered by some to be the last major resource still untapped by utilities. One estimate has put this resource at almost one-half of controllable load (Hirst 1994).

Industrial DSM programs have demonstrated they can overcome obstacles to achieve substantial energy savings. An estimated 154 utilities are conducting 417 industrial sector DSM programs (OTA 1993).

For the purposes of this report, "industry" refers to those firms that utilities define as industrial customers, which include U.S. manufacturing plants, mines, farms, and construction firms. Industrial customers use a variety of different types of energy, including electricity, natural petroleum, natural gas, coal, and renewable sources (OTA 1993). This report describes electric utility DSM program issues, as the majority of DSM programs for industrial customers are heavily weighted to electric, rather than natural gas end uses (PCEQ 1992). Indeed, nearly all industrial use of natural gas is purchased directly from pipelines, and local gas distribution companies have largely shed industrial loads to transportation service only. Industrial DSM programs involve direct utility investment in energy efficiency through

- financial assistance, such as rebates, low-interest loans and grants, and other services
- installation of energy efficiency measures for building shell or equipment end uses
- energy audit assistance
- education.

Identifying opportunities to reduce or shift energy use in industry can result in lower energy costs for the industrial customer, diminished pollution and pollution control costs, and improved competitiveness of industry domestically and internationally.

1.1 Report Scope and Audience

This report was designed to provide a reference for staff of state public utility commissions (PUCs) and state energy offices, as well as other stakeholders who are interested in industrial energy efficiency, but do not have extensive backgrounds in existing DSM program opportunities. It is not a "how-to" guide to DSM, nor does it provide the kind of detailed information that a utility manager would need to formulate an industrial DSM program. Instead, this report provides an overview of the issues surrounding and the status of industrial DSM in the United States by

- explaining the benefits of, and impediments to, successful industrial DSM programs

- describing industrial energy-use patterns to explain the complexity of the challenge that utilities interested in industrial DSM face

- providing order-of-magnitude ranges for the electricity savings potential that industrial energy efficiency techniques offer

- describing the types of industrial DSM programs that are being implemented by utilities today and analyzing the features of the successful programs

- presenting information on other federal, state, and private initiatives that are not officially considered DSM programs because they are not implemented by utilities, but nevertheless aim at improving energy efficiency in the industrial sector

- presenting a synthesis of current literature regarding industrial DSM

- outlining regulatory and policy issues affecting industrial DSM, including the uncertainty associated with a potential restructuring of the electric utility industry.

1.2 Research Sponsorship

This report was prepared by Pacific Northwest Laboratory (PNL)[a] to assist the Integrated Resource Planning (IRP) Program of the Office of Utility Technologies (OUT), Energy Efficiency and Renewable Energy, within the U.S. Department of Energy (DOE). The research described in this report was undertaken to assist OUT in 1) advancing the state of the art of integrated resource planning principles, practices, and methods and 2) providing assistance to DSM program stakeholders. The research will provide qualitative and quantitative information to help OUT provide assistance to state public utility commissions, state energy offices, and other stakeholders regarding IRP and DSM.

The Office of Utility Technologies is responsible for planning and directing DOE research related to utility energy efficiency activities. It sponsors research and development on advanced renewable electricity and generation technologies; encourages efficiency in the nation's electricity transmission, distribution, and storage systems; and provides tools to enable electric and natural gas utilities and stakeholders to make wise resource decisions on the basis of their full costs. The mission of the DOE IRP/DSM Program is to develop and promote sound planning principles and processes through the use of IRP and other techniques and to improve economic efficiency, environmental quality, and economic security, while recognizing the evolving nature of the electric and natural gas utility sectors. Underlying this mission is the belief that, by adopting IRP principles, stakeholders such as states and utilities will make wiser choices affecting production, delivery, and consumption of utility energy services and thereby improve overall economic efficiency, environmental quality, and energy security (DOE 1994).

1.3 Research Approach

To develop this report, the following avenues of research were undertaken:

1. Data Analysis. Detailed data on industrial energy use from the recent Manufacturing Energy Consumption Survey (MECS), conducted by the Energy Information Administration of DOE, were analyzed. These data were combined with estimates of the potential for energy efficiency improvement in various industrial end uses (lighting, motors, and particular processes) to obtain rough estimates (in the form of ranges) of U.S. industrial energy savings potential.

2. Literature Review and Analysis. A thorough literature review was conducted to gather articles, reports, and other published information on industrial DSM. The literature was analyzed to develop information on the views of various stakeholders, to categorize current industrial DSM programs into program types, and to derive elements of successful industrial DSM programs.

(a) Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under contract DE-AC06-76-RLO 1830.

3. Examination of Specific Case Studies. To better understand the dynamics of industrial DSM in practice, two industrial plants with utility DSM programs were studied in depth. The energy conservation measures (ECMs) installed in the plants were documented, the expected versus actual measured savings were analyzed, and the relationship between each customer and its utility was investigated.

4. Interviews of Public Utility Commission Staff. PUCs are responsible for regulating the rates that investor-owned utilities can charge for electricity in each state. Because many utilities wish to include the costs associated with their DSM programs in the electricity rates they apply to customers, PUCs play a big role in DSM program implementation. Researchers interviewed staff from 10 PUCs in states that have high industrial energy use and are active in DSM, as evidenced by the presence of significant industrial DSM programs and/or IRP regulation. The interviews included queries about industrial DSM program status, successful and failed programs, stakeholder views, technical assistance centers, the future of DSM, and potential federal and state roles in industrial DSM programs.

1.4 Report Organization

This report is organized into five additional chapters and six appendices. The chapters are as follows:

- Chapter 2.0 describes the benefits associated with industrial DSM programs and the impediments and issues associated with their implementation. This information was derived from the literature review and interviews.

- Chapter 3.0 provides an overview of how energy is used in industry (based primarily on MECS) and provides ranges of energy savings potential in industry for various categories of end use.

- Chapter 4.0 classifies current types of industrial DSM programs, describing the salient features of each type, based on a review of the literature.

- Chapter 5.0 documents the findings of the case studies—one a company-wide, integrated program to increase energy efficiency, the other a specific, process-based change.

- Chapter 6.0 surveys the regulatory climate, using the results of interviews with state public utility commission staff.

The appendices contain data too detailed for presentation in the main body of the report:

- Appendix A lists and describes a number of programs initiated by federal, state, and private organizations aimed at providing assistance to utilities and industrial customers. Although outside the category of DSM programs per se, these initiatives are related to industrial DSM in that they are aimed at promoting energy efficiency in industry.

- Appendix B describes techniques to evaluate industrial DSM programs and presents case studies of the application of such techniques.

- Appendix C presents a brief discussion of the effects of utility restructuring on industrial DSM.

- Appendix D outlines the protocol used during the interviews of state PUC representatives.

- Appendix E is a bibliography of works relating to industrial DSM.

- Appendix F is a listing of acronyms and initialisms found throughout the report.

1.5 References

Hirst, E. June 1994. *Costs and Effects of Electric-Utility DSM Programs: 1989 through 1997.* ORNL/CON-392, Oak Ridge National Laboratory, Oak Ridge, TN.

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2.0 Perspectives on Industrial Demand Side Management: Benefits and Impediments

This chapter presents a discussion of the benefits to utilities and their industrial customers of energy efficiency improvements gained through DSM programs. The factors impeding DSM program implementation, also discussed here, are troubling and persistent reminders of what must be overcome for energy efficiency to reach its full potential in the industrial sector.

In the sections below, the factors encouraging and impeding industrial DSM programs are presented from the perspectives of industry and electric utilities, as well as the public at large. The "perspectives" discussed in this chapter are not meant to represent the perspective of every utility, industrial firm or public interest group; instead, the chapter captures the prevailing views and describes positions usually presented in public debates. Researchers drew these views and positions from numerous publications, as well as participation in various industrial energy efficiency conferences and panels. The last section presents conclusions about overcoming the impediments to industrial DSM programs.[a]

2.1 Benefits of and Impediments to Demand Side Management: the Industrial Perspective

The industrial sector is highly complex, as is its use of energy. This complexity—small to large firms, different levels of energy intensity, hundreds of different processes and technologies, thousands of different products—means that improving energy efficiency in the industrial sector is also a complex undertaking. Because there is no single profile of the industrial customer's energy use characteristics, energy efficiency programs sponsored by utility companies must pay attention to the special needs of each industrial customer. Although this requirement for individual attention places an extra burden on industrial DSM programs compared with commercial and residential programs, which can take a more standardized approach to DSM, the benefits to industry of improving energy efficiency can be substantial. The factors that encourage and those that impede full industrial adoption of utility DSM programs are discussed below.

2.1.1 Factors Encouraging Industry to Adopt Demand Side Management

Industries that take advantage of utility DSM programs gain major benefits: 1) reduced energy costs and potentially increased profits, 2) more productive state-of-the-art technology that improves the facility's competitive edge, 3) improved environmental performance and compliance with environmental regulations, and 4) an enhanced corporate image as an environmentally friendly company. Each of these benefits is discussed below in more detail.

(a) In this report, "industry" generally refers to firms that utilities define as industrial customers. These customers are primarily manufacturing firms and larger (> 50 kW) commercial firms, as well as agricultural, construction, and mining firms.

- *Energy efficiency, especially that subsidized by utility DSM programs, lowers industrial costs and can increase profits.*

Successful industrial DSM programs are demonstrating to industry that it is possible to lower energy costs by adopting energy efficient technologies. For example, installing energy efficient motors can lower energy costs of operating the motor by 1% to 11% (Ontario Hydro 1994).[a] The purchase price of a new, energy efficient motor represents only a minor portion of its total cost when operating costs are considered. For a 60-horsepower motor operating in a typical industrial situation, the motor's purchase price of approximately $3400 represents only 36% of the first-year cost of operation.[b] (By comparison, the purchase price of an automobile is about 150 times the first-year fuel cost.) In fact, equipment cost can be a minor element in the total cost of an energy-using device. With good operation and maintenance, the motor should last 20 years, so the purchase price represents less than 2% of its lifetime operating cost. In addition to saving energy, energy efficient motors may have a longer life than conventional motors (reducing disruption associated with replacement) and better reliability. (See Chapter 4.0 of this report for an example of a very successful motor-oriented DSM program run by British Columbia Power Corporation.) Clearly, some energy efficiency improvements can reduce costs and, when subsidized by the utility company, even small firms with low electricity intensity can benefit from industrial DSM programs.

Historically, industrial firms looked at their existing energy costs as a cost of doing business that was largely outside their control and usually not high enough to warrant special attention. Today, as energy efficient technologies that can reduce those fixed costs emerge, the importance of energy use to the bottom line still varies widely among industries. Measured in terms of Btu of energy required per dollar of industry shipments, energy intensity varies among manufacturing industries by a factor of 200 (OTA 1993). For most industries, energy accounts for only a small portion of production costs: 5% or less of production costs for 86% of industrial output (OTA 1993). The average for energy cost as a share of manufacturing production costs is about 3% (Bureau of the Census 1992). However, as illustrated by the motor example above, energy costs can be reduced, even in firms with average or low energy intensity. In addition, although energy may represent a minor percentage of the production costs, energy's impact on profits can be much greater. For instance, if energy represents 2% of production costs and profits amount to 20% of production costs, then reducing net energy costs by 30% through greater energy efficiency can result in a 3% increase in profits.

(a) Even larger energy savings opportunities are available when efficient motors are combined with improved efficiencies in their end use loads (e.g., pumps, fans, and compressors) and with measures (such as adjustable speed drivers) to better match motor load to process needs (Elliott 1994).

(b) Assumes that the motor operates 4000 hours per year at an efficiency of 95% with an electricity cost of 5.0 cents/kWh, resulting in an annual operating cost of $9423.

An even greater incentive exists for energy-intensive industries that have not implemented an aggressive energy efficiency initiative in the past.[a] In these industries, electricity costs are a significant portion of total costs and can be an important determinant of product price competitiveness. Table 2.1 shows the fraction of costs devoted to energy and the overall energy intensity (in terms of energy cost per thousand dollars of shipments) for the four most energy-intensive industries: paper, chemicals, stone/clay/glass, and primary metals.

The importance of energy costs to some industries is more evident below the 2-digit standard industrial classification (SIC) level. (The SIC numbering is the nomenclature used for classifying industrial operations.) Table 2.2 lists some of the highly energy-intensive sub-industries within the industries listed in Table 2.1.

For these energy-intensive industries, energy efficiency improvements may be key to the success of a firm.

Table 2.1. Energy-Intensive Manufacturing Industries (U.S. Bureau of the Census 1992)

Industry	Energy Cost as a Fraction of All Operating Costs (%)	Energy Cost per Thousand Dollars of Shipments ($)
SIC 26 Paper	5.0	42.60
SIC 28 Chemicals	4.6	32.10
SIC 32 Stone/Clay/Glass	6.8	56.70
SIC 33 Primary Metals	6.0	57.70
Average for all Manufacturing	2.5	19.60

(a) Firms with less energy-intensive operations may not perceive an incentive to investigate energy-saving opportunities; however, such firms may actually be able to achieve significant energy savings by taking steps that more energy-intensive firms take as a matter of course.

Table 2.2. Energy-Intensive Manufacturing Sub-Industries (U.S. Bureau of the Census 1992)

Industry	Energy Cost as a Fraction of All Operating Costs (%)	Energy Cost per Thousand Dollars of Shipments ($)
SIC 262 Paper Mills	9.0	83.20
SIC 263 Paperboard Mills	9.5	87.00
SIC 281 Industrial Inorganic Chemicals	13.6	103.70
SIC 2812 Chlor-Alkali	22.4	199.90
SIC 2813 Industrial Gases	29.4	236.20
SIC 324 Cement, Hydraulic	21.4	204.80
SIC 3334 Primary Aluminum	19.7	228.90

- *Energy efficiency improvements may increase productivity and global competitiveness.*

Utility DSM programs can stimulate the adoption of new, more energy efficient technologies in industry. These programs alert busy industrial executives to the emergence of new, cost-effective technologies. By offering financial incentives to purchase this equipment, utility DSM programs induce companies to install and assess the value of new technologies.

As energy conservation is implemented in industry, other economic productivity gains may occur. For example, more efficient processes and newer technologies may also bring better quality control and lower labor requirements. These important ancillary benefits associated with efforts aimed primarily at energy efficiency improvements may help to increase the incentives for implementing DSM in industry. Industries typically benefit more from reductions in labor and gains in quality than they do from energy savings; thus, recent industrial DSM efforts have been refocused away from energy savings to the other associated benefits in the hope that industries will respond more readily to these concomitant benefits.

Energy cost savings related to DSM can also affect the global competitiveness of an industry. The aluminum industry provides an extreme illustration of the effect of energy cost savings on a firm's competitive edge. Because this industry uses a great deal of electricity and has a global demand for its product, energy savings in the aluminum smelting process are likely to affect the global competitiveness of the U.S. aluminum industry. The amount of energy used to smelt aluminum varies widely from as little as 6 kWh/pound to as much as 9 kWh/pound. At a cost of 2 cents/kWh, this 3-kWh-per-pound difference results in an additional cost of 6 cents/pound of aluminum produced. When demand for aluminum is high, all smelters can produce at a profit because aluminum purchasers will pay high prices. However, with today's world aluminum prices hovering around 50 cents/pound, this 6-cent-per-pound differential can mean the difference between being competitive in world markets or being forced out of business. Other industries with high energy costs would also benefit from such energy efficiency improvements.

A common argument by U.S. industry is that low-cost energy in this country is essential to our ability to remain competitive in world markets. Yet in many other countries, the higher cost of energy stimulates the adoption of energy efficient technologies. For instance, industry's price of energy is much higher in Japan than in the United States, yet the cost of energy per unit of production is relatively similar. Because higher energy prices have spurred Japan's industry to adopt energy efficient technologies, the amount of costly energy needed in production has been reduced. Utility DSM programs can substitute for lower energy prices in the United States by stimulating industry to adopt the latest technologies.

- *Energy efficiency leads to environmental improvement.*

Industry faces a wide array of governmental requirements to improve the environment, including air, water, and solid waste regulations. In many industries, extensive management time and financial resources are being spent to address these requirements. In some cases, more energy efficient technologies, especially changes in processes and their control, are being used to address environmental requirements. For example, decreasing energy consumption usually leads to lower levels of air pollution. In the case of electricity consumption, however, those benefits usually accrue to the electric utility itself rather than to the industrial facility because electricity used in an end use technology (e.g., a motor) does not produce pollution; the pollution is produced in the generation of electricity. However, some projects designed to improve energy efficiency have environmental benefits beyond those associated with decreased energy consumption. Such benefits are becoming increasingly important as the capital spending required to meet environmental requirements continues to increase. For example, the DOE is working with industry to develop a direct steel-making process that will reduce the energy required to convert iron ore to liquid steel by 20%, while increasing production rates. This process eliminates cokemaking, which has become increasingly expensive in recent years because of the high costs of environmental compliance for coke ovens (OTA 1993). In the first case study discussed in Chapter 5.0, introduction of an energy efficient technology at a paper mill eliminated down-time created by the fact that the amount of waste the mill generated exceeded federal permit levels.

- *Participation in energy efficiency and DSM programs often improves a company's public image as a "green" company.*

Industry is also motivated to improve its perceived environmental performance by a desire to project an environmentally friendly corporate image. With public concern growing over air, land, and water pollution, efforts to improve energy efficiency by industrial firms are generally applauded by environmental groups and many segments of the public at large. The success of the U.S. Environmental Protection Agency's (EPA) Green Lights program, a voluntary corporate commitment program to encourage the adoption of energy efficient lighting technologies, demonstrates the interest of industry in improving its environmental image. A cursory review of advertising literature with a focus on "being green" indicates that industry views conservation and pollution abatement as a good public relations device. The DOE's

Motor Challenge and other industrial programs to reduce the emissions of carbon dioxide are offering industry even more opportunities to improve its environmental performance and gain a better corporate image.

2.1.2 Factors Impeding Industry in Adopting Demand Side Management

A variety of factors come together to produce barriers that must be overcome in implementing industrial DSM programs. The opponents of DSM are angry about cross-subsidization between customer classes in allocating DSM costs among ratepayers, skeptical because of utilities' lack of experience with industrial energy efficiency measures, and concerned over capital constraints that are a financial barrier to investing in energy efficiency. Many companies have indicated that various constraints have kept them from participating in DSM programs, perhaps not realizing that returns on investment can be as much as 300% (Swink 1993). The inertia, financial constraints, and lack of interest on the part of industry present impediments to full industry participation in the industrial/utility partnership needed to reap the potentially large benefits of improvements in industrial energy efficiency. And, if DSM efficiency gains are viewed as a resource, then DSM's impacts on utility rates are no different in principle than the rate effects of capacity additions. The views of DSM opponents stand in stark contrast to the effects of successful programs. Some of the factors impeding DSM are discussed below.

- *Energy is sometimes a low priority in industry.*

As discussed briefly above, energy costs typically represent only 3% of total production costs in industry. While cutting costs is a constant issue at most firms, managers tend to focus their attention on those areas of cost with the greatest potential for savings, such as direct labor and labor-benefit costs. Managerial time and financial resources are typically concentrated on maintaining production, increasing market share, or developing new products. Not only are potential energy cost savings alone often insufficient to motivate investments in energy efficiency measures and efficient equipment, but the relatively low levels of expenditure on energy may make the investigation of ways to decrease energy costs a low priority.

Especially at smaller and medium-sized firms, senior management is seldom aware of energy efficiency options. Spending time and limited resources to reduce energy costs is often seen as a time-consuming endeavor with only modest cost-saving benefits.[a] Senior management sometimes does not appreciate the link between improving energy efficiency/increasing productivity and reducing waste/ addressing environmental problems. Utilities wishing to help these managers improve their energy use and efficiency must break through these barriers to gain their involvement. Utility DSM programs are often an important factor in focusing management attention on the potential for energy efficiency improvements. Rebates or other types of financial incentives are often needed before utilities can get the attention of executives.

(a) For a detailed discussion of barriers and opportunities facing small firms, see "Understanding the Energy Efficiency Investment Decisions of Small and Medium Sized Manufacturers." Alliance to Save Energy, Washington, DC. Estimated for publication in June 1995.

Factors That Influence Industrial Investment Decision Making

Whether the full set of energy efficiency measures that appear to be cost-effective for a given industrial firm will indeed be implemented by that firm depends on several factors in addition to life-cycle cost. Because energy usually represents only a small fraction of total operating costs, investments in energy efficient equipment and processes often do not receive high-priority attention in an industrial firm, even if a particular investment would pay itself back through energy savings. Even when energy use is an important determinant of industrial competitiveness, investments to increase energy efficiency can be very costly, and decisions to undertake such investments are constrained by factors such as capital availability. The economics of these decisions are further complicated by non-economic factors that also influence energy efficiency investment decisions. Managers of DSM programs need to take these factors into account when designing their programs and working with individual industrial customers.

Economic criteria used in decision making often take the form of hurdle rates or payback periods. Management sets the minimum return on investment, or the maximum time by which the investment would pay itself back and considers only those investments meeting the criteria. A review of the empirical basis for assigning payback periods to industrial energy efficiency investments indicates that longer payback periods (over 5 years) are commonly used only by large, healthy, flexible firms that have a large pool of capital to draw from for such investments (Ross 1986). For other firms, which operate under more capital constraints, the required payback period is usually 1 to 3 years. Longer payback periods may be acceptable for investments of proven worth that have been undertaken by other plants, while riskier projects (such as a new application or experience for the plant or company) may require that the payback period be even shorter than usual (ASE 1987). Recent research indicates that, for small and medium-sized manufacturing firms, a payback period of 2 years or less is required.[a]

Energy-saving investments are usually considered discretionary projects and, therefore, compete with other cost-reducing projects. Investments that affect only energy use are usually not selected over opportunities to increase process productivity and improve product quality.[b] However, energy efficiency investments that improve quality or reduce waste production or waste treatment and disposal costs would command more attention within an industrial firm.

A number of factors contribute to the economic potential of investing in efficiency and affect the likelihood that a particular energy-saving investment will be made:

Effect on Product Quality and Yield— If a potential energy-saving measure has a negative effect on product quality and yield, it will normally be removed from consideration. However, if the measure improves yield or quality, the chances that the investment will be made are greatly enhanced.[b]

Technological Risk—If a technology has proven effective and reliable in other applications, a firm will be more likely to implement it than if the firm has no experience with the technology. Newer technologies may be held to a higher economic standard than more familiar technologies. General industry experience with a technology and knowledge of examples of technology failures also will influence the investment decision.

Technology Availability and Vendor Reliability—An industrial firm will be reluctant to invest in a technology if the availability of the technology, spare parts, and/or servicing and maintenance are questionable. Also, for technologies that are new and untried, long-standing relationships with vendors may influence whether an investment is made and may carry more weight than strict hurdle rate or payback criteria.[b]

Training Requirements/Personnel—Some new technologies may require new skills or additional personnel. In this case, the industrial decision maker must consider whether trained employees are available or whether current employees can be trained quickly and cost-effectively.

(a) For a detailed discussion of barriers and opportunities facing small firms, see "Understanding the Energy Efficiency Investment Decisions of Small and Medium Sized Manufacturers," Alliance to Save Energy, Washington, DC. Estimated for publication in June 1995.

(b) Roop, J. M., D. L. Shankle, R. L. Eckert, W. B. Ashton, and M. G. Woodruff. 1994. *Industrial Energy Efficiency Decision Making: Factors that Affect Stock Turnover*. Draft report prepared for the U.S. Department of Energy by Pacific Northwest Laboratory, Richland, WA.

- *The industrial decision-making process does not always encourage investments in energy efficiency improvements.*

Although industrial firms may be very conscious of energy efficiency (Price 1993), the availability of capital presents a potential impediment to participation in utility DSM programs. Industrial customers often organize their assets in a way that keeps excess capital scarce, especially for an energy efficiency project (Williams 1994). These types of projects often have long, complicated, internal application processes (Ertle 1994). (See the textbox on the following page for a lengthier discussion of factors that influence industrial investment decision-making.) These challenges make it difficult for some industrial customers to invest in an energy efficiency upgrade to plant and facilities. Energy efficiency investments must compete with investments meeting other company objectives. The capital used in an energy efficiency investment is often thought to be better used in other areas of the company (research, management, etc.). This view increases the perceived risk in investing in energy efficiency measures.

- *Putting energy efficiency measures in place can disrupt industry operations.*

Industry often encounters problems in trying to install energy efficient technological improvements. Residential and commercial conservation measures can be implemented while people continue to reside and work, but industrial conservation sometimes requires production to be shut down, an obvious impediment. One solution is minimizing production down-time, for instance, by installing new equipment when the plant is not operating or during normally scheduled down-time for maintenance and equipment upgrading. Of course, this requires internal planning or an inventory of conservation measures that can be installed when an opportunity presents itself. For example, many utilities have been reluctant to offer rebates for efficient motors before the plant has a breakdown and needs to replace the motor; however, a plant facing a forced outage because of a motor breakdown will not always wait until an energy efficient motor is ordered and delivered; it will install the first motor available. The plant needs to have efficient motors in stock to install them with minimal disruption.

- *Some industrial firms believe DSM programs have raised industrial electricity rates and view utility DSM programs with a negative attitude.*

Because of the difficulties in designing and conducting industrial DSM programs, the assistance many utilities provide to the residential and commercial sectors through DSM programs is more extensive than their assistance to industrial customers. Some large industrial firms[a] argue that they do not receive the benefits of DSM, yet their rates are higher than need be because they bear a large part of the costs of delivering DSM to other customer classes. This process is commonly called cross-subsidization. Opponents of DSM say that cross-subsidization drives up the base rate for industrial firms and offers nothing in return (Houston 1993). To combat this phenomenon, some state regulators have allowed industries to remove themselves from accruing the benefits or sharing the costs of utility-sponsored conservation

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(a) The position of large industrial firms is often represented by the Electricity Consumers Resource Council (ELCON), a trade organization representing larger industrial energy consumers and often opposing the implementation of DSM programs by utilities.

programs. Known as a subscription service, this arrangement has been recently adopted for one utility in New York State. Some utilities have classes of industrial customers who are not eligible for and do not incur costs for energy efficiency programs sponsored by their utility company.

In recent research on the rate effects of utility DSM programs, Oak Ridge National Laboratory examined several factors which, when used together, have the effect of reducing electricity prices (Hirst and Hadley 1994):

1. using market transformation strategies
2. working closely with trade allies
3. shifting more costs to participating customers
4. targeting the DSM measures where they are most likely to defer large transmission and distribution costs.

- *Some industrial firms fear DSM programs help their competitors.*

Some industrial firms express concern that other firms (perhaps their competitors) participate in and benefit from DSM programs even though these other firms would have installed higher efficiency measures anyway, without the benefits of the industrial DSM program (Rosenblum 1994). This situation is sometimes called the "free-rider" effect. In addition, those who participate will have lower bills as a result of the energy savings, but those who do not participate will have higher bills because the base rate covers the cost of implementing the DSM programs (Nadel and Jordan 1994). Industrial representatives argue that including DSM program expenses in the rate base forces them to share the cost of a competitor's energy efficiency improvements. This complaint has made implementing "custom" DSM program features controversial. To the industrial customer who has already invested in efficiency measures without the assistance of a utility DSM program, including DSM costs in the rate base appears to be a punishment for the efficiency-conscious firm (Houston 1993). These opponents to DSM tend to favor greater use of competition (e.g., allowing independent power producers to compete with utilities for retail customers) so they can obtain the lowest electricity rates possible. Since average costs have been higher than marginal costs at most utilities, some large industrial electricity users believe they will benefit much more by reducing rates through increased competition than through utility DSM activities.

Disparity of rates among different locations also causes concerns related to the competitive position of industrial customers in different states. For example, in the Western Systems Coordinating Council, an industrial firm in one state would pay over $407,000 per month on 10-MW service with a load factor of 68%, while a competitor in an adjacent state might pay only $155,000 for the same power requirements. The disparity in rates may cause the industrial end users to search for alternatives to their standard supplier (Rouse 1994) or to move operations to another service area. Conversely, a corporation with several competing plants is likely, at the plant manager level, to be responsive to utility partnership opportunities to increase plant efficiency and economic productivity.

- *Energy efficiency investments are not always seen as a "sure thing."*

Some industrial customers question the reliability of energy efficiency investments to produce the estimated savings, pointing to measured savings that do not meet those projected in the engineering estimates. In many cases, a technology has not been on the market long enough to test its real ability to reduce consumption (for example, natural gas air-conditioning equipment). In the words of Amory Lovins, "Most of the best of these technologies are less than a year old; that is, the half life of this technology is only one year" (quoted in Kuhel 1994). Also, even in successful cases, engineers miss factors affecting a reduction in energy use. For example, a Sealtest ice cream plant found that because of engineering oversights, its initial verified savings were about 80% of the projected savings (Hepner 1994). In this case, savings were being achieved as expected, but were being measured poorly. Fortunately, the oversights were identified and savings ultimately were found to be in the expected range.

2.2 Benefits of and Impediments to Demand Side Management: the Utility Perspective

Utilities are driven to maintain sales of their product and, hence, to retain customers. Faced with the increased difficulty and cost of siting and building new power plants, they have also been discouraged from increasing production capacity and, instead, encouraged to seek to minimize the need for new plants through DSM programs. They also want to maintain market share by effectively serving their customers. Although DSM programs for residential and small commercial customers are fairly common among investor-owned utility companies, the industrial customers appear to represent the greatest DSM challenge. The following sections describe the benefits to utilities and the impediments that utilities perceive in designing and implementing industrial DSM programs.

2.2.1 Factors Encouraging Utilities to Formulate Industrial Demand Side Management Programs

For utilities, the benefits of DSM programs include 1) deferral of the need to construct new power plants, 2) retention of existing industrial loads, 3) decrease of the environmental stress associated with power plant operation, and 4) enhanced public relations.

- *DSM programs defer the need to construct new power plants.*

Utility industrial DSM programs, coupled with programs addressing other end use sectors, are frequently used to defer or eliminate the need to construct or expand power plants. Investing in the energy efficiency of industrial customer facilities is often less expensive, on a cost-per-kW basis, than adding new capacity. Utility executives are only too aware of the difficulty in siting new plants and gaining regulatory permission to do so. For utilities with excess capacity, efficiency programs may seem an unnecessary activity, but not if it means the difference between retaining or losing an industrial customer.

- *DSM programs help utilities retain industrial customers.*

Utilities can help businesses in their service territory remain competitive by helping these businesses improve their energy efficiency and reduce energy costs. Maintaining a viable economic and industrial base in local communities is an important concern of utilities. If high energy costs are hurting the economic viability of companies so that they might go out of business or move to another location, it is in the utility's interest to help them reduce those costs. Although this may reduce utility revenues from the facility, it is a better option than having those revenues totally eliminated.

Utilities can also use industrial DSM programs to encourage businesses to move into their service territory. Virtually every utility conducts activities to encourage the economic growth of its community. New industry in a service territory represents additional power sales to the facility, as well as new loads from new residential customers and others that move in to support the operations of the new facility. Industrial DSM programs that help a new company subsidize some of the costs of siting a new facility can be a contributing factor to the decision to move to a given area.

- *DSM programs help utilities achieve environmental benefits.*

For every unit of electricity saved, the demand for utility generation of new power is reduced. Generating units fueled with fossil fuels produce air pollution, carbon dioxide (a greenhouse gas implicated in global warming), solid waste, and some water effluents, and they use resources that cannot be replaced (i.e., fossil fuels). Therefore, reducing the amount of electricity required for a given end use has the effect of reducing the toll that utility generation places on the environment, without harming the economic health of the region.

Because they can defer and even decrease the number of future power plants, energy efficiency gains may also reduce the amount of capital that utilities must invest in pollution abatement technology. From the utility's business perspective, these non-value-added investments can be viewed as a pure cost and a necessary one of doing business. Reduction of these costs will reduce rates to a utility's customer over the long term. Industrial energy efficiency and its associated reductions in pollution could also help utilities in siting plants, especially as utilities move to smaller, more distributed generation placed closer to loads. If ambient pollution levels are reduced, a utility will be more likely to secure a siting permit at a reasonable cost. Additionally, a firm that moves its facility to another location is not likely to see a reduction both in emissions and utility rates; however, a firm that joins with a utility to improve efficiency is likely to increase profits and reduce emissions.

- *Utilities experience positive public relations benefits by implementing DSM programs.*

Because utilities are in a regulated market, public relations may mean more to them than to industries in a competitive market. The price of a commodity for an unregulated industry is set in the marketplace, where the constituency supporting "green actions" is dispersed and not always well organized; on the other hand, utility rates are established by a regulatory body (the Public Utility Commission) in public sessions.

Regulatory bodies are lobbied intensely by nongovernmental organizations (NGOs) interested in establishing environmentally sound practices. Utilities that aggressively market their DSM programs are likely to be viewed more favorably by environmentally oriented intervenors in future rate cases. Similarly, industrial firms that publicize their investment in energy efficient practices add to the public perception that the firm is concerned about public welfare.

2.2.2 Factors Impeding Utilities in Implementing Industrial Demand Side Management Programs

Impediments for utilities in implementing industrial DSM programs include 1) the complexity and variety of needs in industrial facilities, 2) the difficulty in estimating future industrial energy savings under DSM programs, 3) the difficulty in measuring such programs' success, and 4) the uncertain business climate for utilities.

- *The industrial sector is very complex, and utilities have limited experience in dealing in detail with industrial facilities and equipment.*

Utility executives sometimes see industrial DSM as relatively difficult to achieve and, therefore, potentially unreliable as an energy-saving resource. The many different types of firms and processes make it difficult to design cost-effective programs. For instance, industrial firms, even in similar SIC levels, can sometimes differ markedly in the types and sophistication of the equipment and processes they use. While they may appear similar in concept, some plants are new, employing the latest technology, while others are older facilities that modify processes continuously and marry old and new technologies in the same plant. Thus, it can be difficult to estimate prospective savings from industrial DSM programs, even based on past experience in other facilities.

Many utilities have only limited experience in designing and delivering DSM programs to the industrial sector. Utilities have much more experience in the commercial and residential sectors, where largely homogeneous opportunities for savings—building shell measures, equipment-efficiency upgrades, and customer education—across different building types and climate zones make it easier to offer standardized programs that apply to most customers. These sectors are also less complex in estimating the expected energy savings, which reduces the cost of auditing, monitoring, and evaluating energy costs.

- *Energy savings from industrial DSM programs are difficult to estimate in advance, leading to uncertainty in program design and difficulty in obtaining program approval.*

Identifying potential energy-saving options in industrial facilities is a complex process, requiring detailed and individual energy audits and analysis to determine which options are appropriate. Utilities often lack the more sophisticated engineering personnel needed to service the industrial sector. Industrial firms often complain that utility staff lack the necessary understanding of their process and business to provide any meaningful assistance. Further complaints are heard about the overly focused industrial DSM initiatives, such as technology-specific rebates which may or may not address the unique needs of individual firms. Utilities have great difficultly helping industry make process change-out improvements, where some of the largest potential for energy savings is found.

In addition, utilities sometimes have difficulty in obtaining information about industrial energy use and the effectiveness of various energy efficiency improvements. Firms typically view this information as proprietary because its release could give competitors inside information about their cost structure. Yet, without the information, utilities have difficulty designing and implementing effective industrial DSM programs. Conducting industry surveys to gather information needed to design industrial DSM programs is one way to overcome this problem. These surveys are typically designed so that information about individual firms is not released, yet overall industry analysis of energy use characteristics is possible.

- *The success of programs is difficult to measure.*

Once an industrial DSM program has been implemented and utility costs have been incurred, the utility must measure the program's success. Evaluation of the impact of industrial DSM programs is crucial to providing the feedback that allows programs to improve. However, design of measurement programs is complicated by many factors, including the difficulty of separating the effects of the DSM program from other changes at the industrial plants and the problems associated with accounting for the "free riders." (A discussion of industrial DSM assessment methods and case studies is included in Appendix B.)

- *Utilities face considerable uncertainty about the future, especially in the face of the potential restructuring of the industry and introduction of retail wheeling of power. Under some future restructuring scenarios, DSM programs might not serve utilities' principal business needs.*

Since passage of the Energy Policy Act (EPACT) in October 1992, the debate on whether the electric utility industry should be restructured to bring more competitive forces to bear on electricity prices has grown almost exponentially. Viewed as a natural monopoly for six or more decades, electric power generation is now discussed as the last major regulated industry about to be "deregulated" by opening up the transmission grid for the retail wheeling of electricity (i.e., the open competition among independent power producers and electric utilities to serve retail customers directly).

When retail wheeling was introduced in some foreign countries (e.g., Norway), support for DSM programs began to decline. Some observers fear that this might also happen in the United States. When faced with increased competition, U.S. utilities might begin to focus primarily on retaining and capturing market share. Those utilities currently saddled with high costs greatly fear competition and its consequences—lost load, lost revenues, failure to cover fixed costs, and declining stock market prices. The managers of such utilities might prefer spending a dollar to increase market share or to reduce production costs rather than spending a dollar on DSM.

However, not everyone sees DSM as being incompatible within a retail wheeling framework. In analyzing the DSM program planning process under different electric industry ownership, planning, and structural scenarios, Wiel (1994) concludes that "robust and effective utility DSM can be implemented in any industry structure." In addition, the path of restructuring is uncertain, as is the fate of the retail wheeling movement. More detailed discussion of this important topic is included in Appendix C.

2.3 Conclusions

A number of very desirable benefits are associated with industrial DSM. Industrial DSM programs have gained substantial experience in overcoming the obstacles to energy and economic efficiency. In addition, society as a whole benefits from the reduced environmental stress and from the potential for a stable industrial base (with the concomitant employment opportunities) that energy efficiency improvements may encourage. Many public interest groups (i.e., NGOs) commend utility efforts to initiate industrial DSM programs.

Considering the different motivations and objectives of various stakeholders described earlier, the successful DSM program must overcome various difficulties. A program that can overcome the impediments described above is likely to be

- flexible enough to meet industrial customer needs, offering a range of energy efficiency improvement options to meet the needs of a range of customer types
- easy for the utility to implement
- management-friendly, minimizing the attention needed to implement the program and leaving managers to deal with their own business needs
- minimal in its disruption to industrial operations
- attuned to the industrial decision-making process
- equitable in terms of rate structure, perhaps allowing firms to "opt in" to rates that include DSM costs
- trusted to reduce the industrial customer's perceived risk of investing in energy efficiency measures
- measurable, that is, using sound measurement techniques, the utility can assess program success and learn from program mistakes
- expert in its treatment of the intricacies of particular industries, perhaps through employment of outside consultants or in-house specialists who understand industry.

The greatest energy savings may result not from direct efforts to reduce energy consumption but from pursuing other goals such as improved product quality, lower capital and operating costs, or specialized product markets (OTA 1993). Many projects undertaken for other reasons yield energy efficiency gains as a secondary benefit.[a]

Equipment upgrades targeted at reducing energy consumption are a natural component of an industrial DSM program. However, energy use, environmental effects, and operating costs are interrelated, so the most important opportunities for industrial DSM may reside in efforts to work with industrial customers to improve their overall efficiency and competitive position. Such efforts may be especially important in helping to retain load from industrial plants that would otherwise cease operations[b] or relocate. Even if retail wheeling were prevalent across the United States, the best way for utilities to retain markets likely would be an aggressive program to work with industrial customers as industrial partners, helping to make their use of electricity an efficient and holistic endeavor and a financial success.

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(a) For example, according to OTA (1993), the steel industry installed continuous casters to improve product yield more than to save energy.

(b) An example of such an effort involved a Sealtest plant in the Northeast that was in danger of closing. The plant was one of the parent company's least efficient; to reduce costs, the plant had cut back to a four-day work week, but further cuts were necessary. A partnership developed among Boston Edison, the Massachusetts Division of Energy Resources, the parent company, a refrigeration engineering firm, and a firm that conducted a comprehensive energy efficiency study. The efforts of the team resulted in comprehensive changes to plant equipment that reduced operating costs by approximately 30% and substantially improved the product (Hepner 1994).

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3.0 Electricity Use and Potential Electricity Savings in the Manufacturing Sector

In recent years, increased attention has been focused on industrial DSM and on removing impediments to investments in industrial energy efficiency. This attention is motivated, in large part, by the large potential energy savings available in the manufacturing sector. Recent estimates indicate that the potential for savings in electricity alone could reach 100 to 200 billion kWh per year, a full 10% to 27% of total manufacturing electricity use (Elliott 1994). These savings could be achieved through an orderly change-out of equipment when equipment fails, processes are modernized, or new facilities are constructed over the next 7 to 20 years (Elliott 1994).

The energy savings achievable at any given manufacturing plant, of course, depend on the specific circumstances at that plant—how it determines whether investments are cost effective, how much capital it has available to invest, what its specific technologies and processes are, the vintage of its equipment, how much of its operating costs are due to energy use, how important operating costs are to profitability, whether it has already implemented an aggressive energy efficiency program, and other factors. Increasingly, the environmental and productivity-enhancing benefits of an energy efficient technology are being stressed along with the energy benefits in an effort to convince manufacturers to look at the overall effects of a technology on their bottom lines when considering whether to invest in the technology.

The purpose of this chapter is to indicate the magnitude of the potential electricity savings available in manufacturing and describe some of the technologies that could help achieve those savings.[a] The discussion is illustrative; as described in Chapter 2.0, no general review of electricity savings can predict the type or magnitude of the savings that could be achieved at any particular plant.

The difficulty in predicting available energy savings in manufacturing is due in large part to the extraordinary diversity of the manufacturing sector. For example, manufacturing industries range from those that transform raw materials into more refined forms (e.g., the primary metals and petroleum refining industries) to those that produce highly finished products (e.g., the food processing, pharmaceuticals, and electronics industries). Even within a manufacturing industry, individual firms vary greatly in the outputs they produce and how they produce them. Further, even two plants producing identical outputs can use different processes; even two plants using identical processes can use different vintages and types of equipment. All this merely emphasizes the importance of what managers of successful DSM program already know: personal attention to individual customers and their particular industrial operations is crucial.

In particular, this personal attention is important if the industrial DSM program is to move beyond a commercial-type program that focuses on a few standard technologies, such as motors, lighting, and heating, ventilation, and air-conditioning (HVAC) systems. These technologies can certainly save energy

(a) The discussion in this chapter is limited to the manufacturing sector (SIC 20-39). Additional savings are possible among other customers that utilities may classify as industrial customers.

in industry; in fact, motor drive is a large fraction of manufacturing energy use and is a potentially fruitful target for industrial DSM programs. Lighting improvements can also yield significant energy savings and may provide a way to build industrial customers' confidence in a utility's DSM activities. The potential savings from using these technologies are discussed in this chapter. However, programs that focus only on these standard technologies are missing the much larger potential energy savings that can be achieved through process upgrades that are specific to an industry or firm. In fact, process upgrades, though potentially very expensive, can have combined energy, environmental, and productivity benefits that make them attractive investments—far more attractive to the firm than when only the energy benefits (and their related cost and emissions benefits) are considered. At the same time, the energy savings can be large enough to be of great interest to industrial DSM programs. In such cases, attention to the barriers to investment described in Chapter 2.0 can be particularly beneficial.

Therefore, while this chapter focuses on conventional equipment changes and a few industry-specific changes, industrial DSM program managers should keep in mind the prospects for large benefits from more custom, process-oriented changes that may be identified for particular customers.

3.1 Energy Use in Manufacturing

In 1991, U.S. manufacturers used 15 quadrillion Btu (quads) of energy for heat, power, and electricity generation (EIA 1994). Of this, about 3 quads was ultimately consumed as electricity, accounting for both purchased electricity and that generated onsite using fossil and renewable fuels.

The energy sources used in manufacturing are as diverse as the manufacturing sector itself. In particular, manufacturers use a much broader array of energy sources than do the residential, commercial, transportation, and electricity supply sectors (OTA 1993). First, manufacturers use energy sources both to produce heat and power and as feedstocks to industrial processes. Also, those energy sources used to generate heat and power include fuels purchased directly for those purposes, such as natural gas, coal, residual oil, and distillate oil, as well as fuels produced as

Accounting for Electricity Use in Manufacturing

Electricity used in manufacturing can be classified into three categories:

- electricity generated elsewhere (offsite)
- electricity generated onsite by the manufacturer from fossil inputs
- electricity generated onsite by the manufacturer from renewable inputs.

The Manufacturing Energy Consumption Survey reports two different measures of electricity use:

- **Net electricity**, which represents electricity generated offsite and that generated onsite from renewable fuels (less amounts sold and transferred out). The value for net electricity can be added to the values for consumption of fossil and other fuels to compute the total energy input for heat, power, and electricity generation
- **Net electricity demand**, which represents all electricity used, including that generated onsite from fossil and renewable fuels (less amounts sold and transferred out). Because there is overlap between the values for net electricity demand and fossil fuel consumption, the value for net electricity demand cannot be added to values for other fuels to compute total energy use.

For purposes of end use allocations and for the analysis in this chapter, electricity use is given in terms of net electricity demand, which represents the amount of electricity use in manufacturing that could be affected by DSM activity.

byproducts of industrial processes. Such byproduct fuels include blast furnace gas and coke oven gas at steel mills; wood chips, wood waste, and pulping liquor at paper mills; and still gas and petroleum coke at petroleum refineries.

When electricity generation, transmission, and distribution losses are excluded, natural gas is the next most important fuel in manufacturing, followed by byproduct fuels and electricity.

A few energy-intensive industries dominate manufacturing energy use. Six industries—chemicals, primary metals, pulp and paper, petroleum/coal, food, and stone/clay/glass—together account for 84% of the energy used for heat, power, and electricity generation. These industries are generally also the largest consumers of electricity. The paper, chemicals, and primary metals industries together account for over half of all manufacturing electricity demand (EIA 1994). The fabrication and assembly industries (such as auto manufacturing, textiles, and metals fabrication) consume relatively little energy. However, as discussed in more detail later, they are comparatively large electricity users because of the relative prominence of motor-driven devices, lighting, and ventilation (OTA 1993).

Manufacturing energy use can be classified into three end use categories:

- Boiler fuel—fuel used in boilers to produce steam for industrial processes.

- Direct process uses—includes process heating (e.g., kilns, furnaces, and ovens), process cooling and refrigeration, machine drive (e.g., motors and their corresponding pumps, fans, and compressors), and electrochemical processes. Process heating is the most diverse end use. It includes the heating of fluids and the heating, treating, melting, curing, forming, bonding, drying, calcining, firing, agglomeration, and smelting of materials (OTA 1993).

- Direct nonprocess uses—includes facility HVAC, lighting, and other support uses, as well as onsite transportation and conventional electricity generation.

These categories are very useful for estimating the potential for energy savings from the use of more efficient technology. However, because manufacturing and its associated energy and fuel use is so complex and diverse, determining how energy and fuel use should be allocated among these categories has heretofore been a difficult task. Beginning in 1991, the Manufacturing Energy Consumption Survey (MECS),[a] which the Energy Information Administration uses to collect information on energy and fuel use in manufacturing, asked respondents to break down their energy and fuel consumption into end use categories. The results are used in this chapter to estimate potential manufacturing electricity savings.

(a) The MECS was conducted triennially between 1985 and 1991 and will be conducted biennially beginning in 1994.

As expected, the MECS results confirm that process uses (which include motor drive) account for most energy use and that nonprocess uses such as HVAC and lighting account for the smallest fraction of energy use. Of the fossil fuel and electricity for which an end use was identified,[a] about 53% went to process uses, while only 12% went to nonprocess uses. While nonprocess end uses can certainly offer potential energy savings analogous to those achieved in the commercial sector, the largest potential savings are available in generic process uses, such as motor drive, process heating, and process cooling, as well as in industry-specific process changes.

Table 3.1 shows the energy inputs to each end use, by fuel. As shown, for both process and non-process end uses, about two-thirds of the energy used is fossil fuel, while electricity represents a little over one-third.[b] Figure 3.1 looks at electricity use across end uses. The most important application is in process uses; about 80% of electricity is used in this category, with only 15% to 17% used in nonprocess uses.[c] Fossil fuel is less heavily concentrated in process uses; as shown in Figure 3.2, about 42% goes for process uses, with 11% going to nonprocess uses. (Most of the rest is used as boiler fuel.)

Table 3.1. Distribution of Total Manufacturing Energy Inputs for Heat, Power, and Electricity Generation Among End Use Categories[a] (Analysis based on EIA 1994)

End Use	Fossil Fuel	Net Electricity[b]	Other[c]	Total
Boiler Fuel	99%	1%	0%	100%
Process Use	62%	38%	0%	100%
Nonprocess Use	66-67%	34%	0%	100%
End Use Not Reported	2.6-2.8%	1.5%-1.6%	95.7%	100%

(a) Values may not sum to 100% due to rounding.
(b) See textbox on page 3.2 for definition of net electricity.
(c) "Other" fuels include net steam as well as other energy sources MECS respondents indicated were used to produce heat and power.

(a) About 37% of total energy use was not allocated to an end use. However, 98% of this 37% is the fuel category "other," which represents net steam (the sum of purchases, generation from renewables, and net transfers) and other energy that MECS respondents indicated was used to produce heat and power. Only 2% of fossil fuel and 3% of net electricity demand were classified as "end use not reported."
(b) These values use "net electricity" as the measure of electricity consumption. (See textbox on page 3.2). The fractions shown in Table 3.1 do not change much when the fossil fuel used to generate electricity onsite is counted in the electricity category rather than the fossil fuel category: for process uses, 55% of energy use is fossil fuel, and 45% is electricity (which the MECS terms "net electricity demand" in this case); for nonprocess uses, 64% is fossil fuel, and 36% is electricity.
(c) These fractions cover both net electricity and net electricity demand. For example, about 80% of electricity use goes to process uses, whether one is counting fossil fuel used to produce electricity as electricity or as fossil fuel.

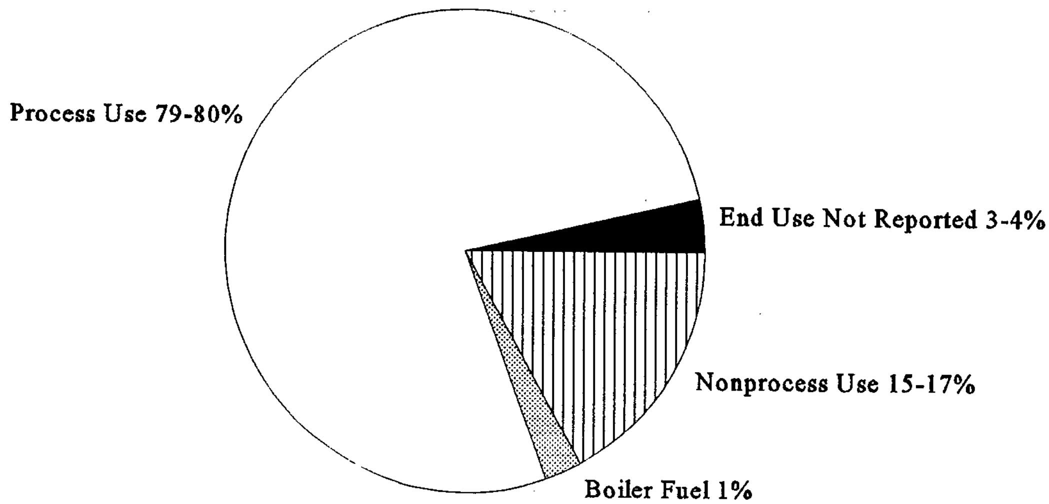

Figure 3.1. Electricity Consumption by End Use [(a)]

(a) Ranges encompass both net electricity demand, which counts fossil fuel used to produce electricity as electricity demand, and net electricity, which counts it as fossil fuel demand. Total net electricity demand in manufacturing is 2,799 trillion Btu; total use of net electricity is 2,370 trillion Btu.

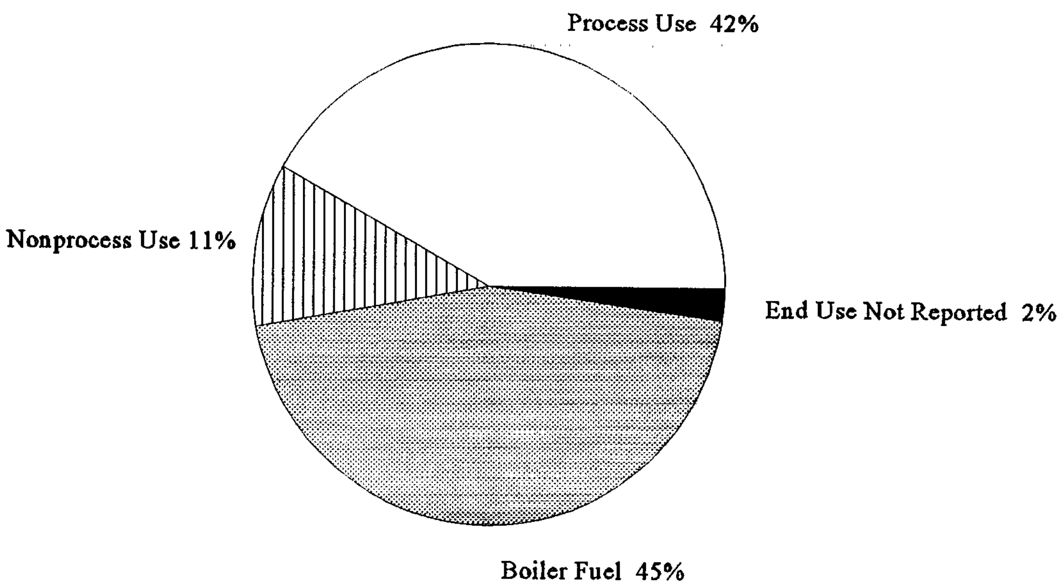

Figure 3.2. Fossil Fuel Consumption for Heat, Power, and Electricity Generation by End Use (EIA 1994)

To provide more detail on electricity use, Table 3.2 shows how net electricity demand (the measure that will be used for the rest of this chapter) is allocated among end uses. Motor (machine) drive is by far the largest electricity end use in manufacturing, accounting for over half of total electricity demand. This percentage is even higher if the motors used in process heating, process cooling, and other end uses are considered. Hence, programs to promote industrial energy efficiency typically place a lot of emphasis on energy efficient motors.

After motor drive, the next largest use is electrochemical processes, followed by process heating and HVAC. These end uses also hold the potential for large electricity savings, as described in the next section.

Table 3.3 contains data from the 1991 MECS on net electricity demand by manufacturing industry and end use at a national level. These data are used in the next section to estimate potential electricity savings. (The industries corresponding to the SIC codes in Table 3.3 are listed in Table 3.4.)

Table 3.2. Net Electricity Demand in Manufacturing[a] (EIA 1994)

Electricity End Use Categories	Electricity Use (Million kWh)	Total Electricity Use (%)
Total Process Uses[b]	**657,659**	**80.2**
Process Heating	71,658	8.7
Process Cooling/Refrigeration	40,987	5.0
Machine Drive	434,349	53.0
Electrochemical Processes	105,663	12.9
Other	5,001	0.6
Total Nonprocess Uses[b]	**125,751**	**15.3**
Facility HVAC	60,301	7.4
Facility Lighting	51,443	6.3
Facility Support	11,522	1.4
Onsite Transportation	1,298	0.2
Other	1,187	0.1
Boiler Fuel	**9,245**	**1.1**
End Use Not Reported	**27,631**	**3.4**
Total Net Electricity Demand[b]	**820,286**	**100.0**

(a) See textbox on page 3.2.
(b) Values may not sum due to rounding.

Table 3.3. Net Electricity Demand by Manufacturing Industries for Specific End Uses, 1991 (million kWh) (EIA 1994)

			Process Uses						Non-Process Uses						
Industry	Total Inputs	Boiler Fuel	Total Process Uses	Process Heating	Process Cooling & Refrig.	Machine Drive	Electro-Chemical Processes	Other Process Uses	Total Non-Process Uses	Facility HVAC	Facility Lighting	Facility Support	Onsite Transp.	Other Non-Process Uses	End Use Not Reported
SIC 20	55,273	1,392	43,198	2,141	13,366	27,580	Q	87	8,590	3,672	3,731	849	177	162	2,093
SIC 21	1,810	5	996	22	W	941	0	W	809	576	213	19	2	0	0
SIC 22	29,866	177	21,621	1,019	2,176	18,260	W	W	7,336	4,238	2,679	370	34	14	733
SIC 23	5,645	56	2,601	194	90	2,298	7	Q	2,091	1,133	829	126	Q	0	897
SIC 24	20,549	456	16,145	978	99	15,016	7	44	2,074	728	1,130	186	28	Q	1,875
SIC 25	4,948	82	3,104	175	W	2,846	22	W	1,435	595	699	115	W	W	327
SIC 26	109,871	3,569	94,985	2,424	1,420	89,329	1,032	780	9,006	3,913	4,058	924	81	30	2,311
SIC 27	15,641	108	7,607	190	551	6,682	76	109	5,484	2,930	1,955	537	50	Q	2,441
SIC 28	170,520	1,150	151,906	4,756	9,921	103,402	33,485	342	14,251	7,253	5,284	1,386	98	230	3,213
SIC 29	44,234	393	39,976	1,210	2,432	36,219	W	W	3,637	1,667	1,499	375	W	W	229
SIC 30	34,022	175	26,368	5,682	2,406	18,111	64	104	6,018	2,758	2,516	626	109	Q	1,461
SIC 31	834	7	507	59	13	434	1	0	239	102	125	12	1	*	80
SIC 32	31,347	122	26,631	8,025	804	17,604	20	178	3,622	1,637	1,614	301	42	27	972
SIC 33	153,499	416	139,042	30,085	966	39,262	67,189	1,541	11,596	4,971	5,232	1,071	173	148	2,445
SIC 34	29,899	244	20,689	3,399	697	15,139	1,240	215	6,939	2,905	3,376	533	99	25	2,027
SIC 35	29,629	168	16,489	2,266	983	12,581	268	392	10,657	4,961	4,291	1,274	74	56	2,315
SIC 36	30,013	171	17,387	4,662	2,180	9,003	1,319	222	11,114	6,100	3,825	1,059	76	53	1,341
SIC 37	35,355	241	20,391	3,071	1,558	14,718	469	574	12,796	6,071	5,362	1,049	132	182	1,927
SIC 38	13,673	285	5,878	800	1,085	3,523	161	308	6,845	3,499	2,539	622	14	171	665
SIC 39	3,661	29	2,140	503	183	1,399	54	*	1,210	592	484	87	13	34	281
Total	820,286	9,245	657,659	71,658	40,987	434,349	105,663	5,001	125,751	60,301	51,443	11,522	1,298	1,187	27,631

Notes: Values may not sum due to rounding.

Q = Withheld because relative standard error is greater than 50%. Data are included in higher-level totals.

W = Withheld to avoid disclosing data for individual establishments. Data are included in higher-level totals.

* = *Estimate less than* 0.5. Data are included in higher-level totals.

As measured by the MECS, net electricity demand is defined as purchases, transfers in, and onsite generation, less quantities sold and transferred out. It includes fossil and renewable fuels used to generate electricity onsite.

Table 3.4. Categories of Manufacturing Industries

Process Industries	Metals Production Industries
Food Processing (SIC 20)	Primary Metal (SIC 33)
Tobacco (SIC 21)	- Steel
Textiles (SIC 22)	- Iron
Paper (SIC 26)	- Aluminum
Chemicals (SIC 28)	- Copper
Petroleum/Coal (SIC 29)	- Other Nonferrous Metals
Materials Fabrication Industries	
Apparel (SIC 23)	Fabricated Metals (SIC 34)
Lumber/Wood (SIC 24)	Machinery (SIC 35)
Furniture/Fixtures (SIC 25)	Electronics (SIC 36)
Printing/Publishing (SIC 26)	Transportation Equipment (SIC 37)
Rubber/Plastics (SIC 30)	Instruments (SIC 38)
Leather (SIC 31)	Miscellaneous Manufacturing (SIC 39)
Stone/Clay/Glass (SIC 32)	

3.2 The Potential for Electricity Savings in Manufacturing

For purposes of discussing energy use and potential energy savings, it is useful to divide the manufacturing sector into three categories: process industries, metals production industries, and materials fabrication industries. The specific industries in each category are shown in Table 3.4.

This section describes how electricity is used in these three classes and provides rough approximations of the potential electricity savings available in three categories: electric motor systems, lighting, and industry-specific savings. These estimates were developed by applying savings estimates (in percentages) derived from the literature to electricity end use data from the 1991 MECS (refer to Table 3.3 above). These approximations illustrate the order of magnitude of the potential savings, but cannot suggest actual savings that could be achieved in practice.

The category of MECS electricity consumption used was net electricity demand, which provides a measure of total electricity use, whether generated offsite or onsite. Because the savings values (in percentages) obtained from the literature are applicable to the total electricity use in an industry, this is the most appropriate measure to use. However, many of the manufacturing industries generate a significant amount of this "net demand" onsite using fossil and renewable fuels. Table 3.5 shows the percentage of each industry's net demand that is generated onsite and offsite (EIA 1994). Because industrial DSM programs

Table 3.5. Manufacturing Net Electricity Demand, Offsite/Onsite Generation (EIA 1994)

Industry		% Generated Onsite	% Generated Offsite
SIC 20	Food and Kindred Products	10.4	89.6
SIC 21	Tobacco Manufactures	44.6[a]	55.4
SIC 22	Textile Mill Products	1.1[a]	98.9
SIC 23	Apparel and Other Textile	0.0	100.0
	Products	14.4	80.6
SIC 24	Lumber and Wood Products	0.67	99.33
SIC 25	Furniture and Fixtures	49.0	51.0
SIC 26	Paper and Allied Products	0.08[a]	99.02
SIC 27	Printing and Publishing	24.3	75.7
SIC 28	Chemicals and Allied Products	30.4	69.6
SIC 29	Petroleum and Coal Products	0.34	99.66
SIC 30	Rubber and Misc. Plastic	4.7	95.3
	Products	1.7	98.3
SIC 31	Leather and Leather Products	5.5	94.5
SIC 32	Stone, Clay, and Glass Products	0.42[a]	99.58
SIC 33	Primary Metal Products	0.5	99.5
SIC 34	Fabricated Metal Products	0.06[a]	99.04
SIC 35	Machinery, Except Electrical	2.0	98.0
SIC 36	Electric and Electronic Equipment	9.6[a]	90.4
SIC 37	Transportation Equipment	0.0	100.0
SIC 38	Instruments and Related Products		
SIC 39	Misc. Manufacturing Industries	15.9	84.1
SIC 20-39	All Manufacturing		

(a) Lower bound based on calculation of approximate value for onsite generation from combustible energy sources. Does not include onsite generation from noncombustible renewable energy sources. Sum of total (SIC 20-39) estimates for onsite and offsite generation using lower bounds for onsite fractions for these six industries understates total net electricity demand (SIC 20-39) by 0.04%.

will be most interested in potential reductions in the use of electricity that manufacturers import from offsite, the savings values estimated in this chapter are computed for both total electricity demand and for the offsite component of that demand.

To determine a very rough approximation of the potential for electricity savings in each industry listed in Table 3.5, the ranges of estimated savings, expressed as percentages of consumption, were taken or derived from the literature (primarily Elliott [1994], which reviews a number of different studies) and applied to the total net electricity demand value and to the offsite component of this demand. Again, this rough approximation only calls attention to the potential order of magnitude of available savings in offsite-purchased electricity from implementing energy efficient technologies. As noted earlier, it does not include potential savings from process redesign and optimization, which could offer substantial additional energy savings.[a]

3.2.1 Categories of Potential Electricity Savings

This section describes two categories of electricity conservation and potential electricity savings: electric motor systems and lighting. A third category, industry-specific savings, is not discussed here, but is considered in the next section.

Electric Motor Systems

Machine drive is by far the largest end use application for electricity in manufacturing. According to the 1991 MECS data, it accounts for over half the electricity consumed in manufacturing. When combined with motors used in processing heating and cooling applications, motor drive can reach two-thirds of total manufacturing electricity use (Elliott 1994).

Motor drive applications are found in three basic operations (EPRI 1988):

- pumps, fans, and compressors
- materials processing operations such as cutting, grinding, and crushing
- materials handling operations such as conveyers, elevators, and robotics.

Opportunities to increase the efficiency of electric motor systems include both reducing losses by using more efficient equipment and more closely matching load to process requirements by using variable-speed drives and other controls. Specific electric motor systems efficiency opportunities include the following (Elliott 1994):

- energy efficient motors
- corrected motor sizing
- improved drive trains, lubrication, and maintenance
- improved electric supply
- increased use of adjustable speed drives
- improved pump and fan efficiency
- reduced compressed air leaks
- improved compressor controls
- improved air compressor efficiency
- improved refrigeration efficiency.

Of the energy-savings categories reviewed in this report, electric motor systems hold the greatest potential for electricity savings.

(a) For a more detailed review of energy use and potential energy savings in particular industries and end use categories, see OTA (1993) and Elliott (1994). The latter reviews the findings of a number of studies that have assessed potential electricity savings.

Lighting

As Table 3.3 indicates, lighting accounts for about 6% of total manufacturing electricity use. When evaluating potential electricity savings from the installation of more efficient lighting equipment, the evaluator needs to correct for any substandard lighting levels (for example, by considering the use of task lighting). The estimates described in Section 3.2.2 incorporate these corrections.

Although the potential electricity savings from lighting improvements are lower than those available through motor-efficiency measures, lighting programs are easy to implement and are cost-effective compared with other types of DSM programs. These qualities have led some industrial DSM program managers to use lighting programs as a means of gaining the confidence of industrial customers before pursuing additional industrial efficiency measures (Elliott 1994).

3.2.2 Electricity Consumption and Potential Savings by Industry Group

This section discusses electricity-using technologies and potential electricity savings for three groups of manufacturing industries: the process industries, the metals production industries, and the materials fabrication industries. For each industry group, potential savings in electricity used for motors, lighting, and industry-specific processes are considered.

Process Industries

From a DSM perspective, the unifying theme of the process industries is the use of almost continuous processes and of five electrotechnologies (EPRI 1988):

- electrolytic separations, used primarily for the production of chlorine and caustic soda; also used for purification and concentration
- electrochemical synthesis, used for the production of organic chemicals
- freeze concentration, used primarily for water removal in food processing applications
- industrial process heat pumps, used for many operations, such as evaporation, drying, and distillation
- membrane processes, used primarily for purification and concentration operations.

The process industries together consumed about 412 billion kWh of electricity in 1991 (EIA 1994). Table 3.6 shows how this electricity demand was apportioned among motors, lighting, and other end uses. The total energy used for machine drive was about 276 billion kWh, or 67% of all manufacturing energy use for this purpose.

Table 3.6. Electricity Use in the Process Industries (EIA 1994)

Industry	Total Demand (million kWh)	Electricity End Use as a Share of Total Electricity Demand for Each Industry		
		% of Demand Used for Machine Drive	% of Demand Used for Lighting	% of Demand Used for Other Purposes
SIC 20 Food	55,273	49.9	6.8	43.4
SIC 21 Tobacco	1,810	52.0	11.8	36.2
SIC 22 Textiles	28,866	61.1	9.0	29.9
SIC 26 Paper	109,871	81.3	3.7	15.0
SIC 28 Chemicals	170,520	60.6	3.1	36.3
SIC 29 Petroleum/Coal	44,234	81.9	3.4	14.7
Total for All Process Industries	**411,574**	**67.0**	**4.2**	**28.8**

The American Council for an Energy Efficient Economy (ACEEE) (in Elliott 1994) estimates that the electricity savings from machine drive and lighting improvements in the process industries could reach the fractions shown in Table 3.7. The savings values understate the total potential savings because some of the energy used in process heating and cooling goes for motor drive, but this use may not be fully reflected in the MECS value for total motor drive demand.

The ACEEE also estimates industry-specific savings for the chemicals industry. Electrolysis to produce chlorine and caustic soda represents up to half of the electrochemical process consumption for the chemicals industry (EIA 1994). For environmental reasons, the industry's original electrolytic cell technology, which used molten mercury as a cathode, has largely been replaced with less efficient diaphragm cells. Within the last decade or so, the industry began using the more efficient membrane cell. By 1993, the membrane cells represented a little over 6% of U.S. installed chlorine production capacity (Chlorine Institute 1993). The ACEEE (Elliott 1994) estimates that a wholesale shift to membrane cells could save significant energy—for example, it could reduce the electricity intensity of this process by 25%. However, a technology change of this magnitude is very expensive, and such a wholesale shift would be expected to occur only gradually.

The ACEEE estimates that improvements in electrochemical processes in the chemical industry, including shifts to membrane cells, could reduce energy consumption in that end use by 20%, which would save an additional 6.7 billion kWh (5.1 billion kWh of which would have been produced offsite).

Table 3.7. Potential Offsite Electricity Savings in the Process Industries

Industry	Potential Motor Savings			Potential Lighting Savings			Potential Industry-Specific Savings	
	% of Motor Demand	Billion kWh		% of Lighting Demand	Billion kWh		Billion kWh	
		Total	Offsite		Total	Offsite	Total	Offsite
SIC 20	19.7-53.9	5.4-14.9	4.9-13.3	20-40	0.75-1.5	0.7-1.3	--	--
SIC 21	13.7-44.9	0.1-0.4	0.07-0.2	21.7-39.1	0.05-0.08	0.03-0.05	--	--
SIC 22	14.8-43.9	2.7-8.0	2.7-7.9	20-40	0.5-1.1	0.5-1.1	--	--
SIC 26	14.8-48.2	13.2-43.1	6.7-22.0	33.3	1.4	0.7	--	--
SIC 28	18.8-63.2	19.4-65.4	14.7-49.5	14.3-42.9	0.8-2.3	0.6-1.7	6.7	5.1
SIC 29	16.8-59.8	6.1-21.7	4.2-15.1	20-40	0.3-0.6	0.2-0.4	--	--
Total		**47-153**	**33-108**		**3.7-6.9**	**2.7-5.3**		

Source: Potential end use savings percentages are taken or derived from Elliott (1994); potential electricity savings are computed using EIA (1994).

Metals Production

The metals production industry, SIC 33, includes both ferrous metals (iron and steel) and nonferrous metals (aluminum, copper, and others). Important electrotechnologies in metals production include the following (EPRI 1988):

- electric arc melting, used in the iron and steel industries
- electrogalvanization, used to produce thin zinc coatings on steel
- electrolytic reduction, used to produce aluminum from bauxite as well as to produce other metals using aqueous electrolytes
- electroslag processing, used to refine nickel- and cobalt-based alloys for aerospace applications and to produce ingots of hard-to-machine metals
- induction melting, used for melting in both the ferrous and nonferrous industries
- ladle refining, used to reheat steel to a precise temperature to refine it to exact chemical specifications
- plasma processing, used in high-temperature metals fabrication processes such as welding, cutting, and surface hardening
- vacuum melting, used to produce high-purity metals and super alloys.

In 1991 the metals production industry used about 154 billion kWh of electricity (EIA 1994). About 67 billion kWh of this energy use went to electrochemical processes; this amount represented about 64% of all manufacturing electricity used for electrochemical processes. Over 39 billion kWh, about one quarter of metals production electricity used, went to motor drive applications. Table 3.8 shows how this electricity use was apportioned among end uses.

The ACEEE estimates that the electricity savings from motor drive and lighting improvements in the primary metals production industry could reach the fractions shown in Table 3.8. The savings values understate the total potential savings because some of the energy used in process heating and cooling goes for motor drive, but this use may not be fully reflected in the MECS value for total motor drive demand.

The ACEEE also estimates industry-specific savings for the steel and aluminum industries. Sources of potential savings in steel production include

- a switch from fossil-fired technologies to electrotechnologies at integrated steel mills
- use of induction and vacuum arc melting
- increases in the efficiency of electric arc furnaces through preheating materials with furnace exhaust gas and other measures.

Table 3.8. Electricity Use and Potential Savings in the Metals Production Industry (SIC 33)

Industry	% of Total SIC 33 Electricity Demand	Potential Savings			
		% of End Use Demand	% of Total Demand [a]	Billion kWh	
				Total	Offsite
Demand Used for Machine Drive	25.6	13.5 - 40.3	--	5.3 - 15.8	5.0 - 15.0
Demand Used for Electrochemical Processes	43.8	--	--	--	--
Demand Used for Lighting	3.4	20 - 40	--	1.0 - 2.1	1.0 - 2.0
Demand Used for Other Purposes	27.2	--	--	--	--
Total Demand	100	--	5.2 - 14.9	8.0 - 22.9	7.5 - 21.0

Source: Potential savings percentages are taken or derived from Elliott (1994); potential electricity savings are computed using EIA (1994).

(a) Savings from process improvements are reported as a percentage of total (rather than end use) demand. These savings are in addition to those shown for motors and lighting.

Sources of potential savings in the Hall-Heroult process (used to reduce alumina to aluminum) include improved process control through use of improved electrolytes and new cathode materials to control anode/cathode distance. Greater use of recycled aluminum inputs also can decrease energy use. The ACEEE estimates that such process improvements could reduce process electricity use (exclusive of motor drive) by 10% to 30%.

Overall, the ACEEE estimates that process improvements in the steel and aluminum industries could save 5.2% to 14.9% of total electricity use in SIC 33, or 7,982 to 22,871 million kWh (7,543 to 21,613 million kWh of which would have been produced offsite).

Materials Fabrication

The materials fabrication industries include industries that fabricate metals products (such as industrial machinery and other equipment), as well as other consumer and durable goods (such as apparel, furniture, and leather) and construction materials (such as lumber and stone/clay/glass products). Important electro-technologies in these industries include the following (EPRI 1988):

- electric discharge machining
- electrochemical machining
- electrofinishing
- electroforming
- electron beam processing
- flexible manufacturing systems/automation
- induction heating
- infrared processing
- laser processing
- microwave heating and drying
- radio frequency heating and drying
- resistance heating and melting
- ultraviolet curing.

Example applications of these processes include shaping, finishing, coating, welding, and heat-treating metal parts and other materials; cooking food products; drying wood and plastic products; and heating and melting glass.

As shown in Table 3.9, machine drive is the most important electricity end use in the materials fabrication industries, accounting for about 47% of the electricity used (EIA 1994). Lighting represents another 11% of these industries' electricity use.

The ACEEE estimates that the electricity savings from motor drive and lighting improvements in the materials fabrication industries could reach the fractions shown in Table 3.10. The savings values under-state the total potential savings because some of the energy used in process heating and cooling goes for motor drive, but this use may not be fully reflected in the MECS value for total motor drive demand.

The ACEEE estimates that improvements in welding and other process heating could save an additional 0.3% to 1.0% of the total electricity demand in three materials fabrication industries: fabricated metals, industrial machinery, and transportation equipment. This amounts to an additional savings of 276 to 910 million kWh (272 to 909 million kWh of which would have been produced offsite).

Table 3.9. Electricity Use in the Materials Fabrication Industries (EIA 1994)

Industry	Total Demand, (million kWh)	Electricity End Use as a Share of Total Electricity Demand		
		% of Demand Used for Machine Drive	% of Demand Used for Lighting	% of Demand Used for Other Purposes
SIC 23 Apparel	5,645	40.7	14.7	44.6
SIC 24 Lumber/Wood	20,549	73.1	5.5	21.4
SIC 25 Furniture/Fixtures	4,948	57.5	14.1	28.4
SIC 27 Printing/Publishing	15,641	42.7	12.5	44.8
SIC 30 Rubber/Plastics	34,022	53.2	7.4	39.4
SIC 31 Leather	834	52.0	15.0	33.0
SIC 32 Stone/Clay/Glass	31,347	56.2	5.1	38.7
SIC 34 Fabricated Metals	29,899	50.6	11.3	38.1
SIC 35 Machinery	26,629	42.5	14.5	43.0
SIC 36 Electronics	30,013	30.0	12.7	57.3
SIC 37 Transportation Equipment	35,355	41.6	15.2	43.2
SIC 38 Instruments	13,673	25.8	18.6	55.6
SIC 39 Miscellaneous Manufacturing	3,661	38.2	13.2	48.6
Total for All Materials Fabrication Industries	**255,216**	**46.8**	**11.3**	**42.0**

3.3 Summary

The potential offsite savings in electricity demand for manufacturing described in this chapter are summarized in Table 3.11. Four industries—food (SIC 20), paper (SIC 26), chemicals (SIC 28), and process-specific improvements in the steel and aluminum industries primary metals (SIC 33)—have minimum estimated savings of more than 5 billion kWh. The primary metals industry itself has a minimum estimated savings of over 13 billion kWh, which includes some

Machine drive represents the largest savings category examined here, although it must be kept in mind that significantly larger savings could be achieved through process optimization. However, motor system improvements alone could potentially save from 55 to 175 billion kWh in all of manufacturing and over 2 billion kWh at a minimum in each of ten specific industries.

Table 3.10. Potential Electricity Savings in the Materials Fabrication Industries

Industry	Potential Motor Savings			Potential Lighting Savings			Potential Industry-Specific Savings	
	% of Motor Demand	Billion kWh		% of Lighting Demand	Billion kWh		Billion kWh	
		Total	Offsite		Total	Offsite	Total	Offsite
SIC 23	13.7-41.2	0.31-0.95	0.31-0.95	22.2-38.9	0.18-0.32	0.18-0.32	--	--
SIC 24	14.2-45.8	2.1-6.9	1.7-5.5	16.7-33.3	0.19-0.38	0.15-0.30	--	--
SIC 25	13.4-38.6	0.38-1.1	0.38-1.1	20-40	0.14-0.28	0.14-0.28	--	--
SIC 27	14.7-46.1	0.98-3.1	0.97-3.1	20-40	0.39-0.78	0.39-0.77	--	--
SIC 30	14.7-47.7	2.7-8.6	2.7-8.6	20-40	0.5-1.0	0.5-1.0	--	--
SIC 31	12.9-37.6	0.06-0.16	0.05-0.16	21.1-39.5	0.03-0.05	0.03-0.05	--	--
SIC 32	14.0-43.2	2.5-7.6	2.4-7.5	25-50	0.4-0.81	0.4-0.79	--	--
SIC 34	14.3-43.2	2.2-6.5	2.2-6.5	33.3	1.1	1.1	0.09-0.3	0.09-0.3
SIC 35	14.2-44.4	1.8-5.6	1.8-5.6	16.7-33.3	0.72-1.4	0.71-1.4	0.09-0.27	0.09-0.27
SIC 36	14.6-43.8	1.3-3.9	1.3-3.9	20-40	0.77-1.5	0.76-1.5	--	--
SIC 37	15.4-48.5	2.3-7.1	2.2-7.0	33.3	1.8	1.8	0.11-0.32	0.1-0.31
SIC 38	13.7-39.7	0.48-1.4	0.44-1.3	20-40	0.51-1.0	0.46-0.92	--	--
SIC 39	13.6-40.4	0.19-0.57	0.19-0.57	16.7-50	0.08-0.24	0.08-0.24	--	--
Total		**17.2-53.6**	**16.6-51.7**		**6.8-10.8**	**6.7-10.5**	**0.28-0.88**	**0.28-0.87**

Source: Potential end use savings percentages are taken or derived from Elliott (1994); potential electricity savings are computed using EIA (1994). Values may not sum due to rounding.

As discussed previously, the savings that could be achieved in practice at a given plant are highly plant-specific, depending on the type and vintages of processes and equipment used. Analyses of industrial efficiency potential have consistently shown that the potential for significant savings can be large enough to warrant the site-specific investigation of ways to achieve such savings.

As discussed in Chapter 2.0, whether these potential savings could be achieved in practice also depends on economic factors. The DSM programs that provide financial assistance are especially effective in those cases where a project is attractive to a firm on technical and other bases and has favorable life-cycle costs, but where capital and other constraints make the upfront capital cost prohibitive, especially in light of other spending needs.

Table 3.11. Summary: Range of Potential Offsite Electricity Savings (billion kWh)[(a), (b)]

Industry	Motors		Lighting		Other		Total	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
SIC 20	4.9	13.3	0.67	1.3	--	--	5.5	14.7
SIC 21	0.07	0.23	0.03	0.05	--	--	0.1	0.28
SIC 22	2.7	7.9	0.53	1.1	--	--	3.2	9.0
SIC 23	0.32	0.95	0.18	0.32	--	--	0.5	1.2
SIC 24	1.7	5.5	0.15	0.3	--	--	1.9	5.8
SIC 25	0.38	1.1	0.14	0.28	--	--	0.5	1.4
SIC 26	6.7	22.0	0.69	0.7	--	--	7.4	22.7
SIC 27	0.97	3.1	0.39	0.77	--	-	1.4	3.9
SIC 28	14.7	49.5	0.57	1.7	5.1	5.1	20.4	56.3
SIC 29	4.2	15.1	0.21	0.42	--	--	4.4	15.5
SIC 30	2.7	8.6	0.5	1.0	--	--	3.2	9.6
SIC 31	0.05	0.16	0.03	0.05	--	--	0.08	0.2
SIC 32	2.4	7.5	0.4	0.79	--	--	2.8	8.3
SIC 33	5.0	15.0	0.99	2.0	7.5	21.6	13.5	38.5
SIC 34	2.2	6.5	1.1	1.1	0.09	0.3	3.4	7.9
SIC 35	1.8	5.6	0.71	1.4	0.09	0.27	2.6	7.2
SIC 36	1.3	3.9	0.76	1.5	--	--	2.1	5.4
SIC 37	2.2	7.0	1.8	1.8	0.1	0.31	4.1	9.1
SIC 38	0.44	1.3	0.46	0.92	--	--	0.9	2.2
SIC 39	0.19	0.57	0.08	0.24	--	--	0.27	0.81
Total	**54.9**	**174.6**	**10.3**	**17.7**	**12.9**	**27.6**	**78.2**	**219.9**

(a) The energy-saving measures considered in developing these estimates do not include process redesign and optimization, which could provide substantial additional savings.
(b) Values may not sum due to rounding.

3.4 References

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4.0 Utility Demand Side Management Experience with Industrial Customers

Utilities are beginning to implement industrial DSM programs with greater frequency and investment. To date, there has been little progress in estimating the cost savings to industry and the success of DSM programs in meeting utility objectives such as load retention, load leveling, or demand reduction. Designing and implementing a successful industrial DSM program involves a number of important choices and issues to be resolved for achieving participation and efficiency goals. As utilities change the way they operate, they need to be more prepared for and aware of customer needs. Finding the right combination of DSM program features, services, and delivery mechanisms can often ensure success in achieving participation and efficiency goals.

This chapter identifies the range of industrial DSM programs currently offered by utilities. For the purpose of this discussion, programs are divided into two general categories: financial incentives, and education and technical assistance. The financial programs are those that include cash incentives to customers, either at point of purchase, after installation, or as energy savings benefits are accrued. The education and technical assistance programs can be classified as non-cash incentives offered by the utility. This program overview is followed by a discussion of each program type and examples of representative programs. Then, qualities contributing to the strength and success of these programs are presented. Finally, federal, state, and private initiatives to assist industrial energy efficiency are reviewed.

Table 4.1 presents a list of each program type and a brief description of the features, strengths, and weaknesses associated with each.

4.1 Financial Incentive Programs

Financial incentive plans include rebates, loans, shared savings, leasing, dedicated funding, incentives for energy management, and market pull programs. Each of these plans is described below.

4.1.1 Rebates

Rebates, payments to industrial firms for purchasing and/or implementing an efficiency measure, are the most common type of DSM program. Features of such a program can range from a rebate for purchase of a specific energy conservation measure (ECM), e.g., an energy efficient motor (a prescriptive measure) to a menu of ECMs that save a certain percent of the total energy used by a facility (a performance measure).

With rebates, utilities bear a greater portion of the cost than with other programs such as shared savings programs or information programs. Conversely, industries bear less of the financial burden; thus, rebates are the most popular DSM programs from the customer's standpoint.

Table 4.1. Utility Industrial DSM Programs

Program Type	Description	Weakness	Strength
Rebates (financial)	Utility pays a rebate to the industrial firm for investment in DSM measures.	Utility must continue to pay as long as it wants to continue the DSM measures.	Most popular program type; involves the least expense for the industrial firm.
Loan (financial)	Utilities create easy ways for industrial firms to acquire capital at lower-than-market rates.	Has limited appeal to industrial firms that can get normal loans from banks.	Helps capital-poor industrial firms, which would otherwise not be able to afford up-front costs.
Shared Savings (financial)	Industrial firm receives incentive to invest in efficiency and then shares its energy savings with utility to pay back part of the incentive.	Involves extensive data collection to administer and figure savings.	Utility is able to recover more of its costs.
Leasing (financial)	Utility buys energy efficient equipment and leases it to the industrial firm.	May be costly to the utility if the lease is terminated before the equipment is paid for.	Takes away some of the risk for the industrial firm that tries efficient equipment.
Dedicated Allocation of DSM Funds (financial)	Money for DSM measures is allocated among a group of industrial firms.	High potential for free riders when everyone is given funding.	Industrial firms can depend on a certain amount of money to encourage efficiency.
Incentives to Hire Energy Managers (financial)	Utility guarantees that a manager will pay for him/herself in savings or the utility will make up the difference.	Costly and savings are difficult to assess in a mutually agreeable way.	Motivates the industrial firm to move on its *own* programming and measures.
Market Pull Programs (financial)	Vendor and customer incentives are used to make the market more energy efficient.	Utility pays more up front to pull the market.	Utility may eventually taper off and even discontinue the incentives.
Information Only (education)	Utility offers information on efficiency to industrial firms.	Difficult to measure actual savings.	Cost is relatively low.
Bidding (technical assistance)	Utility requests bids for another company to operate an efficiency program.	Utilities have difficulty determining when bidding is appropriate.	Theoretically bidding provides for the real market price of programs.
Comprehensive One-Stop Services (technical assistance)	Utility provides for and guides audit and program implementation.	Costly to the utility in time and money.	Individualized service for the industrial firm.
Subscription Services (technical assistance)	Utility provides a breakdown of services and costs, and the industrial firm chooses the services it wants.	Industrial firm may opt out of DSM rebate expenses, but may select from "pay as you go" menu of non-cash assistance services.	Industrial firm chooses the services it is getting and paying for.
Brokering (technical assistance)	A third party encourages efficiency.	Can be more difficult to deal with two parties instead of just the one industrial firm.	Third party may actually facilitate coordinating the action of many industrial firms to provide for the whole.

- *Customized Gas and Electric Rebate Program*

In its Customized Gas and Electric Rebate Program, for example, Pacific Gas & Electric (PG&E) covers up to 50% of the project cost for the purchase of energy efficient equipment, as well as the cost of auditing a customer's facility and installing the energy efficient equipment. These extra perquisites are meant to attract large businesses; however, a high number of businesses with power requirements of less than 50 kW have responded. A recent report reveals that 46% of process-related rebates were for electric measures, and 77% were for natural gas (Kyricopoulos et al. 1994; Results Center 1992d).

- *Energy Conscious Construction*

Rebates can affect many stages of developing business. For example, the Northeast Utilities' Energy Conscious Construction Program provides rebates for new construction and major renovation. This program is available to commercial and industrial customers. The rebates are structured on a tiered system: pre-approved rebates for smaller buildings, more customized rebates as projects get larger and more complex. In conjunction with this rebate incentive, the program provides education on the cost-effectiveness of energy efficient construction and provides technical assistance to building owners and designers. The result has been that participating buildings use 25% less energy than nonparticipating buildings. The objective of this program is to capture energy savings early on by encouraging the customer to buy efficient equipment at the outset. The consumer is informed up-front about the cost-effectiveness of efficient equipment (Results Center 1992c).

- *Energy $avings Plan*

The Bonneville Power Administration sponsored a pilot of the Energy $avings Plan (E$P) in 1987. Since then, the program has grown, largely because it has an annual evaluation process that includes input from all stakeholders. Today, the plan offers funding for firms to audit their facilities and then submit proposals for energy efficiency improvements. The E$P may pay for a portion of the submitted improvement, based upon the level of energy savings. The E$P also offers an easily calculated rebate on the purchase price of energy efficient motors. Fifty-five projects have been reported complete, with energy savings from each project averaging 1.8 Gwh annually (Results Center 1992a).

4.1.2 Loan Programs

Loan DSM programs have a number of advantages for a utility. Unlike rebate/incentive programs, the utility recovers money from the industrial firm. The biggest strength of this type of DSM program is its attractiveness to industrial firms that otherwise could not/would not be able to get a loan for efficiency projects. Unlike a bank loan, the DSM loans are made expressly for energy efficiency investments.

Although the DSM loans a utility offers may be easier to obtain, unless the interest rate or other terms are more favorable, they are not inherently useful to a large percentage of industrial firms who are eligible for regular bank loans. Also, utility DSM loan programs are not as attractive to most industrial firms that prefer rebates, interest buy-downs or other types of financial incentives.

- *Energy Investment Loan Program*

The New York State Energy Office (NYSEO) sponsored a pilot program in 1987 called the Energy Investment Loan Program. Unlike other loan programs, this program is conducted in conjunction with 105 financial institutions to offer low-interest loan subsidies for energy efficiency projects. In this case, the borrower applies to a participating financial institution and is processed for the loan—as any other loan would be processed. If approved, the loan is given at the current market rate. At the same time, the financial institution applies to the NYSEO for an interest subsidy. The proposed project must have a simple payback period of less than 10 years, have a life expectancy longer than the payback period, and be clearly identified and recommended in a recognized energy study. If approved, the lender receives a subsidy twice a year for an equivalent loan rate of 2.5% for loans of 1 to 5 years, then at 5% for 5 to 10 years. The lender can either give the borrower a rebate check or reduce the monthly payments (Elliott and Weidenbaum 1994). The advantage to the industrial firm is the lower cost of financing energy efficiency projects.

4.1.3 Shared Savings (With Up-Front Incentives)

In the case of shared savings, a utility may set up any number of ways to provide for an initial investment in energy efficiency. The industrial firm then uses money saved from energy savings to pay back the utility for the investment. The amount of the recovery may be full or partial, depending on the program. Both the utility and the industrial firm save. The industrial firm saves on the initial energy investment and then, after paying off the utility, continues to save on energy use. The utility saves on program costs and also benefits from reduced or reshaped load profiles.

One weakness is the need for substantial baseline information (to figure savings with certainty) for such a program. The need to continually compare with the baseline data and to calculate savings and money owed back to the utility make the program potentially expensive and time-consuming. With the advent of a number of electrotechnologies, this data collection and evaluation may be done with a relative lack of effort in the future, and shared savings may become a more viable option.

Another concern associated with shared savings DSM programs is the danger of cream-skimming by an energy service company. That is, if only the easiest and most obvious energy efficiency measures (such as lighting) are exclusively applied, substantial opportunities to save energy through more difficult, but perhaps more rewarding, measures would be lost.

Early efforts to implement loan programs encountered difficulty in getting industrial customers to participate. Central Maine Power and Northeast Utilities are among a number of utilities that pioneered shared savings programs in the 1980s. Their programs were not successful in attracting a sufficient number of participants at that time. At Central Maine Power, only 1 out of 45 targeted customers participated, and Northeast Utilities had only 3 out of 179 targeted customers join the program (Nadel and Jordan 1994; Nadel 1990). Pacificorp sponsored a pilot program that included utility subsidies in a shared savings approach. Again, the participation rates were quite low. After a little over a year of the program, only 10 out of a potential 400-700 eligible customers joined. Bangor Hydro sponsored a pilot program but discontinued the program because there were no participants in the first year. Other loan programs have been successful in reaching more customers. Two are presented below.

- *Wisconsin Power & Light*

As a result of the early DSM program experience in shared savings, Wisconsin Power & Light (WP&L) combines prescriptive measures and custom (performance) measures. WP&L began its shared savings program, "Bright Ideas For Business," for their largest commercial and industrial customers in 1987. Unfortunately, because of the high number of small projects, administrative costs exceeded the financial and administrative capabilities of the program. In 1989, in an effort to improve the finances of the program, WP&L added an optional rebate incentive for prescriptive and custom ECMs. The prescriptive measures were lighting and motors; the custom measures were chosen by the industrial customer. Custom rebates were subject to approval by WP&L. The addition of prescriptive rebates and custom rebates for larger customers, which are added upon completion of a project, successfully reduced the strain on the program. Most of the savings in the last 3 years have been through shared savings and customer rebates. However, most of the small industrial projects have selected the rebates available for high-efficiency lighting and motor retrofits. The lack of high administrative cost for the small programs balances the total cost for the utility. WP&L has evaluated the benefits of this program: "cumulative electricity savings as a percent of industrial sales are 0.1%." The program was also found to have a relatively high participation rate of 14% since 1989 (Jordan and Nadel 1993).

- *Gainesville Regional Utilities*

Gainesville Regional Utilities has a shared savings program with up-front incentives for high-efficiency lighting replacements. This program is available to all commercial customer classes, including industrial. A utility lighting specialist works with the utility's commercial auditors to identify eligible candidates for lighting replacement. The utility can finance and install the equipment for the customer (if no electrician is needed). The utility will finance 100% of the cost of materials and any utility-supplied labor (non-hardwired materials only) for a term of up to 3 years. Additional fees (included in the customer's lighting service charge) are a maintenance charge (5% of the equipment cost) and a cost which is a variable percentage of the estimated bill reduction resulting from the measure(s). The customer reimburses the utility through an addition to the monthly bill. In this way, the customers are able to pay in installments for something they would be reluctant to pay for all at once.[a]

4.1.4 Leasing

In leasing programs, utilities make state-of-the-art equipment available to industrial firms via leases. A utility purchases high-efficiency equipment, such as high-efficiency motors, and offers the use of that equipment to industrial firms with a low-cost lease. Such programs take some of the financial risk out of trying out new and supposedly more efficient equipment. Also, leases are a financial option for firms that

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(a) Personal correspondence from J. Donaldson, Gainesville Regional Utilities, February 17, 1995.

do not have the capital to otherwise upgrade in efficiency. Both the industrial customer and the installing contractor also realize other benefits of leasing. Ertle (1994) points out that several services may be made available in a leasing arrangement including design, material installation, maintenance, and other soft costs. Also, the industrial customer maintains a positive cash flow as a result of the financing terms and the energy savings (Ertle 1994). Leasing arrangements may be financed by a utility, but are more likely to include a third-party financial services firm.

The current literature reports that most DSM leasing programs have been positive. But difficulties could minimize the benefits if, for example, new equipment does not work as it should and the expense of retrofitting and refitting is high. The advantage for the utility is that, through lease payments, the industrial customer may pay the full cost (or more) of the equipment. Yet, if the industrial firm chooses to end the lease and replace the leased equipment with other, more efficient equipment, the cost of a program could increase. In addition, the documentation for a leasing program is much more extensive than that for other financing programs. For example, in the San Diego Gas and Electric Program (described below), the lease contract was 25 pages long, whereas the financing contract was only 3 pages long.

- *San Diego Gas & Electric*

San Diego Gas & Electric's program, available to industrial and commercial customers, provides a financial incentive for firms to sublease efficient equipment from the utility. The utility performs a credit check and, if the firm is approved, assumes the liability for payment of the equipment leased. Customers pay for the lease through a fee added to their monthly electricity bills. This addition equals the approximate energy savings during the period of the lease (HBRS 1994).

- *Southern California Edison*

Recently, Southern California Edison sponsored a 24-month pilot program for commercial and industrial customers. This program, called Envest, includes a leasing-type option for financing efficiency investment. Overall, the Envest program provides the customer with a wide range of services in addition to the lease option. Southern California Edison provides an audit, along with equipment selection and installation, financing, and customer protection. By combining these services, the utility is able to offer its customers a more complete product and better customize its services. To date, two projects have been reported as approved (Kyricopoulos et al. 1994).

- *Memphis Light, Gas and Water*

Since 1965, Memphis Light, Gas and Water has conducted a program of free survey and design assistance to industrial customers. A utility lighting specialist designs a lighting plan and recommends the most cost-effective choices. Customers have the option to pay for lights as part of the utility's monthly bill (Hull 1993).

4.1.5 Dedicated Allocation of Demand Side Management Funds

In this type of program, the utility creates a fund from which all industrial firms are allocated money to implement DSM programs. Any money not used is put back into the fund and reallocated to firms that still need money for their energy efficiency measures.

A strength of this approach is that industrial firms *know* they can get at least a certain amount of funding for their energy efficiency investment. This program addresses the cross-subsidization issue, as well as intercustomer subsidization, and endorses efficiency by telling industrial firms, in effect, to use the money before it is given to someone else. However, there is a high likelihood of free riders in this type of program—the utility gives customers the opportunity whether customers are planning an efficiency project or not. Also, the efforts may be completely financed by the utility, as the firm is not required to contribute additional money to install an efficiency measure.

- *Rochester Gas & Electric*

In 1993, Rochester Gas & Electric began a program that provides a set fund for its customers based on the customer's share of the utility's sales. The customer may use none, all, or a portion of the funds for an efficiency project. Any money not used is put back into the fund for others to use (Nadel and Jordan 1994).

4.1.6 Incentives for Firms to Hire Energy Managers

In this case, a utility provides funds as an incentive for industrial firms to hire energy managers. This incentive is the guarantee that within a prescribed time, the energy manager will save enough in energy costs to pay his or her salary (in energy savings) or the utility will make up the difference in cost to the industrial firm. Otherwise, the industrial firm keeps the energy manager and reaps the energy savings benefits.

Here, the advantage for the customer is that the incentive's guarantee takes the risk out of hiring an energy expert. The advantage to the utility is the program's low start-up costs. Like shared savings programs, there may be a difficulty defining savings and the appropriate amount of savings to attribute to work done by the manager. Also, this type of assessment may require a great deal of baseline data and continued intensive monitoring of all programs. The example offered below describes results achieved by a local government customer, but would also work for an industrial customer.

- *North Carolina Alternative Energy Corporation*

From 1983 to 1988, the North Carolina Alternative Energy Corporation (NCAEC), a utility-funded organization, operated an energy manager program which was targeted at local governments and has often been proposed for use by industrial customers. NCAEC guaranteed that after 2 years, the newly hired energy manager would save enough money in energy savings to pay his or her salary. The NCAEC agreed to help train the manager and, if the costs for the manager were greater than the savings, the NCAEC agreed to pay the difference. According to Emmett and Gee (1986) and Nadel and Jordan (1994), NCAEC paid less than 3% of the total salaries in the program.

4.1.7 Market Pull Programs

Market pull programs are also known as vendor incentive programs. Features include a variety of incentives to suppliers of high-efficiency lighting, appliances, equipment, and other energy conservation measures. Types of incentives include rebates on purchases, contests to increase market penetration, and other actions to increase the market demand for high-efficiency products and services. Vendors, also known as trade allies, can be very helpful to a DSM program effort because they are rewarded for reducing specific market barriers such as low stocks of high-efficiency items and lack of consumer information regarding new technologies. When successful, this type of program results in more high-efficiency choices for the consumer, and more experience for the vendor in handling high-efficiency installation and maintenance.

The start-up cost in market pull programs may be greater than in standard rebate programs because of the need to move the actions of vendors, customers, or an entire industry. The long-term advantage, however, is that the market is changed. When a targeted market penetration rate has been achieved, the vendor incentive program is usually phased out. The utility can taper off and eventually discontinue rebates and incentives. Vendor incentive programs are set up to provide a temporary jolt to a sluggish market for high-efficiency products and services.

- *B.C. Hydro*

British Columbia (B.C.) Hydro was successful in promoting increased sale and use of high-efficiency motors. B.C. Hydro began its initiative with the intention to "flip the market" between the sale of standard- and high-efficiency motors. Motor vendors have played a vital role in the transition of the market—the purchase of a high-efficiency motor is no longer the exception, but the rule. In fact, as a result of B.C. Hydro's efforts, customers were so motivated to use high-efficiency motors that vendors at first had difficulty keeping up with the customer's demand, sometimes requiring a 6-8 week lead time. Now, customers find high-efficiency motors readily available and face the 6-8 week lead time for standard low-efficiency motors (Flanigan and Fleming 1993).

B.C. Hydro's solution to the supply problem was to offer both rebates, through their Power Smart initiative, and incentives, through their High Efficiency Motors Program. Rebates were given to customers who bought efficient motors, and incentives were given to vendors for selling efficient motors. As the market began to change, the amounts of rebates and incentives were reduced, consistent with B.C. Hydro's intention to "transform the electric motor market, maintain it with legislation, and then get out of the rebate business." Eventually, B.C. Hydro hopes to discontinue the incentives and rebates entirely and to have substantially assisted in directing the market towards higher-efficiency products and services in British Columbia (Flanigan and Fleming 1993).

4.2 Energy Education and Technical Assistance Programs

Education and technical assistance programs include energy education programs, competitive bidding, comprehensive one-stop services, subscription services, and brokering.

4.2.1 Energy Education Programs

Effective customer education is a crucial part of the communications utilities must have with industrial customers to achieve DSM success. Energy education programs may be the only available source for information on benefits of high-efficiency measures. Such benefits may include improved safety, reliability, quality control, environmentally friendly, ease of maintenance, profitability, or productivity (Mast and Ignelzi 1994; Mihlmester 1992; Newcomb 1990; Peters 1988; Schuck and Van Liere 1991).

The utility may provide information on energy-saving measures by distributing pamphlets or hosting seminars on efficiency measures, or it may act as a center for queries on energy-saving projects. The method by which information is dispersed depends on the utility's resources and the customers it is trying to affect.

The computer software package developed by the Washington State Energy Office, described below, highlights the major attraction of most energy education programs. The relatively low cost and overhead of such programs make them appealing to both the utility and the industrial firm. Unfortunately, there is no good, tangible way to trace and measure the savings from information programs—the only real weakness cited in current literature of industrial DSM education programs.

- *MotorMaster*

The Washington State Energy Office developed MotorMaster, a computer software package which provides information to a variety of users on high-efficiency motors. The software includes three types of cost-effectiveness comparisons: between two new motors; a new motor versus repair of an old motor; an old working motor versus a more efficient replacement. The database includes information on almost 10,000 motors. The cost of operating MotorMaster has been relatively low; it has essentially been run by one person and has a total budget of less than $100,000 (Results Center 1993c).

4.2.2 Competitive Bid Requests

In a DSM bidding program, a utility requests 'bids' from outside parties to supply future resources from savings gained in present demand. This approach is a fairly straightforward way of acquiring new resources using conserved, rather than generated, energy supply. The utility identifies a resource or service it would like to supply, develops criteria for evaluating bids, and then issues the competitive bid solicitation to provide the service or resource. Energy service companies, customers, and others compete to provide the targeted level of conserved energy at the lowest cost per kilowatt-hour. The utility may choose one or several suppliers.

Since 1987, an estimated 30 utilities in 14 states have requested bids from energy service companies (ESCOs) and customers in selected market segments (Goldman and Kito 1994). Experience with industrial customer bidding is limited, and the programs are few but growing. It is difficult to determine the right time to use bidding and how to use it successfully. The advantage of DSM bidding is that the competition may provide some indication of the true price of new efficiency services and resources as they come to the market, as well as the proper mix of resources used. The DSM bidding reduces the utility's perceived risk of investing in DSM resources by offering a long-term controlled arrangement to install and maintain energy conservation measures. Also, if a utility has limited resources, bidding is a way to deliver more effective programs. The disadvantage is that bidding is a lengthy process. The utility has to take the time to assess the various bids, oversee the implementation, and evaluate the energy savings. In a rapidly opening market, that lag time may become an increasingly important disadvantage.

- *Power Partners and Efficiency Buyback Program*

In its Power Partners Program, Central Maine Power (CMP) produced an all-source bidding program for commercial and industrial firms and energy service companies. Responding to requests for proposals for DSM projects, these companies include in their proposals an estimate of costs per kilowatt-hour saved (Nadel and Jordan 1994). Power Partners began in 1988, and in 1989, CMP paid for the first MWh saved through that project. Eight more projects have followed since then, with six completed to date and the remainder expected by 1997. For all nine projects, the total estimated savings is 263,000 MWh per year. For the six completed projects, savings are estimated at 183,000 MWh per year. To date, current savings have been estimated at 34.5 MW and CMP has paid out a total of $39 million. No new requests for bids are expected, as CMP does not anticipate any needs for new power.[a]

4.2.3 Comprehensive One-Stop Services/Technical Assistance Centers

For this type of program, a utility offers to audit an industrial firm's facilities and suggest where the firm might improve its energy efficiency. The utility provides all the personnel needed for evaluation and continued progress towards efficiency goals. The utility is completely interactive with the needs of the industrial firm.

Comprehensive one-stop DSM programs offer more communication and more individual attention to the specific energy efficiency needs of each industrial customer. The customization of programs greatly increases their success. The cost to the utility, however, may be higher than for less customized DSM programs. The utility provides staff and technical services of many types, depending on the industrial firm's needs. The industrial firm, on the other hand, is more likely to be comfortable with the process. Because of the interactive nature of the program, all energy conservation measures are selected according to the industrial firm's unique needs.

(a) Telephone conversation with Dennis Bergeron, Maine Public Utilities Commission, March 20, 1995.

Technical assistance centers (TACs) operated by utilities serve as "technology middlemen" (Kuhel 1994). Market transformation to higher efficiency practices is accelerated, as information and services using new, more energy efficient technologies are transferred to industrial customers. Two examples illustrate the TAC and the comprehensive one-stop concepts.

- *Energy Resource Center*

In 1986, Portland General Electric opened an Energy Resource Center to educate its commercial and industrial customers about improving the efficiency of their energy use to gain competitive advantage. The center consists of a lighting lab, demonstration facilities, exhibit areas, an auditorium, a technical library, as well as an electric vehicle center. The center uses these facilities in addition to technical personnel to provide its services. The workshops, classes, seminars, development training, and on-site support and training combine to create an individualized experience for each participating firm. Because of the many different services it is able to extend, the center bases its services on customer needs and benefits as opposed to some prescribed program (Results Center 1993a).

- *Commercial and Industrial Electricity Conservation Service*

Puget Sound Power and Light's Commercial and Industrial Electricity Conservation Service provides a highly customized service to industrial and commercial firms. The conservation service employs a staff who have the technical expertise to investigate all areas of energy use in a given firm. The service focuses on promoting "tried and true" methods of energy conservation. Typically a customer will receive an incentive payment of 60% to 80% of the installation costs (a level exceeding the typical incentive payment). On average, the utility pays out about half of its avoided costs (Results Center 1993b).

Participation by industrial customers has been relatively high, in part because of the strong customer focus of this program. The most popular projects have been those to install adjustable speed drives (Kyricopoulos et al. 1994).

4.2.4 Subscription Services

In providing subscription services, a utility breaks up the services it provides and allows the customer to subscribe to a certain subset of services.

The Niagara Mohawk Power Company (NMPC) offers the Subscription Option Program. Under this program, costs for DSM program rebates and other efficiency services are divided, instead of being paid for in one lump sum in the base rate. This arrangement is the result of a settlement agreement between the New York Public Service Commission, NMPC, and other parties.

Subscription services have the advantage of making industrial firms more confident about the services they are receiving. In addition, such services allay many of the concerns that industrial firms and advocate groups such as Electricity Consumers Resource Council (ELCON) may have over what they are paying for the price of electricity.

- *Niagara Mohawk*

NMPC is the only utility in New York State that currently offers a subscription DSM program for industrial customers. The NMPC offering was made possible by a rate settlement that reallocated DSM program costs and approved the subscription service as an experimental pilot program (Norris 1993). Rather than continue to recover DSM program costs through an energy charge in addition to the base rate, the NYPSC settlement allows all DSM costs (not including rebates or other similar expenses) to be included in the base rate. The settlement agreement allows 300 industrial customers to sign on to the Subscription Option Program. The program participants may opt out of paying for the rebates and other incentive expenses the utility incurs as a result of operating a DSM program, but they cannot opt out of paying the base rate. Thus, the subscription option may reduce some, but not all costs of the DSM program for those who sign on. However, customers who sign on to the Subscription Option Program are ineligible for incentives or rebates that the utility may have available through DSM programs.[a]

About 150 of NMPC's industrial customers in New York State have signed on for the subscription service (Walton et al. 1995). Reports of initial program experience have been mixed and may reflect the complexity of the industrial customer. Some companies were reluctant to respond to the evaluation contractor the New York State Energy Research and Development Agency (NYSERDA) hired or would not allow him/her entry into the facility. Others were surprised at what they discovered as a result of the audit and were enthusiastically planning the efficiency improvements. Those industrial customers who have not signed on will continue to be eligible for all DSM programs and share in the full cost of administering the programs.

4.2.5 Brokering

Power brokers are a third party in the utility-industrial firm relationship. The power broker brings a number of industrial firms together and coordinates their load shape in response to utility needs. The resulting coalition of industrial firms is then ensured that it will have more consistently reliable supplies of energy available. The broker may have or be able to identify experts in a broad range of industries, further relieving the utility or the customer from the burden of acquiring the expertise required. The broker may also work as a catalyst for other energy efficiency investments and continually raise the energy savings over time.

A power broker adds another participant to the process, and so the relationship between the power broker and the utility is an important feature in achieving energy efficiency objectives. Brokers can provide a number of advantages to both the utility and the industrial customer. The power broker can effectively motivate its members to continue to update efficiency and provide an effective, low-cost way for industrial firms to benefit from load management. The power broker may also be an advantage in that the power broker unifies the needs of a number of customers, whose needs might otherwise be very diverse. Thus, instead of working with multiple customers, the utility can work with just the broker. Finally, third-party intervention is a way for utilities to keep out of the complex business of banking.

(a) Telephone conversation with Shirley Anderson, Niagara Mohawk Power Company, March 12, 1995.

- *California Energy Coalition*

The California Energy Coalition (CEC) is an example of a brokering arrangement. This coalition, formed in 1975, was originally a response to the rising energy prices resulting from the oil embargoes in the 1970s. The CEC has organized 14 energy cooperatives of large utility customers. By altering the way they use their systems, these energy cooperatives can reduce demand when requested by the utility. Today, the coalition can reduce energy use by 18.2 MW when needed. The CEC has also created over $11 million in rotating funds and financing for retrofits and other efficiency measures. This funding can be helpful to energy/plant mangers who would not otherwise have the capital necessary for such measures (Results Center 1992c). Since 1990, the CEC has expanded its energy cooperatives to focus on the development of regional energy initiatives for cities in California and Sweden (Results Center 1992b).[a]

- *New England Power Service Company*

New England Power Service Company and Citicorp are participants in a partnership to provide financing for energy efficiency measures for all New England Power customers. New England Power representatives in the field identify customers with financing needs. The utility representative works with the customer and the financial services firm to facilitate the financing arrangement. The utility representative introduces the customer to Citicorp, who initiates a credit check of the customer. If the credit risk is accepted, Citicorp will finance a lease on higher efficiency equipment or other measures. If the credit risk is not acceptable to Citicorp, the utility will select any one of several other financial service vehicles. In some cases, the referral is to a consulting firm, such as Catalyst Financial Group (of Vermont) which will seek the lowest cost and/or creative financing solution for the customer. New England Power may also seek assistance from state government sources such as the Industrial Services Program of the Massachusetts Industrial Finance Agency and other city and county grants. In this way New England Power Service Company ensures that the efficiency financing needs of all retail customers can be met.[b]

4.3 Assistance from Federal, State, and Private Organizations

Several sources of industrial DSM or energy efficiency assistance are available in addition to those programs offered solely by utilities. Certain federal and state agencies, as well as other nonprofit organizations, offer assistance to industrial entities and the utilities that serve them. The programs offered are designed to help organizations increase the energy efficiency of their industrial processes and facilities. These programs also serve as a resource for organizations and utilities to implement industrial energy efficiency plans. Table 4.2 lists several programs by program name, sponsor (funding agency), and type of assistance provided. This list is by no means a comprehensive list of programs available, but it provides examples of the types of programs available. More detail on these programs is provided in Appendix A.

(a) Memo from John B. Phillips, California Energy Coalition, to Laura Loessner, Pacific Northwest Laboratory, March 21, 1995, "CEC Blurb."

(b) Telephone conversation with Bob Potter, New England Power Service Company, March 12, 1995.

Table 4.2. Selected Industrial Energy Efficiency Assistance Sources

Program Name	Funding Sponsor	Type of Assistance
Energy Analysis and Diagnostic Centers	US Department of Energy	Energy audits and technical assistance
Manufacturing Extension Partnership	National Institute of Standards and Technology	Technical assistance
Energy Star Showcase Buildings	US Environmental Protection Agency	Technical information
Green Lights Program	US Environmental Protection Agency	Financial assistance
Energy Efficiency and Renewable Energy Clearinghouse (EREC)	US Department of Energy	Technical information
DSM Pocket Guidebook for Industrial Technologies	US Department of Energy	Technical information
National Industrial Competitiveness through Energy, Environment, and Economics (NICE3)	US Department of Energy & US Environmental Protection Agency	Financial assistance and technical information
Pinch Technology	Electric Power Research Institute	Computer software
Global, Automated Urban Government Energy System	Public Technology, Inc.	Computer software
The Chicago Energy Management Cooperative	Public Technology, Inc.	Technical assistance
Lighting Research Center	Rennselaer Polytechnic Institute	Technical assistance
Industrial Extension Service	North Carolina State University	Technical assistance
Energy $avings Plan Program	Bonneville Power Administration	Financial assistance
Integrated Resources Research Program	New York State Energy Research & Development Authority	Technical information and forecasting tools
Industrial Energy Efficiency and Economic Development Program	New York State Energy Research & Development Authority	Technical assistance
Flexible Technical Assistance Program	New York State Energy Office	Technical assistance
Customer Technology Application Center	Southern California Edison	Technical assistance
Electric Ideas Clearinghouse	Washington State Energy Office	Technical assistance
Regional Energy Efficiency Initiative	Southern California Edison, Southern California Gas Company, The Irvine Company, and the California Energy Commission	Technical assistance
Innovative Concepts Program	US Department of Energy	Financial assistance and research
Energy Related Inventions Program	US Department of Energy	Financial assistance and research
Federal Energy Management Program	US Department of Energy	Research
Metal Melting & Processing Applications Development	Electric Power Research Institute	Research
Nonmetals Technology Development	Electric Power Research Institute	Research
R&D Applications Center for Materials Fabrication	Electric Power Research Institute	Research
Industrial Program Technical Analysis & Planning Support	Electric Power Research Institute	Research
Establishment of an EPRI Pulp & Paper Office	Electric Power Research Institute	Research
Electricity Use & the Environment	Electric Power Research Institute	Research
EPRI Partnership for Industrial Competitiveness	Electric Power Research Institute	Technical information
Motor Challenge	US Department of Energy	Technical assistance
Rate Service Center	IRT Results Center	Technical assistance

These assistance programs and centers are funded and/or implemented by federal agencies, including the DOE, the EPA, and the Department of Commerce; by state programs such as the Washington State Energy Office, the New York State Energy Research and Development Authority, and the California Energy Commission; by other nonprofit organizations such as universities; and by industry-sponsored research organizations such as the Electric Power Research Institute (EPRI). In some instances these programs or technical centers are collaborative efforts between a number of organizations; in other instances, the programs are worked in conjunction with state or local utilities.

The type of assistance offered through these programs or centers varies greatly. Some of the programs specialize in offering information about energy efficient technologies or processes that can be installed or implemented to reduce energy costs. Some of the programs offer auditing services, such as the federally funded, university Energy Audit Diagnostic Centers, where program personnel go to facilities and perform services. A few of the programs offered recognize the financial risk that is sometimes involved in implementing new technologies and, consequently, offer financial assistance to help offset that risk. Many of the government-funded programs provide research results and information about technical advances in new industrial processes; such information can be useful in DSM planning.

In addition, "one-stop shopping" assistance centers provide some or all of the types of services listed above. These centers are comprehensive programs that help industrial and utility managers determine what assistance is needed and provide information on available services such as technical information, audits, financing, or installation. These centers frequently showcase or demonstrate new technology.

4.4 Traits of Successful Programs

Success in industrial DSM programs may be loosely defined as meeting the goals of the utility and the customer to overcome specific barriers to greater energy efficiency. It is important to keep in mind several traits common to industrial DSM programs noted by utilities and customers as successful when designing industrial DSM programs. This section summarizes the findings of several reports and articles that have characterized such programs (Jordan and Nadel 1993; Hull 1993; Wood and Prindle 1994; OTA 1993; DeVaul and Bartsch 1993). The most frequently cited features of successful industrial DSM programs identified in the literature include

- customer focus
- marketing techniques
- program flexibility
- financial incentives
- program analysis and evaluation
- partnerships (Nadel and Jordan 1994).

Each of these features is discussed below.

4.4.1 Customer Focus

Jordan and Nadel (1993) describe how "industries have been skeptical about the quality and intent of utility DSM programs." One reason for this is that "utilities have paid little attention to the perspective and priorities of industrial customers. In particular, productivity and environmental concerns are more important to industries than are energy costs. Utilities with at least 5 years of industrial DSM experience indicate that it has been important for them to find ways to increase productivity and/or reduce the environmental impact of a customer's facility while also meeting its goals to reduce energy consumption."

While industrial plant managers may be willing to improve the efficiency of nonprocess systems, process changes in the pursuit of energy efficiency are generally perceived as risky. Allowing industrial participants to perform energy efficiency analyses and retrofits themselves and to choose their own vendors and/or engineering contractors to help with energy efficiency projects seems to be more effective than relying on a utility-chosen consultant. Planning marketing approaches around a customer's capital appropriations and efforts to minimize a customer's investment of time can shorten the lag between program enrollment and receipt of an incentive payment; minimizing that time keeps a customer's attention on the program (Jordan and Nadel 1993).

An example of a utility-industrial DSM program that was developed with a strong customer focus is the Southern California Edison Clean Air Coatings Technologies program. This program assists over 23,000 manufacturing and other industrial customers that apply paint, coating, ink, or adhesive. The DSM program goals were to reduce the energy consumption of these customers, as well as assist them in complying with environmental regulations regarding air quality (Delaney 1994).

Baltimore Gas and Electric Company (BG&E) operates a rebate program for compressed air system improvements. Prindle (1994) notes that BG&E's success in this program is largely due to its marketing strategy, which is strong on customer service and trade ally communications. The BG&E representatives are trained in issues of importance to industrial customers, such as the engineering aspects of compressed air system efficiency. Relations with vendors are enhanced by the incentive structure, which includes levels graduated according to compressor efficiency and which allows for the widest range of equipment choices (Prindle 1994). Many sources of the current literature list a strong customer focus as essential to program success. The industrial customer primarily focuses on product manufacturing. In addition, the industrial sector's view of DSM project viability and of energy efficiency varies widely from the commercial sector. In light of the difference in end uses and technologies, it is important that DSM programs use a modified approach when promoting conservation strategies for the industrial sector. For example, in industry's competitive environment, energy cost reduction can be of interest (Fuller 1992). Such sensitivities must be taken into account in an effective DSM program.

4.4.2 Marketing Techniques

Making use of existing contacts with industrial customers seems to be a more efficient way of marketing DSM programs than using utility staff with no previous contact with the customer (Jordan and Nadel 1993). Largely because of historical problems between utilities and industrial firms, the latter are often skeptical of a utility promoting energy efficiency. The industrial firm may find it hard to understand why the utility would want the industrial firm to actually use less energy. On the surface, promoting less use of your product seems contrary to common business sense. However, already established relationships can help build trust between the utility and industrial firm and build an understanding that industrial DSM programs are a win-win investment for both utilities and industrial firms. Initial contacts with industrial customers that result in substantial energy savings are often made by utility field representatives. These representatives know their customers best and are often cited in the current literature as the one person arranging for the energy audit and/or financing alternatives.

Demand side management marketing techniques may include vendors and trade allies. Also, focusing on trade allies to market a program tends to reduce utility administrative costs and customer paperwork. In addition, trade allies and manufacturers can indirectly act as utility marketing staff (Jordan and Nadel 1993).

Other contributors to the current literature have presented additional ideas on marketing techniques. For example, Michaels and Ornstein (1992) offer an alternate theory of market penetration using a customer model rather than a model on returns. DSM marketing should emphasize the modernization or "state of the art" nature of its products, rather than financial return. Focusing on products which are "the best" can be a truly effective marketing technique, stressing the product's value and quality of performance. Customer decision-making tends to recognize more of the overall value of a product rather than payback. DSM products would therefore be accepted not on the basis of cost reduction, but because they are viewed as a good deal—customers getting the most for their money (Michaels and Ornstein 1992).

4.4.3 Program Flexibility

Generally, the more flexible the program, the more successful the utility has been in recruiting participants (Jordan and Nadel 1993). Flexibility is necessary if the utility is going to be able to listen and respond to the needs of its customers. Programs tailored to the needs of the customer and market forces will be better able to deliver the promised results and make the customer confident about the decision to invest time, money, and effort in industrial DSM programs. These qualities are most often found in comprehensive DSM programs because of the variety of measures, financial incentives, and technical assistance offered. The programs offering the larger financial incentives have above-average participation and savings (Nadel and Jordan 1994). Customer-driven features such as financing flexibility and adequate equipment or choice of measures (Wood and Prindle 1994) may improve participation, enhance the effectiveness of technical assistance, and accelerate market transformation.

4.4.4 Financial Incentives and Technical Assistance

Several examples of financial incentives are discussed earlier in this chapter. These incentives are often the most popular features of a DSM program, particularly when they include cash incentives. The current literature makes numerous mentions of financial and other barriers to industrial energy efficiency. Alternative project financing through utility programs is of less interest to industrial customers. Financial incentives to vendors and trade allies streamline and improve the effectiveness of program marketing. They are the type of program feature that often provides a turning point for program success, particularly when capital constraints have delayed or eliminated investments in energy efficiency improvements. When combined with education or technical assistance, the ECM installations can create the market pull needed to transform the marketplace.

For example, in 1989, B.C. Hydro began a program to transform the motor market in the area. It combined an educational program, a rebate to the participating industrial firms, and incentives to the distributors to make the shift in the market. The educational effort was the first step; the utility held seminars on adjustable speed drives, motors, and drive power equipment. After their informational mission succeeded, B.C. Hydro created a market pull by adding a participant rebate, that is, paying the industrial firm for purchasing a more efficient motor, and an incentive to the vendor of 20% of the rebate to create a market pull. Consistent with its original intent, the utility is now phasing out its rebates and incentives—the market on all sides has made a real change to efficient motors and no longer needs the pull (Flanigan and Fleming 1993).

4.4.5 Program Analysis and Evaluation

Load research conducted by the utility to estimate the market potential for efficiency can be an important feature of the process and impact evaluation phases of the DSM program. Monitoring to identify improvements in ongoing DSM programs may be used to increase participation and savings. A lack of analysis and baseline information to make complete evaluation has hindered a number of programs. Industrial firms often do not trust the engineering estimate of savings, which have been known to be misleading compared with real-world test results. Accurate load research is an important tool in developing a DSM program to meet specific needs of utilities and their customers. Process evaluations are used to answer two questions: 1) how was the program implemented and 2) how can service delivery be improved? Impact evaluations measure the quantifiable results (usually energy consumption and cost reductions) of the DSM program (Hopkins and Einhorn 1994). A detailed review of impact evaluation experience with industrial DSM programs is presented in Appendix B of this report. One example evaluation is noted below.

Madison Gas and Electric (MG&E) conducted two types of investigations of commercial and industrial and trade allies eligible for the MG&E Power Plus Program. The results of this study gave MG&E some insight into the ways in which the participants heard about the program; which promotion efforts were most effective for small, medium, and large customers; and reactions to rebates and rebate incentive levels. The qualitative exploration of participant reaction and the quantitative evaluation of nonparticipant reaction helped MG&E identify aspects of the program which were most effective, as well as those which needed improvement (HBRS 1989).

4.4.6 Partnerships

Partnerships between utilities and their industrial customers are most often noted as successful in cases where the utility contributes an essential skill or service the customer needs. DeVaul and Bartsch (1993) present several projects of cooperative partnerships. For example, efficiency investments by Wisconsin Electric Power with Charter Manufacturing helped the steelmaker install a new technology melting system, thereby reducing demand and flattening load.

As industrial DSM programs have grown, so has the appreciation of how these programs benefit both the utility and the industrial customer. Partnerships between a number of entities, including government, industrial firms, energy service companies, vendors, and utilities, have created a growing list of programs that are funded with cooperation among different bodies. As programs grow more complex, developing these partnerships will become more important. Technical assistance centers have been developed by government, utilities *and* industrial firms for the dispersion of technology as well as the dispersion of good will and trust.

Electric Power Research Institute's (EPRI) Partnership for Industrial Competitiveness (EPIC) includes 18 EPRI member utilities. It was established by EPRI in 1992 to assist their members in identifying, developing, and implementing energy efficiency measures to improve industrial competitiveness. The EPIC program targets three areas for improvement: environmental issues, energy efficiency, and economic productivity.

The EPIC program operates over a multi-year time frame. Participating utilities select industries to be studied in the Plant Survey phase. Not an energy audit, the Plant Survey process is a detailed assessment of a broad array of issues related to a specific facility. The Plant Survey team reviews alternative energy use analyses and identifies operational issues; and the utility staff and plant managers develop strategies to promote competitiveness. Following the Plant Survey, the utility staff work with those customers to implement strategies identified in the Survey (Smith and Appelbaum 1994).

4.5 Summary

This review of current industrial DSM programs reveals the general shift from a financial focus to a multifaceted service emphasis to respond to the energy efficiency needs of industrial customers.

After wholesale customers, industrial customers hold the largest potential for load loss; therefore, industrial customers are a focus of concern for the future of utilities (Rudden and Hornich 1994). The successful industrial DSM programs have services and delivery mechanisms that were designed according to the needs of the industrial customer. In some cases, such as Southern California Edison, the intense competition and diversity of industry leads to programs which aggressively seek to meet the needs of every industrial customer. The solution for Southern California Edison is not the only solution. The variety of programs is growing rapidly as the complexity and awareness of industrial needs grow, and as the market opens up. Utilities are combining different services and financing mechanisms in DSM programs to find the optimal combination of motivation for the industrial firm and the financial commitment by both the industrial firm and the utility.

Programs such as comprehensive one-stop services illustrate a change in the use of industrial DSM by utilities. The shift from solely financial to more service-oriented programs is a response to the coming of competition. Industrial DSM programs of the future are likely to continue this change, i.e., treating utility kilowatt-hour sales as a service, instead of a commodity. Industry's perception of energy efficiency benefits may also be expected to change as energy saving benefits are further demonstrated.

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5.0 Case Studies

In this chapter two case studies of companies that have implemented industrial DSM programs are presented: Boise Cascade Corporation and Eli Lilly and Company. These case studies illustrate how the process and outcomes are affected by the industrial characteristics discussed in Chapter 3.0 and/or the successful DSM program features described in Chapter 4.0.

The case studies describe in detail the actions taken (and being taken) by energy management personnel to improve energy efficiency, the attitudes of the personnel toward energy efficiency and utility DSM programs, and the impacts and benefits of the individual projects or groups of projects. In addition, the utility DSM programs and their implementation are described, along with the goals and the future directions of the programs. These case studies will illustrate with hard data many of the issues and benefits of industrial DSM programs highlighted in Chapters 1.0 and 2.0. The concluding section of this chapter will discuss those issues and benefits in light of the experience of the case study companies.

5.1 Boise Cascade's West Tacoma Mill

Boise Cascade Corporation's West Tacoma Mill illustrates the key role a utility DSM program can have on the decisions an industrial firm makes to remain competitive and to comply with environmental regulations. This case study describes the actions the director of technical and environmental affairs of Boise Cascade's West Tacoma Mill took to parlay a utility DSM program into a mechanism to reduce the risk in adopting new technology to treat the waste water of a new newsprint recycling plant. The case study also describes the competitive environment the newsprint operation faced, the industrial DSM program of Bonneville Power Administration (BPA), the role of Tacoma City Light (TCL), and the newsprint recycling and production process.

5.1.1 Industry Background

The West Tacoma Mill produces recycled newsprint—the paper newspapers are printed on. Such mills are classified under SIC 2621. Paper mills (of all types) are heavy users of electricity. This SIC ranks fourth out of 459 four-digit SICs in electricity consumption (32,012 million kWh in 1987) and 35th in electricity as a percentage of the industry's value of shipments (3.6%). This SIC also accounts for 53.2% of all electricity consumption by Paper & Allied Product (SIC 26).

The paper mill industry (SIC 2621) is made up of companies primarily engaged in manufacturing paper from wood pulp and other fiber pulp. In the 1987 Census of Manufactures, paper mills employed 129,100, less than a 1% gain over the employment recorded in the 1982 census. Leading states in employment are Wisconsin, Maine, Alabama, and New York, accounting for 37% of total employment. Of these employees, 77% are production workers (U.S. Bureau of the Census 1987b).

The U.S. paper mill industry is composed of 122 companies. The total value of their shipments in 1987 was $28.9 billion. This value breaks down into $14.9 billion (52%) for the cost of materials and $14.0 billion (48%) in value added by the manufacturer. Newsprint product shipments totaled $2.765 billion in 1987, or about 10% of the total shipments by the paper mill industry.

The cost of materials for the paper mill industry includes materials consumed, resales, fuels, purchased electricity, and contract work. In 1987, these categories were valued as shown in Table 5.1. Total wages and salaries (including benefits)—which counts as part of value added—were $5.6 billion. Thus, materials, wages, and salaries total $20.5 billion, or 71% of value of shipments.

Newsprint manufacturers compete globally. Prior to 1991, about 60% of U.S. newsprint was imported. The figure now is near 40% because of recent capacity additions in North America. Within North America, Canada is a large supplier of newsprint to the United States, having exported as much as 66% of its newsprint to the United States; currently, the figure is about 50%. Manufacturers in the Pacific Northwest compete well on the west coast of the United States, in South America, and in the Pacific Rim, but cannot compete with manufacturers on the east coast of the United States because their raw material does not allow as high a quality as that of the east coast.

Prices for newsprint hit an all-time high in 1988 at about $600/ton, then dipped to a low not seen since the Great Depression—$411/ton. Actually, with industry discounting (as great as 15% to 20%), prices dropped well below $400/ton at times and have been low on average for the past 3 years (1991-1994), currently at about $450/ton.

Given the cost to produce a ton of newsprint (currently estimated at about $400), profits have been virtually nonexistent for the past 3 years in the industry. Over the last 4 years, the pulp and paper industry has experienced a downturn because industry capacity has increased in conjunction with an economic recession. Competitive pressures are severe.

Table 5.1. Cost of Materials for the Paper Mill Industry, 1987

Category	Cost (millions $)	Percentage of Total Cost (%)
Materials, parts, containers, etc., consumed	12,104	81.5
Resales	83	0.6
Fuels	1,232	8.3
Purchased electricity	1,198	8.1
Contract work	238	1.6

5.1.2 Company and Facility Background

Boise Cascade Corporation produces uncoated and coated white papers, newsprint, containerboard, and market pulp in eight U.S. and two Canadian pulp and paper mills. The annual capacity of these mills is 4.1 million tons, which is 3.5% of the total North American capacity (Boise Cascade 1993).

In 1993, Boise Cascade recorded a $137 million loss in its paper and paper products segment, down from a loss of $187 million in 1992. The loss was reduced by significant reductions in unit costs, a modest increase in sales volume, and an upgrade of the product mix. The 1993 sales of $1.9 billion were similar to 1992, reflecting flat product prices.

Newsprint (and groundwood specialty papers) accounts for 30% of Boise Cascade's pulp and paper capacity. Newsprint is sold directly from the mills to customers. North American newsprint consumption grew slightly in 1993, and industry capacity remained fairly constant. The company's average annual newsprint prices rose 4% during 1993.

In July 1993, the company started production in its new recycled newsprint facility—the West Tacoma Mill in Steilacoom, Washington—located just off Puget Sound. The facility, which has two machines, has an annual practical capacity of 190,000 short tons of newsprint. The mill is now one of only 10 to 15 mills in North America that can use recycled materials to produce newsprint. Recycled newspapers and magazines account for up to 40% of the raw material input.

The West Tacoma Mill produces standard newsprint and markets to newspapers located on the U.S. west coast, Canada, South America, and the Pacific Rim. The mill employs about 250 workers full time and can produce 530 tons/day, 365 days/year, of which the recycling operation produces 250 tons/day.

5.1.3 Production Process Description and Electricity Use

Touring a newsprint mill leaves a lasting impression—noise. The room housing the de-ink machines, for instance, is very noisy with all the electric motor drives. Even noisier is the refining operation, where four large motors produce pulp from wood chips. And the next stage in the process features a comparably noisy paper machine—a roaring technological wonder. The paper machine produces noise (and newsprint). (The annual output of one machine, if laid continuously around the globe at the equator, would circle the earth almost 14 times.)

Production Process Description

Starting the process is the handling of the raw materials. Semi tractor-trailers bring in the recycled newspapers and magazines. The company's diesel-electric switch engine moves special railroad hopper cars of raw wood chips; the entire load (about a four-day supply) is dumped at once onto a conveyor system to move to the raw materials stockpile. The chips are initially processed to remove residual sawdust, which is collected and mixed with other process waste (sludge from the ink removal process) to use as fuel for the plant's low-pressure steam boiler. Virtually every bit of material and waste product in this plant is used in the total process.

At first, the recycled newsprint and magazines are handled separately to remove ink using slightly different chemical processes. The removed ink is treated to form a sludge (along with other processing rejects), which later is used as steam boiler fuel. The pulp from the de-inked newsprint and magazines and the pulp made from wood chips are combined in a fluid (water) solution. Then, four refiners—powered by 12,000-hp electric (air- and water-cooled) motors—crush the wood chips between two large rotating plates to produce the wood chip pulp, ensuring the development of the proper fiber characteristics for newsprint.

Then, the raw pulp flows to the paper machine, which operates virtually almost continuously at a newsprint production rate of about 3,500 linear feet/minute. The pulp—a watery, gray mixture of wood fibers and water—flows onto a rotating mesh approximately 21 feet wide. The fibers catch on the mesh and the bulk of the water falls through. The fiber mat on the mesh gets squeezed between a series of felt rollers, which pick up more water, vacuum it off, and press and separate the mat from the mesh. The 21-foot-wide paper runs through a series of 50 drying cylinders (hollow rollers heated by steam), further reducing the water content of the paper, and finally producing paper of 8% moisture content.

The newsprint—now almost dry—is rolled onto a drum reel (a cylinder about 21 feet long and 1 foot thick). Taking up paper at 3,500 feet/minute, the roll grows until it is 6 or more feet in diameter. Another drum reel is then positioned over the newsprint sheet. Using an air gun, an operator gives a short blast on one side of the paper; instantly the paper stream is cut and starts winding on the new uptake reel. The approximately 6-foot-diameter roll, which weighs several tons, is moved by overhead crane to the rewinder, where it is pressed, rewound on a smaller, thicker cardboard core, and cut into 4 to 10 rolls of a newsprint width, depending on the customer's requirements.

Each roll is then sampled and tested in the laboratory for strength and other characteristics and prepared for shipping to customers.

Electricity and Other Energy Use

The West Tacoma Mill's 1993 electric bill totaled $9.6 million. Electricity cost per ton of newsprint runs between $50 and $60. The lowest total production costs for newsprint (of any mill) are no lower than $400/ton; thus, electricity cost is as much as 12.5% to 15% of total costs. For the West Tacoma Mill, electricity costs are about 10% of total costs. Electricity is the second largest controllable variable cost (behind the costs for raw materials).

The mill uses low-pressure steam, which is fueled by burning bark and sawdust residue (from the raw material) mixed with the sludge from the de-inking process and the waste water treatment process. The process uses very little natural gas.

5.1.4 Process Improvement Opportunity: The Aeration System for Waste Water Treatment

The newsprint recycling operation produces additional waste water effluent and thus required modification of the mill's waste water treatment plant (WWTP) to meet new permit requirements for effluent. The mill had experienced recurring problems with high levels of total suspended solids and biological oxygen demand. At times, the mill has shut down production temporarily to avoid monetary penalties from exceeding the maximum discharge levels specified in the plant's operating permit.

In the initial project planning, the company had chosen conventional technology—a continuous, large-bubble aeration system—for the plant's aerated stabilization basin. This "proven" system was priced at $1 million. This waste water treatment system consists of 1) three main sumps and pump stations that collect primary process waste water and convey it to the primary clarifier, 2) the primary clarifier, 3) the primary clarifier effluent pump station, 4) the aerated stabilization basin with a maximum liquid volume of 30 million gallons, and 5) discharge to Puget Sound (Larson et al. 1994). The aeration system is the major energy-consuming component of the waste water treatment system.

At the time this planning was well under way, a new Director of Technical & Environmental Affairs took up duties at the West Tacoma Mill. Previously, the new director had worked in Boise Cascade's corporate offices with previous corporate experience in environmental and technical affairs. The new director was very familiar with technologies used in waste water treatment and was particularly aware of a new technology being used in Europe—cyclical aeration using fine bubbles. Because it used fewer and/or smaller air compressors and cycled them on and off rather then running them continuously, this technology had the potential to provide the same, or better, aeration while using much less electrical energy.

The key component of the project is the new aeration system. It provides oxygen for biological stabilization of the organic compounds in the waste water and facilitates the mixing to keep the material in suspension. The design air requirement for mixing was determined to be about three times the air requirement for biological stabilization, providing an opportunity to reduce the air requirement for mixing. In the conventional system, the installed air capacity would be made equal to the air required for mixing. The new technology—called a "Biomizer"—divides the aerated stabilization basin into 14 different zones (air laterals) and uses a programmable logic controller to cycle the air flow to fine bubble diffusers (Bhatia 1994).

Boise Cascade decided to implement the "unproven" technology for at least three reasons. First, the total air requirement for the system could be significantly reduced by matching the air required for mixing to that necessary for biological stabilization. In the case of the West Tacoma Mill, the annual energy savings from use of the new technology equaled almost 7 million kWh. Second, this innovative technology, along with a new secondary clarifier, stabilized the whole system, making it capable of meeting limits on biological oxygen demand and total suspended solids with a much greater degree of confidence. Third, the project's energy savings qualified the company for a large cash rebate from Tacoma City Light. The money substantially reduced the project's capital cost.

5.1.5 Bonneville Power's Energy $avings Plan

The BPA had initiated the DSM program that assisted Boise Cascade as a pilot program in 1987 and promoted it system-wide in 1988. Called the Energy $avings Plan (E$P), the program is targeted to industrial customers (other than aluminum smelters which have their own programs); utility distribution systems; and local, state, and federal governments with industrial processes located in BPA's service territory. Ineligible projects include those that receive funding under other BPA programs, that involve routine repairs, cogeneration, or fuel switching; or that result in adverse environmental impacts (BPA 1993a,b).

The BPA offers this program to help cut industrial electricity costs and add to the region's power supply.[a] The BPA, which considers industry to be the largest untapped source of electrical energy conservation, is committed to helping industries become energy efficient. To do so, BPA will purchase the energy savings resulting from industry's installation of energy efficiency measures.

Utilities that sign agreements with BPA to run E$P submit all required paperwork to BPA for their participating customers. The BPA's Direct Service Industries, and industries whose utilities do not run E$P, sign agreements and work directly with BPA. Either way, industrial firms make their own decisions on how they will design and implement energy efficiency projects in their facilities.

The E$P offered in the Seattle District provides three options to industry:

- acquisition payments for energy savings resulting from the installation of electrical energy saving equipment
- Energy Reviews to identify potential electrical efficiency measures
- rebates for the purchase of high-efficiency electric motors, lights, and single-phase amorphous core transformers.

Acquisition projects begin with a proposal (BPA 1993c), which can be for single or multiple projects. Key parts of a proposal include a description of the project, estimated project costs, estimated energy savings and any anticipated environmental impacts. Once BPA approves the proposal, the project is installed and the energy savings are verified. A Completion Report is written by the company and submitted to BPA. After it approves the Completion Report, BPA makes an acquisition payment. Acquisition payments are based on a project's estimated first year electrical energy savings (unless actual savings deviate significantly from the estimate) times $0.15, or 80% of the actual project cost, whichever is less. (For a 10-year project, at a real discount rate of 3%, 15 cents per annual kWh saved translates into a purchase price per kWh of 1.8 cents.)

(a) Site visit conversation with Tony Koch, mechanical engineer for BPA's Seattle District.

Energy Review funding allows industrial firms to pay for project proposals without waiting for an acquisition project to be installed, approved, and paid by BPA. An industry may create its own project proposal or hire a technical expert from a consulting firm to write the project proposal. Once BPA approves the Energy Review, it makes a payment to the industrial firm. Facilities using more than 10 million kWh annually have their Energy Review payment based on $0.0005 times the facility's annual electricity use (not to exceed $50,000), or the actual cost of the Energy Review, if it is less. Facilities consuming less than 10 million kWh will receive $5,000 or the actual cost of the Energy Review, whichever is less.

Rebates are a quick way for an industry to receive cash for purchasing high-efficiency motors, lights, and single-phase amorphous core transformers. No verification of installation is required to receive a rebate payment.

Tacoma City Light

Tacoma City Light is the local electric utility for Boise Cascade's West Tacoma Mill. It is a division of Tacoma Public Utilities, which also provides water and belt-line railroad services to the city of Tacoma in Washington State.

The TCL manager assigned to industrial conservation services reported that about 62% of TCL's conservation savings come from the industrial sector at an average cost of 1.2 cents/kWh saved, in contrast to the average cost of 4.5 cents/kWh saved for the residential and commercial sectors. (Industrial services are administered by one person, residential and commercial by 45.) TCL has some of the lowest industrial rates in the country, averaging 2.1 cents/kWh, with the very largest customers' rates averaging 1.9 cents/kWh.[a]

This utility manager, in spite of these low rates, has been successful in getting industry participation through hard work in the field. To promote the E$P program, he called TCL's 100 largest industrial customers and met each customer face-to-face. By persisting over time, he built up trusting relationships with each customer. To be successful in selling the E$P Program, he learned to couple the energy savings benefits of the program with other benefits and/or concerns of the customer, such as safety, process improvements, and environmental compliance. This manager also found that he had to sell these combined benefits to the top management of the companies.

So far, TCL has achieved a 50% participation from the 100 largest customers, with 70 projects. Among all industrial customers, 200 projects have been (or are in the process of being) funded. The largest savings have come from projects in the four largest industries—chemicals, pulp and paper, industrial gases, and refining—which together account for 85% of TCL's savings. The other 15% savings come from motor and lighting rebates. About half of the motor rebates are for new motors and half for motor replacements.

(a) Site visit conversation with Steve Craig, the TCL manager assigned to industrial conservation services.

According to TCL, the 1.2 cents paid for electric conservation savings is a far more cost-effective way to provide "capacity" than the 5-6 cents/kWh it would cost to build and operate more hydro capacity. The acquisition of electrical savings is definitely an alternative resource to traditional generation.[a]

The cost of running the industrial program is $120,000. This amount covers salaries, overhead, secretarial services, newsletter, and all other costs of running the E$P Program. BPA breaks the $120,000 into two amounts: $40,000 for administrative costs, and $80,000 as a bonus under BPA's program agreement with TCL.

Tacoma City Light's Experience with Boise Cascade

TCL's manager had contacted managers with electrical and environmental responsibilities at the West Tacoma Mill for 3 years with no results until the new Director of Technical and Environmental Affairs arrived. The mill needed to upgrade its holding pond in order to produce newsprint with recycled newspapers and magazines. The new director's proposal to use fine-bubble diffusion coupled with cycling aeration provided an opportunity to use the E$P as an additional incentive. The available energy savings of fine-bubble diffusion and cycling aeration (about 7 million kWh/yr, worth about $133,000 per year), plus the BPA/TCL incentive (worth approximately $1,000,000) and the new director's recommendation persuaded Boise Cascade's top management to make the investment.

The new director faced definite risks that, in effect, put his job on the line. Upper management had to be convinced that adoption of this "unproven" technology would work. The recycle plant could not begin operation without approval of the waste water treatment pond technology. The acquisition payment associated with the technology investment helped the director analyze all major risks associated with the adoption of the technology. The worst-case analysis demonstrated that proceeding with the new technology would not jeopardize the startup and operation of the plant.

TCL's industrial manager assisted in talking with vendors, met with Boise Cascade's new director and BPA's E$P contract administrator for TCL, and helped to sell the project on its energy and environmental benefits. The project was expected to cut biological oxygen demand and total suspended solids by 40% for the plant (even with the recycle operation—a larger generator of these emissions), a win-win solution for energy and environmental savings, for Boise Cascade, and for TCL and BPA.[a]

The 6.6 million kWh saved from the West Tacoma Mill project is the third largest industrial DSM project ever for TCL. The largest project was the 24 million kWh saved from an electrolytic cell application, followed by 12 million kWh saved from a project involving new refiners in another pulp mill.

(a) Site visit conversation with Steve Craig, the TCL manager assigned to industrial conservation services.

5.1.6 Assessment of Potential and Actual Savings

Boise Cascade's agreement under the E$P Program spelled out energy savings verification criteria:

- pre-project metering of energy use
- post-project metering of energy use
- post-project effluent permit compliance.

Pre-project metering of energy use was conducted in August 1993. Post-project metering was conducted during late October through mid-November 1993. Effluent permit compliance was verified during the same period. Discharges from the basin are regulated under the National Pollution Discharge Elimination System (NPDES) which sets limits on five-day biochemical oxygen demand (BOD) and total suspended solids (TSS). All effluent levels were measured to be well below required limits. In addition, the amplitude of fluctuation in the levels of BOD and TSS declined along with their average levels. This improvement enabled Boise Cascade to spend less time monitoring these effluent levels each day and virtually eliminated the need to shut down operations temporality to avoid exceeding those limits.

An engineering and financial analyses of the West Tacoma Mill project states:[a]

> Based on this impact evaluation, energy savings from the project are expected to be 6,614,000 kWh/year (.76 average MW). On a per-ton basis, this project will save 36.7 kWh/ton (saleable product). The project cost is $1,414,900 to install, and BCC [Boise Cascade] received payment of 1,016,400 (in 1993 dollars) from Bonneville for the acquisition of energy savings. The real levelized cost of these energy savings to Bonneville is 13.5 mills/kWh (in 1993 dollars) over the project's assumed 15-year life, and the real levelized cost to the region is 20.9 mills/kWh, not including transmission and distribution effects. Because the high-efficiency system would not have been installed without the acquisition payment, this project was not a free rider.

Not only did the report evaluate the electrical energy saved annually, but it also assessed fuel switching, productivity, output at the West Tacoma Mill, output at Boise Cascade's other plants, the net impact in terms of electricity consumption on the serving utility (TCL), and the real levelized cost to BPA and the region.

Energy Savings and Fuel Switching

The conventional technology would have required 21,000 cfm of air, while the new technology required only 6,700 cfm. Pre-project power to run the air compressors was estimated at 1,530 hp. Actual project horsepower was 485, a savings of 1,045 hp. Assuming 24-hour operation, 365 days a year and a

(a) Larson, L. L., S. L. Freeman, M. A. Oens, and G. E. Spanner. 1994. *Impact Evaluation of an Improved Wastewater Aeration System Installed at Boise Cascade Corporation Under the Energy $avings Plan*. PNL-996, Pacific Northwest Laboratory, Richland, WA.

horsepower-to-kW conversion ratio of 0.7457, the estimated annual savings are 6,776,000 kWh. Actual savings, as estimated by Boise Cascade, turned out to be 6,619,915 kWh/year (97.7% of estimated). Based on actual energy usage measured at 517.5 hp, estimated actual energy savings at 6,614,000 kWh (or 97.6%). At this latter estimate, kWh/ton of product is estimated to drop from 51.7 to 15.0.[a]

No other fuel was involved in this project, so no fuel switching occurred.

Impacts on Boise Cascade

The waste water system upgrade was undertaken because 1) the existing system was not adequate to keep solids in suspension in the aerated stabilization basin (and recurring problems with high effluent biological oxygen demand and total suspended solids resulting in lost production and/or emission penalties) and 2) the production process change to handling recycled materials was expected to increase the loading on the system. These modifications included the de-inking operation and the rebuilding of the number three paper machine. As a result of the paper machine rebuild, product output was expected to increase from 530 tons/day to 617 tons/day.

Boise Cascade received an acquisition payment of $1,016,400 from BPA. This payment reduced its equipment investment from $1,141,900 to $398,500. In addition, Boise Cascade will save about $133,000 in electricity costs annually.

No other Boise Cascade facilities will be affected by the change at the West Tacoma Mill.

Impacts to BPA and the Region

For the E$P Program, acquisition payments are based on the lesser of 1) 80% of the actual project's cost, or 2) $0.15/kWh times the estimated annual electricity savings. BPA paid Boise Cascade an acquisition payment of $1,016,400 ($0.15/kWh times the estimated annual savings, which turned out to be lower than 80% of the project's cost--$1,131,920). In addition, BPA's administrative and evaluation costs equaled $115,640 for this project.

The net impact to BPA is simply the estimated 6,614,000 annual reduction in kWh. From BPA's perspective, the levelized cost equals 13.5 mill/kWh (including 1.0 mill/kWh for transmission and distribution losses). From the regional perspective, the acquisition payment is considered a zero net cost to the region. Boise Cascade has lost money over the last 3 years; thus, no federal income tax is associated with the acquisition payment. Tacoma City Light conservatively estimated its cost of administering the project at $4000. The total regional cost was estimated by the Pacific Northwest Laboratory to be 20.9 mill/kWh

(a) Larson, L. L., S. L. Freeman, M. A. Oens, and G. E. Spanner. 1994. *Impact Evaluation of an Improved Wastewater Aeration System Installed at Boise Cascade Corporation Under the Energy $avings Plan*. PNL-9966, Pacific Northwest Laboratory, Richland, WA.

(again including 1.0 mill/kWh for transmission and distribution losses). The 20.9 mill/kWh figure equals the sum of the levelized costs for Bonneville, Boise Cascade, and TCL: 13.5 mill/kWh, 7.4 mill/kWh, and 0.05 mill/kWh, respectively.

5.1.7 Demand Side Management and Process Improvement Decision-Making Processes

Boise Cascade's upper managers are typically risk averse; they are most comfortable with proven technology. The then-new Director of Technical and Environmental Affairs faced a formidable challenge to convince upper management to adopt an aeration technology that had not been used in any full-scale operation in the United States. He proposed scrapping a tried-and-true technology, which was through the design stage and almost into the implementation stage, to adopt a new technology. Moreover, the new technology had to work, or the new recycling plant (worth $60 million) could not operate.

The new technology would not have been adopted without the technology's energy savings benefits *and* the BPA program. The cost savings potential and the BPA incentive provided the Director with an argument to spend Boise Cascade dollars to investigate and analyze the technology risks of the project. That analysis provided the information that reduced the technology risk to the point that upper management approved the investment.

5.1.8 Future Considerations

Different follow-on activities are planned for the utility, the company, and BPA.

Bonneville Power Administration

BPA says 1995 will be the last year it offers the Energy $avings Plan. In anticipation of a more competitive electricity supply environment, BPA is changing its philosophy toward pricing and away from DSM. The BPA is cutting operating costs, staffing, and reliance on DSM dollar incentives. At the rate structure level, BPA will be moving from essentially flat energy rates and low demand charges to an "inverted" type of rate structure—one with a higher rate for large volumes of electricity purchased. The higher "tailblock" rate will act like a consumption tax and provide the "incentive" to customers to conserve. In addition, the philosophy is to unbundle services and to have customers pay for services based on their value.

Tacoma City Light

In the meantime, during the transition period, BPA has entered into a new 2-year contract with TCL that provides more flexibility to reduce its energy draw on BPA. At the end of the period, BPA will pay TCL for the energy it has been able to conserve through the industrial DSM program.

Regardless of BPA's plans for the Energy $avings Plan, a TCL representative says TCL will continue encouraging its industrial customers to conserve. The reason is simple—conserved energy will cost less than BPA's rates. Because it will lose the dollars from BPA to fund DSM projects, TCL is exploring alternative means of financing projects, with particular interest in zero-interest loans.

With some of the lowest industrial rates in the country, TCL is not threatened by the possibility of retail wheeling. Also, because of its low rates, it does not face any cogeneration threat.

Boise Cascade

Taking advantage of BPA's Energy Review, Boise Cascade had an outside consultant perform a total electricity use audit of the West Tacoma Mill (at a cost of $50,000). That audit showed a potential for about an 8% to 10% reduction in electricity use (or about 50 to 56 million kWh). Boise Cascade is now reviewing the auditor's report to determine projects to seek BPA/TCL funding for before the BPA program expires.[a]

This audit was the first comprehensive energy audit performed at this mill. Another audit that was not as extensive was performed during the 1980s. The goal of the present audit was to look at major energy conservation opportunities (process and energy) in the plant. The capital necessary to undertake the favorable projects will fall in the $8 million to $10 million range. The biggest project is to adopt the latest technology in the thermal mechanical pulping process. This improvement could result in a 15% to 20% savings in pulping costs. Boise Cascade has divided the potential project into three sets:

- projects with proven savings of 6% to 8%
- projects that can add on savings of 6% to 8%
- projects with 4% to 5% savings that require technology to be "proven."

5.1.9 Summary and Implications

This case study illustrates the benefits and costs of a utility industrial DSM program. The BPA, TCL, and Boise Cascade all benefited from BPA's DSM program. The BPA "acquired" long-term supply in the form of reduced energy demand on its system. It paid for this supply at a cost (1.35 cents/kWh saved) less than the cost of building generation capacity to supply a less efficient waste water treatment process. It also will benefit as several other paper mills and other industries adopt the same technology now that it has been proven in the Boise Cascade plant.

Tacoma City Light has benefited—at a cost of only $4000—by gaining a happy customer and by not facing the need to build its own high cost capacity or purchase higher cost energy from BPA at some point in the future.

(a) Site visit, conversation with Mr. Om Bhatia, the then-new Director of Technical and Environmental Affairs, Boise Cascade.

Boise Cascade has gained an important competitive edge, not only saving $600,000 in capital it otherwise would have spent on the aeration system and $133,000/year on energy costs, but also cutting the plant's discharges (biological oxygen demand and total suspended solids) to 40% of current discharge permit limits. As a result, West Tacoma Mill is in an excellent position environmentally to make further improvements while other plants struggle to lower their discharges to meet future, more stringent discharge limits coming in 1995 and beyond. The success of the aeration technology will encourage upper management to support further technology changes. In the future, the Director of Technical and Environmental Affairs hopes to improve the plant's processes to re-use and recycle water and move toward a long-term goal of near-zero waste water discharge. His overall goal is to achieve total economic conservation of all inputs and waste byproducts: water, energy, chemicals, solid wastes, etc. His overall business goal is to become a preferred supplier, one that has a stable and capable process, best customer satisfaction, best employee satisfaction, and better profits.

People in the Pacific Northwest have also gained by having a cleaner environment.

5.2 Eli Lilly and Company: Greenfield Laboratories

This case study of the Greenfield Laboratories of Eli Lilly and Company illustrates how an active corporate energy engineering staff can leverage technical assistance and incentives of a utility DSM program to help meet corporate energy efficiency and competitiveness goals. The staff of Lilly's Energy Engineering Technical Center used utility DSM programs to enhance the energy efficiency of its main offices, a technical center, a site for animal science and toxicology research, and two major production facilities in Indiana.

5.2.1 Industry Background

Eli Lilly and Company is a major manufacturer of pharmaceutical products. Lilly's primary activities are classified under SIC 2834, Pharmaceutical Preparations. Such establishments engage in the manufacturing, fabrication, or processing of drugs for human or veterinary use.

Electricity is not a large share of pharmaceutical firms' value of shipments. SIC 2834 ranks 377th out of 459 4-digit SICs in electricity cost as a percentage of value of shipments (0.595%). However, the industry ranks 32nd for electricity consumption (3964 million kWh in 1987). SIC 2834 accounts for 71.2% of all Drug Industry (3-digit SIC 283) electricity consumption, but only 4.4% of its 2-digit industry (SIC 28—Chemicals).

The 1987 Census of Manufactures (U.S. Bureau of the Census 1987a) shows that pharmaceutical firms employed 131,600, a 5.8% gain over the employment recorded in the 1982 census. New Jersey, Indiana, Pennsylvania, and New York account for 49% of total pharmaceutical employment. Of these employees, 45.5% are production workers.

In 1987, the 640 companies that compose the U.S. industry had a total value of shipments of $32.2 billion. This value breaks down into $8.4 billion (26%) for cost of materials and $23.8 billion (74%) in value added by the manufacturers. The cost of materials includes materials consumed, resales, fuels, purchased electricity, and contract work as shown in Table 5.2. Total wages and salaries (including benefits), which count as part of value added, were $5.1 billion. Thus, materials, wages, and salaries total $13.6 billion, or 42% of the value of shipments.

Competitive Environment

In 1993, the health care systems of many countries either implemented or prepared to implement major policy changes affecting the pricing and use of medicines. In the United States, this has taken the form of health care reform. Market pressures in 1993, imposed by purchasers and competitors, resulted in the lowest increase in 20 years in the U.S. Producers Price Index for pharmaceuticals. Market forces were driving the pharmaceutical industry to globalization: 1) Countries experiencing rapid economic growth were placing a high priority on improved health care; 2) The company was affected by cost pressures from government and health care providers; and 3) Research and development requirements, even for minor drugs, escalated, squeezing profit margins. To counteract these forces, drug companies sought and continue to seek, new ways to increase unit volumes to increase revenues—through a greater global presence (Eli Lilly and Company 1993).

5.2.2 Company and Facility Background

Lilly is a world-wide pharmaceutical company, headquartered in Indianapolis, Indiana, where its founder, Colonel Lilly, started the company in 1876 following the Civil War. Colonel Lilly, a pharmacist, was frustrated by the poor quality of medicines at the time. He dedicated himself to the founding of a company to make high-quality pharmaceutical products based on the best science of the day (Eli Lilly and Company 1992).

Table 5.2. Cost of Materials for the Pharmaceutical Industry, 1987

Category	Cost (millions $)	Percentage of Total Cost (%)
Materials, parts, containers, etc., consumed	6,374	75.3
Resales	1,436	17.0
Fuels	84	1.0
Purchased electricity	195	2.3
Contract work	374	4.4

Today, Lilly spends 15% of its revenue on research and development, or $955 million per year ($4 million per work day in 1993). Lilly employs 29,800 throughout the world, 7800 located in Indianapolis and 3200 in the rest of Indiana. The company makes many widely used drugs, including insulin, a major antidepressant, oral and injectable antibiotics, cancer treatment agents, and an anti-ulcer drug.

Lilly has five major operations in Indiana: 1) Lilly Corporate Center in Indianapolis; 2) the Lilly Technology Center (North and South) for development, pharmaceutical manufacturing, and distribution in Indianapolis; 3) the Greenfield (Indiana) Laboratories, primarily used for animal health and toxicological research; 4) the Clinton (Indiana) Laboratories, a biochemical manufacturing plant; and 5) Tippecanoe Laboratories (Lafayette, Indiana), also a biochemical manufacturing plant. In addition, Lilly has plants and other facilities elsewhere in the United States, Puerto Rico, and the world.

DSM projects at three facilities were investigated in this case study: the Lilly Technology Center, the Lilly Corporate Center (LCC), and the Greenfield Laboratories.

The Lilly Technology Center manufactures, packages, and distributes human insulin and other pharmaceuticals. The administrative buildings, containing engineering and other support services, are modern buildings that feature the latest technologies in lighting, such as occupancy sensors and Biax lamps.

The Lilly Corporate Center is undergoing retrofits to install state-of-the-art lighting. At the LCC, incandescent recessed lighting on one of the executive floors was upgraded to compact fluorescent lighting. Light levels were maintained, maintenance was reduced (due to the longer life of the fluorescents), and heat load was reduced, allowing comfort levels to be met without installing additional equipment.

To provide space conditioning for the nearly 3 million square feet of administrative and research space at LCC, chilled water is produced with a combination of electric and steam-driven chillers. A District Steam System owned and operated by Indianapolis Power & Light, the investor-owned utility serving Marion County, delivers steam directly to both of the Lilly campuses in Indianapolis. The LCC system is a primary/secondary loop system that provides chilled water to each building or building cluster, which in turn use pumps controlled by variable speed drives to supply the individual building needs. The LCC system incorporates sophisticated computer control and monitoring.

A toxicology research building is a major part of the Greenfield facility. This building is essentially a two-story structure: one floor for the research labs and a second enclosed floor to house all of the heating, ventilating, and air-conditioning (HVAC) equipment. Extensive HVAC systems are required for the air exchange rates and air quality requirements of research operations. To meet these environmental requirements, electrical requirements often rise to 15 to 20 W/square foot, which greatly exceed the standard 2 to 3 W/square foot of a typical office building. This huge air-handling requirement becomes immediately evident when one tours the building's upper floor. There are HVAC units everywhere across the top of the building. The noise level is high. Special units control not only temperature, but humidity. Other units continuously vent test and experiment hoods, as well as room air. An additional requirement is back-up emergency generation equipment. Some tests and experiments require years to complete—leaving no room for a breakdown in power supply.

5.2.3 Production Process and Electricity Use

The processes for producing drugs are as varied as the drugs themselves. Because of the obvious strategic business nature of the formulas and processes for manufacturing drugs, descriptions of such processes are proprietary and cannot be divulged in this case study.

Lilly's total 1993 electricity consumption (in both the United States and Puerto Rico) was 1.192 billion kWh. For the three major plants located in PSI Energy's service territory (Clinton, Greenfield, and Tippecanoe), 1993 electricity consumption was as shown in Figure 5.1. Total electric cost for Lilly in 1993 was $44,646,000. The total energy cost was $71,162,000; thus, electricity was 63% of Lilly's total energy cost. This figure compares to 70% for all pharmaceuticals (SIC 2834) in the 1987 Census of Manufactures.

Lilly draws electricity from PSI Energy, which has one of the lowest average industrial prices in the United States (average price defined as total bill/total kWh). At 3.46 cents/kWh, PSI Energy ranks 146th (out of 168) in level of industrial rates.[a]

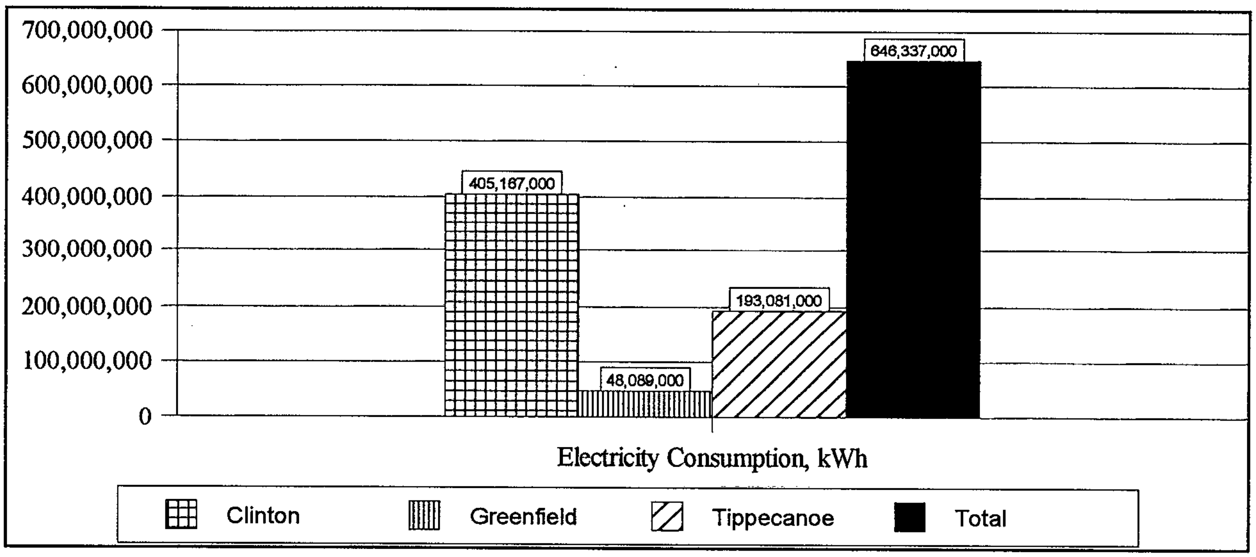

Figure 5.1. Electricity Consumption in Lilly's Three Major Plants, 1993

(a) The contrast in prices across utilities is huge, from the high, Long Island Lighting at 17.15 cents, to the low, BPA at 1.78 cents/kWh (*Energy User News*, November 1993).

5.2.4 Demand Side Management and Process Improvement Opportunities

Early identified opportunities are primarily lighting and HVAC options. This finding is expected because of the nature of Lilly's office and research facilities and production processes, the latter not readily lending themselves to DSM types of investment.

Numerical data for Lilly's DSM projects started and completed (or to be completed) during 1992-94 are presented in Table 5.3; project descriptions are presented in Table 5.4. Lilly also has a number of projects planned for start-up in 1994 to be completed in 1995. These projects for the Clinton and Tippecanoe plants are shown in Table 5.5.

As shown in Table 5.3, the total savings of all projects (in facilities in PSI Energy's service territory) started and completed by Lilly during 1992-94 equaled 24,853,786 kWh and 5,502 kW. The dollar savings of lower electric bills equals $1,009,725 (demand and energy) over the 3 years. These savings will become even higher in the near future because a pending rate case (of PSI Energy) may result in a rate hike of 13% to 15%. The electric bill savings will continue to occur over the life of the equipment, which could easily be 15 years in many cases. Lilly's Energy Engineering Technical Group predicts that projects will continue to be forthcoming over the next 10 years, these savings will continue to grow.

The savings (on a kilowatt-hour basis) for the three plants equals 3.85% of the total kilowatt-hours. This percentage may continue to grow over the next 10 years, depending on the business activities at the various plants.

The total investment for the options installed at the three plants equaled $1.842 million. The payback of the electric bill savings of $1.009 million is 1.6 years including incentives (and would have been 1.8 years without the incentives). Lilly received $229,600 in cash incentives from PSI, approximately 12.5% of the total investment's installed cost.

5.2.5 PSI Energy's Industrial Demand Side Management Programs

PSI Energy developed its Energy Matters program (PSI Energy 1992) to help customers improve their energy efficiency and to manage the growth of demand for electricity. Helping their customers reduce the amount of energy used lowers PSI Energy's cost of doing business by deferring the need for future investments in generation capacity. The program sets up a win-win relationship for all stakeholders, including the environment. PSI Energy's specific goal in the near term is to reduce its summer peak demand by 120 MW—the capacity of a medium-sized peaking unit—by the summer of 1995. PSI Energy plans to reduce its demand and energy use by 1% each year over the next 10 years.

PSI Energy's goals for the industrial sector include reducing operating costs and improving the efficiency of their facilities, while increasing customer satisfaction. From a resource planning perspective, PSI has targeted the industrial sector for a 40-MW demand reduction. PSI's Energy Matters program for industrial customers includes nine different programs, which are described in Table 5.6.

Table 5.3. Eli Lilly and Company Energy Savings Projects, 1992-94

Plant (Utility)	Project Description	Project Duration, Months	kW Savings	kWh Savings	Annual Savings, $	Installed Cost, $	IRR, %	Utility Incentive, $	Payback	
									Without Rebate	With Rebate
Clinton (PSI)	Bldg. C93 - Lighting (New)	7	42	127,722	3,832	0	--	0	NA	--
	Bldg. C93 - Chillers	9	75	408,798	12,264	61,130	NA	0	5.0	--
	Site Lighting (Retrofit)	3	71	612,357	21,432	85,000	20.0	10,600	4.0	3.5
	Bldg. C83 - Lighting Retrofit	1	38	161,228	6,500	52,000	16.5	25,000	8.0	4.2
	Air Compressor Controls	12	2,200	13,481,640	389,843	286,000	NA	0	0.7	--
	High Efficiency Motors	NA	24	118,122	4,559	NA	NA	9,550	--	--
Greenfield (PSI)	Bldg. G212 - Office Lighting	5	6	19,214	950	3,800	NA	0	4.0	--
	Free Cooling Retrofit	3	680	765,000	22,444	82,260	21.0	22,000	3.7	2.7
	Bldg. G242 - Lab Lighting	3	4	12,248	551	2,980	NA	1,950	5.4	1.7
	Direct Digital Controls (DDC)	3	237	3,449,678	300,000	390,000	50.0	31,000	--	--
	Site Lighting Retrofit	3.5	587	2,467,542	86,364	545,000	17.2	89,100	6.3	5.3
Tippecanoe (PSI)	Peak Reduction	1	1,075	0	35,733	0	--	0	--	--
	Air Handling Unit Rebalance	5	18	153,100	4,760	3,000	--	0	0.6	--
	Site Lighting Retrofit	5	423	2,889,000	116,000	325,500	20.0	37,600	2.8	2.5
	Bldg. T1, T2, T27 Lighting	3.5	22	188,077	4,493	5,600	20.2	2,800	1.2	0.6
Totals			5,502	24,853,786	1,009,725	1,842,270		229,600		

NA = not available

Table 5.4. Eli Lilly and Company DSM Project Descriptions, 1992-94

Location	DSM Option	Option Description
Clinton	Bldg. C93 - Lighting	Installed T8s, electronic ballasts, and occupancy sensors.
	Bldg. C93 - Variable Speed Chillers	Installed two York Turbomodulators chillers. These chillers use a variable frequency drive to slow compressor operation at part load for improved efficiency.
	Bldg. C83 - Lighting	Installed T8s, electronic ballasts, and occupancy sensors.
	Air Compressor Controls	The original compressor system consisted of four 2000-hp single-stage, centrifugal compressors operating at full load to provide 15 to 17 psig spare air to the 16 fermenters in Bldg. C41A. The capacity of these machines was automatically controlled by opening the blowoff values as air demand dropped, resulting in large air losses. The new control system coordinated the control of the compressors and used inlet valves to reduce the output of the compressors. The implementation of this measure eliminated the operation of one fully loaded machine (which is used as a backup) and saved approximately 2.2 MW.
	Site-Wide Lighting	This project was recently completed and involves a variety of energy efficiency lighting retrofits.
	High Efficiency Motors	Installed 29 premium efficiency motors ranging in size from 5- to 125-hp.
Greenfield	Bldg. G212 - Engineering Office Lighting	Retrofit of 72 existing two-lamp, 2 x 4 fluorescent fixtures with T8 lamps and electronic ballasts.
	Free Cooling Retrofit for Chiller #5	Retrofitted chiller #5 to provide free cooling via refrigerant migration when outdoor temperatures allow. Free cooling is accomplished by eliminating the use of the compressor and allowing the free flow of refrigerant through a bypass connection between the cooler, condenser, and intercooler, with the compressor vanes open. The circulation of condenser water and chilled water, by pump operation, triggers free cooling.
	Bldg. G242 Lighting	Retrofit of 78 existing four-lamp, 2 x 4 fluorescent fixtures with T8 lamps and electronic ballasts.
	Site-Wide Lighting	A variety of energy efficiency lighting retrofits.
	Direct Digital Controls	The current system consists of 41 air-handling units (AHUs). All of these units handle 100% outside air. Thirty of these AHUs have heat recovery units (HRUs) for exchanging energy between the exhaust air stream and the outside air stream. Out of the 30 HRUs, 19 units are of the Q Dot Thermal refrigerant type while the remaining 11 are of the glycol type. Poor performance of the HRUs and a high pre-heater discharge temperature (80°F) are two of the many problems associated with the current pneumatically controlled system. The new system involves converting the AHUs and associated HRUs from pneumatic control to direct digital control (DDC). With the DDC control, the HRUs are expected to perform per design, and a pre-heater temperature of 55°F can be maintained without risk of freezing coils.
Tippecanoe	Bldg. T2, T27 - Lighting	Replacement of existing fluorescent with high pressure sodium fixtures and high-efficiency fluorescent components. Forty nine two-lamp, 96-watt fixtures were replaced with 26 two-lamp, 60-watt T8s and electronic ballasts and four 400-watt HPS fixtures.
	Peak Reduction	Lilly has agreed to reduce its electric demand at Tippecanoe by 1075 kW upon request by PSI Energy. Lilly will achieve this reduction by using a standby generator. In return, Lilly receives a summer and winter credit ($25,340/$10,393) for its participation.
	Air Handling Unit Rebalance	Air conditioning unit A/C-1, located in Bldg. T99, was originally designed to serve six drying rooms and six dryer feed rooms, along with an office and a control room. Since then, however, three of the drying rooms and three dryer feed rooms have been removed from the system, cutting the requirement for conditioned air in half. The air distribution system has since been rebalanced, saving energy.
	Site-Wide Lighting	A variety of energy efficiency lighting retrofits.

Table 5.5. Eli Lilly and Company Future DSM Project Descriptions, 1994-95

Location	DSM Option	Option Description
Clinton	Bldg. C41 - Cooling Water	Eight 750-hp centrifugal chillers currently produce chilled water for the C41 area. This chilled water is circulated to the fermentation tanks where it is poured over the shells to carry away the heat of reaction. Mechanical cooling is not necessary in the winter months, however, since the cooling towers are used for free cooling when outdoor temperatures are below 35°F. At present, a significant amount of cross-mixing between the tower water and chilled water systems results in unnecessary chiller loads. In addition, the existing chemical water treatment system is inadequate, resulting in fouling problems. The focus of this project is to modify the system to eliminate cross-mixing and to improve water treatment.
	Bldg. C49 - Fermenter Cooling	This system is similar to the one described for Bldg. C41. The projects that will be considered are increasing the chilled water supply temperature from 52° to 65°F per the original design, performing variable flow pumping, and repairing spray nozzles for improved heat transfer.
	EG40 & EG0 Chiller Project	This project will determine the potential savings for combining three separate EG40 and EG0 chiller systems into a single system. The consolidation will result in more efficient chiller loading.
	CT91 & CT92 Cooling Towers	This project will investigate potential options to maximize savings for cooling tower water pumping. These towers serve the chiller systems in the EG40 & EG0 project.
Tippecanoe	Synchronous Belts	Synchronous belts were recently installed as a pilot on two 100-hp scrubber recirculation pumps and two 75-hp purge fans.
	Developmental Bldg. - New Construction	Projects for variable speed pumping of chilled water, high-efficiency chillers, high-efficiency lighting, premium efficiency motors, and fume hood air flow control sensors have been identified.

Table 5.6. PSI Energy's Energy Matters Program

Specific Program	Description
Industrial Efficiency Program	Comprehensive program designed to improve energy-use efficiency, improve processes, and shift or curtail load. Open primarily to large and medium-sized customers with demands above 1000 kW. PSI will pay the full cost of a preliminary survey ($3,000 to $15,000) to identify improvement and load shift/curtail options. It will co-fund subsequent analyses to calculate savings and paybacks. After a measure has been adopted, PSI may pay a cash incentive or apply credits on monthly bills.
High-Efficiency Motors Plan	Designed to encourage the purchase of energy efficient motors by paying incentives for part of the cost differential between them and standard efficiency motors. Incentives are provided on the purchase of three-phase open drip-proof or totally enclosed fan-cooled motors of 3 to 200 hp. Incentives range from $50 to $150 per motor for sizes 3 to 7.5 hp. Incentives for 10- to 200-hp motors range from $5 to $20 per hp. Plans are available for new applications, motor replacement upgrades, inventory replacement, motor system analyses, and variable speed drive applications.
Peak Reduction Program	Encourages large and medium-sized users to curtail their demand. Three methods are encouraged: 1) curtailing a large single load, 2) changing overall operation by going to a firm level of demand, and 3) using standby generators. Notification is 24 hours or 30 minutes, depending on option. Participation can be annual or summer only.
New Construction	Designed to encourage investment in high-efficiency cooling, energy-saving lighting, and energy management systems in the construction of new buildings. Packaged, unitary, rooftop, water source heat pumps, air-cooled chillers, and water-cooled chillers of qualifying EER, SEER, or coefficient of performance (COP) levels receive incentives from $5/ton to $150/ton. Incentive levels depend on the degree to which equipment efficiency exceeds minimum requirements. Lighting equipment includes compact fluorescent, dimmers, exit compact fluorescent or light emitting diode (LED) panels, occupancy sensors, daylight controls, dimmable ballasts, and T8 lamps and electronic ballasts. Incentives range from $10 to $35 per fixture. Incentives for energy management systems (EMS) range from $100 to $200 per point.
Equipment Replacement Program	The equipment replacement program is the same as the new construction program, except it is targeted to existing facilities.
Time of Use Rate Program	The rate is designed to encourage shifting of energy use from peak to shoulder or off-peak periods. The rates vary by season (summer, winter, and spring/fall) and customer load factor.
Barrel Wrap Program	One free barrel wrap and a $200 wiring allowance is provided for installation of a wrap on injection-molding machines.
Energy Efficiency Financing	Loans of $5000 or more for energy efficiency investments are available from PSI.
Energy Awareness Program	Free seminars, onsite demonstrations, informational materials, industry expert advice are available through this program.

PSI Energy offers a preliminary survey to qualified participants to identify specific ways to reduce costs of using electricity and reducing expensive peak usage. PSI also offers customized incentives to make investments in conservation affordable by "buying down" project costs to meet participant's return on investment or payback criteria. Special rates are also available to companies that can shift demand off peak.

PSI Energy's Energy Matters program is designed to reduce costs and improve industrial firm productivity in four ways:

- efficiency improvement—surveys; measure analyses; lighting, motors, and HVAC equipment; customized incentives; and regional seminars, demonstrations, and brochures

- process improvement—motor improvement options, motor drives, pre-failure plans, custom incentives, and vendor arrangements

- load curtailment—monthly bill credits for use of standby generators and shedding of loads

- load shifting—bill credits for load shifting, custom plans, and load factor improvement.

Incentive values are determined on a project-by-project basis. All projects that qualify for incentives are evaluated with respect to their kilowatt and kilowatt-hour savings, net present value, and benefit/cost ratio. Incentive values are examined in reference to the customer's investment criteria, their percentage of project installed costs, value to PSI Energy, and impact on project payback. This information is used to judge the amount of incentive to provide. In this manner, PSI Energy sets incentive levels to encourage investment without creating "free riders."

PSI Energy uses four industrial sales engineers to manage and direct the "selling" of the programs to customers. They indirectly leverage the market already established by those who make, specify, and/or sell energy efficient equipment and services. Three of the engineers are assigned specific territories; the fourth covers all facilities/accounts and provides technical support to the other three sales engineers. In addition, PSI Energy has industrial power engineers in the field, who act as the primary utility contact, work with customers on rates and power quality matters, and team with sales engineers on DSM.

PSI Energy views Lilly, one of its largest customers, as a proactive company on DSM. PSI has an excellent working relationship and many successful projects with Lilly. For example, PSI Energy is supporting all of Lilly's lighting projects that do not meet Lilly's corporate investment hurdle rate. PSI Energy has also made a number of presentations on lighting efficiency. (Lilly is also a participant in EPA's Green Lights program.)

PSI Energy conducted a comprehensive full-plant survey of Lilly's Greenfield Laboratories, a massive undertaking. Because of the size of Lilly's other major Indiana plants—Clinton and Tippecanoe—survey work there is being done in segments or by areas. An energy consultant has been hired to conduct building audits (four or five at a time) to identify opportunities in auxiliary support equipment—opportunities that can be approved and implemented with least resistance. For Lilly, DSM projects have been concentrated in the areas of reduced maintenance costs, improved process control, and lighting and HVAC efficiency.

5.2.6 Demand Side Management and Decision-Making about Process Improvement at Lilly

Decisions in favor of energy efficiency improvements at two Lilly facilities are discussed.

Lilly Corporate Center

Energy is a small portion of the cost of goods sold for Lilly. But even so, competition worldwide among pharmaceutical companies and public and government concerns about health care costs are spurring cost containment in many ways. According to a senior project engineer at Lilly's Energy Engineering Technical Center, Lilly has always valued energy efficiency, long before its electricity suppliers started encouraging DSM, and Lilly supports the concept of utility-industrial DSM programs. The company also understands the value of these programs to the utility. Lilly specifically believes that DSM programs make sense 1) if they are used to improve the marginal projects so they can pass a corporate hurdle rate and 2) if they reduce utility costs of supply (by delaying the construction of new capacity). DSM should not be used, however, for social reform, or as a lure for new customers.[a]

Investments in energy efficiency are based on projects beating Lilly's hurdle rate and on the availability of funds. Investment runs in cycles. When a new production facility is built, the primary concern is to get it built to meet U.S. Food and Drug Administration requirements and get it into production. Thereafter, emphasis is placed on getting the greatest efficiency out of the plant. With PSI Energy's DSM programs, Lilly has been able to identify and fund marginal projects and to identify good projects it did not realize existed in its facilities.

The Energy Engineering Technical Center (EETC) is a corporate engineering group involved in energy-related matters. The EETC consists of three mechanical engineers and two electrical engineers. They are all responsible for business case analysis, energy project consulting and development, and energy/utility planning. Beyond those duties, they all have different areas, tasks, and projects to perform.

One recent innovation is the development of the Energy Buster program, which was first tried at the Clinton plant in January 1994. Under this program, a team was established to identify savings measures primarily related to steam, electricity, and refrigeration, the largest uses of energy at the site. The team consists of five staff—two EETC engineers and three plant personnel; the plant personnel are in charge of energy, environment, and containment. The Energy Buster concept was started because it is at the plant site that energy and process considerations can best be combined for decision-making.

(a) Site visit, conversation with Dave Johnson, Senior Project Engineer at Eli Lilly's Energy Engineering Technical Center.

Lilly is considering the benefits of a corporate energy policy including specific targets and actions designed to reduce energy costs. A major problem with setting numerical goals, however, is how to define a unit of production when production processes vary greatly in number and steps. For example, processes can vary from 2 to 15 steps. In addition, how to treat non-direct process costs and benefits—such as waste-handling improvements—create additional definitional problems.

Lilly does not have a fully comprehensive tracking system for energy demand or use. While it tracks monthly energy bills and some large uses of energy, much of its specific energy use goes untracked. At the plant level, energy is tracked monthly. The company has a goal to enhance its energy tracking whenever it will make economic sense to do so. To be useful in process control, any such system will have to provide real-time information and control.

Lilly's average energy rate from PSI Energy is about 3.0 cents/kWh. Lilly expects a major rate hike soon, as PSI Energy is seeking greater revenues to pay for recently installed scrubbers and peaking capacity. Lilly also benefits from a high load factor—nearly 90% at most production facilities—as they operate 24-hours per day, year round.

Lilly had performed some comprehensive facility audits in the past. Today, however, the philosophy is to confine auditing to smaller areas so that options can be identified and undertaken fairly quickly. Lilly has had walk-through audits performed through PSI's Energy Industrial Program. Lilly looks for the best energy savings options identified during the walk-through, then often follows up with a more detailed audit. Lilly has used some ESCOs to perform this more detailed audit, but primarily uses in-house staff or outside architectural/engineering consultants.

Lilly project engineers believe opportunities in lighting and motors exist, but far larger improvements can be achieved in process-related items. Lighting can save 30% to 40% in office situations, but a 5% savings in production areas is more realistic. In analyzing such larger-scale options, Lilly finds that energy savings are not the only thing to consider. Often, large non-quantifiable savings can be obtained in areas such as safety, life extension, vibration reduction, etc. Many projects may have return-on-investments in the 30% to 500% range. Overall, Lilly engineers expect to be working at energy savings reductions for at least the next 10 years.

Greenfield (Indiana) Plant[a]

One major goal at the plant level is to reduce operating costs. Each year, a capital plan and operating budget are prepared for the next 12 months. The planning is done in an iterative manner with Lilly's corporate office. Sometimes, but not always, in the development of the plan, specific cost reduction targets (e.g., energy reduction) will come back from corporate. In general, though, the plant sets its own goals. The planning goal for 1994-95 is to keep actual costs flat through the remainder of 1994 and throughout 1995.

(a) Information from Steve Lucas, the Manager of Plant Engineering, Maintenance and Utilities Administration, and Randy McClarnon, Senior Plant Engineer, Plant Engineering.

The major costs to maintain and operate the physical plant at Greenfield are 1) purchased utilities, 2) personnel expense, and 3) fixed facility expenses (taxes, depreciation, etc.). These categories are roughly equal, although purchased utilities is the largest area of controllable cost. Over one-third of purchased utilities cost is electricity. The other utility costs are natural gas (used to fire the boilers), water, and miscellaneous. Some submetering of electricity use is done, but not by building or end use. Electricity costs are primarily tracked by the monthly bill. The plant has also developed and used some spot engineering estimates of electricity use, such as for their largest chiller.

Although energy savings are very important, electricity reliability is of equal or greater importance. Toxicology testing and other experiments are ongoing over several years; loss of electric power would be very disruptive to these tests and to new drug development. Because of this concern, the Greenfield plant has electric power back-up capability for a number of critical operations.

The emphasis for energy-cost reduction is placed at the plant site, where energy savings opportunities are located. Plant personnel work with corporate staff and share experiences. Sometimes, corporate staff will initiate ideas and provide technical assistance. However, the process is flexible. Whatever works the best and the fastest, plant- or corporate-initiated action, is preferred. Also, PSI Energy personnel generally work through corporate staff; direct communication with plant personnel is encouraged to quicken implementation and enhance plant-site ownership of conservation efforts.

The Greenfield plant had a comprehensive energy audit performed 4 years ago. A DSM consultant (engineer) hired by PSI Energy performed a walk-through, then used a computer software program to produce an audit report. The Lilly plant and corporate staff said the information and data in the report were not presented in a useful way. The results concentrated primarily on lighting and motor opportunities. But the audit did point out several areas of potential savings Lilly personnel had not previously considered. Later, PSI Energy brought in another ESCO/engineering firm to conduct a more detailed audit on several of these items. Out of the second audit came the DDC project (see Tables 5.3 and 5.4).

The decision to include a project in a given year's capital budget depends in part on how the project fits into the current planning strategy. All projects have to compete for dollars. Each year, each plant is allotted a capital budget based on its prior success in reducing costs and on the needs and priorities of the entire company. At the Greenfield plant where the goal is to hold operating costs level, the plant personnel have the primary responsibility for their capital budget. (The current capital budget does not include the Green Lights Program, as that is being funded with corporate funds.)

Greenfield has projects for both lighting and motors. Lighting retrofits have been completed in the engineering office and one of the smaller laboratories and are just beginning in the plant. Some projects have received incentives from PSI Energy; others are awaiting a retrofit contractor. Motors are being upgraded only when new purchases are required or upon normal replacement. All such motors are now premium efficiency motors. Lilly has developed internal guidelines for motor replacements. Guidelines recommend the use of high-efficiency motors, but each application is justified by a cost-benefit analysis. (Lilly is participating in PSI Energy's High Efficiency Motors Plan at the Clinton plant.)

Plant personnel are continually looking for new savings opportunities, particularly in under-used facilities. Because unused facilities are kept functioning with minimum levels of utility service, ways are being explored to further minimize utility service or to shut it off until needed. One small facility that was no longer needed was torn down. To help identify and implement these opportunities, Greenfield has added an engineer.

5.2.7 Future Considerations

As discussed above, Lilly will soon experience higher electricity rates. The expected 13% to 15% rate hikes will make electricity savings investments even more economical and will add to Lilly's potential list of DSM projects. Also, for PSI Energy, the higher rates will mean continued emphasis on its DSM program. If an active DSM program had been in place earlier, PSI Energy might have avoided part of the recent addition of peaking units. Continued emphasis on DSM will help forestall the need for capacity additions in the near future.

5.2.8 Summary and Implications

Both PSI Energy and Lilly are working hard and cooperating to make the best use of scarce resources. They see the role of DSM as a means for the utility to avoid, or delay, construction of new, costly generating capacity. Both see DSM as a program to identify overlooked efficiency opportunities in manufacturing and to spur investment in projects that are of marginal cost-effectiveness to the industrial firm, but that are cost-effective to the utility. Both agree that DSM is a mechanism to help a manufacturing company stay competitive—or become more competitive—at the same time making the utility more competitive. They also see this emphasis continuing for many more years.

This case study demonstrates that even in an uncertain and competitive business climate, traditional utility DSM programs make sense and help promote added investment in energy efficiency measures through information exchange and incentives. It shows there can be a place for utility DSM programs and corporate investment in DSM options even if rates are low.

5.3 Demonstrations of Demand Side Management Program Effectiveness

This section discusses many of the issues and benefits of industrial DSM in light of the two case studies. The discussion begins with comments on the benefits of DSM and then finishes with a discussion of the DSM issues presented in Chapter 1.0.

5.3.1 Industrial Demand Side Management Benefits

First, and most obvious, is the fact that these DSM programs saved significant amounts of electricity. Boise Cascade will save almost 7 million kWh annually as the result of a single project—enough electricity to supply 700 homes using 10,000 kWh/year. In addition, the energy manager expects to save another 50 to 56 million kWh/year by investing in options identified in a comprehensive audit just completed. For Eli

Lilly and Company, the average annual savings over the last 3 years for three of its plants is over 8 million kWh for a total of 24 million kWh. The company expects to achieve such savings yearly for at least the next 10 years. If Lilly meets its goal, it will have saved over 100 million kWh.

Second, these case studies—particularly that of Boise Cascade—show that energy efficiency savings in an industrial manufacturing environment is almost always tied to production and related processes. For Boise Cascade, significant energy savings went hand-in-hand with significant waste water reductions in biological oxygen demand and total suspended solids. For Lilly, energy efficiency goes hand-in-hand with environmental, health, and safety compliance and improvements. Thus, electricity savings in industry go far beyond simple lighting and motor high-efficiency retrofits.

Third, both case studies show the importance of auditing facilities to look for all opportunities—equipment efficiency, as well as process improvement. Through audits, both case study firms discovered potential savings and energy efficiency projects they had not seen or had not had the time to identify for themselves. For both firms, the comprehensive audit proved to be a valid and important part of the industrial DSM program.

Fourth, these case studies show that top management commitment (in the case of Lilly) or individual commitment (in the case of Boise Cascade) is a crucial and necessary requirement for successful utility DSM programs. Without it, companies do not become involved and individual managers will rarely take the initiative. Likewise, the commitment of top utility management and individual utility managers is vital. The companies presented in these case studies have that commitment and individual managers personify that commitment. DSM makes sense, for PSI Energy, TCL, and BPA because the cost of such programs is less than the cost of constructing traditional or even new (natural-gas-driven turbine) generating capacity. If DSM still makes sense for TCL with cheap hydro and low BPA rates, it should be considered virtually everywhere else in the country.

5.3.2 Industrial Demand Side Management Issues

The savings for Boise Cascade and Lilly appear to fall near the low end of the potential savings estimate suggested by the American Council for an Energy Efficient Economy (14% to 38%) (ACEEE 1990). Boise Cascade has identified about 10% to 11%, Lilly about 11% to 12%. These facts may be peculiar to these two case studies; however, both firms (and Lilly in particular) have suggested that realizable energy efficiency improvements are often overestimated for process facilities because estimators do not understand the ability of real companies to make changes readily to their production facilities. In some cases, where project economics are favorable, no amount of energy and dollar savings can offset operational risks or physical constraints.

Staff at both Lilly and Boise Cascade fully understand the economics and rationale behind DSM programs. Lilly considers industrial DSM to be acceptable if 1) only marginal projects were supported and 2) the savings result in deferred construction of generating capacity. For Boise Cascade, the DSM program is also seen as legitimate if 1) the program results in undertaking projects that would otherwise go unfunded and 2) the program is a cost-effective alternative to building generation capacity.

In both cases, the utilities offered the incentives (PSI Energy and BPA/TCL) have mechanisms to avoid free ridership. Because of the individual, unique and specific nature of industrial DSM projects and contacts, free ridership does not have to be a major problem in industrial DSM implementation.

Along these lines, the utilities are benefiting from the investment in projects of the case-study firms. In addition, the participating industrial customers are benefiting from reduced energy costs. They (and the public) are benefiting from a cleaner environment and improved health and safety. This is a win-win-win situation for the utilities, the industrial companies, and society.

Finally, while retail wheeling was not a consideration in these two case studies, its importance cannot be overlooked. Partially in response to the potential for retail wheeling, the BPA has decided to close out its industrial DSM program by the end of 1995. In its place, the BPA will rely on price signals in newly redesigned rate structures. Time will tell if this is as effective in bringing forth DSM investment as BPA's current DSM program. On the other hand, TCL plans to continue its DSM programs regardless of retail wheeling. To TCL, the economics of DSM have not changed. The only thing that will change is how DSM program administration, marketing, implementation, and incentive costs will be financed or structured. Tacoma City Light is investigating zero-interest loans as an incentive mechanism.

5.4 References

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6.0 Review of Regulatory Issues

State public utility commissions (PUCs) have responsibility for overseeing utility industrial DSM programs within integrated resource planning (IRP) and other activities to promote energy efficiency. The PUC regulations concerning utility DSM programs vary from state to state. This regulatory oversight usually includes review and approval of the DSM program design, implementation, and evaluation processes. PUCs often review all expenses a utility incurs for DSM and grant cost recovery only for those expenses judged to be prudent. PUCs have often been the initiators of energy efficiency investments by utilities. It is in the state regulatory forum that issues surrounding industrial DSM programs, such as environmental externalities and retail wheeling, are resolved in each state.

This chapter presents results of interviews with PUC staff who are responsible for advising commissioners on utility industrial DSM program issues. Our intent is provide a status report on the state regulatory and policy issues surrounding utility industrial DSM programs now under discussion at a sample group of PUCs. In all, interviews were conducted with 10 states known to have active industrial DSM programs.

6.1 Approach

The sample group of states was selected according to several sources in an attempt to include a broad range of industrial DSM program experience among states with substantial DSM activity. States with the highest incidence of industrial DSM programs as reported in the *1992 Survey of Utility Demand Side Management Programs* published by EPRI in 1993 were crossed with states known to be active in IRP activities. Ten states were then selected (see Figure 6.1): California, Georgia, Iowa, Massachusetts,

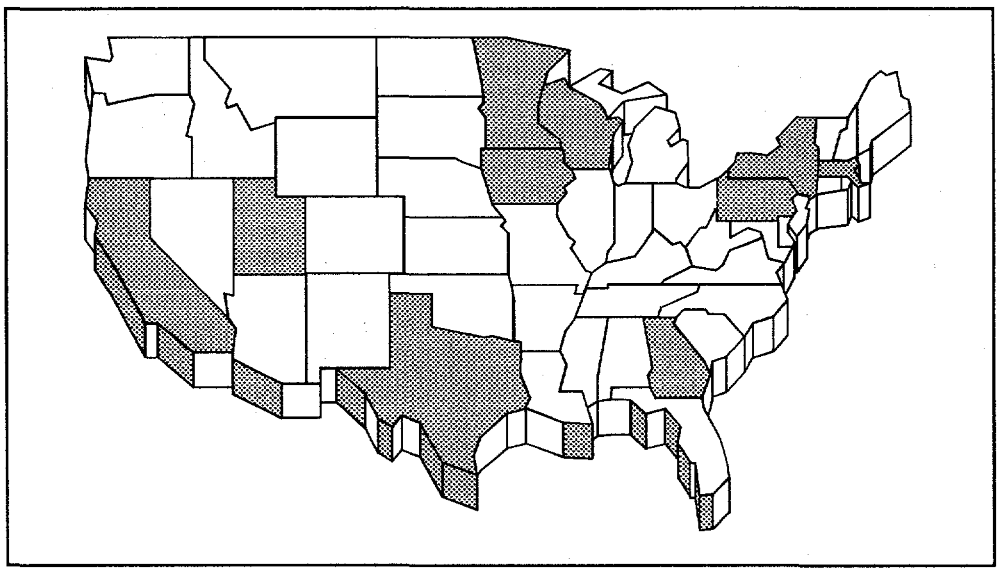

Figure 6.1. State PUCs Interviewed

Minnesota, New York, Pennsylvania, Texas, Utah, and Wisconsin. Staff from PUCs in those states were interviewed; interviews included a discussion of

- industrial DSM program status
- accounts of successful or failed programs
- stakeholder views
- DSM cost-recovery issues
- the future of industrial DSM.

6.2 Results

Several points of agreement were evident among all ten PUC staff interviewed:

- Active industrial DSM programs are in place.

- The benefits to utilities are load retention and load management.

- The benefit to industrial customers is reduced cost of energy.

- Industrial customers object to sharing the cost of utility DSM programs for other customer classes and other industrial customers.

A few states are moving toward subscription or optional DSM cost-sharing schemes and performance-based incentives. Successful programs noted by PUC staff used an innovative and usually comprehensive approach and had significant non-energy benefits. All but one indicated the future of DSM has a greater customer-service orientation.

Retail wheeling is not uniformly seen as inevitable. The estimated effects are perceived differently by utilities and industrial customers, but not consistently. Most PUC staff interviewed thought that retail wheeling would jeopardize rates and services now enjoyed by core customers. PUC staff interviewed most often recommended federal and state energy offices promote industrial energy efficiency through demonstration projects in their states.

6.3 Discussion

This section presents a compilation of information gained for each topic area included in the interviews. Although one protocol (included in Appendix D) was used to guide the conversation with each PUC staff person, actual discussion varied according to the activity and interest level in each state.

6.3.1 Status of Demand Side Management

Activity levels regarding industrial DSM programs by utilities may be described as high, medium and low. At the high end, PUC staff in New York, Minnesota, Wisconsin, Massachusetts, and California reported several years' experience in implementing and evaluating industrial DSM programs by electric utilities. These states are characterized by DSM programs that are largely comprehensive, including financial incentives, energy-use education, and technical assistance. In the middle, Utah, Iowa, and Texas are in the development process. Programs in these states may be characterized by program features that are largely oriented toward load management, such as peak load control via interruptible service and flexible rates, with few financial incentive and technical assistance features. At the low end are Pennsylvania and Georgia, where many large industrial firms claim to have already installed all cost-effective measures. In these states, industrial DSM programs are in the beginning stage of development. States most representative of different stages of development (California, Wisconsin, Iowa, Texas, Georgia, and Pennsylvania) are described below.

- In California, industrial DSM programs are in jeopardy because of a regional economic downturn and the uncertainty and controversy surrounding the retail wheeling issue. Although utilities in California had been at the forefront of DSM implementation, electric utilities such as Southern California Edison and Pacific Gas & Electric Co. are considering severely reducing or completely eliminating DSM funding in an effort to push rates down as low as possible to retain industrial customers. The regional economic issues are characterized by staff as short-term problems, but retail wheeling seems to be a likely possibility for the long term in California.

- In Wisconsin, all utilities offer rebates for both custom and prescriptive measures. The most frequently installed measures have been high-efficiency motors and lighting. Activity in loans, shared savings, and new programs offering leasing were also reported. In addition, utility industrial account representatives act as energy advisors to address industrial customers' issues such as power quality and reliability and improvements to process equipment.

- Iowa reports that industrial DSM programs are developing in this state. All seven utilities in Iowa offer DSM programs to industrial customers, mainly in interruptible and flexible rates and high-efficiency equipment incentives for lighting and motors. The first round of DSM programs began in 1991, and the first evaluation reports are now being filed with the PUC. The first programs are characterized as popular with customers "who were ready to roll," a designation that connotes a potential free-rider problem. However, Iowa Electric Service Co. was the recipient of an award from the DOE for its work in implementing a complete upgrade assessment and installation of energy conservation measures at the Crane Vale Company. Similar "search and assessment" projects are under way for another six industrial customers. This work is funded by the Iowa Energy Center.

- In Texas, Houston Light and Power was able to shift 654 kW off-peak and save commercial and industrial customers an estimated $69,000/year through the Cool Storage Program. Non-energy benefits were also noted: better quality control, a decrease in machinery failure and maintenance costs, and increased economic productivity.

- In Georgia, the PUC certified industrial DSM programs for Georgia Power after much controversy in 1993. The approved programs include an energy audit service, a loan program offering an interest rate of 1% above prime for purchase of energy conservation measures, and a rebate of up to $1600 for smaller commercial and industrial customers. A pilot program to promote high-efficiency lighting was also included. To date, the loan program has no participants; there has been some limited participation in rebate applications; and use of the energy audit service is continuing. Georgia Power has requested that it be allowed to discontinue the lighting program because the Energy Policy Act of 1992 raises the lighting standard.

- In Pennsylvania, the PUC had not required the utilities to offer DSM programs to industrial customers; any utility program for industrial customers was strictly voluntary on the part of the utility. These programs have relatively small budgets and small numbers of participants. The predominant activity by utilities has been in disseminating information about efficiencies in electrotechnologies and a limited energy audit. Financial incentives have not usually been used. The PUC staff is currently drafting new guidelines for utilities regarding DSM programs, and further DSM program advancement is expected.

6.3.2 Accounts of Successful or Failed Programs

States with more experience in implementing industrial DSM programs were most likely to report successful projects with industrial customers. Successful programs are also comprehensive programs, which include financial incentives for both prescriptive and performance-based measures and technical assistance in conducting energy audits and selecting installation vendors. Factors such as participation rates and achievement of energy savings were as important a measure of success as several non-energy benefits. These include increasing economic productivity, keeping a company in business, saving jobs, promoting new technologies, and complying with environmental regulations. Failed projects reported by PUC staff seemed to have very small budgets; to consist of information-only or loan programs; and to have captured little, if any, participation. Some examples of program experiences noted by PUC staff are described below.

- In Utah, the Energy Finance Program sponsored by Pacificorp was noted as a strong DSM program, with a very high cost-effectiveness ratio (nearly 1.0 on the rate impact measurement test). A large project to lease high-efficiency process equipment to the Geneva Steel company has resulted in significant energy cost savings to the company. Energy savings exceed lease payments, and the company is reported to be very pleased with the leasing arrangement.

- In Minnesota, Minnesota Power was noted for a DSM program the company offers to large industrial customers. Following an energy audit, the customers propose projects to improve the energy efficiency of their operations, such projects to be financed via a grant from the utility. The grants are awarded one to a customer and can be as much as $1 million. In another project, an estimated 600 jobs were reinstated after Minnesota Power awarded $7 million from the Conservation Improvement Program to National Steel Company. The company had already shut down by the time the award was granted; but the improvements were made, and the company started back on-line on August 1. It now has contracts to keep it in business through the year 2004.

- In Wisconsin, the Responsible Power Management Motors Program was noted by PUC staff to be particularly successful in recruiting vendors. Participation is relatively high, in large part owing to the marketing assistance the vendors give the programs. Within the Program, PUC staff noted another ongoing project, the Performance Optimization System demonstration project. This project is funded by several Wisconsin utilities through Wisconsin Demand Side Demonstrations, Inc. A team of electric utility staff, consulting engineers, energy service company representatives, and equipment manufacturers is working on the project. The objective of this project is to provide a systems approach to improve performance of motor drives and increase industrial energy efficiency.

6.3.3 Cost Recovery

The regulatory staff interviewed noted three issues as most important.

Incentives for Conservation

Several states reported that the PUC allows cost recovery of lost margins and/or bonus payments to shareholders for achieving specified levels of efficiency improvements. In Minnesota, conservation goals are set at roughly 5% of current consumption. In Iowa, utilities may be awarded part of the energy savings as an incentive, based on the amount of savings and the benefit-cost ratio.

Cross-Subsidization

In several states, PUCs are receiving requests from industrial customers and, in some cases, from utilities that no cross-subsidization of DSM expenses between rate classes be approved. Requests have been received in Utah, New York, Pennsylvania, and California. The DSM expenses are confined to the relevant customer class in Massachusetts, Wisconsin, and Iowa; in the other states, expenses are shared across classes and then allocated by load share. In Wisconsin, energy savings resulting from utility expenditures in DSM are considered a supply resource, and all DSM costs are recovered in the rate base.

Subscription Service

The New York Public Service Commission and other parties negotiated a settlement with Niagara Mohawk Power Company (NMPC) which includes a subscription service arrangement for industrial customers of that utility. In this arrangement, 300 of NMPC's largest industrial customers were offered the option of 1) business as usual, sharing in all costs of DSM programs or 2) the subscription service, selecting not to pay some DSM expenses, such as rebates and other program costs (but still sharing in the administrative costs). Approximately half the industrial customers selected the subscription service. These customers agreed to the subscription option program requirement to undergo an energy audit (which they had to pay for) by a professional engineer. Audits were to be completed by October 1993. Further, these customers agreed to report annually on what energy conservation measures were installed, with reports due to NMPC by the end of 1994. NMPC has estimated that by April 1994 subscription customers had reached 40% of the goal to reduce consumption by 32,000 MWh. Further, NMPC estimates the full goal will be realized by the end of 1994. These estimates are currently undergoing verification by NMPC.

Similar subscription-like arrangements are being considered in Pennsylvania. The PUC is currently drafting proposed DSM rules for the commissioners to review. A final draft is expected in November 1994.

6.3.4 Stakeholder Views

Reduced cost of energy services to enhance economic productivity is uniformly hailed, but how to achieve that differs.

Utilities Want Low Rates

The PUC staff are unanimous in reporting that utilities want to keep rates low, retain industrial customers, and comply with environmental regulations. With the exception of Pennsylvania, utilities in all states interviewed operate industrial DSM program as instructed by regulators. In jurisdictions where industrial rates (and utility profit margins) are low, as in Utah, the utility is likely to see more benefits to investing in industrial energy efficiency. This benefit stems from the fact that the resource potential is highest among industrial loads, and the loss in revenue associated with conservation is less per kWh conserved than with other rate classes. In states with significant surplus capacity, such as Georgia and Pennsylvania, DSM is held in less regard by utilities.

Industrial Customers Want Low Rates

Industry views regarding utility DSM programs are reported to be mixed. Industrial customers in nearly all states interviewed were described as being in support of DSM programs if they participated, but objecting to sharing in the expense if they did not receive a rebate or other similar DSM program benefit as a participant would. They, too, want the lowest possible rates. Industrial customers in New York, Pennsylvania, and Georgia are active in promoting rate settlements that excuse industrial customers from sharing in DSM expenses in the rate base. In addition, industrial customers in some states claim that they have already installed all cost-effective measures without the incentives offered in a utility DSM program. These customers object to sharing in DSM utility costs in their rates because they do not want to subsidize a competitor.

6.3.5 Retail Wheeling

Retail wheeling has caused uncertainty in the future of industrial DSM programs in California. Utilities are reported to be preparing for retail wheeling by acquiring smaller generating facilities; ensuring that expenses to the rate base are kept to an absolute minimum; and restructuring internal organizations along separate lines for generation, transmission, and distribution.

Task Forces to Investigate State Concerns

The following states have organized a task force to investigate the ramifications of the potential of retail wheeling: New York, Massachusetts, Pennsylvania, Wisconsin, and Minnesota. These states were concerned with issues such as protection for stranded investments and economic productivity. In Wisconsin, two utilities, Wisconsin Electric Power Co. and Wisconsin Power & Light Co., have become active proponents of retail wheeling. The PUC staff reported that Motorola Corporation is currently negotiating with Wisconsin Power & Light to purchase land and install and operate its own transmission lines within Wisconsin borders.

Retail Wheeling Not Recommended

In Massachusetts, the state energy office organized a task force that included many stakeholder organizations. The task force recommended encouragement of wholesale wheeling, but not retail wheeling. The PUC staff noted that large industrial customers in Massachusetts were in favor of retail wheeling. Similar effects were noted by staff in New York. The Chairman of the New York PUC has noted that a large portion of the estimated benefits of retail wheeling could be captured through wholesale competition, which is already active in New York.

Some Retail Competition Exists

In Georgia, an integrated transmission network has created virtual retail competition for some industrial customers. Any customer with at least 900 kW of demand at any time may choose to buy from the co-owners: Georgia Power, Oglethorpe, and Municipal Electric Authority of Georgia. The PUC staff in Georgia noted that this creates more competition among suppliers and that industrial customers who can connect are likely to have more rate choices than customers who cannot. A similar situation occurs in Texas, where several utility jurisdictions overlap, creating virtual retail competition for any customers served by more than one company.

Future Price and Equity Concerns

In Texas, Utah, and Iowa, PUC staff are monitoring the national discussion, but are not aware of any actions by utilities or industrial customers to initiate retail wheeling. In several states, PUC staff expressed concern that industrial customers favoring retail wheeling might not be prepared for prices that could rise as easily as they could drop. As retail wheeling evolves, electricity is more likely to be sold at a regional market price; the effect will be to thereby level, but not necessarily decrease, the price to all consumers in a certain region. In addition, several PUC staff noted equity issues in discussions of retail wheeling, indicating that core customers, notably residential and small commercial, were least likely to benefit.

6.4 The Future of Industrial Demand Side Management Programs

Regulators interviewed noted these issues to be of greatest future importance.

Comprehensive Demand Side Management Programs

The PUC staff interviewed believe that industrial DSM is moving toward comprehensive programs, that is, programs that include rebates or other financial incentives for some prescriptive measures, such as lighting or motors, and performance measures, as described in a custom-designed efficiency upgrade. This view of the future also assumes that electricity will be marketed less like a commodity and more like a service, even in the event that retail wheeling becomes a reality. Any prognostications regarding industrial DSM programs necessarily include the likely effects of retail wheeling.

Performance-Based Rate-making

Performance-based rate-making, that is, the use of conservation incentives, will become more widespread, increasing the likelihood of more service-oriented efficiency programs.

Continued Rate Pressure

PUC staff in California and elsewhere believe that if retail wheeling becomes a reality, utilities will eliminate industrial DSM programs in an effort to maintain the lowest possible costs. Equity considerations will emerge as the effects on core customers and others become known.

Efficiency Demonstrations

Energy efficiency investments by industrial customers are expected to increase as the benefits in energy savings and economic productivity are demonstrated. PUC staff in several states look forward to increasing these projects to educate industrial customers and utilities in their states. In addition, federal support was encouraged in the areas of equipment efficiency standards, standard labels for motors, and training regarding engineering energy audits.

6.5 Summary

State public utility commission staff are currently sorting through the many intertwined issues regarding industrial DSM programs. A sample group of ten states was selected for PUC staff interviews. Each state interviewed has active industrial DSM programs, although in various phases of development. States with more experience with DSM programs for industrial customers were more likely to have evaluation data or results of the DSM program investment.

Comprehensive DSM, with flexible features that meet the specific needs of customers, is the type of program most PUC staff cited as most successful. The complexity of industrial customers' energy efficiency needs was noted as the biggest difference between industrial and other market sectors. The complexity of the industrial customer's energy use was also cited as a difficult, but essential criterion for utilities to address in designing and implementing DSM programs.

Success is defined loosely as meeting the goals of the DSM program; reaching participation levels; realizing energy savings; and improving load profiles. Non-energy benefits were often cited as a dominant part of a successful project. The successful program may have improved the economic competitiveness of a local industrial company's operation through the technical assistance services of a utility or third party. These services include one or more that can be categorized as identification, financing, and installation of energy efficiency measures. The resulting improved productivity has often kept the industrial customer operating—and employees working.

Cost recovery for DSM program expenses is treated differently in nearly every state, but similarities were noted in recovery of lost margins and in performance-based recovery features. Retail wheeling is beginning to emerge as an area of concern for state regulators, and several states have organized task force groups to investigate issues of interest to that state.

Most regulatory staff described three features in their vision of future DSM program: that program designs will be more comprehensive; that the commodity aspect of utility sales will be replaced by a more dominant service orientation; and that retail wheeling and its effect on inter-utility competition will increase pressure for efficiency services to retain customers.

Appendix A

Current Federal and State Programs and Private Initiatives

Appendix A

Current Federal and State Programs and Private Initiatives

This appendix is designed to be a practical resource directory of selected state and federal technical assistance programs designed to help organizations increase the energy efficiency of their industrial processes and facilities. While not a complete directory of resources available, the list provides some examples for discussion and may direct the reader to a source he/she had not previously considered. The programs listed serve as resources to help utilities implement industrial DSM programs and are generally meant to complement programs offered by the utility.

For each program or center, information on the types of assistance provided is presented, along with case study information (where available) that is representative of the type of assistance offered. The programs are organized by the source of funding, covering federally funded programs, federally funded state programs, industry collaborative (primarily EPRI) programs, university-funded programs, federal power marketing agency programs, and state-funded programs.

A few utility programs have also been listed as they represent a unique type of DSM program, the technical application center. This list is not exhaustive. Sources of information were generally obtained through word-of-mouth, rather than through a systematic census of services available; consequently, a few programs may have been inadvertently omitted. The programs listed are a sample of the types of programs available. They range from hands-on diagnostic centers to directories of energy service providers to sources of technology development funding.

A.1 Federally Funded Programs

Many federal agencies fund programs encouraging energy efficiency and DSM for industrial customers. The U.S. Department of Energy (DOE) has several programs that are designed to encourage energy conservation and efficiency. These programs range from funding provided to other organizations to assist industry in becoming energy wise, to programs that provide direct funding to offset costs of implementing new energy efficient technology. Through its National Institute of Standards and Testing (NIST), the Department of Commerce also encourages energy efficient industrial technology. This form of assistance is more broadly focused than the DOE programs and generally encourages new industrial processes that consume less energy for the amount of output. Another agency that offers assistance is the Environmental Protection Agency. Through its environmental focus, EPA encourages industries to be conservative with natural resources, including energy. Programs listed below are directly funded by the federal government.

Energy Analysis and Diagnostic Centers (EADC)

Sponsor:	U.S. Department of Energy
Contact:	Charles Glaser, (202)586-1298
Project Start:	1976 End: Ongoing
Annual Funding:	$5.4 million

The U.S. Department of Energy funds the EADC program which conducts energy audits for small and medium-sized manufacturing firms. Teams of faculty and students from participating universities conduct the audits. The types of assistance these teams offer typically include a pre-audit data-gathering function, a one-day site visit, and report preparation. The report provides information about plant energy use,

Participating Universities

Arizona State University
Bradley University
Colorado State University
Georgia Tech
Hofstra University
Iowa State University
North Carolina State University
Mississippi State University
Oklahoma State University
Old Dominion University
Oregon State University
San Diego State University
San Francisco State University
South Dakota State
Texas A&M University
Texas A&M University - Kingsville
University of Arkansas - Little Rock
University of Dayton
University of Florida
University of Kansas
University of Louisville
University of Maine
University of Massachusetts
University of Michigan
University of Missouri-Rolla
University of Nevada - Reno
University of Notre Dame
University of Tennessee
University of Wisconsin
West Virginia University

processes and other operations, as well as energy conservation opportunities (ECOs) with enough detail to estimate savings, implementation costs, and simple payback. The team contacts the manufacturer six months after the audit to assess the degree of implementation. The data gathered from these audits since 1980 has been compiled in a database, which can be accessed via computer network from Rutgers University.

NIST Manufacturing Extension Partnership (MEP)

Sponsor: National Institute of Standards and Testing, U.S. Department of Commerce
Contact: Kevin Carr, (301)975-5020
Project Start: August 1988 End: Ongoing
Annual Funding: $30.2 million

MEP is a nationwide network of organizations to support U.S.-based manufacturers through ongoing technological advancement. The partnership includes four parts: 1) regionally based Manufacturing Technology Centers (MTCs) which provide technical assistance to small and mid-sized manufacturers; 2) Manufacturing Outreach Centers that are smaller satellite centers; 3) the State Technology Extension Program (STEP) that provides matching grants to help states build the infrastructure to assist manufacturers, and 4) the Links program which helps tie all these efforts together (electronically and otherwise). The cornerstone of the program is the MTC; a list of current MTCs is shown on pages A.4 and A.5. MTCs provide factory service visits and technical training and help introduce modern manufacturing equipment into plants.

Two of the many successes of the MEP include Brimfield Precision and Newburg Molded Products. Brimfield saved over $200,000 on computer-aided design and manufacturing equipment after trying several systems at an MTC and recognizing that a less expensive system managers had intended to buy was adequate for their needs, and Newburg used MTC advice and incorporated new processing technology, increasing its production volume by two-thirds and reducing waste.

Federal Energy Management Program

Sponsor: U.S. Department of Energy
Contact: Mark Ginsberg

The Federal Energy Management Program (FEMP) is designed to achieve specific energy use reduction goals in the federal sector. It works through creating partnerships, leveraging resources, transferring technology, and providing training and support. While the program is designed for improving the energy efficiency in the federal sector, many of the lessons learned and technologies developed have application in the private sector.

Regional MTCs (by state)			
State	Contact	Address	Phone/Fax
AZ	Charles Klement	Arizona Applied Manufacturing Center c/o Gateway College, 108 N. 40th St., Phoenix, AZ 85034	(602)392-5184/ (602)392-5329
CA	Joan Carvell	California Manufacturing Technology Center (CMTC) 13430 Hawthorne Blvd., Hawthorne, CA 90250	(310)355-3060/ (310)676-8630
	Katy Wolf	Pollution Prevention Center, Inst. for Research & Technical Assistance 2800 Olympic Blvd., #101, Santa Monica, CA 90404	(310)453-0450/ (310)453-2660
CT	Peter LaPlaca	Connecticut State Technology Extension Program 368 Fairfield Road, Storrs, CT 06269-2041	(203)486-2585/ (203)486-3049
DE	John J. Shwed	Delaware Manufacturing Alliance, Delaware Technology Park One Innovation Way, #301, Newark, DE 19711	(302)452-2520/ (302)452-1101
GA	Charles Estes	Georgia Manufacturing Extension Alliance, Georgia Institute of Technology, 223 O'Keefe Bldg, Atlanta, GA 30332	(404)894-8989/ (404)853-9172
IL	Rheal Turcotte	Chicago Manufacturing Technology Extension Center, Homan Square 3333 West Arthington, Chicago, IL 60624	(312)265-2020/ (312)265-8336
IA	Del Shepard	Iowa Manufacturing Technology Ctr., Des Moines Area Community College, 2006 South Ankeny Blvd., ATC Bldg. 3E, Ankeny, IA 50021	(515)965-7040/ (515)965-7050
KS	Paul Clay	Mid-America Manufacturing Technology Center 10561 Barkley, #602, Overland Park, KS 66212	(913)649-4333/ (913)649-4498
KY	Don Smith	Kentucky Technology Service 167 West Main St., Suite 1006, Lexington, KY 40507	(606)252-7801/ (606)252-7900
MD	Edwin Gregg, Jr.	Maryland Manufacturing Modernization Network, MD Dept. of Economic Dev., Div. of Business, 217 East Redwood St., Baltimore, MD 21202	(410)333-0206/ (410)333-1836
MA	Jan Pounds	Massachusetts Manufacturing Partnership, Bay State Skills Corp 101 Summer Street, 4th Floor, Boston, MA 02110	(617)292-5100/ (617)292-5105
MI	W.C. (Butch) Dyer	Midwest Manufacturing Technology Center P.O. Box 1485, 2901 Hubbard Road, Ann Arbor, MI 48106	(800)292-4484/ (313)769-4064
MN	Todd Loudenslager	Upper Midwest Manufacturing Technology Center 400 Mill Place, 111 Third Avenue South, Minneapolis, MN 55401	(612)338-7722/ (612)339-5214
NE	Jack Ruff	Nebraska Industrial Competitiveness Service 301 Centennial Mall South, Lincoln, NE 68509	(402)471-3769/ (402)471-3778
NM	Bill Rector	New Mexico Manufacturing Extension Program, New Mexico, Inc. 1601 Randolph Road, S.E., Suite #210, Albuquerque, NM 87106	(505)272-7800/ (505)272-7810
NY	Judith Gustinis	New York Manufacturing Extension Partnership Rensselaer Technology Park, 385 Jordan Road, Troy, NY 12180	(518)283-1010/ (518)283-6876
	Douglas Koop	Hudson Valley Manufacturing Outreach Center, Hudson Valley Technology Development Ctr, 300 Westage Business Ctr, #140, Fishkill, NY 12524	(914)896-6934/ (914)896-7006

Regional MTCs (by state)			
State	Contact	Address	Phone/Fax
NY	Frank Markovich	Manufacturing Outreach Center of New York-Southern Tier UniPEG, 59-61 Court Street, Binghamton, NY 13901	(607)774-0022/ (607)774-0026
	Sara Garretson	New York City Manufacturing Outreach Center, New York Industrial Technology Assistance Corporation (NY ITAC) 253 Broadway, Room 302, New York, NY 10007	(212)240-6920/ (212)240-4889
	Betsy Poole	Western New York Manufacturing Outreach Center, Western NY Technology Development Ctr, 1576 Sweet Home Rd, Amherst, NY 14228	(716)636-3626/ (716)636-3630
OH	Edward Kwiatkowski	Great Lakes Manufacturing Technology Center Prospect Park Building, 4600 Prospect Avenue, Cleveland, OH 44103	(216)432-5322/ (216)361-2900
	David L. Chalk	Miami Valley Manufacturing Extension Center 3171 Research Boulevard, Kettering, OH 45420	(513)259-1340/ (513)259-1303
	David Thomas-Greaves	Plastics Technology Deployment Center, Great Lakes Manufacturing Technology Center (GLMTC) Manufacturing Outreach Program, Prospect Park Bldg, 4600 Prospect Ave, Cleveland, OH 44103	(216)432-5300/ (216)361-2088
OK	Edmund J. Farrell	Oklahoma Industrial Extension System 525 South Main, Suite #500, Tulsa, OK 74103	(918)592-0722/ (918)592-1417
PA	Edith Ritter	Manufacturing Extension Partnership of North/East Pennsylvania 125 Goodman Drive, Bethlehem, PA 18015	(610)758-5599/ (610)758-4716
	Ray Christman	Southwestern Pennsylvania Industrial Resource Center 4516 Henry Street, Pittsburgh, PA 15213	(412)687-0200 (412)687-5232
SC	Belford E. Cross	Southeast Manufacturing Technology Center P.O. Box 1149, Columbia, SC 29202-1149	(803)252-6976/ (803)252-0056
TN	Jimmy Johnston	Tennessee Manufacturing Extension Partnership 320 6th Avenue North, 6th Floor, Nashville, TN 37243-0405	(615)741-2994/ (615)741-5070
VA	John D. Hudson, Jr.	A.L. Philpott Manufacturing Center 231 East Church Street, Martinsville, VA 24112	(703)666-8890/ (703)666-8892
WA	Peggy Flynn	Washington Alliance for Manufacturing 2401 Utah Avenue South, Suite #700, Seattle, WA 98134	(206)622-3456/ (206)622-1609
WI	Larry Schneider	Northwest WI Manufacturing Outreach Ctr., University of Wisconsin Stout Tech. Transfer Inst., 103 First Ave. West, Menomonie, WI 54751	(715)232-2397/ (715)232-1105

- Federal Energy Decision Screening System (FEDS) - The FEDS system includes a family of software tools designed to provide a comprehensive approach to fuel-neutral, technology-independent integrated resource planning and acquisition. Level-1 is a top-down energy systems analysis and decision software for energy resource acquisition for buildings and facilities; Level-2 allows specific engineering inputs and provides detailed output. The FEDS software and User's Guide are available free to federal agencies.
  Contact: Rosemarie Bartlett (509)375-6606.

- Test Bed Demonstration Program - The program is designed to expedite application of new technologies (past the R&D stage without significant federal sector use). The program tests and showcases a new U.S. technology at a federal site through a partnership of public and private investments. A test bed demonstration project provides case histories, reduces risk in investing in new technologies, and reduces energy and technology expenditures, among other benefits. A federal site is identified and matched with proposals from a utility and manufacturer. The results of the project are tested energy efficient technologies that can be implemented by both the federal and private sectors.
  Contact: David Hunt (202)646-7867.

Energy Star Showcase Buildings

Sponsor: U.S. Environmental Protection Agency (EPA)
Contact: Manager of Energy Star Showcase Buildings, (202)775-6650

EPA is working to identify 20 to 30 commercial and industrial buildings nationwide to "showcase" comprehensive energy efficient upgrades. Participants work closely with EPA to demonstrate an upgrade process that maximizes energy savings through the appropriate use and sizing of energy efficient heating, ventilating, and air-conditioning systems and other related building efficiency measures. The Showcase Buildings initiative will demonstrate the potential pollution prevention of cutting-edge, energy efficient technologies. The five stages of the programs are 1) Green Lights, 2) Building Tune-up, 3) HVAC Load Reductions, 4) Fan Systems Upgrades, 5) HVAC Plant Improvements.

The Green Lights Program

Sponsor: U.S. Environmental Protection Agency (EPA)
Contact: Manager of Green Lights Program, (202)775-6650

Green Lights is a voluntary program in which its members sign a Memorandum of Understanding (MOU) with EPA. Members agree to survey 100% of their facilities; within 5 years of signing the MOU, to upgrade 90% of the square footage that can be upgraded profitably without compromising progress in the member's earlier upgrades; and to report at least annually to EPA on their upgrade progress. The range of support systems EPA provides for its participants are 1) Lighting services group (technical support), 2) decision support system (software), 3) financing directory (database), 4) the national lighting product information program, 5) ally programs, and 6) public recognition.

Energy Efficiency and Renewable Energy Clearinghouse (EREC)

Sponsor:	NCI Information Systems, Inc., for U.S. Department of Energy
Contact:	Energy Efficiency and Renewable Energy Clearinghouse (EREC) 1-800-DOE-EREC; E-mail: energyinfo@delphi.com
Project Start:	1976 End: Ongoing
Annual Funding:	$8 million

EREC arose through the combination of the Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) and the National Appropriate Technology Assistance Service (NATAS). EREC receives inquiries about energy efficient technologies/processes and related material through a toll-free telephone service, an Internet address, and a post office mail box. When receiving an inquiry, EREC staff perform on-line searches of databases to provide information and technical assistance on energy efficiency and renewable energy technologies. EREC maintains an inventory of over 250 publications and 500 computer-generated information briefs, as well as having access to a number of technology databases. Technical engineering assistance can include help with system design, component comparisons, system problem solving, economic analysis, and identification of local technical support for a project. Most inquiries can be responded to immediately or within a few days and there is no charge for this service.

DSM Pocket Guidebook for Industrial Technologies

Sponsor:	National Renewable Energy Laboratory (NREL) for U.S. Department of Energy
Contact:	Nancy Carlisle, (303)275-6034
Project Start:	1992 End: 1993
Annual Funding:	1992: $88,000

This guidebook was initially prepared for Western Area Power Administration, but is available to other parties. The guide provides 2-4 page briefs on energy conservation measures that industrial customers can use to reduce energy use in buildings or to shift demand. The guide emphasizes measures that are generally applicable to all industries. It also includes a bibliography and matrix to direct individuals to sources of information on DSM strategies for specific industrial processes. Call the number above to receive a free copy of the guide.

Energy Related Inventions Program

Sponsor: U.S. Department of Energy and U.S. Department of Commerce
Contact: Terry Levinson, (202)586-1478
Project Start: 1975 End: Ongoing
Annual Funding: $5 million

The Energy Related Inventions Program (ERIP) is a grant program co-funded by DOE and the U.S. Department of Commerce. Any energy-related invention is eligible, including inventions designed to increase the energy efficiency of industrial plants. The program accepts proposals at any time. The proposals undergo an in-depth review by NIST. The technical review is helpful in redesigning the invention if necessary for the market or in credentializing the concept. If the proposal is recommended for funding, it goes to DOE for review and potential award. Once awarded, the grant recipient is also eligible for commercialization training that helps to ensure that the concept is market-bound. Over 400 awards have been granted, with the average award in the past few years being $80,000.

Innovative Concepts Program

Sponsor: U.S. Department of Energy
Contact: Robin Conger, (509)372-4328
Project Start: 1982 End: Ongoing
Annual Funding: $600,000

The Innovative Concepts Program encourages commercialization of energy efficient concepts. Individual grants (typically ranging from $15,000 to $22,000) are awarded about every 18 months. The concepts selected are given nonfinancial assistance, including development of promotional brochures, a commercialization planning workshop, a showcasing opportunity at a technology fair, and technical guidance. A technology focus area is identified for each cycle of the program. Past focus areas have included waste stream minimization and utilization, industrial process improvements, buildings, and building retrofit. Requests for proposals are announced in the *Commerce Business Daily*, as well as in trade journals such as *Mechanical Engineering Progress*. Interested parties can have their names added to a mailing list that will ensure notice of upcoming solicitations and technology fairs.

Motor Challenge Information Clearinghouse

Sponsor: U.S. Department of Energy
Contact: Curtis Framel, Washington State Energy Office, 1-800-373-2129, (360)956-2172
Project Start: 1994 End: 1998

The Motor Challenge program, a joint effort by the U.S. Department of Energy, industry, motor/drive manufacturers and distributors, and other key participants, provides information about energy efficient electric motor system technology. The program encourages industries to share information about energy efficient motor systems and to take part in showcase demonstrations where they will receive technical assistance to improve their facility's performance and document the success in a case study. Currently there are over 200 Motor Challenge Partners. Through the Motor Challenge Information Clearinghouse, industries can receive reliable, up-to-date information to enhance the quality and profitability of their electric motor system strategies and decisions. Information clearinghouse staff and resources are accessible through a toll-free hotline and an electronic bulletin board service. The following resources are available through the Clearinghouse:

- Written Materials - Motor and drive handbooks, data and fact sheets, case studies, technical bulletins, research reports, sourcebooks, and schedule of events.

- Decision Tools - MotorMaster software provides extensive performance and price data on over 12,000 motors from 1 to 600 HP. The program also performs an economic analysis of the cost effectiveness of motor purchase or replacement options for a specific application.

- Technical Assistance - Direct technical assistance from staff engineers and energy specialists about motor systems.

- Education and Training Materials - Information about motor and drive conferences, seminars, and Motor Challenge events.

- Motor Challenge BBS - An electronic bulletin board system that provides a forum for stakeholders in the electric motor system to exchange information and insights. Topics (more than 80) include discussion forums on motors, power quality, Motor Challenge, HVAC, and industrial technologies. The BBS also has software libraries, a training calendar, a programs and organizations' database, electronic mail, and a job and resume listing service. Up to 28 simultaneous users can log onto the BBS using any computer and modem (with a toll-free phone number available to Partners and baud rates up to 19,200) or the Internet (with baud rates up to 38,400).

A.2 Federally Funded State Programs

The federal government also encourages energy efficiency through the states. The states are entrusted with federal funds to allocate within their states to the industries and for the technologies that most need the support. The NICE3 program described below is one such program.

National Industrial Competitiveness Through Energy, Environment, and Economics (NICE3)

Sponsor:	U.S. Department of Energy and U.S. Environmental Protection Agency
Contact:	DOE's Golden Field Office, (303)275-4700
Project Start:	1991 End: Ongoing
Annual Funding:	FY1994: $3.5 million
	FY1995: $7 million (projected)

The NICE3 program offers grants to industrial companies that partner with a state energy or pollution prevention office to increase energy efficiency, reduce pollution, and improve the process economics. The federal funding is given to state offices to be awarded to industries within each region. The average grant is $250,000. The funding allows grantees to design, test, demonstrate, and assess the feasibility of new processes and/or equipment. The grants are awarded each September, with a February solicitation. The projects are selected based on concept description, innovation, cost efficiency, applicant capabilities, energy savings, waste savings, competitiveness, commercialization/marketing plan, and job savings/ growth. Past awards have included ultrasonic cleaning for dishwashing, use of 40% post-consumer waste-paper, expansion of an energy efficient aluminum can coating process, development of an automated dyebath reuse system for carpets, reduction of energy and waste in TV picture tube manufacturing, and the use of low-value molasses as fertilizer.

A.3 Industrial Collaborations/Industry Trade Associations

Most of the industry-sponsored and -funded energy efficiency and DSM programs are sponsored by the Electric Power Research Institute (EPRI), an industrial cooperative. The support provided through this avenue consists primarily of technical advice, technology demonstrations, and contact information.

Energy Service Companies (ESCO)

Sponsor:	Private Funding
Contact:	National Association of Energy Service Companies (NAESCO), (202)371-7812

The National Association of Energy Service Companies publishes a list of ESCOs throughout the country. In addition, individual utilities (public and private) maintain lists of ESCOs that have been qualified and have contracts with them for any energy-related work with their customers. An ESCO will work with a utility and an industrial customer to identify energy-saving opportunities and then help implement or install the cost-effective projects. ESCOs are typically paid for their services through savings achieved by the projects installed.

Electric Power Research Institute (EPRI) Programs

EPRI's mission is "to discover, develop, and deliver high value technological advances through networking and partnership with the electricity industry." Funded through membership dues from member utilities, its programs are designed for utilities and their customers. The EPRI programs listed below are intended to serve specific industrial sectors of member utilities' customers. EPRI headquarters are in Palo Alto, California.

Metal Melting & Processing Applications Development

Sponsor: EPRI
Contact: Gene Eckhart, (202)293-7517
Project Start: 1984

The objective is to accelerate the development of new/improved electrotechnology applications in primary metals and mining/minerals processing industries to improve productivity and energy efficiency, and reduce environmental concerns. The strategy is to develop

- scoping studies and collaborative R&D in the areas of electric melting/casting, rolling/finishing, and electrolytic processing for the metals industries including iron, steel, aluminum, nonferrous, and related materials.

- technology transfer services including workshops/symposia.

Nonmetals Technology Advancement

Sponsor: EPRI
Contact: Gene Eckhart, (202)293-7517

The Center for Materials Fabrication, with its broadening involvement in the areas of plastics, ceramics, and composites, is developing products and services (including technology transfer) relating to the use of electrotechnologies in nonmetals fabrications industries. The strategy includes

- scoping studies and collaborative R&D in the areas of electric heating, drying, and cutting; fabrication; and removal/finishing in nonmetals industries including plastics, ceramics, composites, and wood

- technology transfer products, including workshops/symposia.

R&D Applications Center for Materials Fabrication (CMF)

Sponsor: EPRI
Contact: Gene Eckhart, (202)293-7517

The goal is to develop new and improved technology and disseminate technical information aimed at maximizing the value of electricity. The program addresses opportunities for improving productivity and energy efficiency and reducing environmental concerns in the materials fabrication industries. The objective is to assist EPRI members and their industrial customers by providing products and services that advance electrotechnology awareness, promote cost-effective electrotechnology applications and demonstrations, improve education, and offer technical support.

Industrial Program Technical Analysis and Planning Support

Sponsor:	EPRI
Contact:	Marsha Grossman, (415)855-2899
Project Start:	1990

This project provides the Electrotechnology Reference Guide (ERG), which analyzes the electricity consumption by industry sector, electrotechnology, and application. Gas consumption and applications are also analyzed and a directory of electrotechnology equipment suppliers provided. In addition, the Industrial Program Index (IPI) provides an IBM-PC-based index to products and services (from the Industrial Program) which can be accessed by industry sector, technology, application, title, and/or key word. Projects in process are also included. A recently initiated motors and drives analysis will provide a disaggregated database of motor and drive use in the industrial sector.

Establishment of an EPRI Pulp & Paper Office

Sponsor:	EPRI
Contact:	Jeff Caldwell, Institute of Paper Science Technology, (404)853-9511
Project Start:	1990
Annual Funding:	1994: $250,000

The goal is to develop new and improved technologies and disseminate technical information aimed at maximizing the value of electricity. The program addresses opportunities for improving productivity and energy efficiency and reducing environmental concerns in the pulp and paper industries. The objective is to assist EPRI members and their industrial customers by providing products and services that advance electrotechnology awareness, promote cost-effective electrotechnology applications and demonstrations, improve education, and offer technical support.

Electricity Use & The Environment

Sponsor:	EPRI
Contact:	Dwight Agan, Science Applications International Corp., (415)960-5918
Project Start:	1992 End: 1994

This project aims at providing information and tools to assist utilities in understanding environmental impact of electric end use options. In the face of increasing political, public, and regulatory concern for environmental quality, a knowledge of the environmental impacts of electrotechnologies and DSM options will enable utilities to enhance their marketing and planning strategies. The project's approach consists of information development in conjunction with residential, commercial, industrial, and power electronics and controls programs, leading to a database of end use environmental impacts.

Comprehensive Least Emissions Analysis (CLEAN) database and PC-Windows software is an example of the kind of tools developed under this EPRI program. CLEAN was developed to analyze the comprehensive life cycle emissions from electric and non-electric end use technologies. The CLEAN database includes over 93 end use technologies (including industrial) and takes into account the four sources of emissions that make up the life-cycle emissions of end use technologies; fuel production emissions, supply-side emissions, end use emissions, and downstream emissions. Funding for the development of CLEAN was provided through an EPRI-tailored collaborative project.

EPRI Partnership for Industrial Competitiveness (EPIC)

Sponsor:	EPRI
Contact:	William M. Smith, (415)855-2415
Project Start:	1992

EPIC is composed of over 15 utilities. Its purpose is to help electric utilities identify, develop, and implement competitiveness improvement opportunities for their industrial customers. The program focuses on environmental issues, energy efficiency, and productivity for a particular industry. The projects develop industry manuals, action guides, and plant survey reports for the selected industries. The industry manuals provide broad background information about the industry, customers, products, etc. The action guides are workbooks for on-site plant use to help identify and screen improvement strategies. The plant survey reports are developed following surveys conducted by an EPRI team and contain recommended plant improvements. All of the efforts combine to give a "best-in-class" typical plant in a given industry so that a particular utility can get ideas for improvement strategies, compare to a model plant, and set performance goals.

Pinch Technology

Sponsor:	EPRI
Contact:	1-800-4320-AMP (for utilities only)

Pinch technology is a technique for finding the best way to assemble building blocks of industrial processes to maximize energy efficiency with minimal capital costs. A pinch analysis examines an entire plant's heating and cooling requirements, sets targets for energy efficiency, and allows optimal design of heat exchanger networks between heat sources and sinks. EPRI has conducted many case studies from 1988 to 1992 showing that pinch assessments saved between $31,000 and $4 million per year per plant, with payback periods that averaged 1.5 years. EPRI has also published technical reports that explain pinch principles and offer guidelines for putting pinch to work. There are computer programs that utilize pinch principals (APLUS 2.0, HPSCAN, SuperTarget, Advent). The American Institute of Chemical Engineers offers a course in pinch technology, and licensors of the commercial-grade software offer training for their software.

Global Automated Urban Government Energy System (GAUGES)

Sponsor: Metro Dade County Information Technology, Inc.
Contact: Marge Firestone, (305)375-5413

Developed by and for local government end users, GAUGES will be a practical, enhanced automated energy planning, analysis and management system that addresses common energy problems. The system will be able to assess electric usage, providing a means to examine rate structures and evaluate the impact of alternative electricity supplies and conservation methods. The objective of the project is to enhance an existing system that already successfully monitors energy consumption and costs. Modules to be added will improve electrical cost budgeting, bill processing and analysis of energy saving projects. The project is expected to foster partnerships among governments, utilities, and building contractors and will result in marketable software for transfer to governments and utilities.

The Chicago Energy Management Cooperative

Sponsor: Public Technology, Inc.
Contact: Dwight Baily, (312)744-3630

The purpose of this project is to develop an organization of electric consumers which collaboratively designs, implements, and executes energy management techniques. The initial objectives focus on peak demand reduction; later efforts will address strategic conservation. The participants in the project include the California Energy Coalition, Commonwealth Edison, the City's franchise negotiating team, and the Illinois Department of Environment.

A.4 University Programs

In addition to the EADCs listed earlier, university-sponsored programs encourage energy efficiency and DSM. A few are listed below to show the types of programs offered; others can undoubtedly be identified by contacting the universities in a given location.

Lighting Research Center

Sponsor: Rensselaer Polytechnic Institute
Contact: Katheryn M. Conway, (518)276-8716
Project Start: 1988 End: Ongoing
Annual Funding: 1991: $1,714,000
1992: $2,328,000
1993: $2,892,000
1994: $3,300,000

The National Lighting Product Information Program was initiated in October 1990 to establish an objective source of manufacturer-specific performance information for efficient lighting products. New regulations that provide incentives to utility companies for energy conservation programs have focused attention on the large energy-saving potential of efficient lighting. In addition to the long-term financial gains, every kilowatt-hour saved with efficient lighting benefits the environment through reduced power plant emissions. However, a lack of timely, objective and easily accessible information about efficient lighting products has constrained efforts to promote energy-saving technologies. To help close this information gap and accelerate the acceptance of efficient lighting, the program provides a medium for presenting existing and new performance data in useful formats.

Industrial Extension Service

Sponsor: North Carolina State University for the State of North Carolina Energy Division
Contact: Karen Klinger, North Carolina State University Industrial Extension Service (919)515-5439
Annual Funding: $625,000

The center offers technical and educational services focusing on improving plant efficiency and productivity to industries in North Carolina. The services include seminars for industrial employees on process energy flows, equipment maintenance, waste heat recovery, machinery use, and auditing techniques. This unique regional service is funded by the U.S. Department of Energy through the State of North Carolina Energy Division and administered through the North Carolina State University.

A.5 Federal Power Marketing Administrations

Federal power marketing administrations also sponsor industrial energy efficiency and DSM programs. Examples of programs offered are listed below.

Energy $avings Plan (E$P) Program

Sponsor: Bonneville Power Administration
Contact: Sheila Riewer, (503)230-5473

The E$P Program is operated by the Bonneville Power Administration and its utilities. The program seeks to conserve energy by encouraging the industrial sector to install energy-saving technologies. The program is based on electrical savings in a variety of technologies. Projects must have a minimum of 1-year simple payback and an estimated measure life of 15 years. The program offers motor rebates, energy reviews, and "incentives" in the form of the purchase of the energy saved from the retrofit project. The energy review includes an assessment of the industrial firm to determine where there are potential electric energy savings. The responsibility of the industrial firm includes pre-installation measurement of energy consumption and post-installation measurement of the project.

Electric Ideas Clearinghouse

Sponsor: Bonneville Power Administration
Contact: Curtis Framel, Washington State Energy Office, 1-800-373-2129; (360)956-2172
Project Start: 1989 End: Ongoing

The Electric Ideas Clearinghouse is operated by the Washington State Energy Office's Energy Ideas Clearinghouse program and is funded by the Bonneville Power Administration. It serves the energy information needs of utilities, industry, and government agencies by providing technical and library research assistance. Following is a list of the types of information and assistance available from the Clearinghouse:

- Technical Assistance - Professional engineers, energy specialists, and research librarians are available to respond to general or specific questions about industrial processes, building energy efficiency, and electrotechnologies. The hotline is toll-free, and initial responses are made within eight working hours.

- Product Information - Over 1 million pages of product literature related to energy efficiency in new and retrofit buildings and processes are available from the Clearinghouse.

- Industrial Library - The Clearinghouse Technical Library accesses industrial databases and has cataloged numerous industrial-related documents, reports, codes, standards, directories, and periodicals. The library includes over 13,000 books and reports, more than 500 journals and newsletters, access to over 400 databases, and network access to libraries across the country.

  - Electronic Bulletin Board Service (BBS) - The Clearinghouse BBS allows users to share information with 6500 other energy professionals. This service can be accessed toll-free in Bonneville's service territory with information transfer speeds up to 19,200 baud, as well as from Internet at twice that speed. Up to 28 users can access the service simultaneously; usage was over 11,000 connections per month at the end of 1994. This service includes the following features: Electronic mail, with Internet access and file attachments, avoiding phone tag and saving postage and phone costs

- Discussion forums on over 80 energy topics, including lighting, power quality, motors, HVAC, and industrial technologies. Most are general public forums, but some are imported news groups from the Internet, some are private, some are on-line college courses on energy topics; some trade messages daily with other energy BBS.

- Training calendar with hundreds of energy-related events

- Programs and organization database to locate speakers and consultants

- Software libraries with over 1100 energy-related programs and data files

- National jobs and resume listing service

- Fax-Online, which allows the user to have numerous fact sheets and case studies faxed automatically

- Gateways to other energy information resources on the Internet

Power Line/Power Plug

Sponsor: Western Area Power Administration
Contact: Curtis Framel, Washington State Energy Office, 1-800-373-2129; (360)956-2172
Project Start: 1994 End: Ongoing

The Power Line hotline and Power Plug BBS are operated by the Washington State Energy Office's Energy Ideas Clearinghouse program and are funded by the Western Area Power Administration. The hotline and the BBS serve the energy information needs of utilities, industry, and government agencies by providing technical and library research assistance. Following is a list of the types of information and assistance available from the Power Line:

- Technical Assistance - Power Line professional engineers, energy specialists, and research librarians are available to respond to general or specific questions about industrial processes, building energy efficiency, and electrotechnologies. The hotline is toll-free, and initial responses are made within eight working hours.

- Product Information - Over 1 million pages of product literature related to energy efficiency in new and retrofit buildings and processes are available from the Power Line.

- Industrial Library - The Power Line Technical Library accesses industrial databases and has cataloged numerous industrial-related documents, reports, codes, standards, directories, and periodicals. The library includes over 13,000 books and reports, more than 500 journals and newsletters, access to over 400 databases, and network access to libraries across the country.

- Power Plug - The Power Plug electronic bulletin board system (BBS) allows users to share information with 6500 other energy professionals. This service can be accessed toll-free in Western's service territory with information transfer speeds up to 19,200 baud, as well as from the Internet at twice that speed. Up to 28 users can access the service simultaneously, and usage was over 11,000 connections per month at the end of 1994. This service includes the following features:

  - Electronic mail, with Internet access and file attachments, avoiding phone tag and saving postage and phone costs.

  - Discussion forums on over 800 energy topics, including lighting, power quality, motors, HVAC, and industrial technologies. Most are general public forums, but some are imported news groups from the Internet, some are private, some are on-line college courses on some energy topics; some trade messages daily with other energy BBS.

  - Training calendar with hundreds of energy-related events

  - Programs and organization database to locate speakers and consultants

  - Software libraries with over 1100 energy-related programs and data files

  - National jobs and resume listing service

  - Fax-Online, which allows the user to have numerous fact sheets and case studies faxed automatically

  - Gateways to other energy information resources on the Internet.

A.6 State-Funded Programs

Many states have also invested in developing programs which promote energy efficiency and DSM in their states. Three of the leading states in this area are New York, through its State Energy Office and the New York State Energy Research and Development Authority; Washington, through its State Energy Office; and California, through the California Energy Commission. The programs tend to provide direct assistance to industries within the state or provide technology development for technologies specific to that state's major industry. The programs listed are examples of some of the well-known programs.

Integrated Resources Research Program

Sponsor:	New York State Energy Research & Development Authority
Contact:	Marsha Walton, (518)465-6251 ext. 271
Project Start:	1988 End: 1994
Annual Funding:	1991: $1,000,000
	1992: $1,200,000

This program supports policy research and software development in the following fields: design and evaluation of electric DSM programs; modeling of environmental externality costs of utility operations; development and implementation of utility integrated resource bidding programs; development of regulatory incentives to achieve DSM and integrated resource planning goals; estimation of short-run marginal costs of wheeling electricity; analysis of potential of natural gas efficiency and fuel switching measures; and economic development of DSM in Eastern Europe.

Industrial Energy Efficiency and Economic Development Program

Sponsor:	New York State Energy Research & Development Authority (NYSERDA)
Contact:	See contacts listed below for each program
Project End:	Ongoing
Annual Funding:	1994: $4 million

The NYSERDA Industrial Division assists New York businesses with a number of energy-related product demonstrations and process improvement activities. Most of the assistance is provided to the industrial sector. The following programs are part of the Industrial Energy Efficiency and Economic Development Program:

- Industrial Process Improvements - This program assists New York State industries with engineering feasibility studies and financial assistance for the demonstration of innovative, energy efficient technologies. Industrial DSM is a recent area of interest for the program. Contact Bill Reinhardt at (518)465-6251 ext 257.

- Materials Process Development - This program assists with the development of energy efficient materials processing and materials applications. Materials of interest include metals, ceramics, plastics, and glass in monolithic, composite, surface-modified and recycled formats. Contact Nag Patibandla at (518)465-6251.

- Energy Systems and Applications - This program assists with the development, demonstration, and commercialization of energy efficient advanced power systems applicable to electric and thermal energy production and distribution systems. Recent project applications include cogeneration, district heating and cooling, superconducting generators, flywheel storage systems, high-phase order transmission, and five-wire distribution systems. Contact Fred Strnisa at (518)465-6251 ext 244.

- Energy Products Center - This program provides financial and technical assistance for high-risk commercial development of innovative, energy related products in targeted technology areas. Contact Peter Douglas at (518)465-6251 ext 214.

- University-Industry Energy Research - This program supports university and industry collaboration to solve problems in well-defined technology areas having energy efficiency and/or environmental benefits. Projects may involve process efficiency studies and new product/process development. The university-industry project team proposes its budget and NYSERDA pays a portion of that budget. There are co-funding requirements. Contact Ed Kear at (518)465-6251 ext 269.

Flexible Technical Assistance Program

Sponsor:	New York State Energy Office	
Contact:	Customer Service Bureau, (518)474-3393	
Project Start:	1992	End: Ongoing

The New York State Energy Office provides a variety of technical assistance services custom fit to the specific energy efficiency needs of New York businesses, including industrial facilities. Most organizations receiving assistance spend over $100,000 per year for energy costs. Program services include detailed analyses of specific energy efficiency products; comprehensive on-site surveys to identify energy efficiency measures of building systems, manufacturing and waste treatment processes, and renewable technologies; full-scale engineering feasibility and technical assistance studies; technical materials and seminars on energy efficiency topics and technologies; engineering studies to support project financing proposals; equipment efficiency assessment; project planning assistance; general technical analysis and support; and post-installation assistance. These services are provided on a negotiated, cost-shared basis. The Program has served over 115 customers to date.

Regional Energy Efficiency Initiative

Sponsor:	California Energy Coalition members
Contact:	John Phillips, (714)497-5110
Project End:	Ongoing

In California, a municipal government, two utilities, and a large developer have created a unique partnership to overcome the barriers to developing and delivering large-scale, cost-effective energy efficiency that meets the needs of the end user community and the serving utilities. The coalition has developed a Regional Energy Efficiency Initiative that helps coordinate energy use among its members during peak periods to allow more efficient use of energy resources. It also provides DSM counseling to its members (industry, municipalities, and utilities).

A.7 Utility-Sponsored Technical Applications Centers

A unique service being developed by several large utilities allows industrial customers to test energy efficient technologies. The service allows a "one-stop-shop" where industrial customers can get information, see demonstration projects, and get technology consultation relevant to their particular needs. To date, these are the only such programs currently available.

Customer Technology Application Center

Sponsor:	Southern California Edison	
Contact:	Jerry Kauffman, (818)812-7500	
Project Start:	1990	End: Ongoing

The Center showcases energy efficiency, air quality compliance, and customer competitiveness through demonstrations, evaluations, workshops and seminars. Since its opening in January 1990, CTAC has hosted over 110,000 guests, including commercial and industrial customers, professional and technical organizations, foreign dignitaries, legislators, and regulators. In 1993, CTAC presented 100 workshops and seminars to over 4,000 attendees on such topics as Power Quality, Electric Motors, Lighting, Refrigeration, Heat Pumps, and Energy Management and Controls. CTAC's engineers and technicians provided information, demonstrations, and hands-on experience to approximately 120 industrial customers who needed assistance with environmental compliance, productivity and product quality.

Georgia Power Technology Applications Center

Sponsor:	Georgia Power Company
Contact:	Gary Birdwell, (404)526-7359

To help Georgia industry remain competitive, Georgia Power Company has established the Technology Applications Center. The complementary service can show customers how to reduce production costs, improve product quality, increase productivity, and address environmental concerns. Sample technologies featured include ultraviolet curing, robotic applications, microwave heating, and laser processing. The center offers technical assistance, equipment demonstration, product testing, manufacturing process evaluation, materials analysis, and solutions for clients' production problems. The technical assistance draws on collaborations with experts from many research institutes, including EPRI and Battelle Memorial Institute.

Electrotechnology Application Center

Sponsor:	Pennsylvania Power & Light and Northampton Community College
Contact:	Keith Sames, (610)861-5381
Project Start:	1994 End: Ongoing

Pennsylvania Power & Light Company and Northampton Community College are jointly developing the Electrotechnology Applications Center (ETAC). The center will house equipment that demonstrates new high-efficiency electric technologies in manufacturing. At ETAC, customers can investigate electrotechnologies before making a substantial dollar investment. Technical staff can test products or substrate materials to evaluate the effects on a process line of implementing a technology. The center offers awareness seminars, site investigations, laboratory demonstrations, application-specific consulting, and hands-on training of plant personnel. Many of these services are offered at no charge for PP&L customers. Non-PP&L customers may also use the center for a fee.

Industrial Electrotechnology Laboratory

Sponsor:	North Carolina Alternative Energy Corporation
Contact:	Russ Starkey, (919)515-3941 or 1-800-227-0874
Project Start:	April 1991 End: Ongoing
Annual Funding:	$1.1 Million

The Industrial Electrotechnology Laboratory (IEL) is located at the North Carolina State University College of Textiles in Raleigh and is operated by the North Carolina Alternative Energy Corporation (AEC). IEL focuses on electricity-based technologies that are energy efficient and environmentally responsible. Through testing, demonstration, education and research, these technologies are used to improve industrial productivity and competitiveness.

Two major technology areas on which the IEL focuses are electrotechnologies and motors. The electrotechnology or "ET" program focuses on finding beneficial and cost-effective ET applications through consultation, site visits and laboratory testing. The IEL's location at the College of Textiles provides a unique opportunity to use full-scale industrial equipment to duplicate a variety of industrial processes in a controlled, manufacturing-scale environment. The motors program operates one of the premier motor testing labs in the United States. IEL's database of industrial motor testing information is growing and has become very useful in creating guidelines for motor management policy.

IEL services are free to member utilities' industrial customers. The participating utilities are Carolina Electric Cooperatives, Carolina Power & Light Company, Duke Power, Nantahala Power and Light Company, North Carolina Power, South Carolina Electric & Gas Company, and Virginia Power.

Wisconsin Responsible Power Management™ - Motors (RPM™ - Motors)

Sponsor:	Wisconsin Center for Demand Side Research (WCDSR)
Participating Utilities:	Wisconsin investor-owned utilities and participating municipal utilities
Contact:	Angela Prestil, (800)55-WI-RPM or 1-800-559-4776
Project Start:	1994 End: 1997

RPM™ - Motors has a variety of materials available to promote the purchase and use of energy efficient motors, including the MotoRater, a hand-held calculator wheel for calculating energy cost and energy savings of energy efficient motors. Through participating utilities, the program also offers rebates for 1- to 200-hp energy efficient motors. The goal of the program is to transform the Wisconsin motors market to energy efficiency by January of 1997. The program works closely with motor distributors and vendors. Vendors may receive marketing and sales tools from the program to distribute to their customers, and the limited-term rebates have been coordinated statewide to make it easier for vendors to participate.

Wisconsin Responsible Power Management™ - Performance Optimization Service (RPM™ - POS)

Sponsor:	Wisconsin Center for Demand Side Research (WCDSR)
Participating Utilities:	Wisconsin utilities and participating municipal utilities
Contact:	Ronald G. Wroblewski, P.E., (608)238-4601
Project Start:	1994 End: Ongoing

The RPM™ - POS program looks beyond the component approach and instead addresses the efficiency of the motor-driven *system* for fan, pump, and blower applications in industry. The program includes three components: training; implementations at pilot sites; and market research to determine the applicability and cost effectiveness of tools and procedures. The training consists of a one-day overview session on the background and general POS approach and a three-day, in-depth technical training session for engineers and consulting engineers. A one-day training session focused on site prescreening and screening is under development. Pilot sites are being sought in Wisconsin with 75-hp (or greater) fan pump or blower systems operating 4000 hours per year or more in either a varying or throttled flow condition. The market research being undertaken is to determine market potential as well as when and how these tools can be applied cost effectively to smaller systems. Participants include Wisconsin investor-owned utilities and some municipal utilities.

Appendix B

Impact Evaluations in the Industrial Sector: Methods and Case Studies

Appendix B

Impact Evaluations in the Industrial Sector: Methods and Case Studies

Evaluating the impact of industrial DSM programs is crucial to providing the feedback that allows programs to improve. Impact evaluation and process evaluation are the tools used to move progressively toward better and more effective programs. This appendix begins with a discussion of the techniques used for impact evaluation, drawn from a report to Bonneville Power Administration (BPA) at the onset of BPA's Energy $avings Program (E$P).[a] This particular program is one of the longest running and most thoroughly evaluated industrial DSM programs in the country. Accordingly, the second section of this report includes case studies and findings from a series of evaluations of that program (Spanner et al. 1993).

B.1 Methodology for Evaluation Attributes and Techniques

The first step in developing the impact evaluation methodology was to establish attributes against which individual impact assessment techniques could be judged. Nine attributes were established: five address how well a technique satisfies the methodology's objectives and four address implementation issues such as cost, accuracy, and difficulty. In the evaluations of the techniques in the next section, the five attributes that address the objectives of the methodology are grouped together under the category of "usefulness." The attributes are described below.

- Does the technique assess the energy savings of the project? Some of the assessment techniques directly measure energy savings, some do so indirectly, and others do not address this question at all. In addition, some of the techniques assess kWh saved, while others assess energy savings in terms of kWh per unit of process output.

- Does the technique determine the levelized costs of the project? Of the techniques that address this question, one is used to calculate levelized costs, and the others provide data that support the levelized cost calculations.

(a) Spanner, G. E., D. R. Brown, D. R. Dixon, B. A. Garrett, R. W. Reilly, J. M. Roop, and S. A. Weakley. June 30, 1988. *Potential Techniques for Evaluating the Impact of Industrial Energy Conservation Projects Under Bonneville's Energy $avings Plan*. PNL-Letter Report. Prepared by Pacific Northwest Laboratory for the Bonneville Power Administration, Portland, OR.

- Does the technique provide insight into changes in production that result from implementing the project? The only direct way to obtain information about production changes is to ask the firm involved; however, some indirect techniques allow one to draw conclusions about likely production changes.

- Does the technique determine the net impact of the project upon the servicing utility? The net impact to the servicing utility results from a combination of factors such as energy savings per unit of output, change in output level, and fuel switching. Some techniques capture all of the relevant factors and some do not.

- Does the technique determine whether or not an energy conservation project would have been undertaken in the absence of the DSM program? Would only part of the project have been undertaken without the incentives offered? How much of the project's impact can be attributed to the DSM program? A few techniques offer direct answers to these questions, while others provide evidence that indirectly answers them.

- What is the relative accuracy of the technique? What are the data requirements? Any assessment of impact requires data, and the degree of difficulty in obtaining the necessary data varies widely among the techniques under consideration, even to the point of eliminating some from practical use.

- What is the relative cost to prepare the technique for use in evaluating projects? Many of the potential evaluation techniques require preparation up front to make them applicable to the projects being evaluated. For example, several techniques require that a questionnaire be developed so that consistent information is gathered during interviews. Preparation costs will also vary depending upon which industries are ultimately selected for the project evaluations.

- What is the relative cost to implement the technique? Implementation costs vary widely among the techniques, so this factor will be useful for differentiating among them when selecting the methodology.

The second step in developing the impact evaluation methodology was to generate a list of potential techniques that could be combined to make up the methodology. The list was generated from three primary sources: discussions between PNL and Bonneville, interviews with industry experts during an earlier literature search, and a "brainstorming" session among senior project participants at PNL. A list of eleven independent evaluation techniques was developed.

Each of the eleven evaluation techniques falls into one of two broad categories: modeling and analysis, or data collection. The modeling and analysis techniques include economic models, engineering models, investment analysis, comparison groups, and matched pairs. Data collection techniques include time-series and one-time metering (both physical measurements); contractor submittal reviews, site visits and interviews, and process evaluation reviews (three self-disclosure techniques); and vendor interviews (a third-party, independent technique).

Each of the eleven techniques was then qualitatively evaluated against the nine attributes described above. A workshop was also held with energy conservation and evaluation experts to obtain their feedback about the appropriateness of the eleven techniques for evaluating industrial projects.

B.2 Evaluation of Potential Assessment Techniques

Qualitative evaluations of the eleven potential impact assessment techniques are presented below. The evaluations describe the degree to which each technique fulfills the nine aforementioned attributes in the context of the E$P. The qualitative evaluations of the eleven potential techniques are also summarized in Table B.1.

The qualitative ratings shown in Table B.1 are analogous to scholastic grading scales, such that a technique with an "A" in a certain attribute is the best (or in the top group) with respect to that attribute. Conversely, a "C" grade signifies a lower rating with respect to an attribute. An "F" in the table means that the technique in question either does not exhibit the corresponding attribute at all, or that the technique is not feasible because of data collection constraints.

As can be seen in the table, at least one technique will directly satisfy each of the methodology objectives (the first five attributes listed), while only one of the objectives is satisfied by only one technique (investment analysis to determine levelized costs). Both of the techniques for directly determining whether or not changes in production resulted from an energy conservation project and all three of the techniques that directly address project installation in the absence of the program's incentives rely upon self-disclosure from the contractors. The attribute (and hence methodology objective) which is directly addressed by the greatest number of techniques (6) is that of assessing energy savings by the project. The key trend shown in the table is that a variety of techniques will be required to evaluate the impact of the projects and that technique selection will be affected by characteristics such as accuracy and cost.

B.2.1 Economic Models

An economic model, in this context, is the application of economic theory to evaluate the effect of an energy conservation measure (ECM) on a particular firm or industry. It takes into account the fact that by altering the production process, the ECM has changed the potential modifications the plant might undertake in the future. In the simplest of terms, the ECM has not changed the current production technology, although it may have altered the most economically efficient set of resources that the plant uses in production. Such a change, even if it is minor, will alter the future organization of the plant in a way that can be anticipated by economic theory.

Table B.1. Summary of Impact Evaluation Technique Attributes

	Attributes								
	Methodology Objectives					Implementation Issues			
Scales	Assess Energy Savings	Determine Levelized Costs	Assess Production Changes	Determine Net Impact To Utility	ECM Installed in Absence of DSM Program?	Accuracy	Data Requirements	Prep Cost	Implementation Cost
A B C F	Yes Indirectly -- No	Yes Supporting Data -- No	Directly Indirectly/Perhaps -- No	Yes Perhaps -- No	Directly Indirectly -- No	High Open Low --	Trivial Significant -- Infeasible	Low Medium High --	Low Medium High --
Technique									
Modeling/Analysis									
Economic models	F	F	B	B	B	B	B	C	C
Engineering models	B	B	F	B	F	B	B	B	B-
Investment analysis	F	A	B	F	B	A-	B	B	A-
Comparison groups	A	F	F	F	F	B	F	B	B
Matched pairs	A	F	F	F	F	B	F	B	B
Data Collection									
Time-series metering	A	F	F	A	F	A	B-	B	C
One-time measurements	A	F	F	A	F	A	B	A	B
Contractor submittal review	A	B	B	B	A	B	A	A	
Site visit and interviews	A	B	A	B	A	B	B	B	B
Vendor interviews	B	B	B	B	B	B	A-	B	A
Process evaluation review	F	B	A-	B	A	B	A	A	A

Economic modeling can take a variety of forms. The economic analysis may be simply a literature review of previous studies. Alternatively, it may rely on a detailed analysis of data gathered from primary and secondary sources; an excellent example of such a study, *The U.S. Primary Iron and Steel Industry Since 1958,* has been published by the Office of Business Analysis, U.S. Department of Commerce. At an even more complex level, there are econometric studies (the integration of statistics and economic theory, usually expressed as a set of mathematical equations that describe a system) of industry that rely on multi-equation statistical models of factor inputs such as electricity, fossil fuel, capital costs, and labor. This information may be further combined with historical evidence of the penetration of new technologies so that projections of technical change are available for the industry.

Economic modeling often relies on a combination of economic theory, mathematical modeling, and statistical estimation of the parameter values of the model. Based on the estimated parameter values, the mathematical form is manipulated to assess the static and dynamic properties of the system. The properties of the system can then be used to determine how a particular change in the production environment may affect the system. Thus this technique is well suited for estimating the impact on a production process that results from adopting a particular ECM. For example, under appropriate circumstances, economic methods could be used to estimate the likely effect of a particular ECM on a contractor's inputs (such as labor or materials) and output.

Economic modeling can be applied to a variety of levels and with different types of information. A sufficient sample of one type of ECM adopted by an industry with similar characteristics could be used as the database for a statistical examination of the effectiveness of the ECM. Another application could be at the industry level where, statistically, the technical production relationships that are relevant to the assessment are determined. This application requires that an ECM fit within a well-specified sequence of processes that describe the industry and that the data for the industry are available. The impact of the ECM, then, could be based on the technical production relations revealed by the econometric model. The two different types of data used are cross-sectional and time series. Cross-sectional data are at a single point in time, while a time-series tracks a single unit of observation over time.

B.2.2 Engineering Models

An engineering model consists of calculations based on engineering principles. These calculations may be made using theoretical information or in conjunction with direct metering or monitoring of process variables. The engineering model would generate two equations relating energy usage (input) to units of production (output). One equation would describe the base case (before ECM installation), the other the energy relationship after ECM installation. With two equations, the energy savings can be calculated at any level of production.

To develop an engineering model, several simultaneous equations of mass and energy equilibrium are solved to produce the two final equations. The mass and/or energy balance may be applied around an individual piece of equipment or an entire process. For example, a new heat exchanger may replace an older, less efficient model for heating a product stream. The theoretical heat transfer equations relating

Btu transferred to the product versus Btu input to the heat exchanger would be developed for each case. For any product flow rate, the energy savings could be directly calculated. If the theoretical equations do not describe the actual case sufficiently (because of fouling or wear in the older model), one-time energy measurements may be required to improve the accuracy of the technique.

B.2.3 Investment Analysis

Investment analysis techniques can be used within an impact evaluation to determine whether the project would have been undertaken in the absence of the DSM program and to determine the economics of the program. In examining the first issue, it is important to use the analysis tool most commonly accepted for investment decisions in each particular company. In addition, energy savings estimates, rather than measured savings, should be used in addressing this issue since these are the data that were considered in the investment decision.

In determining the economics of a DSM program, discounted cash flow (DCF) techniques should be used. Discounted cash flow analysis is the technique used to properly account for the time value of money. DCF is used to adjust revenues (cash flows) occurring at different points in time to a common basis before they are added or subtracted.

Net present value (NPV) and levelized production cost (LPC) are two related investment decision techniques that are based on DCF analysis. Both techniques will identify the economically correct investment decision, i.e., the investment that maximizes the wealth of the investor. NPV is commonly used to evaluate investments which create changes in the cash flows of an existing process, for example, a decision to invest in an energy-saving device. The cash flows that would occur as a result of the investment are compared with those of continued operation of the existing system. LPC analysis is commonly used to evaluate the relative production economics of alternative investments, for example, one of two or more alternative electric generating facilities.

Two other commonly employed financial evaluation techniques are payback and internal rate of return (IRR). While these two techniques are commonly used, they will not always result in an economically correct investment decision. The payback technique fails to account for the time value of money (among other deficiencies), while certain cash flow patterns will result in multiple solutions to an IRR analysis.

B.2.4 Comparison Groups

The strategic issue in impact assessment is how to estimate the difference between two conditions: one in which the intervention is present, and one in which it is absent. Ideally, the absent condition is identical in all respects to the present condition, except for the intervention or change being studied. In comparison group study, targets or subjects are divided into two or more groups, with one group participating in the program being assessed. The others may take part in another program or may not participate in any program (if so, the first group is called the experimental group and the second is called the control group). In a true experimental comparison group study, assignment of individuals to the various groups is completely random.

B.2.5 Matched Pairs

When randomized or "true" experimental studies cannot be undertaken, the impact assessor must choose one procedure or some combination of procedures for approximating the equivalence of control and experimental groups achieved through randomization. These alternatives, called quasi-experiments, may be the only feasible approach under many circumstances. These non-randomized approaches compare experimental groups created out of subjects who have elected (in some fashion) to participate in a program with "constructed controls" or groups of nonparticipants who are in some critical ways comparable to participants.

In a matched pairs study, a participant is paired with a nonparticipant whose major relevant characteristics are similar. To choose a matched pair, the evaluator must have prior knowledge and an understanding of the processes that both participants are exposed to before, during, and after the implementation of the change to be evaluated. Using such knowledge, the evaluator can construct a matched pair so that all relevant and significant factors are identified and taken into account.

B.2.6 Time-Series Metering

Time-series metering is the process of measuring, on a continuous real-time basis, the performance of a system and the related quantities that are important to understanding the performance of the system and for predicting future performance. For instance, to characterize the performance of an air conditioning system in a building, performance factors such as electricity consumption and internal temperature and related factors such as external temperatures and internal heat sources are measured. This approach allows the evaluator to understand how performance is affected by environmental factors and to predict future performance as a function of weather, building use, etc. Data can be recorded continuously (analog) on a strip-chart pen recorder or periodically (digitally) by a computer-based system. In practice, measurements are usually not made continuously, but rather through digital sampling, because it is easier to evaluate and compare data in digital databases.

Time-series metering is most appropriate when input and output parameters vary continuously over time. In processes that are constant over time (such as the electric input to a continuously running fan motor), adequate information can be gathered much more inexpensively through one-time measurements (using a portable watt meter) and/or by using product-specific information (nameplate rating). Sometimes combinations of time-series metering and one-time measurements are used: periods of use are metered over time using inexpensive on/off sensors, and the "one-time" data are combined with one-time measured information on energy consumption to obtain total energy use over any period of time.

All time-series metering activities require at least three, and often four, linked components: sensors; a collection network; a data acquisition system; and a centralized data collection, management and storage system. The sensors measure the quantities of interest (electricity consumption, gas consumption, engine speed, etc.) and convert these quantities into signals. These signals are then transferred over a collection network (wires, phone lines, or radio waves) to a data acquisition system (DAS) that collects, organizes, and records the information. Data recording may be simple, e.g., continuous writing of one measurement on a strip-chart recorder, or sophisticated, e.g., electronically digitized and recorded for ease of data management and evaluation. In large time-series metering projects, many data acquisition systems may collect data from many different sensors, digitize it, and retransmit it to a centralized data collection, management, and storage system. This fourth system element is often a sophisticated computer system that initiates interrogation of the field DASs and performs simple data quality checks, giving notification of potential problems.

Thus, time-series metering can be as simple as a technician counting the number of process completions in a period and recording this information in a notebook, or as complex as a totally automated computer system collecting information from thousands of sensors all linked to the DAS by microwave transmitters.

B.2.7 One-Time Measurement

One-time measurements are measurements of the instantaneous values of energy consumption, process flow, and similar parameters, typically made with portable, clip-on ammeters, watt meters, and similar instrumentation. This approach eliminates the cost of expensive dedicated metering equipment. These measurements can be used to characterize and help understand the performance of a system. Pre-ECM and post-ECM one-time measurements can be used to characterize the performance (output versus energy use) of an ECM as it is applied to a specific industrial process.

In general, one-time measurements are most useful in evaluating industrial processes that do not vary with time. For instance, when evaluating the energy savings that are achieved by reducing the motor size on a continuously running fan, the evaluator can measure the instantaneous energy consumption of the two motors and calculate the annual energy savings with a high degree of certainty.

When constant energy-use systems are not operated continuously and exact operating schedules are not known, one-time metering is sometimes combined with time-series metering. In this situation, rather than using an expensive flow meter to measure actual energy use, operation of the equipment is metered through a simple on/off status sensor, and energy consumption is then calculated through knowledge of instantaneous energy use. For processes that continuously change, a series of one-time measurements (or snapshots) of energy use taken at specific operating conditions can be used to develop an operating curve of the equipment as a function of input parameters. This curve can then be combined with binned, metered, or estimated input data to estimate overall performance. Actual time-series metering would provide better information, but would typically be far more expensive.

B.2.8 Contractor Submittals Review

The contractors are retained to perform energy use measurements. This data collection technique includes an examination of all data reported by a contractor and may include site visits and interviews.

B.2.9 Site Visits and Interviews

This technique for collecting data on the impact of the project consists of visiting the industrial plant to interview key personnel and view the project installation firsthand. The primary purposes of the visit are to fill any gaps that may exist after reading the plant's submittals and to obtain more detailed information.

B.2.10 Interviews with Vendors or Private Firms

This technique involves obtaining secondary information on the impact of ECMs through phone interviews with vendors or other firms that have made similar installations. In most cases, a questionnaire to use in the interviews would be prepared ahead of time. Information received would generally be used to get an approximate idea of the costs and potential energy savings for the ECM under evaluation. In specific instances, it may be possible to make the engineering calculations required to assess the energy savings entirely from the interview information.

B.2.11 Process Evaluation Review

This part of the data collection activities describes what situations, conditions, and events took place during the ECM program. Process evaluations are carried out at several intervals during the program to respond to changes in market assumptions, and program effects, and to improve the program delivery and effectiveness. The program may be altered at this time or continue unchanged.

B.3 Case Studies and Findings

To meet the increasing demand for energy at reasonable cost, while minimizing the effects of energy production on the environment, the Pacific Northwest is pursuing energy conservation as a source of energy. Bonneville Power Administration's (Bonneville) goal is to save 660 average megawatts (aMW) by the year 2000 as its share of the Northwest conservation goal.

Bonneville recognizes that a potential source of significant energy conservation is the industrial sector. Accordingly, in 1987, Bonneville began offering the Energy $avings Plan (E$P) to obtain electrical energy conservation in this sector. Combined annual savings for all of the completed projects to date total over 104 million kWh per year. In terms of capacity, the program is saving about 11.9 aMW thus far. To date, the program has made acquisition payments totaling $3,853,800 to 55 participants. The total installed cost of the projects is $38,178,100. The average project is saving 1,892,300 kWh/yr (1,482,900 kWh/yr excluding the largest project which saves 24,000,000 kWh/yr).

B.3.1 Energy $avings Plan Description

The E$P Program is a retrofit program for industrial energy efficiency improvements designed to acquire conservation resources in the Pacific Northwest. The program pays the region's industrial customers to install electrical energy conservation projects. The E$P is an outgrowth of two earlier programs that involved installing projects in industrial firms: the Industrial Test Program and the Sponsor-Designed Program.

The E$P Program is open to a wide variety of technologies and provides an acquisition payment for each industrial project installed. Projects are accepted on a first-come, first-served basis. They must pass a free rider screen (as determined by Bonneville's Area Offices) and have an expected operating life of at least 15 years.

A firm interested in participating in the program first develops a proposal for the project. The proposal includes a description, anticipated installation schedule, estimated project costs, estimated energy savings (with calculations), an approach to energy consumption metering, and a proposed method to verify energy savings.

If Bonneville approves the proposal, a contract is negotiated according to site-specific provisions. Contract negotiations for the E$P are simple and generic. This feature is the result of lessons learned from evaluations of previous industrial sector programs that experienced difficulties with extensive contract negotiations (Gustafson et al. 1986; Gustafson and Peters 1987; Peters and Gustafson 1987). Some E$P contracts are between Bonneville and industrial firms directly; others are between Bonneville and local utilities, who then establish contracts with industrial firms in their service areas. After contract negotiation and award, a project's equipment can be purchased and installed.

Upon installation of the project, the firm is required to submit a "Completion Report" that includes pre- and post-installation energy consumption metering data, actual project costs, and calculation of the payment due from Bonneville. The payment ranges from 5 cents to 15 cents (at the discretion of the Bonneville Area Office involved) per kWh saved in the first year, or 80% of the installed cost of the project, whichever is less. Following receipt of the Completion Report, Bonneville inspects the site to verify installation of the project.

B.3.2 Impact Evaluation of the Energy $avings Plan Program

From its inception, the E$P has included provisions for impact evaluation of the program. Thus far, the evaluation has consisted of evaluating the impact of selected projects installed under the program. Twenty-five projects have been evaluated to date (Spanner and Brown 1993). Impact evaluations of more projects will be performed as the program continues.

The general objective of the impact evaluations is to determine how much electrical energy each project saved and at what cost to Bonneville and to the region. In support of this general objective, answers are sought to the following questions:

- How much electrical energy is saved annually by the project in terms of kWh and kWh per unit of plant output? Also, did any fuel switching result from implementing this project?

- If the project improved the productivity of the process, did the firm then increase output of the process to take advantage of the productivity improvement? Did the change in output result in a net increase or decrease in energy used by the process (takeback effect)? Did the change in output result in changes in output at the firm's other plants in the region?

- What was the net impact to the serving utility in terms of electrical energy consumption (in kWh) from implementing the project (after adjusting for effects such as cogeneration or obtaining power from multiple sources)?

- What are the levelized costs of the project from the perspectives of Bonneville and the region?

- How much of the project's impact can be attributed to the E$P?

To meet the evaluation objectives listed above, PNL developed a general impact evaluation methodology (Spanner et al. 1988). The major finding of the methodology development was that in the industrial sector, the impact of energy conservation projects must be considered on a case-by-case basis. Accordingly, the general methodology consists of a variety of impact evaluation techniques that can be applied to individual projects according to the specific circumstances. Various combinations of seven evaluation techniques from the general methodology have been used in impact evaluations to date. The techniques are engineering analysis, financial analysis, review of participants' submittals, site visits and interviews, equipment vendor interviews, time-series metering, and review of process evaluations if available.

Thus far, 25 projects have been evaluated using the case study method. Industries represented by the 25 projects include food processing, electrochemical processing, wood products manufacture, petroleum refining, iron casting, electronics manufacture, glass container manufacture, cement manufacture, and air separation. Technologies represented by the 25 projects include adjustable speed drives, waste heat recovery heat exchangers, refrigeration controls, electrochemical improvements, and compressor modifications. (See Table B.2 for a list of 14 projects evaluated; the studies describing impact evaluations are shown in the reference list for this appendix.)

In addition to the first 14 projects evaluated by the case study method, self-reported data for all 55 projects were also considered in this appendix.

Table B.2. Levelized Costs in 1992 Dollars, Including Administrative Costs

Type of Firm	Description	Year	Annual Savings (kWh/yr)	Installed Cost ($)	Bonneville Acquisition Payment ($)	Bonneville Levelized Cost (cents/kWh)	Regional Levelized Cost (cents/kWh)
Lumber mill	Adjustable speed drive	1988	1,029,000	45,925	34,442	0.51	0.73
Cold storage plant	Refrigeration control system	1988	1,094,000 minimum	169,300	65,100	0.76	1.63
Food processor	Heat exchanger	1989	4,037,100	67,020	40,212	0.13	0.21
Pulp mill	Screw press	1989	3,038,700	2,286,000	250,000	0.93	7.91
Electrochemical plant	Blade anodes	1989	6,242,200 maximum	418,176	250,000	0.67[a]	1.15[a]
Lumber mill	Adjustable speed drive	1990	286,500	24,086	19,269	1.02	1.21
Cattle feed plant	Heat exchanger	1990	339,400	15,754	9,452	0.47	0.65
Air separation plant	Larger compressor	1989	2,549,200	361,496	161,426	0.58	0.74
Petroleum refinery	Compressor destaging	1990	2,112,800	367,650	158,460	0.78	1.79
Electrochemical plant	Increase anode area	1990	24,000,000	1,410,400	212,500	0.09	0.62
Cast iron foundry	Furnace replacement	1992	1,122,000	293,469	123,780	1.08	2.49
Glass container plant	Adjustable speed drives	1991	1,711,500	182,834	95,581	0.56	1.07
Cement plant	Various measures	1992	1,782,000	248,232	115,615	0.62	1.41
Electronics plant	Adjustable speed drives	1992	2,582,900	252,068	206,654	0.75	1.07
Weighted Means						0.38	1.28

(a) Middle of likely range.

B.3.3 Energy Savings

By far, the technology that yielded the greatest energy savings per project is electrochemical improvements—over 15 million kWh/yr per project. Refrigeration controls, compressor improvements, and waste heat recovery technologies are all about equal in terms of energy savings per project—over 1.2 million kWh/yr.

Energy savings from the most-often installed technologies are shown in Table B.3. The most prevalent technology installed under the E$P Program to date is refrigeration controls (19 projects), typically computer-based energy management and control systems. These systems are installed at cold storage facilities and food processing plants to more accurately control refrigeration equipment. Refrigeration controls account for over 23 million kWh/yr in energy savings (~ 1.2 million kWh/yr per project). The next most prevalent technology, with 10 projects, is adjustable speed drives, which account for about 8.9 million kWh/yr in savings. Compressor improvements are the fourth largest energy saving technology, with savings of 7.4 million kWh/yr from 6 projects.

B.3.4 Output Changes

Of the first 14 projects evaluated, only 3 expected any increase in output to result from installing a project under the E$P. One of the projects allowed shorter cycle times for a batch process, so more cycles could be run per year. For this project, output was expected to increase by 12%, while energy consumption per unit of output decreased by 48%. The net energy consumption of the process decreased by 42%, even with the production increase.

Table B.3. Annual Energy Savings by Technology

Technology	Number of Projects	Annual Energy Savings (kWh/yr)	Average Annual Energy Savings per Project (kWh/yr)
Electrochemical improvements	3	4,653,580.00	1,551,190.00
Refrigeration controls	19	2,332,220.00	1,227,500.00
Adjustable speed drives	10	8,865,000.00	886,500.00
Compressor improvements	6	7,379,300.00	1,229,900.00
Waste heat recovery	4	5,048,100.00	1,262,000.00
Lighting improvements	5	796,500.00	159,300.00
Totals	**47**	**9,194,690.00**	

Another project simultaneously saved energy and increased the capacity of the firm's air pollution equipment so that the plant could be operated at higher output. The output level for the third project is limited by the plant's electric current carrying capacity. By reducing energy consumption per unit of output, the plant can increase its output up to its capacity to conduct electric current. At this higher level of production, there is no net energy savings for the process. Thus far, because of decreased demand for its product, this plant has not increased production above pre-E$P levels. The plant intends to eventually increase production such that net energy savings from its E$P project will be zero. It is unknown if this will ever happen, but in the meantime, the project is a net saver of energy.

Five of the first 14 projects evaluated were installed at firms with other plants in the Pacific Northwest. None of these firms expected to change output at their other plants as a result of E$P participation. Three of the firms with other plants in the region do not produce exactly the same products at the other plants, so shifting production is not a viable option for these firms. Another firm produces exactly the same products at several plants in the region. However, this firm will not be shifting production because differences in transportation costs for input stock (farm products) far outweigh any cost advantages resulting from the project installed. The final firm, with two plants in the region, had already installed a similar project at its other plant before installing a project under the E$P. Therefore, the E$P project did not lead to a cost advantage over the firm's other plant.

B.3.5 Net Impact to Utilities

Even though all of the projects that participate in the E$P save electricity, the electricity savings may not be fully realized at the participants' serving utility. There are several reasons for this. For instance, if a participating firm is a cogenerator, it might decide to realize the savings by decreasing its own electricity production and continuing to use the same amount of electricity from the serving utility. Or, the serving utility would not realize the savings if the participant decides to boost production as a result of its E$P project. Even though the plant is producing more output per kWh consumed, the net effect of the project could be zero if production is increased after project installation.

For the one project that may not result in decreased load at Bonneville (this firm happens to be served directly by Bonneville), the level of savings realized will vary depending on production levels. The output at this plant is limited by the amount of electricity that can be conducted by the busbars in the production equipment. At maximum production from this plant, the net savings from the E$P project are zero. The savings realized by Bonneville increase as the production level drops. At all levels of production, however, this project results in greater output per kWh consumed.

B.3.6 Levelized Costs

Levelized annual costs are used to compare the attractiveness of various projects or investment alternatives. The levelized cost is the annual cost that would be incurred over the life of the project, accounting for the time value of money. In other words, the levelized cost shows the cost per kWh saved over the life of the project, considering all relevant cash flows. Levelized costs provide a single figure of merit for comparing energy conservation alternatives. In addition, levelized costs can be used to compare and rank conservation projects with options for new generating capacity. The objective of using levelized costs to evaluate these projects is to determine the financial impact of each project to Bonneville ($/kWh saved) and to the region (Bonneville and the industrial firms combined).

In the industrial sector, the life of a project cannot be accurately predicted because any number of external factors could shorten or lengthen the project's expected life. To allow comparisons of levelized costs among projects installed under the E$P, all projects are assumed to have a life of 15 years. Even though some projects will have longer or shorter lives, 15 years is considered a conservative but likely life for typical projects in the industrial sector.

Bonneville's levelized costs are based on the acquisition payment it makes, the project's energy savings, an assumed discount rate, and an assumed project life of 15 years.

The levelized costs to the region include Bonneville's levelized costs, plus the levelized costs to the industrial firms. The major component of the firms' costs is the capital cost of procuring and installing the projects. The acquisition payment by Bonneville is included as a cost to Bonneville and as a reduction in cost to the firm. This approach is taken because the acquisition payment has federal income tax consequences to the firm and, therefore, is not a net zero cost to the region.

Table B.2 (shown on page B.12) presents the levelized costs for Bonneville and the region in 1992 dollars. The levelized costs in this table also include the cost for Bonneville to administer and evaluate the E$P Program. Administrative costs are assumed to be 10% of the acquisition payment for each project.

The bottom line of Table B.2 presents the weighted means of the levelized costs. The levelized costs for the individual projects are weighted in proportion to the energy saved by the projects, so that the weighted means indicate the "average" cost of energy savings for the program. Energy saved by the E$P Program costs Bonneville 0.38cents/kWh and costs the region 1.28cents/kWh.

Because outliers tend to skew the weighted mean levelized costs for the program, the program levelized costs were also calculated with two outliers excluded from analysis. In the second column of Table B.4, the levelized cost of the program is shown with two outliers excluded. One of the projects is an outlier because the savings are so great (24 million kWh/yr) compared with the other projects. The other project is an outlier because the firm installed its project largely for reasons besides energy savings (chemical savings and labor savings). The project was more than five times as costly as any other project except one, resulting in an artificially high levelized cost. With these outliers excluded, the levelized cost of the program is 0.59 cents/kWh and 1.07 cents/kWh for Bonneville and for the region, respectively. The figures in this column are the best representation of the levelized costs for typical projects in the program.

Table B.4. Effect of Outliers and Free Riders on Program Levelized Costs, 1992 Dollars

	14 Projects Included	Excluding Two Outliers	Free Riders Excluded, Bonneville Costs for Free Riders Included	Free Riders Excluded, Bonneville Costs for Free Riders Excluded
Bonneville Levelized Cost (cents/kWh)	0.38	0.59	0.42	0.33
Regional Levelized Cost (cents/kWh)	1.28	1.07	0.87	0.82

As Tables B.2 and B.4 show, the E$P Program is a cost-effective means to obtain energy conservation. From Bonneville's perspective, the most expensive energy conserved by the program costs slightly more than 1 cent/kWh, with an average real levelized cost of 0.38 cents/kWh. From the region's perspective, the typical kWh saved by the program costs about 1.28 cents/kWh, which compares favorably with the levelized cost for new generating resources of about 5 cents/kWh.

B.3.7 Free Riders

One of the most important questions to be answered by the impact evaluations is whether the projects receiving acquisition payments are free riders. That is, would the projects have been installed without the acquisition payments from Bonneville's E$P Program? Free ridership hurts the E$P Program because free riders dilute the resources available for industrial energy conservation and thereby inhibit the program's impact.

Throughout its existence, the E$P has included provisions to prevent free ridership. Early in the program, only projects with a simple payback greater than 1 year were eligible. Simple payback was defined as the project cost divided by the value of annual electrical energy savings resulting from the project. Included in the value of energy savings are the effects from demand, energy, and power factor. In the current E$P, simple payback requirements still exist, but there is no fixed limit. Another former provision to prevent free riders was that installation of a project could not begin before the effective date of the project's authorizing agreement.

Even though the E$P has always included provisions to prevent free rider participation, the impact evaluations found a significant level of free ridership in the program. Of the first 14 projects evaluated, four were found to be complete or partial free riders. All four met the criteria intended to prevent free rider participation. Of these four, two were completely free riders, one was a partial free rider because the project would have been installed a few years later without the acquisition payment from the E$P, and one was a partial free rider because one of the four measures in the project would have been installed without the acquisition payment from the E$P.

To help put the free rider issue in perspective, the levelized costs of the program were re-calculated to show the effect of using E$P funds to pay for energy savings that are not attributable to the program. Note that the levelized costs presented in Table B.2 do not distinguish between free riders and legitimate participants; both are included in the levelized cost calculations.

Table B.4 shows how free riders affect the levelized costs of the E$P Program. In the first column of the table, 14 projects are included in the levelized cost calculations (refer also to Table B.2). The third column illustrates the effect if Bonneville pays for free riders. The figures in this column were calculated by excluding the energy savings and installation costs of the free rider projects, but including Bonneville's costs for those projects. Notice that Bonneville's levelized cost for the program is higher than for the original 14, but the levelized cost for the region is lower. Bonneville's cost is higher because its costs remain the same while savings decrease. The region's cost is lower because a very costly free rider project without correspondingly great energy savings is excluded, which decreases the overall levelized cost. The fourth column of the table illustrates what levelized costs for the program would have been if an effective free rider screen had been in place. In this case, none of Bonneville's costs, installation costs, or energy savings associated with the free rider projects are included because they would not have been part of the program if it had a perfect free rider screen. With free riders excluded completely, Bonneville's levelized cost drops to 0.33 cents/kWh versus 0.38 cents/kWh, and the region's levelized cost drops to 0.82 cents/kWh versus 1.28 cents/kWh.

As noted earlier, four of the projects identified as free riders by the impact evaluations met the criteria intended to prevent free rider participation. Therefore, a more effective screen is necessary to better prevent free ridership.

Most of the firms interviewed during the impact evaluations said they use simple payback as the criterion for making implementation decisions regarding energy conservation projects. The simple payback criteria cited ranged from 1 or 2 years to 4 years. The mean value for firms that use simple payback as the decision criterion is 3.1 years. One way that Bonneville could improve the effectiveness of its free rider screen is to increase the simple payback threshold from 1 year to 2 or 3 years.

Another finding from the impact evaluations is that firms consider more factors than just electrical energy savings when calculating simple payback for energy conservation projects. Other factors mentioned included improved process control, reduced operation and maintenance costs, shorter cycle times, and improved product quality. To make its simple-payback free rider screen more effective, Bonneville should specify that the payback calculation includes all savings associated with a project, not just electricity savings. Such a requirement would have eliminated three of the free riders identified during the impact evaluations.

B.3.8 Persistence

In any discussion of impact evaluations in the industrial sector, it is important to understand that savings over time (persistence) are highly uncertain. It is difficult enough to verify the energy savings from a project at one point in time, let alone over the life of the project. Even though significant uncertainty is involved, the energy savings contained in the individual impact evaluation reports and reproduced in this appendix are intended to be long-run estimates.

When evaluating the impact of the first 14 projects, the evaluator considered all of the available information that indicated long-term savings. For some of the projects, whose impact was evaluated approximately 1 year after project completion, large differences between savings reported in the Completion Reports and those calculated in the impact evaluations were already apparent. The differences arose because in only a year or less, factors that affect the long-term savings from the projects had changed at the firms.

The long-term savings from projects at industrial firms can be affected by changes in a number of factors, many of which are interdependent. One major factor that affects long-term energy savings is changes in market conditions. As market conditions change, firms respond by adjusting output either up or down. Changes in market conditions were found to take many forms for the firms evaluated. The most common type of market change was changing demand for the firms' products. Another type of changing market condition was the success or failure of competitors. Output increased for one firm whose competitor closed a nearby plant, while output decreased for another firm that lost a large contract to a competitor. Another E$P participant stated that the availability of substitute products in the market affected demand for its product, which in turn affected long-term energy savings.

Plant expansions were also found to affect long-term energy savings. Some of the plants evaluated expanded after they had installed E$P projects, although the projects had no bearing on the plant expansions. Depending on the specifics of the plant and its project, the expansions could lead to either an increase or decrease in energy savings.

At some plants, the availability of input materials was found to affect the long-term savings of E$P projects. In particular, plants that process forest products face uncertain supplies of raw material in the future because of continuing controversy over how to best manage forest resources in the Pacific Northwest. Other plants use fish and agricultural products for their inputs; the availability of these vary over time, thereby affecting plant throughput and, hence, energy savings.

Governmental regulations were found to affect the long-term energy savings of some projects installed under the E$P. For instance, the regulation of dioxins in the pulp industry affected the demand for the output produced by one E$P participant, and this change in demand is in turn expected to affect the energy savings achievable.

The final factor—changes in output level and product mix that affect long-term savings—is highly interdependent with the other factors described previously. Changes in either output or mix can affect energy savings either up or down, and these changes are frequently related to at least one of the factors discussed above. In some cases, an increase in output can cause a decrease in net energy savings, while increasing the energy savings per unit of output.

B.3.9 Conclusions

A number of conclusions are drawn from the impact evaluations discussed in this appendix.

- When considered from the perspective of savings per project, industrial sector energy savings obtained by the E$P are significant, particularly compared with the residential and commercial sectors. For the first 14 projects evaluated, energy savings vary from 286,000 kWh/yr to 24,000,000 kWh/yr. For the E$P Program on the whole, savings are 11.9 aMW.

- The E$P is a cost-effective means to obtain electrical energy savings. From Bonneville's perspective, the levelized cost of energy saved by the program is between 0.09cents/kWh and 1.08cents/kWh in 1992 dollars for the first 14 projects evaluated. From the region's perspective, the typical kWh saved by these 14 projects costs about 1.3 cents/kWh.

- In the industrial sector, it is difficult to predict the long-term savings from energy conservation projects with any certainty. For purposes of these impact evaluations, all projects are assumed to last for 15 years, and for most projects, savings are assumed to be constant throughout the project's life. A number of factors make it difficult to accurately predict long-term savings in the industrial sector, most notably changes in market conditions.

- Impact evaluations of selected E$P projects may be more effective if performed over time to assess the persistence of the savings.

- There is appreciable free ridership among participants in the E$P Program. Of the first 14 projects, four were found to be complete or partial free riders. A more effective screen would reduce the number of free riders who are unnecessarily using program funds. One example of an improved screen might have these three features: 1) projects should have a minimum simple payback of 2 years; 2) the simple payback calculation should consider all financial savings that result from a project, not just the avoided cost of electrical energy saved; and 3) no equipment should be ordered, purchased, or installed (as opposed to the former program rules, which stipulated "purchased or installed" only) before an E$P contract has been signed.

- Impact evaluations performed to date have been done on a case-by-case basis because, in the industrial sector, that is the only approach that has been shown to work. Nonetheless, the ultimate goal of industrial sector evaluations should be to somehow predict the impact of entire industrial sector programs. Specifically, it would be useful to have a methodology that allows DSM planners to predict with more confidence the amount of energy savings expected to accrue from a given industrial sector program.

B.3.10 How the Evaluation Results Are Used

Since 1980, Bonneville's policy has been to perform rigorous evaluations of all of its conservation program.[a] Bonneville views the acquisition of conservation resources as an iterative process involving 1) assessing the availability of the resource, 2) planning to acquire it, 3) implementing pilot and demonstration programs, 4) evaluating the results, and 5) modifying plans and program design based on the results.

In general, evaluation results are used to inform ratepayers on the cost of programs and net actual savings, to indicate a program's cost effectiveness, to affect planning estimates of future program savings, and to forecast future loads. Most especially, the evaluations help determine the real levelized cost of a program over its life and the amount of conservation resources needed.

In the case of the E$P Program, impact evaluations were begun during the pilot stage of the program. These early evaluation results were used to adjust the acquisition payments offered in later phases of the program and to estimate future program savings. The results of process evaluations done concurrently with the early impact evaluations were used to modify the program in a number of ways to increase its penetration.

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Appendix C

Prospects for Utility Industry Restructuring

Appendix C

Prospects for Utility Industry Restructuring

To understand the debate about electric power restructuring and its potential effects on DSM programs, it is important to define wholesale and retail wheeling. Historically, only investor-owned utilities, municipal utilities, and federal or state power authorities could build and own electric generating plants and could buy and/or sell electricity to other entities under federal regulation. Buying or selling such electricity was called a wholesale transaction and the "movement" of the electricity through the transmission grid was called **wheeling**. Starting in 1978, under the Public Utilities Regulatory Policies Act (PURPA), other parties were allowed to build and/or own electric generating facilities while not being considered public utilities under the Public Utility Holding Company Act (PUHCA) of 1935. Such parties, called independent power producers (IPPs), can sell their output from a generating unit to a public utility on the grid. These electricity sales, because they are not to final consumers of electricity, are referred to as "sale of electricity at wholesale," the transmission being **wholesale wheeling**.

With the passage of the Energy Policy Act of 1992 (EPACT), a new class of non-PUHCA power plant owners was created—the exempt wholesale generator, or EWG. An EWG is a corporate entity engaged exclusively in the wholesale generation of electricity. The Federal Energy Regulatory Commission (FERC) was empowered to order transmission owners to provide access to the grid to IPPs or EWGs for wholesale wheeling.

The EPACT specifically prohibited the FERC from ordering **retail wheeling**. Retail wheeling is the transmission of power generated and sold by third parties (IPPs or EWGs), using utility transmission lines, to ultimate end users, such as a factory (Terzic 1992). The authority to allow or order retail wheeling lies with each state or local government under applicable state law.

C.1 ELCON and Other Interested Parties

The Electricity Consumers Resource Council (ELCON) advocates the establishment of retail wheeling for industrial customers so they can purchase electricity from the lowest cost utility, IPP, or EWG and have the power wheeled to their facilities. Retail wheeling would spur competition among electricity generators and eliminate high and disparate prices.[a] ELCON's position is that current electricity prices are

(a) Anderson, J. 1994. "The Changing Structure of the Electric Power Industry." Presentation at the Energy/Environment Seminar. U.S. Department of Energy, Washington, DC.

too high. According to ELCON, severe rate disparities exist in most regions and states, resulting in significant anticompetitive consequences for industrial end users. ELCON cites price discrimination, cross subsidies, inefficient utility planning and operation, and inadequate regulatory oversight as the cause of the rate disparities.

Another industry group—the Ad Hoc Committee for a Competitive Electric Supply System (ACCESS)—lists additional benefits it sees in retail wheeling, including 1) pressure on utilities to control costs, 2) closer matching of generating capacity to demand, 3) better mix of generating fuels, and 4) provision of benchmarks for regulators (EEI 1992).

Other organizations and groups, including municipalities and school districts, are also in favor of retail wheeling to secure significant electricity price savings where they are available. Altogether, ELCON, individual industrial companies, municipalities, and other groups advocate some form of retail wheeling. Because FERC cannot order it, the matter is being debated in state legislatures and public service commissions in many states.

C.2 Status of Retail Wheeling in the States

As of September 1994, four states had some form of legislative initiative regarding retail wheeling. These initiatives range from investigating retail wheeling to recommending greater reliance on market forces to holding hearings on the subject to prohibiting retail wheeling outright. Eighteen states had initiated some type of regulatory action on retail wheeling: workshops and conferences, generic competition dockets, retail wheeling proposals, decisions that retail wheeling is not in the public interest, permitting of retail wheeling where market forces allow, a utility proposal to offer retail wheeling to its largest customers, investigation of back-up rates and stranded investment, a pilot retail wheeling experiment, petition by a new entity to provide retail wheeling on a utility transmission system, and the tabling of a petition by a township to engage in retail wheeling until completion of a generic retail wheeling investigation (EEI 1994). The two states that are being most closely watched are Michigan and California.

In Michigan, the Public Service Commission (PSC) issued an interim order on April 11, 1994, authorizing a retail wheeling experiment. The order asserted jurisdiction to order retail wheeling, approved certain terms and conditions of an experimental retail wheeling program for end use customers located in Consumers Power and Detroit Edison's service territory, and set a future proceeding to set rates and charges. To minimize stranded costs, the experiment would not occur until Detroit Edison's next capacity bid solicitation, expected in the year 2000. Detroit Edison is appealing the order to a U.S. District Court, basically on the grounds that the Michigan PSC has no authority to order such an experiment (EEI 1994).

Also in April 1994, the California Public Utility Commission (CPUC) proposed a restructuring of the California electric industry. Key objectives of the proposal are

- to exert downward pressure on electricity prices
- to phase in direct access, from 1996 to 2002
- to move to performance-based regulation.

The direct access would begin with the industrial customer class in 1996 and expand to cover all classes (commercial and residential) by 2002. The objectives would be accomplished while maintaining the financial integrity of the utilities, providing for transition cost recovery, protecting smaller customers, and continuing social and environmental programs (EEI 1994).

Pacific Gas & Electric (PG&E) urges the CPUC to phase the program in over 12 years—through 2008—to avoid stranded costs, allow PG&E to collect above-market qualifying facility (QF) costs and regulatory assets in a "transition" charge, ensure social and environmental program funding, and develop procedures and protocols for large-scale implementation based on initial small-scale experience.[a]

C.3 Utility and Trade Association Reaction

The reaction of utilities throughout the country depends primarily on each utility's own production cost and rate-base situation. Utility views toward retail wheeling vary considerably, from those completely in favor to those completely opposed. In general, those most in favor of retail wheeling have low production costs and low-valued production assets, for example PSI Energy and Wisconsin Electric Power Company.

Utilities that are against retail wheeling take that position because they have high generation costs and/or high-cost assets on the books, especially if they own recently constructed nuclear power plants or coal plants with expensive scrubbers. Such high costs put them in peril of losing load to lower-cost suppliers and losing revenue needed to recover costs of expensive generating equipment—the stranded investment problem. Such utilities include Detroit Edison, Boston Edison, and Potomac Electric Power Company.

An executive of the Edison Electric Institute (EEI) argues that electric utilities already face considerable competition from IPPs and EWGs, as well as from other fuels. Investor-owned utilities are also saddled with the obligation to serve, which other suppliers do not face. Investor-owned utilities with excess power already sell such power in the wholesale market, and utilities are either purchasing lower-cost power or building it themselves. Thus, in this executive's view, retail wheeling is not likely to occur. Customers want a choice, but given the past regulated power market, any change cannot proceed without first establishing a consistent set of rules for all suppliers; a framework is needed to promote efficient competition, i.e., access to and pricing of (based on marginal costs) the whole system for all customers.[b]

(a) Pfannenstiel, J. September 29, 1994. "PG&E's Proposal to Restructure California's Electric Industry." Presentation to invited group, Washington, DC.

(b) Owens, D. September 28, 1994. Comments at the Energy/Environment Seminar. U.S. Department of Energy, Washington, DC.

C.4 Issues and Concerns Associated with Retail Wheeling

Of the many issues surrounding retail wheeling, some of the most debated are these:

- the conflict between retail wheeling and a regulated utility's obligation to serve
- the higher rates to cover lost revenue from lost load, the potential harm to customers—residential and small commercial and industrial—who may not be allowed to, or may be unable to, engage in retail wheeling
- the problem of how to allocate costs between a utility's regulated core business and its competitive business
- potential degradation of the quality and reliability of service (EEI 1992)
- the extent (in terms of customer classes and size of customers) to which retail wheeling is offered to customers and the timing of the restructuring
- the impact on the funding and implementation of social (i.e., low-income) programs and DSM programs.

The last area of concern, specifically concerning industrial DSM, is of greatest interest for this report.

C.5 Potential Impacts of Retail Wheeling on Industrial Demand Side Management Programs

Under a retail wheeling market structure, to what extent will investment in DSM be encouraged? Will utilities continue, change, or abandon their DSM programs?

Clearly, no technical barriers exist to prevent retail wheeling for large commercial and industrial customers in the short-term and for all customers in the long-term. Retail wheeling is already being implemented in Australia, Norway, and the United Kingdom. All of these countries have plans to extend retail wheeling to all customers (the U.K. as early as 1998).

However, it is also clear from the experience of these countries that the introduction of retail wheeling poses a definite threat to DSM. In 1991, the Norwegian government enacted legislation creating a market-based system with open competition in the production and sale of electricity. As a consequence, even though at the time the government supported IRP and DSM, interest in DSM on the part of the electric industry and the government declined. Since 1991, the electric industry has been more interested in capturing market share. Prices for large customers initially dropped by 25%, while prices for small, captive customers rose by 3%. Meanwhile, DSM activity and funding dropped by 50%; the government dropped its electric industry IRP and DSM requirements, putting conservation activities into separate regional energy conservation centers but with limited funding (Haaland and Wilhite 1994).

Swisher (1994) provides another perspective on deregulation in other countries: in his view, the trend toward deregulation "...makes it increasingly unlikely that electricity suppliers...will adopt energy-efficiency programs similar to those of the regulated North American utilities." The goal of deregulation is to improve the efficiency of the electric *supply* system, not the demand side. Demand side management does not compete well in this environment primarily because the decision-making process becomes fragmented, i.e., there is no longer a mechanism such as IRP that compares energy efficiency against the long-run marginal cost of new supply (Swisher 1994).

In the United States, several examples point to at least a partial erosion of support for DSM. After submitting and receiving approval for a 3-year comprehensive DSM plan in Arkansas, Entergy (serving much of Arkansas, Louisiana, and Mississippi) recently suspended all expenditures and implementation of the plan. In New York, the New York State Energy Research and Development Administration and Niagara Mohawk Power Company are pilot testing "by-pass," a concept that allows industrial customers to choose not to participate in or share the full cost of financial incentives included in a DSM program in exchange for lower rates devoid of some DSM costs. In the Northwest, Bonneville Power Administration has announced its intention to drop its industrial DSM incentive programs at the end of 1995 and substitute "two-tiered" rates: one tier reflecting average embedded costs and the other market-determined costs (i.e., price competitive with IPPs). In addition, services formerly linked together would be unbundled into discrete component services, including remaining DSM services for other customer classes, which would have to succeed in a competitive market (Warwick and Bailey 1994).

Not everyone, however, sees DSM as being incompatible within a retail wheeling framework. Wiel (1994) writes that no incompatibility exists—even across a broad range of restructuring possibilities. A former state regulatory commissioner now with Lawrence Berkeley Laboratory, Wiel examines DSM from a program planning perspective, which divides DSM program planning into four phases: analysis, design, implementation, and evaluation. Analyzing these phases of DSM program planning under different electric industry ownership, planning, and structural scenarios, Wiel concludes that "...robust and effective utility DSM can be implemented in any industry structure." Nothing limits a government from imposing IRP or DSM, though, how and where the implementation occurs will, of course, depend on the exact structure involved. Likewise, he states, "If one is disinclined to do IRP or DSM, then functional separation, structural separation, competition or privatization can become the excuse. If one is inclined to do IRP or DSM, there is nothing inherent in structural separation, functional separation, competition or privatization that limits it." (Wiel 1994)

C.6 Conclusions

It is fair to say that the present system—characterized primarily by state regulation of investor-owned utilities—has failed to attain the performance one would expect from the operation of a competitive market. The simplest proof of this is twofold: 1) the existence of significant electric rate differentials (ranging from 2-to-1 to 4-to-1) existing in numerous utilities having common franchise boundaries and 2) the existence of significant numbers of overvalued generation facilities, especially most recently built nuclear power plants and some coal-fired plants (with costly scrubbers). The major reasons for these phenomena are, first, PUHCA, which largely froze the structure of the utility industry in 1935 into numerous small and medium-sized utilities, and, second, state utility franchise regulation, which looks only at costs and cost recovery by an individual utility according to rate-base formulas. In this environment, real market competitive pressures do not exist. Only when the federal government forced a crack in the wall of franchise regulation with PURPA's allowance of IPPs and QFs did new and cheaper generation alternatives arise. Now with the advent of wholesale (through EPACT) and state retail wheeling initiatives, competitive pressure will accelerate and may break the wall down completely.

Industrial DSM as it is currently applied (mostly audit and efficient-equipment incentive programs) may fade from the scene in the short-term. Those utilities currently saddled with high costs greatly fear competition and its consequences—lost load, lost revenues, failure to cover fixed costs, and declining stock market prices. The managers of such utilities will prefer spending a dollar to increase market share or to lower production costs to any dollar spent on DSM. Only utilities with low costs will consider DSM (as a value-added service), but even they may abandon it themselves and compete only on price because in a competitive market they also will prefer a dollar spent to increase market share and to maintain their low-cost production competitive edge. Thus, unless an outside force requires the offering of cost-effective DSM programs in the short-term, the logical conclusion is that DSM programs will likely be abandoned by most utilities currently offering them.

IRP and DSM can be implemented in a retail-wheeling environment (Wiel 1994). Assuming full retail wheeling, DSM can at minimum be planned and implemented at the distribution level. Marginal generation costs and prices can be signaled through the generation/transmission system and kept separate from the costs of transmission/distribution. Transmission and, particularly, distribution costs and prices will likely remain under traditional regulation, which can maintain IRP and DSM planning and implementation. In addition, nothing prevents government itself from undertaking DSM programs directly because DSM programming is, in essence, a public good. Government can raise money through taxes and provide basically the same programs and incentives. So far, the simpler course has been to "tax" ratepayers through higher initial rates to fund DSM to obtain its long-run benefits (Wiel 1994).

Finally, to reap its full rewards (lower costs supply *and* more efficient use of energy), retail wheeling services must be offered at true marginal cost-based real-time rates to all customers. In this way, providing the correct price signal at all hours to all customers will aid the introduction and adoption of new energy efficient equipment and new communication and energy use control technologies. And if DSM programs should wither away, such pricing and open access may support and stimulate the market for ESCO services, particularly specialized ESCO services targeted to the industrial sector.

In the two case studies presented in Chapter 5 of this report, among the values of industrial DSM programs and incentives in spurring cost-effective energy efficiency investment are the adoption of new, more effective wastewater treatment and other technologies. Energy use is so tied to process productivity, environmental emissions compliance, health and safety, etc., that it would be very unfortunate to abandon these programs. Utilities such as PSI Energy and Tacoma City Light serve as models for industrial DSM in the face of retail wheeling. If stranded investment is the real driving force behind diminished emphasis on DSM, a mechanism could be devised to eliminate that problem to keep DSM on a footing equal in cost and price competition with supply options.

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Appendix D

Protocol for Interviews With State Regulators and List of Interviewees

Appendix D

Protocol for Interviews With State Regulators and List of Interviewees

A. State
Contact

B. Data on this State
Utilities with DSM programs
Types of DSM
Method of cost recovery

C. Issues Discussion

1. Industrial DSM activity
   What is the status of industrial DSM in your state?
   What is the industrial customer motivation to participate in a DSM program?
   What is the utility motivation?
   Can you describe a particularly successful industrial DSM program?
   Have there been any failures?
   How would you characterize the customer and utility points of view?

2. Cross subsidization
   How are industrial DSM costs recovered by the utility?
   Are costs for DSM programs allocated across all customer classes, or confined to the class incurred?
   Has your commission made a judgment on cross subsidization?

3. Retail wheeling
   Is retail wheeling a looming issue in your state?
   Why or why not?
   Do you expect a retail wheeling rule in another state to affect you?

4. Cogeneration
   Are there any industrial cogenerators?
   How does cogeneration affect industrial DSM?

5. Independent Power
   Are industrial customers also served, or capable of being served, by independent power producers?
   Have any industrial customers threatened to turn to an independent if forced to incur costs for DSM programs in their rates?

6. Integrated Resource Planning (IRP)
   Have industrial customers participated in any IRP-related proceeding?
   What were the docket and issues related to DSM?

7. Environmental Externalities
   Have the utilities and/or industrial customers signed on to the Climate Change Action Plan (CCAP) Climate Challenge?
   Is emissions reduction an objective of the industrial DSM programs?
   How much SO2/NOX/NO2 has been reduced?

8. Technical Assistance Centers (TACs)
   Is there a TAC-type facility in your state?
   Do utilities and industrial customers use it?
   Who can I call to find out more about this?

9. Other Issues
   Estimating the market potential
   Anti-trust concerns
   Scheduling (business cycle effects)
   Complexities of implementing energy conservation measures at industrial sites
   Opting out of utility DSM programs
   Policy positions of nongovernmental organizations

10. Recommendations
    What do you think will happen with industrial DSM over the next 3 years?

    What do you think the DOE/State Energy Office/other federal agencies should do to improve industrial DSM activities?

The following PUC staff were interviewed:

Pennsylvania Public Utility Commission
Dan Griffith
Cal Birge

Wisconsin Public Service Commission
Tim Kay

Utah Public Service Commission
Richard Collins

Iowa Utilities Board
Gordon Dunn

Public Utility Commission of Texas
Danielle Jaussard

California Public Utility Commission
Don Schultz

Minnesota Department of Public Service
Allen Krug

New York State Public Service Commission
Shirley Anderson

Georgia Public Service Commission
Dan Cearfoss

Massachusetts Department of Public Utilities
Theo MacGregor

Appendix E

Bibliography

Appendix E

Bibliography

This bibliography includes the many works which may have influenced the writers but were not directly cited in this report. In addition, included at the beginning are six abstracts which present a summary of information from major surveys and important references on industrial DSM.

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In 1992, the Energy Power Research Institute surveyed the states on the types of utility demand-side management programs that existed in each state. The 951 industrial programs revealed by the survey were divided into general categories which included

- 168 special rate
- 155 lighting and lighting equipment
- 128 efficient equipment and appliance
- 122 heating, ventilation, and air-conditioning
- 114 motor and efficient motor drives
- 111 audit and building envelope
- 60 thermal storage
- 53 load control
- 30 standby general
- 10 miscellaneous and information.

The top ten states in order of number of programs are Wisconsin, California, Minnesota, Texas, Iowa, Massachusetts, New York, Washington, Pennsylvania, and Vermont.

These general statistics may be helpful when trying to determine the programs and states with expertise in industrial DSM.

MSB Energy Associates. March 1992. *Industrial Demand-Side Management Opportunities: Utility Programs, Technologies, and Information Services.* MSB Energy Associates, Middleton, WI.

This report, published by MSB Energy Associates, examines different kinds of industrial DSM programs offered by utilities, and types of technologies which can be implemented to improve industrial energy efficiency. These technologies include

- efficient motors and motor drives
- efficient heating, ventilation, and air conditioning equipment
- efficient lighting
- electrotechnology, including industrial technologies for heating, melting, drying and curing, refrigeration, electrolytic reduction, plating and galvanizing, and others.

This report includes brief summaries of 12 industrial DSM programs, including examples of program literature each utility provides to prospective participants. It also includes selected documents about technical aspects of industrial energy conservation.

Nadel, Steven and Jennifer A. Jordan. 1994. *Designing Industrial DSM Programs That Work.* American Council for an Energy Efficient Economy, Washington, DC.

This report analyzes 31 cutting-edge industrial DSM programs conducted by 17 utilities. The authors identify key components of the most successful programs. These components include

- addressing customer concerns
- strong marketing techniques
- program flexibility
- financial incentives
- program analysis and evaluation.

Based on these programs, the authors recommend measures which can be taken to reduce system-wide barriers to DSM in the United States and to improve the effectiveness of individual programs.

Office of Technology Assessment (OTA). August 1993. *Industrial Energy Efficiency.* OTA, Washington, DC.

This report, developed by the Office of Technology Assessment of the U.S. Congress, provides a comprehensive overview of industrial energy efficiency issues in the United States and policy measures which have been taken to address these concerns. Policy options for future action are also addressed, including

- energy auditing and technical assistance
- energy-use reporting and targeting
- public recognition programs
- energy efficiency equipment standards, testing, and labeling
- technology research, development, and demonstration
- nonutility power generation
- utility efforts to encourage industrial energy efficiency, including integrated resource planning and demand-side management programs.

This report includes macroeconomic data profiling overall energy consumption in the United States, energy use by industries, and national energy intensity figures. It also describes technologies and management techniques which can be applied to achieve improvements in industrial energy efficiency, including industrial DSM programs. The final section concerns energy efficiency in the corporate context.

President's Commission on Environmental Quality. 1992 *Energy Efficiency Resource Directory: A Guide to Utility Programs.* Barakat & Chamberlin, Inc., Oakland, CA.

This directory, developed by Barakat & Chamberlain for the President's Commission on Environmental Quality, provides information on a range of utility-sponsored energy efficiency programs. Each entry identifies the program's target market, lists program services offered by the utility, and briefly describes the project. In all, the directory contains data on 1,021 DSM programs electric utilities are conducting in the United States.

Of the programs contained in this report, approximately

- 530 programs targeted the residential sector
- 560 programs targeted the commercial sector
- 350 programs targeted the industrial sector
- 70 programs targeted the agricultural sector.

Utility Data Institute (UDI). December 1993. *The Official Guide to Demand Side Management Programs and Research.* UDI/McGraw-Hill, Washington DC.

This guide, published by the Utility Data Institute, begins by addressing the topic of modifying the behavior of electricity consumers. Based on survey results from 223 organizations, the report analyzes the market for DSM and profiles organizations involved in DSM programs. These organizations include

- 109 electric utilities
- 13 gas and electric utilities
- 6 gas utilities
- 38 consultants
- a broad range of other actors, including state governments, manufacturers, trade associations, independent laboratories, and energy service companies (ESCOs).

This guide also includes a database with sections covering DSM organizations and contacts, 913 utility DSM programs, programs conducted by the Electric Power Research Institute and the Gas Research Institute, a keyword index, and a listing of DSM consultants and reference programs to support the implementation of DSM.

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Appendix F

Acronyms and Initialisms

Appendix F

Acronyms and Initialisms

AMW	average megawatt
ACEEE	American Council for an Energy Efficient Economy
ACCESS	Ad Hoc Committee for a Competitive Electric Supply System
ADSMP	Association of Demand-Side Professionals
AEC	Alternative Energy Corporation (North Carolina)
AGA	American Gas Association
AHU	air-handling unit
ASE	Alliance to Save Energy
BBS	bulletin board service (on computer networks)
BCC	Boise Cascade Corporation
BG&E	Baltimore Gas and Electric Company
BOD	biochemical oxygen demand
BPA	Bonneville Power Administration
CAREIRS	Conservation and Renewable Energy Referral Service
CCAP	Climate Change Action Plan
CEC	California Energy Coalition
CLEAN	Comprehensive Least Emission Analysis
CMF	Center for Materials Fabrication
CMP	Central Maine Power
CMTC	California Manufacturing Technology Center
COP	coefficient of performance
CPUC	California Public Utility Commission
CTAC	Customer Technology Application Center (sponsored by Southern California Edison)
DAS	data acquisition system
DCF	discounted cash flow
DDC	direct digital control
DOE	U.S. Department of Energy
DSM	demand side management
EADC	Energy Analysis and Diagnostic Centers (a program of the DOE)
ECM	energy conservation measure
ECO	energy conservation opportunity
EEI	Edison Electric Institute
EER	energy efficiency rating
EETC	Energy Engineering Technical Center (Eli Lilly and Company)
EIA	Energy Information Agency

ELCON	Electricity Consumers Resource Council
EMS	energy management systems
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act of 1992
EPIC	EPRI Partnership for Industrial Competitiveness
EPRI	Electric Power Research Institute
EREC	Energy Efficiency and Renewable Energy Clearinghouse
ERG	Electrotechnology Reference Guide
ERIP	Energy Related Inventions Program (a grant program run jointly by the DOE and the Department of Commerce)
ESCO	energy service company
E$P	Energy $avings Plan (BPA demand-side management program)
ETAC	Electrotechnology Application Center (sponsored by PP&L)
EWG	exempt wholesale generator
FDA	U.S. Food and Drug Administration
FEDS	Federal Energy Decision Screening System
FEMP	Federal Energy Management Program
FERC	Federal Energy Regulatory Commission
GAUGES	Global Automated Urban Government Energy System
GLMTC	Great Lakes Manufacturing Technology Center
HRU	heat recovery unit
HVAC	heating, ventilation, and air conditioning system
IEL	Industrial Electrotechnology Laboratory (North Carolina)
IPI	Industrial Program Guide
IPP	independent power producers
IRP	integrated resource planning
IRR	internal rate of return
LCC	Lilly Corporate Center
LPC	levelized production cost
LPG	liquefied petroleum gas
MECS	Manufacturing Energy Consumption Survey
MEP	Manufacturing Extension Partnership (a program of the Department of Commerce, NIST)
MTC	Manufacturing Technology Center (part of the NIST MEP program)
MOU	Memorandum of Understanding
NAESCO	National Association of Energy Service Companies
NATAS	National Appropriate Technology Assistance Service
NCAEC	North Carolina Alternative Energy Corporation
NGO	nongovernmental organizations
NICE3	National Industrial Competitiveness Through Energy, Environment, and Economics
NIST	National Institute of Standards and Testing (part of the Department of Commerce)
NMPC	Niagara Mohawk Power Company
NPDES	National Pollution Discharge Elimination System

NPV	net present value
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NY ITAC	New York Industrial Technology Assistance Center
NYPSC	New York Public Service Commission
NYPUC	New York Public Utility Commission
NYSEO	New York State Energy Office
NYSERDA	New York State Energy Research & Development Agency
OTA	Office of Technology Assessment
OUT	U.S. Department of Energy, Office of Utility Technologies
PG&E	Pacific Gas and Electric
PNL	Pacific Northwest Laboratory
PP&L	Pennsylvania Power & Light
PSC	public service commission
PUC	public utility commissions
PUHCA	Public Utility Holding Company Act of 1935
PURPA	Public Utilities Regulatory Policies Act of 1978
QF	qualifying facility
ROI	return on investment
SECO	State Energy Conservation Office (Texas)
SEER	standard energy efficiency rating
SIC	standard industrial classification
STEP	State Technology Extension Program (part of the NIST MEP program)
TAC	Technical Assistance Center
TCL	Tacoma City Light
WCDSR	Wisconsin Center for Demand Side Research
WP&L	Wisconsin Power and Light
WWTP	waste water treatment plant

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